Product-Service System Design for Sustainability

Carlo Vezzoli, **Cindy Kohtala** and **Amrit Srinivasan**

with **JC Diehl, Sompit Moi Fusakul, Liu Xin** and **Deepta Sateesh**

Learning Network on Sustainability

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1 Politecnico di Milano, Design Department, School of Design, Italy.
2 Aalto University School of Arts, Design and Architecture, Department of Design, Finland.
3 Indian Institute of Technology Delhi, India.
4 King Mongkut's Institute of Technology Ladkrabang, Faculty of Architecture, Department of Design, Thailand.
5 Delft University of Technology, Faculty of Industrial Design Engineering, the Netherlands.
6 Tsinghua University, Academy of Arts & Design, China.
7 Srishti School of Art, Design and Technology, India.
8 Brunel University, School of Engineering and Design, Department of Design, UK.

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Contents

Foreword xvii

Introduction: sustainability in design 1

Design and sustainability: an increasing role 1

The structure of this book 7

PART I: PRODUCT-SERVICE SYSTEM DESIGN FOR SUSTAINABILITY: CONSOLIDATED KNOWLEDGE AND KNOW-HOW 9

1. Sustainable development and system discontinuity 10

1.1 Sustainable development 10

1.2 The sustainability dimensions 13

1.3 Sustainability: demand for radical change 19

1.4 Sustainability within a context in strong evolution 22

1.5 The diverse paths towards sustainability 23

2. PSS innovation and sustainability 29

2.1 Product-Service System eco-efficiency 29

2.2 Product-Service Systems for emerging and low-income contexts 43

3. Product-Service System design for sustainability 49

3.1 PSS design for sustainability: a definition 49

3.2 PSS design for sustainability: approaches and skills 50

3.3 Design criteria for and examples of system eco-efficiency 54

3.4 Design criteria for and examples of social equity and cohesion 67

3.5 PSS design for sustainability in Asia 76

4. Methods and tools for system design for sustainability 87

4.1 Criteria, methods and tools 87

4.2 MSDS: a modular method for system design for sustainability 90

4.3 Design tools for SDS 109

Bibliography 179

Appendices 188

PART II: THE NEW DESIGN FRONTIERS OF PRODUCT-SERVICE SYSTEM DESIGN FOR SUSTAINABILITY 197

Section 1: New Ways to Deliver Satisfaction and Manage the Transition 199

1. An aesthetic for sustainable interactions in Product-Service Systems? 200

1.1 The limited diffusion of eco-efficient Product-Service Systems 200

1.2 Eco-efficient Product-Service System (PSS): user acceptance barriers 201

1.3 A potential role for aesthetics? 203

1.4 Semiotics, aesthetics and eco-efficient PSS 208

1.5 Conclusions and future research directions 215

References 216

2. Sustainable consumer satisfaction in the context of clothing 218

2.1 Introduction 218

2.2 Consumer-based eco-efficiency 220

2.3 Consumer satisfaction 221

2.4 Satisfaction through design strategies and PSS 226

2.5 Discussion 233

2.6 Conclusions 234

References 235

3. Developing new products and services in entrepreneurial contexts 238

3.1 Introduction 238

3.2 Models of product innovation and PSS innovation 239

3.3 An emerging theory of entrepreneurship: effectuation 242

3.4 PSS innovation process in effectuation 244

3.5 SDC case 245

3.6 Conclusions 248

References 249

4. The societal embedding of sustainable Product-Service Systems: looking for synergies between strategic design and transition studies 250

4.1 The problem of implementing and diffusing eco-efficient PSSs 250

4.2 Insights from transition studies 252

4.3 A conceptual framework for the implementation and diffusion of eco-efficient PSSs 256

4.4 Implications for design: a new role for strategic design for sustainability 262

4.5 Towards a new way of designing and implementing eco-efficient PSSs 269

4.6 Conclusions 272

References 273

5. Our common nature: insights from the 'moral faculty' and its potential role in system design for socially and environmentally sustainable outcomes 277

5.1 Our common nature/future 277

5.2 Fragments from the history of morality 279

5.3 Human morality and economic theory 281

5.4 Advances in the understanding of the 'moral faculty' 283

5.5 Some case studies 285

5.6 Insights from the 'moral faculty' and a potential role in system design for sustainability 289

5.7 Conclusions 291

References 291

Section 2: New Perspectives on Sustainable PSS in Low-Income and Emerging Contexts 295

6. PSS in waste: lessons from the Indian informal economy 296

6.1 Introduction 296

6.2 The waste pyramid 298

6.3 Social equity in PSS design for waste 300

6.4 PSS and the privatisation issue 301

6.5 PSS and the political economy of waste recycling and re-use 302

6.6 PSS promotion and cultural perceptions of waste 303

6.7 Conclusions 306

References 306

7. Sustainable Product-Service Systems in the informal economy of poor urban contexts: India and the case of press workers in clothes care system in Delhi 308

7.1 Urbanisation and rising poverty in India 308

7.2 Profiling the press workers of Delhi 311

7.3 Sustainability of this unique Product-Service System 317

7.4 Conclusions and future PSS intervention 319

References 320

8. Sustainability at work, sustainability at play: the consequences of an urban horticulture project involving underprivileged children in India 321

8.1 Introduction 321

8.2 Understanding human needs through the capabilities approach 323

8.3 City Spinning 324

8.4 Social and ecological consequences of the project 326

8.5 Focusing on human needs and capabilities in design 329

8.6 Conclusion: lessons for PSS design 330

References 332

Section 3: New Ways to Leverage Social Innovation for Sustainability 335

9. Design for Chinese social innovation: pilot PSS design experiences for sustainable lifestyles 336

9.1 Chinese social innovations for a sustainable and harmonious society 336

9.2 Design exercises on grassroots social innovation 337

9.3 Design scenarios of Chinese sustainable lifestyles 340

9.4 Conclusions 343

References 344

10. Design and social innovation: design practice and methods based on networks and communities 345

10.1 Introduction 345

10.2 Design objectives and methods 346

10.3 Case study: Social innovation practice in a traditional community 350

10.4 Conclusions 359

References 360

11. Catalysing social resources for sustainable changes: social innovation and community-centred design 362

11.1 Social innovation 362

11.2 Community-centred design 369

11.3 An open, distributed design agency 376

References 378

Section 4: New Ways to Design for Moderation 381

12. A brief introduction to the Sufficiency Economy Philosophy 382

12.1 The origins of the Sufficiency Economy Philosophy 382

12.2 The essence of the SEP 383

12.3 Implementing the Sufficiency Economy Philosophy 386

12.4 Sufficiency Economy for all 389

References 390

13. The principle of self-reliance in design for a sufficiency economy 391

13.1 The need for self-reliance 391

13.2 Applications of self-reliance 393

13.3 Conclusions 397

References 397

14. MATTEROLOGY: a Chinese method for sustainable design thinking 399

14.1 Introduction 399

14.2 The significance of industrial design in contemporary society 400

14.3 Shift from designing ‘objects’ to designing ‘matters’ 402

14.4 Design MATTEROLOGY in a knowledge economy 404

14.5 Conclusions 409

References 410

15. Modern Product-Service System design and the concept of an ecological civilisation: a traditional Chinese view 411

15.1 Design culture as a worldview 411

15.2 Acceptance of the essence and rejection of dross in traditional culture 413

15.3 Connotations of the concept that 'man is an integral part of nature' 415

15.4 A branch of knowledge dealing with environmental selection: the theory of fengshui 416

15.5 The science of fengshui and modern Product-Service System Design for Sustainability 417

References 419

Section 5: New Ways to Educate 421

16. New ways of educating: articulating experience 422

16.1 Introduction 422

16.2 Epistemological beliefs of Indian undergraduate art and design students 424

16.3 The role of experience 426

16.4 First pedagogical endeavour: Fear and Gender in Public Spaces 428

16.5 Second pedagogical endeavour: Public Space and Pedagogy 430

16.6 Third pedagogical endeavour: Aesthetics of Protest 432

16.7 Fourth pedagogical endeavour: Aesthetics of Experience 434

16.8 Conclusions 436

References 439

17. Creative sustainability: the role of (design) education 441

17.1 Creative sustainability 441

17.2 A new role for academia 442

17.3 Design and art for a sustainable society 443

17.4 A transdisciplinary approach to (design) education 445

17.5 Afterword: experiences 447

References 448

18. Transdisciplinary platforms: teaching sustainability to design students..... 450

18.1 Introduction..... 450

18.2 Transdisciplinarity: what and why..... 451

18.3 Transdisciplinarity: who and how 453

18.4 Design at the boundaries..... 458

18.5 Transdisciplinarity in education 462

References 468

19. Learning the unlearned: product design for sustainability 471

19.1 The three transitions 471

19.2 The rise of DfS and its learning in China 472

19.3 The myth of 'T-shaped' design training 475

19.4 The risks of blurring the 'old' discipline for DfS..... 476

19.5 Learning the unlearned 478

19.6 Sample cases of PDfS practice 482

19.7 Conclusions 487

References 487

20. Bringing streamlined LCA into the sustainable PSS design process..... 489

20.1 Introduction..... 489

20.2 Life Cycle Assessment and PSS design..... 490

20.3 Understanding the system in PSS 492

20.4 Life cycles in the LeNS Student Design Competition 494

20.5 Implications for PSS methodology..... 496

20.6 Conclusions 501

References 501

Foreword

Arturo Dell'Acqua Bellavitis
Dean of the School of Design, Politecnico di Milano, Italy

Silvia Piardi
Head of the Design Department, Politecnico di Milano, Italy

During the last few decades, the history of design culture and practice, when dealing with the issue of sustainability, has moved from individual products to systems of consumption and production, and from strictly environmental problems to the complex blend of socio-ethical, environmental and economic issues.

In fact, design can take a proactive role and become a part of the solution, i.e. an agent for sustainability. It can do so because within its genetic code there is the idea that its role is to improve the quality of the world: an ethical-cultural component that, though not generally apparent, can be found in a deeper examination of the majority of designers' motivations.

At the same time, design can actually become an effective agent for sustainability because it is the social actor that above all others, by its very nature, has to deal with the everyday relationships of human beings with their artefacts and with the expectations of well-being that are built on them. That is, design has to deal with the core of the problem: the change towards sustainable ways of being.

A long journey is ahead of us. And from this perspective I believe this book will contribute to a larger change in the design community requested to meet this challenge.

Helena Hyvönen
Dean, School of Arts, Design and Architecture, Aalto University, Helsinki, Finland

with Cindy Kohtala
LeNS project team, Department of Design

and Tiina Laurila
Programme Director of Creative Sustainability Master's Programme

John Thackara once suggested that we are all emerging economies—rich countries, poor countries, in-between regions—that nowadays the very notions of 'progress' and 'development' too often clash with existing cultural practices and social capital. This is a useful, even necessary, perspective to adopt, as the global pace of change and scale of uncertainty continues to accelerate. No country or region can be assured of future status, job security, resource security, even food security; the globalised web that we have spun for ourselves entangles us into demand for mutual responsibility.

Our country of Finland, for instance, pulled herself up from the horrors of war and a struggling agrarian existence to become a highly educated nation whose 'design drivers' have been equality, cooperation, and a deep respect for nature. Even so, we face the same challenges as other countries in the North: job flight and adaptation to rapid global economic changes, a growing gap between rich and poor, and significant demographic shifts. If we are emerging into a post-industrial context, how do we define 'progress'? Or success? Or rather—how should we? And most importantly, who is it that decides on the definition we use?

These complex global and local challenges raise the role of higher education and research as an essential element of sustainable development in society, requiring the inter-linkage of environmental, economic, socio-cultural aspects also in education.

At Aalto University one concrete answer to this challenge was launching the international Master's Degree Programme in Creative Sustainability (CS) in autumn 2010, an interdisciplinary teaching platform in the fields of architecture, urban planning, landscape planning, real estate, business and design. The CS programme brings together students to study in multidisciplinary teams in order to enhance understanding of different disciplines and activate them to create new sustainable solutions for community, urban, industrial and business environments. In the near future, more organisations will take a strategic position on transformation towards sustainability; therefore an increasing number of professionals who are capable of a holistic approach to sustainability will be needed to work as multidisciplinary experts in these organisations. Among the competences required in future jobs, design thinking—those creative problem-solving capabilities that utilise design process methods to define the problem, generate ideas and implement solutions—is key.

For these reasons, we feel the publication of this book could not be more timely, as students, teachers and researchers in design schools must not only speak their own disciplinary language fluently, but must also be able to communicate with

other disciplines and experts in the design of sustainable systems. If we are all emerging economies, we recognise that we have lessons to learn and success stories to share. We all need to identify and dismantle the models that are unsustainable and rebuild them, while strengthening the models that are promising in their compliance with sustainability principles. This is a process that will redefine what we mean by 'development' for humanity on earth.

S.N. Singh
Dean, Industrial Research & Development (IRD), Indian Institute of Technology Delhi, India

It gives me great pleasure to contribute to the Foreword of *Product-Service System Design for Sustainability*, the innovative new textbook brought out by the recently concluded LeNS Project of the European Commission's Asia-Link Programme. LeNS was one of the few chosen projects awarded to the Indian Institute of Technology, Delhi by the EC. As Dean of IRD, The Industrial Research and Development Unit of the IIT Delhi which has looked after the project right from its inception in December 2007 I congratulate Professor Carlo Vezzoli, Politecnico di Milano, Italy (Co-coordinator) and Professor Amrit Srinivasan (Principal Investigator, IIT Delhi) for their futuristic vision in bringing out this much needed publication on sustainability in design pedagogy and research. The book very effectively reflects the spirit of academic exchange that took place during the tenure of the project among the partner institutions and countries of LeNS—Italy, the Netherlands, Finland, India, China and Thailand. Also, by making this textbook available as a free and downloadable version along with the printed text it is a mission well accomplished by LeNS.

I congratulate the editors and contributors for the path breaking progress they have made in the discipline of design education and in helping us achieve a sustainable society.

Zheng Shuyang
Dean of Academy of Arts & Design, Tsinghua University, Beijing, China

Humankind's continuation and the progress of civilisation are influenced by the development of design.

Design for Sustainability in essence is a macro strategic concept. The balance between 'environment and development' is not only the core of any national strategy on sustainable development, but also a basic sign of the balance between 'human and nature'. Therefore, Design for Sustainability becomes a key element in maintaining the balance.

The optimum state to reflect the ideal living environment of human beings includes a virtuous cycle of the ecosystem, civilisation and progress of the social

system, appropriate allocation of natural resources, and scientific construction of living space. The implementation system of the overall sustainable development strategy is then Design for Sustainability.

In the context of the global village, it is impossible to realise the dream of sustainability in ecological civilisation by only relying on one city, one region, or even one country. The hope lies in worldwide cooperation and international comprehensive coordination, which forms the global concept of Design for Sustainability.

Rapid economic growth, the huge and expanding population, massive consumption of natural resources, and unbalanced regional development put great pressure on the environment and the development of China in the 21st century. In parallel, these factors will also have a negative impact on the world. China is in the dilemma of neither following the 'pollution first, treatment later' way of the developed nations, nor avoiding placing priority on 'development'.

Confronted with the global challenges and opportunities brought by sustainable development, as professional designers and design educators of China, we are shouldering even greater responsibilities. How to solve the contradictions between 'environment and development' and how to find a proper balance point between the two will be an enormous undertaking for the future. Therefore, SPSS design has an important role in answering this challenge.

Sompit Moi Fusakul

Course Director, Master of Architecture Program in Industrial Design, Faculty of Architecture, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand

At the beginning of the LeNS project, we found the term 'Product-Service System' to be challenging, yet we are confident that our painstaking efforts will have worthy results: helping us find a better way to educate young designers suitable for this increasingly deteriorating world. The LeNS project offered the opportunity to delve into the essence of PSS and DfS in addition to the chance to share knowledge with all of our inspiring and supportive partners.

Complementary to the PSS approach, we have another main agenda: to explore how design could contribute to a 'Sufficiency Economy'—a unique philosophy bestowed by our beloved HM King Bhumibol Adulyadej. In exploring the connections between PSS and Sufficiency Economy approaches, we identified similarities and differences, and as we progressed, we realised that PSS is naturally embedded in Thai culture even though the term 'Product-Service System' is not common as such.

The progress of other researchers and thinkers on Sustainability paved the way to our interpretation of 'Design for Sufficiency Economy (DSEP)'. Within this book, readers will find not only practical information that help design educators develop a course on PSS, but also a brief report on how DSEP could help to achieve a more balanced lifestyle toward self-reliance; promote humanity's harmonious relationship with nature and society; and to modernise in line with the forces of

globalisation while preserving human dignity and cultural values. This exploration can be seen as a 'work in progress' since DSEP is still in its beginning phases. We are still exploring, with much to argue and conclude. Even after the LeNS project, research on DSEP must be continued because the world could better proceed towards sustainability by having sufficiency as a critical step.

If one observes people on a hot, sunny beach, most seek shelter under umbrellas. However, it is not the umbrella but rather its shadow that people seek. For us, the Sufficiency Economy and Sustainability create similar 'shadows'. Although both differ in their nature, they do have one similar function—to create a silhouette that would shelter people to live on with a more comfortable life. The expansion of these umbrellas should be encouraged, and by doing so the whole world will soon become a cooler place to live.

Han Brezet

Research Director of the Faculty of Industrial Design Engineering, Head of the Design for Sustainability Research Program, Delft University of Technology, the Netherlands

Over time design has taken a more and more progressive role in teaching sustainability issues as well as solving these challenges in practice. Starting from Eco-design in the 1990s with a focus on redesign of existing products from an environmental point of view, the design world went to a next stage by including social aspects resulting in Design for Sustainability approaches. Subsequently, these design approaches towards sustainability went beyond products and led to more radical approaches such as Sustainable Product-Services and Sustainable System Innovation.

Even though more profound approaches towards sustainability were developed, its origin and focus was still somehow narrow: to a large extent these approaches were developed in a Western context. From this perspective, the LeNS initiative is unique by bringing together academics, educators and students from Asia and Europe to explore, discuss and develop teaching materials for Design for Sustainability and Sustainable Product-Service Systems. Consequently it has resulted in a distinctive knowledge base in this field. In addition the LeNS project distinguishes itself from many other projects by sharing the jointly developed materials for free on the internet, and as such providing educators and students worldwide with knowledge, approaches and examples to make a leapfrog start in developing their own courses or projects. We think that young designers, characterised by their open minds, critical and reflective thinking, as well as their multidisciplinary skills can be key to change towards a sustainability society.

This book provides a jumpstart by presenting a comprehensive overview of the state of the art on design and sustainability, from Asia to Europe, from Eco-design to Sustainable System Innovation, from academic and educational approaches to cases in the field.

We hope it will inspire you!

Geetha Narayanan
Founder-Director, Srishti School of Art, Design & Technology, Bangalore, India

It is with a sense of deep concern and the courage to hope against hope that I write this Foreword to the LeNS publication *Product-Service System Design for Sustainability*, a compilation that comes as the culmination of three years of collaborative teaching and exchanges between cutting-edge design colleges and a successful international conference in Bangalore hosted by the Srishti School of Art Design & Technology in late September 2010.

Concern, because Mother Nature is urgently questioning Humanity, by means of unexpected 'disasters' on a scale as yet not encountered, about our present trajectory propelled almost helplessly by ingrained traditions, political and economic ideologies and gigantic infrastructures making use of state-of-the-art concepts in engineering and design that are perhaps no longer relevant.

Courage, because it takes faith and hope in the face of our rising anxieties to challenge and equip designers, engineers, social scientists, educationists and, most importantly, the younger generation to approach the needs of our times and the future with both intelligence and spirit to form a new philosophy of non-discriminatory resilience. The LeNS project and conference, and this end-record of an emergent multi-disciplinary thinking that prioritises the sustainability of the human race, its artefacts and aspirations, yield a valuable contribution.

It is clear that the processes and practices of product-service system design must question the very roots of its 'evolution' (if it can be called that) till now primarily dependent on exclusive Western paradigms. Radical shifts must be based on inclusive global paradigms so that future innovation allows for the understanding, conceptualisation, design and implementation of a sustainability that benefits the planet and its inhabitants as a 'whole' and not as 'fragments'.

We must understand now that Nature does not spare rich or poor but has a stern warning for Humanity to pursue processes of 'enactive design' that are collaborative and comprehensive, enabling development which meets the needs of human beings across the globe in ways that are compassionate, just and equitable.

This book offers some gleanings towards such an end.

Introduction: sustainability in design

Design and sustainability: an increasing role

Historically, the reaction of humankind to environmental degradation, especially since the second half of the last century, has moved from an end-of-pipe approach to actions increasingly aimed at prevention. Essentially this has meant that actions and research focused exclusively on the de-pollution of systems have shifted towards research and innovation efforts aimed to reduce the cause of pollution at source.

In other words, the changes have been from:

- Intervention after process-caused damages (e.g. clean up a polluted lake), to
- Intervention in processes (e.g. use clean technologies to avoid polluting the lake), to
- Intervention in products and services (e.g. design product and services that do not necessitate processes that could pollute a lake), to
- Intervention in consumption patterns (e.g. understand which consumption patterns do not (or less) require products with processes that could pollute that lake)

Due to the characteristics of this progress, it is evident that the role of design in this context has expanded over time. This increasing role is due to the fact that:

- The emphasis shifts from end-of-pipe controls and remedial actions to prevention
- The emphasis expands from isolated parts of the product life cycle (i.e. only production) to a holistic life cycle perspective

- The emphasis passes further into the socio-cultural dimension, into territory where the designer becomes a 'hinge' or link between the world of production and that of the user and the social/societal surroundings in which these processes take place
- The emphasis widens towards enabling users' alternative and more sustainable lifestyles

Within this framework the discipline of **Design for Sustainability** has emerged, which in its broadest and most inclusive meaning could be defined as: 'a design practice, education and research that, in one way or another, contributes to sustainable development'.[1]

Design for Sustainability has enlarged its scope and field of action over time, as observed by various authors (Karlsson and Luttrop 2006; Rocchi 2005; Vezzoli and Manzini 2008a; Ryan 2004; Charter and Tischner 2001). The focus has expanded from the *selection of resources with low environmental impact* to the *Life Cycle Design* or *Eco-design* of products, to *designing for eco-efficient Product-Service Systems* and to *designing for social equity and cohesion*.

All this should be understood as a process widening the boundaries of the *object* of design. In fact, this interpretation of Design for Sustainability (and its four approaches: 1. selection of resources with low environmental impact; 2. design of products with low environmental impact; 3. Product-Service System Design for eco-efficiency; 4. design for social equity and cohesion) does not necessarily represent a chronological evolution, nor does it define precise boundaries between one approach and another, as its status varies in various contexts. Nevertheless it may be useful for a schematic understanding of the increased and increasing contribution of design to sustainability, as will be illustrated in the following sections.

Selection of resources with low environmental impact

One basic level on which numerous theorists and academics have been working is the selection of material and energy resources with low environmental impact.

Here the first issue has been the identification and selection treatment of **toxic and harmful materials**. In addition to a traditional competence in actual design, this demands from the designer an extended knowledge about correlated norms and actual adoption of the rather general *precautionary principle*.

Another closely related topic that has an influence on other environmental problems is waste management, especially **recycling** and re-using materials and **incineration** in order to recover contained energy. Over time it has been understood that handling design-for-recycling-and-re-use demands a transition from estimating

1 Some authors adopt a more stringent definition of Design for Sustainability: e.g. Tischner (2010) argues that Design for Sustainability requires generating solutions that are equally beneficial to the society and communities around us (especially unprivileged and disadvantaged populations), to the natural environment, and to economic systems (globally but especially locally).

the recyclability of materials to the economic and technological feasibility of the whole all-encompassing process. Thus design for recycling and re-use and its indicators must cover every single stage: collection, transportation, disassembly and eventually cleaning, identification and production of secondary raw materials and identifying opportunities for re-application.

One ongoing debate is on the subject of **biodegradability**: an environmental quality that has raised many misinterpretations. It is important for materials to be re-integrable with ecosystems. Nevertheless for many products biodegradable materials may pose a problem in the sense of a premature expiration date; this in turn creates new production and distribution processes for both substituting and discarding reasons.

Last, but not least, is the subject of **renewable resources** (either energy or material ones) and research and development on various alternative sources such as solar, wind, water, hydrogen and biomass power and their integration into (power-consuming) product systems. This topic has also taken some time to be understood properly, when renewability was associated with both the speed of recovery of the resource and with the frequency of utilisation. More precisely, it is crucial to understand that a resource is renewable only when it is replenished by natural processes at a rate comparable to its rate of consumption by humans.

Product Life Cycle Design or Eco-design

Since the 1990s, attention has partially moved to the product level, i.e. to the design of products with low environmental impact, usually referred as *product Life Cycle Design*, *Eco-design* or *Design for the Environment* (Keoleian and Menerey 1993; Brezet and Hemel 1997; Manzini and Vezzoli 1998; Tischner *et al.* 2000; Hemel 2001; Heiskanen 2002; Ryan 2003; Sun *et al.* 2003; ISO 14062 2002; Nes and Cramer 2006). In those years, the environmental effects attributable to the production, use and disposal of a product and how to assess them became clearer. New methods of assessing the environmental impact of products (the input and output between the techno-sphere, the geo-sphere and the biosphere) were developed; from among them the most accepted is Life Cycle Assessment (LCA). In particular two main approaches were introduced.

First, the concept of *life cycle approach*—from designing a product to designing the product life cycle stages, i.e. all the activities needed to produce the materials and then the product, to distribute it, to use it and finally to dispose of it—are considered in a holistic approach.

Second, the *functional approach* was reconceptualised from an environmental point of view, i.e. to design and evaluate a product's environmental sustainability, beginning from its function rather than from the physical embodiment of the product itself. It has been understood that environmental assessment, and therefore also design, must have as its reference the function provided by a given product. The design must thus consider the product less than the 'service/result' procured by the product.

Design for eco-efficient Product-Service Systems

From the end of the 1990s, starting with a more stringent interpretation of sustainability that called for more radical changes in production and consumption models, attention has partially moved to *design for eco-efficient Product-Service Systems*, a wider dimension than that of the single product (Stahel 1997; Hockerts 1998; Goedkoop *et al.* 1999; Lindhqvist 2000; Cooper and Sian 2000; Brezet *et al.* 2001; Charter and Tischner 2001; Manzini and Vezzoli 2001; Bijma *et al.* 2001; Zaring 2001; Mont 2002; UNEP 2002; Scholl 2006). From among several converging definitions, the one given by the United Nations Environment Programme (UNEP 2002) states that a Product-Service System (PSS) is 'the result of an innovative strategy that shifts the centre of business from the design and sale of (physical) products alone, to the offer of product and service systems that are together able to satisfy a particular demand'.

In this context, it has therefore been argued (Vezzoli 2003a) that the design conceptualisation process needs to expand from a purely *functional approach* to a *satisfaction approach*, in order to emphasise and to be more coherent with the enlargement of the design scope from a single product to a wider system fulfilling a given demand related to needs and desires, i.e. satisfaction.

This approach is the epistemic core of this book and is extensively elaborated upon in the following chapters.

Design for social equity and cohesion

Finally, design research has opened discussion on the possible role of *design for social equity and cohesion* (Margolin 2002; Razeto 2002; Mance 2001; Manzini and Jégou 2003; Crul 2003; Guadagnucci and Gavelli 2004; Rocchi 2005; Penin 2006; Tischner and Verkuijl 2006; Vezzoli 2003a; Leong 2006; Maase and Dorst 2006; EMUDE 2006; Carniatto *et al.* 2006; Carniatto and Chiara 2006; Weidema 2005; Crul and Diehl 2006; dos Santos 2008). This potential role for design directly addresses various aspects of a 'just society with respect for fundamental rights and cultural diversity that creates equal opportunities and combats discrimination in all its forms' (EU 2006). Moreover, several writers and researchers urge a movement (and a key role for design) towards harmonising society such that it is not only just and fair, but that people are encouraged to be empathic, kind and compassionate for the benefit of others (Fusakul and Siridej 2010; Rifkin 2010).

We can indeed observe new, although sporadic, interest on the part of design research to move into this territory, to trace its boundaries and understand the possible implications. This is an extremely vast and complex issue, and its implications for design have thus far been little analysed. They are also problematic to face without falling into easy, hardly constructive moralism.

Some authors (Crul and Diehl 2006; dos Santos *et al.* 2009; Kandachar 2010) argue that in low-income contexts, more immediate technical support is needed to introduce design for product sustainability; i.e. a Design for the Base of the

Pyramid (BoP) approach is proposed. Regarding social impact, other authors (Weidema 2005) are investigating the option of extending product Life Cycle Assessment beyond environmental impact to social impact, which is in principle more closely linked to the product innovation level.

Other authors (Soumitri and Vezzoli 2002; Kandachar 2010) have argued that a promising approach would be that of Product-Service System design for social equity and cohesion, or more generally, system design for sustainability. Furthermore, some authors (Fusakul and Siridej 2010)[2] propose the integration of a Sufficiency Economy Philosophy in the design of the system of products/services that support livelihoods or business at technological, socio-cultural, organisational and infrastructural levels.

This issue of Product-Service System design for social equity and cohesion is extensively explored and discussed in the following chapters.

If we then examine the theoretical contributions made by design culture in the field of consumption, not all of them are necessarily recent.[3] We can recall Tomas Maldonado who appealed for a new 'design hope' (Maldonado 1970), bringing up the question of the social responsibility of designers at the beginning of the 1970s. Victor Papanek expressed a similar position, regarding the role of consumption: 'design can and must become a means for young people to take part in the transformation of society' (Papanek 1971). These contributions were disseminated before the concept of sustainable development was even introduced at the end of the 1980s.

Design for sustainability: the current status

To gauge the current status of Design for Sustainability as a whole, we may consider the four dimensions described above according to two dimensions: the level of disciplinary consolidation (derived from the results of design research) and, second, their level and dissemination in design education and practice.[4] The new research frontiers represent no or very low consolidation and dissemination, while we wish to steer the various dimensions of the discipline towards a high degree of consolidation and widespread dissemination in design education and practice.

In industrialised contexts, represented especially by European countries, the choice of low impact material/energy and the Life Cycle Design (LCD) or eco-design

2 See Part 2, Section 4.

3 Already at the end of the 1960s, for various reasons, the theory and culture of design in Italy anticipated a critique of consumption patterns, or at least some of the leading figures in the realm of design culture acted as spokespersons for issues relating to the responsibility of designers for consumption patterns, although in different ways and not directly and exclusively associated with environmental impact.

4 Note that the UN has declared the United Nations Decade of Education for Sustainable Development (2005–2014) with the scope of integrating the principles, values, and practices of sustainable development into every aspect of education and learning. This means that it should be an obligation for every design university to establish courses on Design for Sustainability.

of products are positioned at a good level of consolidation (Vezzoli and Manzini 2008a), with a modest level of penetration in design education and practice. For eco-efficient PSS design, the level of consolidation is inferior and education and practice is, logically, far more sporadic.

Very few design researchers are working on the design for social equity and cohesion front. It is in fact a new research frontier, meaning that little has been shared in the design community on a theoretical level and few methods and tools have been developed for the operative level.[5] In parallel there are very few curricular courses.

If we look at emerging countries and contexts, the landscape of Design for Sustainability research and education is more varied. Aguinaldo dos Santos (dos Santos 2008) has argued that in Brazil, for example, the socio-ethical dimension of sustainability has garnered attention earlier than product design for environmental sustainability. In Thailand, on the other hand, LCD/Eco-design teaching has a longer official history in the curriculum, but new courses have been implemented in higher learning institutes using methods and tools such as Design for a Sufficiency Economy and Design for Social Enterprise. These address prominent new social movements and discourse in Thailand regarding both social equity and social cohesion and the philosophy of a Sufficiency Economy. Design research in sustainability has thus been enhanced and expanded in a unique way, emphasising the design of appropriate ways of life that foster public consciousness or allow opportunities for users to do good through their consumption choices or activities.

Some authors have argued that the differences between Design for Sustainability research in industrialised contexts compared to emerging and low-income contexts is largely due to differences in local industry need and innovation climates. Especially in the least industrialised regions, whose economy and labour market are dominated by micro Small and Medium sized Enterprises (MSMEs), companies' product development processes are generally unstructured and based on practical experience as well as benchmarking what is already familiar. Staff tend to be less educated and operating sectors tend to be low-tech, such as food processing or metal processing. The drivers for Design for Sustainability practice and research therefore differ when comparing industrialised and low-income or emerging contexts. External drivers such as legislation and consumer and supplier demand that play the key role in the European context, for instance, are not present to the same extent in emerging contexts. The main driving forces for Design for Sustainability in less industrialised economies are seen more in internal drivers such as cost efficiency, competitiveness and new markets (Crul and Diehl 2008, 2006).

In this volume we will focus our attention on Product-Service System design for environmental, socio-ethical and economic sustainability, for industrialised, emerging and low-income contexts, with the aim of contributing to the diffusion of such an approach to design.

5 Cf. Part 1, Chapter 4.

The structure of this book

The scope of this book is to introduce and describe the theory and the practice of **Product-Service System Design for Sustainability**.

The book is divided into two parts:

Part 1 is a basic textbook on **Consolidated knowledge and know-how on Product-Service System Design for Sustainability**: designed primarily to meet the demands of a course taught at undergraduate level.

Part 2 is an advanced textbook on **The new design frontiers of Product-Service System Design for Sustainability**: designed primarily to meet the demands of a course taught at postgraduate (MSc, PhD etc.) level.

In particular **Part 1** of the book is organised as follows.

- The first chapter will describe the conceptual framework, the meaning and implications of sustainable development: namely, the need for system discontinuity
- The second chapter introduces the concept of PSS innovation and explains why it is a promising approach to sustainability: i.e. capable of potentially bringing radical reductions in resource consumption, leveraged by the economic interest of the provider/s and without minimising consumers' level of satisfaction. It explains its characteristics and features, how the different types of PSS can be classified, and the related benefits, drivers and barriers. Examples of sustainable PSS are described
- The third chapter will illustrate the role, approaches, skills and criteria involved in designing PSSs for Sustainability
- The fourth chapter will present a methodology and several related tools to design sustainable PSSs adopted and tested within the LeNS project

Part 2 of the book explores promising research directions and hypotheses on sustainable PSS design. It is composed of themed sections and their chapters on the promising research directions on sustainable PSS design:

- New ways to deliver satisfaction and manage the transition
- New perspectives on sustainable PSS in low-income and emerging contexts
- New ways to leverage social innovation for sustainability
- New ways to design for moderation
- New ways to educate

The reading of the book may be complemented by the use of educational learning resources (slideshows, video recorded lectures) and design tools available for free and in open source and copyleft format on the LeNS website (www.lens.polimi.it).

PART I

PRODUCT-SERVICE SYSTEM DESIGN FOR SUSTAINABILITY: CONSOLIDATED KNOWLEDGE AND KNOW-HOW

1

Sustainable development and system discontinuity

1.1 Sustainable development

During recent decades the concept of sustainable development has entered the scene of international politics. This term refers to systemic conditions where on a planetary and regional level both social and productive development takes place:

1. Within the limits of environmental resilience,[1] i.e. within its capacity to absorb the effects of human impact without causing any irreversible deterioration
2. Without compromising the ability of future generations to meet their own needs, i.e. maintain the means, or natural capital,[2] which will be passed on to future generations
3. On the grounds of equal redistribution of resources following the principle that everyone has the same rights to environmental space,[3] i.e. the same access to global natural resources

1 Resilience is the capacity of an ecosystem to overcome certain disturbances without losing irrevocably the conditions for its equilibrium. This concept, extended planet-wise, introduces the idea that the ecosphere used for human activities has limits on its resilience, that, when surpassed, give way to irreversible phenomena of deterioration.

2 Natural capital is the sum of non-renewable resources and the environmental capacity to reproduce the renewable ones. But it also refers to natural diversity, to the amount of living species on this planet.

3 Environmental space is the quantity of energy, territory and primary non-reproducible resources that can be exploited in a sustainable way. It indicates the amount of environment available for every person, nation or continent to live with, produce or consume without surpassing the environmental resilience level.

Let us see how this concept has emerged and spread over time.

The environmental issue, understood as the impact of the production-consumption system on ecological equilibrium, began to be raised in the second half of the 1960s, as a consequence of the accelerating and spreading industrialisation. The first scientific works handling these problems were published at the beginning of the 1970s. International studies and debates considered the deterioration and exhaustion of natural resources as an undesirable effect of industrial development. The natural limits of our planet became more apparent in the light of both uncontrollable technological and productive development as well as the increase of the world's population.

International debate about environmental issues intensified and spread further during the 1980s. The pressure from public opinion intensified, and institutions took their stand with a series of ecological norms and policies examining productive activities and based on the *Polluter Pays Principle*. The watchword of the United Nations Environment Programme, and other institutions, then became *cleaner production*, defined as 'the continual redesigning of industrial processes and products to prevent pollution and the generation of waste, and risk for mankind and the environment'.

In 1987 an important study was drafted by the *UN World Commission on Environment and Development* to provide indicators regarding the future of humanity. This report was called *Our Common Future* and was the first to define sustainable development as '*a development that meets the needs of the present without compromising the ability of future generations to meet their own needs*'.

During the 1990s environmental issues reached the phase of maturity. The *Caring for the Earth: A Strategy for Sustainable Livin*g publication for the World Conservation Union (IUCN) by the United Nations Environment Programme (UNEP) and World Wide Fund For Nature (WWF) had a competing definition of sustainable development: '*improving the quality of human life within the limits of capacity to protect the ecosystems*'. This accentuates the possibility to actually improve human life conditions while safeguarding the Earth's capacity to regenerate its resources.[4] These two definitions considered together thus describe sustainable development as a practice that delivers benefits to human beings and ecosystems at the same time.

Another historical event of those years was the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992. This and other initiatives have provided a persistent integration of the concept of sustainable development into the documents of all international organisations, as a model for reorientation of social and productive development. Since 1994 sustainable development and environmental sustainability have formed a fundamental benchmark in the *5th Environmental Action Programme* of the European Commission.

4 See www.gcmd.nasa.gov/records/GCMD_IUCN_CARING.html.

Onwards from the 2000s (following the Johannesburg Conference and ten years after Rio de Janeiro) the necessity of awareness and active engagement of all social participants involved in the production-consumption circuit is even more present and pronounced. Particularly significant was the setting up of UNEP's Sustainable Consumption Unit in May 2000 (see UNEP 2000). The initial assumption was that 'in spite of the progress made by the industrial world and enterprise during the last decade […] the extent to which consumption exceeds the Earth's capacity to supply resources and absorb waste and emissions is still dramatically evident' (Geyer-Allely 2002).

In June 2006 the European Council adopted an ambitious and comprehensive *Sustainable Development Strategy (SDS)* for an enlarged EU.[5] It builds on the Gothenburg strategy of 2001 and is the result of an extensive review process that began in 2004. The renewed EU SDS sets out a single, coherent strategy on how the EU will more effectively live up to its long-standing commitment to meet the challenges of sustainable development. It recognises the need to gradually change our current unsustainable consumption and production patterns and move towards a better integrated approach to policy-making. It reaffirms the need for global solidarity and recognises the importance of strengthening our work with partners outside the EU, including those rapidly developing countries that will have a significant impact on global sustainable development.

The European Council in December 2009 confirmed that 'sustainable development remains a fundamental objective of the European Union under the Lisbon Treaty'. As emphasised in the Presidency's 2009 review of the Union's Sustainable Development Strategy, the strategy will continue to provide a long-term vision and constitute the overarching policy framework for all Union policies and strategies. A number of unsustainable trends require urgent action (EU 2009).[6]

In parallel with this EU sustainable development strategy, Asian countries have equally been developing various locally relevant strategies to co-exist harmoniously with nature. Numerous royal projects in Thailand, for example, led by His Majesty King Bhumibol Adulyadej, emphasise the revitalisation of natural resources, conserving cultural heritage and prioritising human development and people's well-being according to the philosophy of a Sufficiency Economy. In May 2006, UN Secretary General Kofi Annan presented the first ever Human Development Lifetime Achievement Award to His Majesty the King in recognition of His Majesty's visionary thinking and sixty years of contributions to human development.

From a global perspective the UN approach has been to break down general policy frameworks into regional and country agendas. This has been the case with Agenda 21 (with the development of Local Agenda 21 in local levels of government) and it is the case for Sustainable Consumption and Production (SCP). The Marrakech Process, a joint initiative by UNEP and UN DESA (United Nations Department

5 EU, Renewed Sustainable development strategy, Council of the European Union. No. 10117/06, Brussels, 2006.

6 See www.ec.europa.eu/environment/eussd.

for Economic and Social Affairs), promotes and supports regional and national initiatives to promote the shift towards sustainable consumption and production (SCP) patterns. Among its actions is the organisation of National Roundtables and regional consultations in regions and countries, as well as the Task Forces, the main mechanism for implementing 'concrete projects and programmes at the regional, national and local levels to develop and/or improve SCP tools and methodologies'.

The result of the effort is a draft 10-year Framework of Programmes on SCP which will then be negotiated by countries at the 19th session of the UN Commission on Sustainable Development in 2011.

The UN's agenda is to recognise the diversity of countries and their economic and social systems, especially considering the disparity of environmental impact produced by industrialised, emerging and low-income countries/contexts and the pressing needs for social inclusion and its related basic needs. This has been an important parameter for sustainable development and the SCP approach throughout the UN's directives and policy orientation. The positive assertion is that the necessary shift towards sustainability is presented as an *opportunity* for emerging and low-income countries/contexts rather than yet another burden to be borne. For emerging economies, this entails leapfrogging to sustainable structures of consumption and production without repeating the mistakes of the West, and for low-income contexts, developing dedicated solutions as the basis for sustainable growth (Tukker, Stø and Vezzoli 2008a). While general guidelines are certainly important to help us understand our place in the big picture, it is when they reach the regional, national and local level and are incorporated and translated into local action that the real potentialities and difficulties can be measured.

At the educational level it is important to note that UNESCO has established a *Decade on Education for Sustainable Development* (UN DEDS 2005-2014).[7] The Decade aims to integrate the values inherent in sustainable development into all aspects of learning, to encourage changes in behaviour that will enable a more viable and fairer society for everyone. During this decade, education for sustainable development will contribute to citizens becoming better equipped to face the challenges of the present and the future and decision-makers acting more responsibly to create a viable world.

1.2 The sustainability dimensions

For a better understanding of sustainability and its implications, it is common to schematise it as three (interlinked) dimensions:

- The **environmental (Planet)** dimension: not to exceed the 'resilience' of the biosphere-geosphere, that is, its ability to absorb anthropic perturbations

7 See www.unesco.org/education/desd.

without provoking irreversible phenomena of degradation such as global warming, ozone layer depletion, acidification, eutrophication

- The **socio-ethical (People)** dimension: the ability of future generations to meet their own needs and the achievement of social equity and cohesion, where a key issue is equal redistribution of resources following the principle that everyone has the same access to global natural resources
- The **economic (Profit)** dimension: economically practicable solutions, in a more or less norm-oriented market

These dimensions have certain significant and characterising features that are described in the following paragraphs.

1.2.1 The environmental dimension (Planet)

In the 1960s, industrialised countries saw a strong acceleration in the development of consumption and production systems, but it was soon realised that this did not produce only advantages. In those years we can recall the pollution of the Great Lakes in North America; the winter smog in London at the end of the 1950s, which led to the death of thousands of people; and the ecological disasters caused by the washing of cargo tanks from oil tankers into the sea.

In 1972 the book *Limits to Growth* (Meadows *et al.* 2006) was published, the first computerised simulation of the effects of the ongoing system of production and consumption on nature; it was the first scientific forecast of a possible global ecosystem collapse. Hence these were the years of the discovery of environmental limits (and irreversible harmful effects). Still today we face such dangers. The smog from Suspended Particulate Matter (SPM) in cities affects thousands of victims each year; ozone layer depletion makes sunbathing increasingly dangerous; and global warming increases the violence of climatic phenomena, often with many victims.

If we examine the exact meaning of these environmental effects, we see that each environmental effect is based on an impact of exchanging substances between nature/the environment and the production and consumption system.[8]

These effects can occur in two directions:

- As *input*, namely extracting substances from the environment
- As *output*, namely emitting substances into the environment

Which effects, then, must be considered in relation to environmental requirements?

Regarding **input**—extracting resources—the first harmful effect is their exhaustion, the social and economic result of which is a lack of resources for future generations.

8 Obviously not all impacts are equally damaging, if they are damaging at all. The release of 1 kg of water into the environment differs greatly from releasing 1 kg of asbestos powder in high concentration.

Related to this is the issue of altering ecosystem balance. For example, deforestation due to the use of timber in construction (of various types of artefacts) or in heating systems has made the land more vulnerable to erosion over the course of time and caused the extinction of several species.

Finally, there are the harmful effects connected to extraction processes, e.g. oil leaks during extraction and transportation processes. These issues will be discussed further below together with outputs.

Regarding **output**—emitting resources—the main environmental impacts and the main environmental *effect*s of such *impacts* are listed in Table 1.1.

Table 1.1 **The main environmental impacts and their environmental effects**

Environmental impact	Environmental effects
global warming (greenhouse effect)	melting of polar ice-caps, rising seawater levels, inundated lowlands desertification migration of pathogens
ozone layer depletion	damage to flora and fauna elevated skin tumour risk immune system weakening
eutrophication	loss of aquatic fauna due to oxygen depletion contamination of groundwater and lakes, resulting in non-drinkable water obstacles to swimming
acidification	limited regrowth of forests limited regrowth of trees in urban zones corrosion of monuments and buildings contamination of groundwater loss of aquatic fauna sanitary risks (respiratory problems)
smog	some organic compounds (e.g. aldehydes) provoke lacrimation and irritate respiration some compounds (e.g. PAN) can have toxic effects on plants
toxic emissions	dioxin (TCDD) provokes chloracne and soft tissue cancer inhaling pyrene and benzopyrene is highly carcinogenic lead poisoning (saturnism) may cause irreversible neurological damage
waste	presence of waste: reduces availability of waste disposal sites pollutes soil and groundwater creates olfactory pollution and explosion hazard in landfills waste transportation implies: fuel consumption noise and air pollution
others	olfactory pollution acoustic pollution electromagnetic pollution deterioration of the landscape

Observing the relations between the anthropic world and nature altogether, we can distinguish two fundamental actions.

- Concerning the **input** from nature we must **preserve resources**, using fewer resources and preferably more renewable ones
- Concerning the **output** we must **prevent the pollution** (of resources), reducing emissions and increasing their biocompatibility

These actions can be further elaborated into three related scenarios.

First there is a **biocompatibility** scenario where the resource flows for the production of goods and services are compatible with the natural system: using renewable resources and disposing of biodegradable and biocompatible emissions and waste. In industrialised economies, this scenario has several limits that must be faced.

A second possible scenario is **non-interference** where resources are no longer drawn from nature but are rather recycled (if raw materials) or used in cascade (if energy resources).

This scenario also has its limits, at minimum, the laws of thermodynamics which always increase entropy during any process of transformation.

Finally we can imagine a third scenario of **dematerialising how we satisfy the demand for well-being (i.e. 'dematerialising demand for satisfaction')**, where resource flows would be quantitatively diminished in relation to a given social demand for needs and wants satisfaction.

It is therefore clear that the transition towards sustainable development will consist of a mix of these scenarios depending on the various conditions in different contexts.

1.2.2 The socio-ethical dimension (People)

Promoting socio-ethical sustainability means taking into account (according to the assumptions of the concept of sustainable development) the so-called *equity principle* (UN 1992), whereby every person, in a fair distribution of resources, has a right to the same *environmental space*, i.e. to the same availability of global natural resources or better, to the same level of satisfaction that can be had from these in different ways. When the issue of sustainable consumption crosses that of socio-ethical sustainability, the spectrum of implications, of responsibilities, extends to several different issues such as the principles and rules of democracy, human rights and freedom; the achievement of peace and security; the reduction of poverty and injustice; improved access to information, training and employment; and respect for cultural diversity, regional identity and natural biodiversity (UN 2002).

When talking about the socio-ethical dimension of sustainability a dominant issue is that of ***poverty eradication***.

In 2006 the World Bank and the United Nations Population Fund (UNFPA) reported the following dramatic poverty statistics:[9]

9 See www.heartsandminds.org/poverty/hungerfacts.htm

- 1.37 billion people live on less than 1.25 US dollars a day[10]
- 2.56 billion people (40% of the world population) live on less than 2 US dollars a day
- 1 billion children (1 in 2 children in the world) live in poverty
- 10 million children die every year before their fifth birthday
- 18 million people a year die (1/3 of all deaths) due to poverty
- 8 million people die from lack of food and nutrition
- 1.1 billion people have no access to safe water
- 2.6 billion people lack access to basic sanitation
- 800 million people go to bed hungry every day
- 640 million live without adequate shelter
- 270 million have no access to health services

In 1996 a summit organised by the UN's Food and Agriculture Organisation (FAO) was held in Rome, where 185 countries agreed and committed to cut the number of undernourished people by half. Four years later, on 8 September 2000, following a three-day Millennium Summit of world leaders at the UN headquarters, the General Assembly adopted the *Millennium Declaration*[11] signed by 191 member states. For example, the Declaration undertook to:

> eradicate poverty by 2015: a) reduce by half, from 1990 to 2015, the percentage of persons living in extreme poverty; b) grant a full and productive employment and a dignified job for all, including women and youngsters; c) reduce by half, from 1990 to 2015, the percentage of undernourished persons.

The *State of Food Insecurity in the World 2012* report by the FAO presents estimates of the number and proportion of undernourished people going back to 1990, defined in terms of the distribution of dietary energy supply.[12] With almost 870 million people chronically undernourished in 2010–12, the number of hungry people in the world remains unacceptably high. The vast majority live in low-income and emerging countries, where about 850 million people, or slightly fewer than 15 per cent of the population, are estimated to be undernourished. As shown in Figure 1.1 any notable progress was achieved before 2007–08. Since then, global progress in reducing hunger has slowed and levelled off.

10 The World Bank defines extreme poverty as living on less than US$1 (PPP) per day, and moderate poverty as less than $2 a day.
11 See the full document at www.undemocracy.com/A-RES-55-2.pdf
12 www.fao.org/docrep/016/i3027e/i3027e.pdf

Figure 1.1 **Undernourishment in low-income and emerging regions**

Source: Food and Agriculture Organization of the United Nations, 2012, FAO, WFP and IFAD, *The State of Food Insecurity in the World 2012. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition*, www.fao.org/docrep/016/i3027e/i3027e.pdf. Reproduced with permission.

After all this, it is worth noting that social equity is not only a matter of eradicating poverty, but more widely a matter of facilitating an improvement in quality of life, by the 'promotion of a democratic, socially inclusive, cohesive, healthy, safe and just society with respect for fundamental rights and cultural diversity that creates equal opportunities and combats discrimination in all its forms' (EU 2006).

1.2.3 The economic dimension (Profit)

Regarding economic sustainability, the principle is that an environmentally and socio-ethically sustainable model of production and consumption should also be economically feasible. Three main strategies could be drawn regarding this dimension: internalisation of costs, orientating the main ongoing transitions towards sustainable solutions, and enhancing promising niche market economic models.

We can observe that in industrialised contexts many natural resources have low costs which do not correspond to the cost of their actual use. Removing wood from tropical forests may lead to erosion, loss in biodiversity and other negative effects that are not taken into account in the purchasing price but are a cost for society. Using petrol carries with it consequent CO_2 emissions that contribute to global warming. Furthermore, indirect costs appear when resources are embedded in products, generating life cycle environmental and economic costs. The producer and the user of a car pay very little of the indirect costs of the car, such as health costs incurred by society when people contract lung illnesses due to polluted air.

The **internalisation of costs** would entail embedding in the cost of the resource all direct and indirect costs, in order to encourage the minimisation of environmental impacts. In other words we should move towards a proper attribution (or internalisation) of resource costs, which is mainly a political and legislative issue.

Another strategy is to **orientate the main ongoing transitions** towards sustainable solutions, i.e. transitions regarding interconnection, globalisation and localisation (referred together as *glocalisation*), information, services, etc. (A simple example to illustrate this would be exploiting the dematerialisation potential of new ICT and e-mail systems if compared to the traditional postal system.) In fact, re-orientating may produce much more effective results, than, say, attempting to go back in time and return to former production-consumption models.

Finally, and complementary to the above strategy, it could be very interesting to promote and **enhance promising economic models** even if they are currently with **niche market value**.

Some promising models fitting into the frame of environmental and socio-ethical sustainability have been studied, such as Distributed Economies (DE) and Product-Service Systems (PSS), the latter forming the core of this volume.

1.3 Sustainability: demand for radical change

1.3.1 The size of the change

During the second half of the 1990s a series of studies and analyses led to a clearer understanding of the dimension of change necessary to achieve a society that is effectively and globally sustainable. It was then realised that conditions for sustainability can only be achieved by drastically reducing the consumption of environmental resources compared to the average consumption by mature industrialised societies.

Several studies—taking into account demographic growth forecasts and hypothesising an increase in the demand for well-being in currently disadvantaged countries and contexts—have staggering findings: in 50 years, conditions for sustainability are achievable only by increasing the eco-efficiency of the production-consumption system by a factor of ten. In other words we can only consider sustainable those socio-technical systems whose use of environmental resources per unit of satisfaction/service rendered is at least 90% below what is currently to be seen in mature industrial societies.[13]

Most study authors agree that if in the 1970s the goal was to slow down before hitting the limits, the goal must now be to get back down below the limits without war and severe damage to the earth. For example, if the current trends of overfishing and pollution continue, all seafood faces collapse by 2048. By the middle of the 21st century 7 billion people in 60 countries may be faced with water scarcity. Scientists have shown that human beings and the natural world are on a collision course (e.g. Meadows *et al.* 2006) and global society will most likely adjust to limits by overshoot and collapse, not by asymptotic growth.

1.3.2 The quality of change

These estimates (while currently under scientific discussion) are valid enough to indicate the scale of the change that should take place. A profound, radical transformation in our development model is necessary, and the production and consumption system in this sustainable society will be profoundly different from what we have been taking for granted up to now. In other words the transition towards sustainability requires **radical changes** in the way we produce, consume and, more in general, in the way we live. The prospect of sustainability necessarily places the model of development under discussion.

Over the next few decades we must enable ourselves to move from a society where well-being and economic health are measured in terms of growth in production and material consumption, to a context where economic growth cannot be seen as the ultimate goal and where, as Sen upholds (Sen 1999), freedom is the initial means by which to achieve a development that must be orientated towards improving life: freedom as a guarantee that people are the protagonists of their own destiny and not the passive beneficiaries of a development programme.

How this may happen is at present difficult to foresee. It is, however, certain that there will have to be a *discontinuity* that will affect all facets of the system. In other words, given the nature and the dimension of this change, we have to see

13 On this issue see works by the Wuppertal Institut fur Klima, Umwelt, Energy; by the Advisory Council for Research on Nature and Environment (in particular: The Ecocapacity as a challenge to technological development, a study funded by a group of Dutch ministries); by the Working group on eco-efficiency sponsored by the World Business Council for Sustainable Development (see particularly the final report Eco-efficient Leadership [WBCSD 1996]).

transition towards sustainability (and, in particular, towards sustainable ways of living) as a wide-reaching social learning process in which a *system discontinuity* is needed. In fact, the debate on more sustainable consumption patterns has been included in the agenda of major international governmental institutions in recent years (the United Nations, for instance, set up the *Sustainable Consumption Unit* in May 2000).

This complex debate can be summarised in the following question: how can we foster new quality criteria so as to separate the social demand for well-being from a relationship that is directly proportional to the increase in consumption of resources, characteristic of mature industrialised societies?

1.3.3 System innovations for a sustainable development

Keeping in mind that there are great differences between contexts, it has been argued above that if we are to take the concept of a sustainable society seriously, we need a *wide-reaching social learning process* in which a *system discontinuity* is catalysed. Therefore, when taking this to the implementation level, a **systems innovation** approach has emerged with the aim of seriously tackling the transition towards sustainability.

System innovations tend to imply changes at the level of components, the level of the architecture of technologies (Henderson and Clark 1990), and equally at the level of social and institutional arrangements, such as mechanisms of coordination (regulation, governance) or patterns of interaction at the supplier and the user side of innovation. At a system innovation level not only products, services and production systems are optimised and new ways of satisfying consumption needs are found within existing institutional frameworks and infrastructures, but new infrastructures, spatial planning and incentive systems are developed and implemented that promote more sustainable lifestyles (Tukker and Tischner 2006).

System innovations refer to major shifts in dominant 'socio-technical regimes'[14] and the way in which societal functions are fulfilled. They are long-term and complex processes between the social, economic, technological and policy domains (Rip and Kemp 1998; Geels 2002, 2004).

Within the wide debate on how to approach and foster system innovation (see e.g. Andersen 2006), the offer model of Product-Service Systems (PSS) appears a promising one to decouple resource consumption from value creation. This type of innovation is described in the following chapter. Nevertheless before doing this it is important to situate it within the context in which we are living today.

14 The socio-technical regime can be defined as the dominant way of innovating, producing, distributing, consuming etc. It is made up of different socio-economic stakeholders, practices, shared rules and ways of doing related to a specific field (mobility, energy, etc.).

1.4 Sustainability within a context in strong evolution

Nowadays it is very clear that contemporary social reality is no longer conceivable in terms of isolated, rooted and independent worlds, nations or communities, since it is characterised by:

- The advent of information and communication technologies (technologies of knowledge that are at the base of productivity, competition and power)
- Interconnection (people, ideas, images, goods, and money that are circulating at an unprecedented scale)
- Networked societies (no longer divided into only independent and isolated nations or communities)
- Enterprises in networks (teamwork, networking, outsourcing, subcontracting, delocalisation, etc.)

In this age, individuals and ideas are more mobile than ever before in history: we live in a global context that is becoming more and more *interconnected* and *multicultural*. Individuals and groups seek to include the global in their (modern) activities, thus creating a new, modern subjectivity, as Appadurai claims, fundamentally characterised by the effect that the interconnected elements of mass electronic communications and mass migration have on the workings of our collective, social imagination (Appadurai 1996). It is an age in which the crisis of the nation state is evident, in which it cannot be taken for granted that effective public spheres are typically, exclusively or necessarily national; in which it seems hardly probable that nation states, in a complex interactive system, can in the long term govern relations between the global and the modern (Appadurai 1996). To use Bauman's evocative metaphor it is a *liquid modernity*, where more and more is transitory, modifiable and experimentable (Bauman 2000).

Although individuals continue to act in specific places, what has now become apparent is how various geographical areas are linked together in different ways by a continual circulation of objects, people and information. This has changed and will continue to change relationship patterns, concepts and our perceptions of near/far, pertinent/afferent, possible/impossible, belonging/extraneous, exclusive/inclusive, etc. We have thus entered a truly multicultural, interdependent world, which can be understood and changed only in a plural perspective that is able to converge cultural identity, global networking and multidimensional policy.

The new industrialised economy is organised, according to Castells (1996), on global networks of capital, management and information, whose access to technological knowhow lies at the root of productivity and competition. Despite the obvious technical problems we face daily and differences from context to context, interactive computer systems operate in wide-ranging, open networks, and the information technology paradigm has jumped from mere connection between computers to *co-operative computing*, which reaches beyond the position of the subjects involved in the interaction.

Out of networking as a fundamental form of competition in the new global economy (and its accompanying new information technology) a new organisation model has emerged: the *networked enterprise* (Castells 1996). These are enterprises (and a growing number of organisations and institutions) that are organised in networks of variable geometry, the webs of which make the traditional distinction between large and small companies less important. Networked enterprises provide services through their connectivity (their structural capacity to facilitate communication without interference between their component parts) and consistency (the degree of interest sharing between the goals of the network and those of its components). This is a new division of work based on the attributes and capabilities of each worker, rather than on the organisation of their working roles. Work is increasingly based on teamwork, networking, outsourcing and subcontracting.

Continuing along Castells's line of thought (1996), our contemporary societies are increasingly built around a bipolar opposition between the network (globalisation) and the ego (identity). The networked society looks increasingly like a *meta-social* mess to the eyes of most people, where setting up a meta-network leads to the disconnection of non-essential functions, of subordinate social groups and of devalued geographical areas.

Interconnection and multiculture are key context factors that some people very explicitly interpret as aggravating circumstances (to defend oneself against), others as a necessary field of confrontation (the starting point), and still others as an opportunity and driving force for sustainable innovation (to be exploited).

Finally, we also recognise that services, not products, comprise 50% of Europe's GDP (70% in Germany), 76% of US GDP, and in Asia, 40% in China, 69% in Japan, and 45% in Thailand. We must also acknowledge that (at the time of writing) we are in the context of a structural economic crisis, and even a social crisis, that began with the financial collapse of 2008. We are therefore facing a double crisis today, socio-economic and environmental, where many rightly talk about risks and how to prevent them. But at the same time we should talk about opportunities. And it is within the nature of design to consider *the opportunities and how to develop and promote them*.

1.5 The diverse paths towards sustainability

1.5.1 Industrialised, emerging and low-income contexts

Sustainability is a challenge for industrialised, emerging as well as low-income contexts.[15] However, achieving this goal in the different types of context requires

15 The following terminology is used: low-income is preferred over developing, and industrialised is preferred over developed, since they reflect more objective characteristics and less of a value judgement. Moreover it should be emphasised that the production and consumption model of industrialised contexts is far from being developed, in that it is the one creating most of the damaging environmental impacts. Contexts is preferred to countries because in different countries different socio-economic contexts may be present.

differing paths (Hart and Milstein 1999): while in *industrially mature contexts* there is the need to reduce the use of resources per 'unit of satisfaction' (together with improvement of quality of life), in *emerging contexts* the aim is to see how communities can orient towards sustainable consumption and production systems. In *low-income contexts* the impellent need is to enable the systems of production and consumption to cover basic needs and provide a subsequent basis for a sustainable growth.

It is the level of human satisfaction in relation to the earth's carrying capacity that has to be taken into consideration when measuring the sustainability level of a given context. The *Happy Planet Index*[16], for example, combines environmental impact with human well-being to measure the environmental efficiency with which, country by country, people live long and happy lives; it illustrates that the best scoring countries are not the highly industrialised ones but rather emerging countries in Central America. Moreover, knowing that today 80% of the world's population uses only 20% of resources and 20% of humans consume the other 80%, *social equity and cohesion* must be addressed. Thus even though satisfaction is not necessarily linked to resource consumption, it is obvious that a redistribution of resources has to take place. Moreover, it is important to underline that sustainability is not only a matter of resource redistribution, but it is connected, as previously stated, to a wider spectrum of socio-ethical implications and responsibilities.

In the following sections, we present an overview of paths to sustainability as delineated in European and Asian agendas.

1.5.2 European sustainability agenda

European countries in the EU today follow the norms, practices and policies established by the European Commission (EC) for what regards sustainable development. Sustainable development as such is addressed as a cross-cutting issue reflected in the policy orientation of many sectors, informing private and national public practices, applying the EC's indications at the local level.

For that reason, the three European countries involved in the LeNS project, Italy, Finland and the Netherlands, are to some extent very similar regarding the general approach to the sustainable development agenda. Naturally, local agendas are built and applied according to the specificities of each country's consumption and production systems.

The **Renewed EU Sustainable Development Strategy** adopted by the European Council since June 2006 establishes four key objectives:

16 The Happy Planet Index in fact shows that no country successfully achieves the three goals of high life satisfaction, high life expectancy and one-planet living (www.happyplanetindex.org).

Environmental protection

Safeguard the earth's capacity to support life in all its diversity, respect the limits of the planet's natural resources and ensure a high level of protection and improvement of the quality of the environment. Prevent and reduce environmental pollution and promote sustainable consumption and production to break the link between economic growth and environmental degradation.

Social equity and cohesion

Promote a democratic, socially inclusive, cohesive, healthy, safe and just society with respect for fundamental rights and cultural diversity that creates equal opportunities and combats discrimination in all its forms.

Economic prosperity

Promote a prosperous, innovative, knowledge-rich, competitive and eco-efficient economy which provides high living standards and full and high-quality employment throughout the European Union.

Meeting our international responsibilities

Encourage the establishment and defend the stability of democratic institutions across the world, based on peace, security and freedom. Actively promote sustainable development worldwide and ensure that the European Union's internal and external policies are consistent with global sustainable development and its international commitments.

We observe that the main concerns are to a great extent related to the well-being and welfare of EU inhabitants. Issues regarding the greening of the production sector are no longer the main focus of sustainability-related policies as was the case in past decades. This is related to the fact that Western Europe finds itself in a post-industrial phase, moving from a manufacturing-based economy towards a service-based economy. It is not by chance that in one of the key challenges listed above, *Sustainable consumption and production*, the word *consumption* comes before *production*. This significant approach is addressed by the SCORE EC project[17] as follows: 'Consumption has to be understood as an activity that takes part in and is partially driven by a system context, and not only aims to fulfil material needs, but

17 SCORE! Sustainable Consumption Research Exchange is supported by the EU`s 6th Framework Programme. It is a network project that acts as one of the EU's central support structures for the UN's 10 Year Framework of Programmes for Sustainable Consumption and Production (SCP).

also relates to symbolic and cultural values'.[18] Moreover, in the current globalised economy, the EC plays a decisive role in establishing regulations regarding industrial production and agriculture that will reflect in the dynamics of global trade, affecting thus the worldwide economy.

In the European Sustainable Consumption and Production Policies two issues can be highlighted. One is the decoupling of economic growth from environmental degradation as an overall strategy for SCP, leading us towards new patterns of well-being and socio-economic and even institutional structures. The second issue is the understanding that to achieve SCP, we must change 'the way we **design**, produce, use and dispose of the products and services we own and consume'.

In this sense, not only specific product-related policies have to be implemented (through for example EU eco-design policies and IPP, Integrated Product Policy), but a **systemic approach** is called into action, as adopted in the SCORE project:

> sustainable consumption and production structures can only be realised if experts that understand business development, (sustainable) solution design, consumer behaviour and effectiveness of (policy) instruments work together in shaping them. Furthermore, this should be linked with experiences of actors (industry, consumer groups, eco-labelling organisations) in real-life consumption areas.

The EU has been increasing its role as promoter of research and innovation aiming at economic competitiveness in a knowledge-based society, but it has also been an important force for the advancement of sustainable development knowledge, methods and application tools in a vast range of areas on a worldwide scale. The EU has been investing significantly in pro-sustainability research.

The EC through the Community Research & Development Information Service (CORDIS) establishes a new Framework Programme for research and technology development every five years, a financial tool to support research and development activities covering almost all scientific disciplines. Both the CORDIS Framework Programmes and other external cooperation programmes (for example EuropeAid) have been important mechanisms in the promotion of sustainability knowledge internally and externally to European borders. The EU has thereby been a key force in shaping sustainable development and SCP approaches in the world and, through initiatives such as the SCORE! Network, has been strengthening synergies with the UN in this regard.

18 This is also mentioned in the EU Sustainable Development strategy of 2006. SCP covers 'almost the full "human" (social) system and the (economic) support sub-system' (Tukker, Charter, *et al.* 2008b), thus dealing with environmental, social and as well as economic aspects.

1.5.3 Asian sustainability agenda

The rapid economic development in Asia has led to an increase in terms of access to goods and services (at least for some share of the population), but on the other hand it has created increased environmental pressure, including pressure on urban infrastructure and its consequent level of liveability, and social gaps especially the urban/rural gap. There is also great concern about the impact of this economic growth on the global environment in the long run:

> As China and India become world-class economies, they are set to join already industrialised nations as major consumers of resources and polluters of local and global ecosystems. And while the largest burden of these developments will fall on China and India themselves, the global impact is clear (Flavin and Gardner 2006).

It must be said that although escalating, the environmental impact per capita in China, for example, is still much lower than that of industrialised countries, and consequently, the ecological footprint per capita of a country such as China is far lower than that of European countries or the United States. India has been able to achieve this through traditional cultural consumption patterns relating in particular to food consumption and waste recycling.

Even with massive rural–urban migration, countries like India and China are still predominantly rural. On the local level, rural-based traditional lifestyles are being replaced by a western-like, product-based well-being mind-set, based on a resource-intensive economy and individualistic values. This, however, does not necessarily translate into actual well-being of the majority of the population.

Nevertheless it is in the cities that it is easier to perceive the impact of socio-environmental pressure deriving from accelerated economic growth, since cities are the arena where the transformation processes are more dynamic. According to the Worldwatch Institute (2006), from the twenty most polluted cities in world, sixteen are in China. By the year 2015, the six biggest cities in the world, with populations above 20 million, will be found in the emerging countries and more than half of them in Asia. Issues such as air pollution, mobility systems or food and water supply gain, in the urban arena, an unprecedented scale.

At the policy level, if the UN has been stimulating governments worldwide in the promotion of local SCP debates, national governments in their turn have also been responding to the pressing issues related to environment degradation. Unlike the three European countries involved in the LeNS project, which share much of the same sustainable development agenda, the three Asian LeNS project countries, Thailand, China and India, see greater variability in their priorities and policies. In China, for example, the new five-year economic plan (as of time of writing) stresses the need for the conservation of natural resources. Also in China, a Green GDP index has been created as an indicator for economic growth that also takes into consideration the costs of environmental impact and resource consumption.

According to recent research conducted by the IUAV and Camerino universities in Italy,[19] Chinese environmental policy from the early 1980s to date has been following the route of end-of-pipe solutions to cleaner production, towards a life cycle approach. However, models such as PSS that are linked to environmental issues, life quality improvements as well as new types of entrepreneurship have not yet reached policy level, and it is now beginning to emerge as a scientific area to be explored.

Sustainability is a critical issue in Thailand, which has a unique agenda: the Sufficiency Economy Philosophy (SEP), bestowed by the nation's King. The Sufficiency Economy Philosophy prioritises human development and placing people's well-being at the centre of development. SEP thus serves as a guide for people at all levels of society on how to live and behave toward the middle path. Implementers (ranging from farmers, businesspersons, politicians, government officers to educators) are thus enabled to meet global challenges, as the SEP intends to indicate the routes to recovery that lead to a more resilient and sustainable economy. It is a universal approach applicable and scalable to conducts starting from the level of families, communities, as well as the level of nation in development and administration so as to modernise in line with the forces of globalisation. It entails three components (reasonableness, moderation and self-immunity) and two conditions (knowledge and morality).[20]

19 Study conducted by Medardo Chiapponi and Laura Badalucco (IUAV University Venice, Dadi department) and Lucia Pietroni (Camerino University ProCAm Department) within the research project 'Il Made in Italy per la Cina' (Made in Italy for China). Internal document 'La sostenibilità ambientale in Cina, inquadramento generale e prospettive' (Environmental sustainability in China, general framework and perspectives), IUAV University, October 2006.

20 The Sufficiency Economy Philosophy is described in detail in Part 2, Section 4.

2

PSS innovation and sustainability

A more strategic and systematic approach to Product-Service Systems first emerged in industrialised contexts (mainly Europe), as mentioned in Chapter 1, as a business opportunity to decouple value creation from an increase in resource consumption and more generally detrimental environmental impact. In terms of origin (Baines *et al.* 2007), most authors since 1999 have been from Scandinavia (particularly from Sweden), the Netherlands or Italy. A few articles on PSS have emerged from Asia, although numerous relevant cases are presented without adopting the term 'PSS' per se.

In this chapter we will first see what a Product-Service System is, why a PSS is understood as an opportunity for system eco-efficiency in industrialised contexts, and finally why and how such an approach could be promising in emerging and low-income contexts, i.e. for all sustainability dimensions, environmental, socio-ethical and economic.

2.1 Product-Service System eco-efficiency

2.1.1 What is a Product-Service System?

As stated in the introduction, in recent years several design research centres, starting with a more stringent interpretation of environmental sustainability (requiring a systemic discontinuity in production and consumption patterns) have reset part of the debate on Design for Sustainability starting from a system innovation approach. In fact, several authors have observed that product Life Cycle Design or Eco-design implementation meets obstacles in traditional supply models of product sale (Stahel 2001; Cooper and Sian 2000; Lindhqvist 2000; Goedkoop *et al.*1999; Manzini and Vezzoli 1998).

For these researchers a more significant scope in which to act to promote radical changes for sustainable consumption seems to lie in widening the possibilities for innovation beyond the product: commonly referred to in this context as Product-Service Systems (PSS).

Table 2.1 lists some of the definitions provided during this period.

Table 2.1 **Definitions of Product-Service System**

Authors	Year	Definition
Goedkoop, van Halen, te Riele, Rommens	1999	A Product-Service System (or combination of products and services) is a set of marketable products and services jointly capable of fulfilling a need for a client. [...] The PSS may lead to a benefit for the environment in connection with the creation of a (new) business.
Mont	2002	PSS is a system of products, services, networks of actors and supporting infrastructure that continuously seeks to be competitive, satisfy customer needs and have a lower impact than traditional business models.
UNEP: Manzini, Vezzoli	2002	Result of an innovative strategy that shifts the centre of the business design and sale of products only (physical) to systems offering products and services that are jointly capable of satisfying a given application
Brandstotter	2003	PSS is a product of material and intangible services designed and combined so that both jointly are able to satisfy a specific need of a user. In addition a PSS may reach sustainability targets.
EU, MEPPS: Van Halen *et al.*	2005	Result of an innovation strategy focused on the design and sale of a system of products and services that are jointly capable of fulfilling a specific customer demand
Baines *et al.*	2007	PSS is an integrated offering of a product and a service that provides a value. Using a PSS offers the opportunity to decouple economic success from material consumption and thus reduce the environmental impact of economic activity.
UNEP: Tischner, Vezzoli	2009	System of products and services (and infrastructure), to jointly cope with the needs and demands of customers in a more efficient way with better value for both businesses and customers, compared to only offering products [...]. PSS can decouple the creation of value from the consumption of materials and energy and thus significantly reduce the environmental impact in the life cycle of traditional product systems.

To clarify this concept we can take the following example (UNEP 2002): given the 'satisfaction' in having clean clothes, we do not need only a washing machine, but also detergent, water and electricity (and the services that supply them), and maintenance, repair and disposal services. When we talk, then, about PSS innovation, it refers to an innovation that involves all the different socio-economic stakeholders in this satisfaction system: the washing machine and detergent producers,

the water and electricity suppliers, the user and those responsible for maintenance and disposal.

Furthermore, as we saw previously, it is a shared opinion that ideally PSS innovation 'continuously strives to be competitive, satisfy customer needs and have a lower impact than traditional business models' (Mont 2002), 'as a consequence of innovative stakeholder interactions and related converging economic interests' (UNEP 2002). Thus eco-efficient PSS innovation derives from a new convergence of interest between the different stakeholders: innovation not only at a product (or semi-finished) level, but above all as new forms of interaction/partnership between different stakeholders, belonging to a particular value production system (Porter and Kramer 2006).

In other words, the research interest in this innovation model relies on the fact that it can raise system eco-efficiency through innovative stakeholders' interactions.

The definition of an **eco-efficient PSS** proposed by the LeNS project runs as follows:

> **an offer model providing an integrated mix of products and services that are together able to fulfil a particular customer demand (to deliver a 'unit of satisfaction') based on innovative interactions between the stakeholders of the value production system (satisfaction system), where the economic and competitive interest of the providers continuously seeks environmentally beneficial new solutions.**

The main characteristics of eco-efficient PSS innovations are:

- They are rooted in a satisfaction-based economic model, i.e. each offer is developed/designed and delivered in relation to a particular customer *satisfaction*
- They are stakeholder interaction-based innovation, i.e. radical innovations, less so technological ones, as new interactions and partnerships between the stakeholders of a particular satisfaction production chain
- They have intrinsic eco-efficiency system potential, i.e. innovation in which it is the company/companies' economic and competitive interest that leads to an environmental impact reduction, where the creation of value is decoupled from resource consumption

In reality, this interpretation of *PSS innovation* forms part of the foundation and criteria already expressed in *product Life Cycle Design*. However, when this approach was adopted, it emerged even more clearly (as its basic assumption) that it was the reconfiguration of the system that constituted the starting point towards achieving certain results.

2.1.2 The limits of a traditional product sales/design approach

To understand in general terms why PSS innovation and related innovative stakeholder interaction could be more eco-efficient compared to traditional product

sales/design let us use the laundry example of *satisfaction* system again. For this satisfaction I do not need only a washing machine, but also detergent, water and electricity (and the services that supply it), and maintenance, repair and disposal services.

In the case of a traditional product sale/design, the producer of the washing machine (but also of the detergent and the electricity and water supply) has an interest in reducing material and energy consumption during the production phase. At the same time, she/he has no direct economic interest in limiting consumption during use, nor in reducing disposal impact or valorising the resulting waste. Sometimes the producer is even interested in selling products with a short life span, with the aim of accelerating replacement.

Similar arguments could be made regarding other (all) stakeholders of a particular product life cycle (stakeholders of the pre-production, the production, the distribution, the use and the end-of-life), so in a nutshell the economic interests behind traditional product sale or design lead the various stakeholders towards reduction of resource consumption of those processes under their direct control: i.e. an economic interest leads towards *discrete resource optimisation* (Figure 2.1). In other words, the biggest problems in the transformation processes do not appear within one given phase, when related to a single stakeholder (e.g. the manufacturer of a washing machine). In terms of eco-efficiency, more problems arise during the sale or disposal of (semi-finished) products. Here can arise *indifference towards reducing resource consumption* or even worse, an *interest to increase consumption of resources*. For example a producer of plastic has an interest to increase the sales of its materials (causing an increase in resource consumption).

Figure 2.1 **Stakeholders in a product life cycle: discrete vs. system resource optimisation**

Source: derived from UNEP 2002

In summary, applying a product Life Cycle Design approach in a traditional sale/design model (due to its sole focus on the sale of products) faces several constraints due to the low level of interaction among the *satisfaction system's stakeholders*.

Finally, we can observe that the fragmentation of stakeholders in the various phases of a product's life cycle (in the traditional economic framework of industrialised countries) means that the eco-efficiency of the life cycle system usually does not coincide with the economic interests of the individual constituent stakeholders.

2.1.3 PSS towards system eco-efficiency

From an eco-efficiency perspective, regarding the convergence between economic/competitive and environmental interests, it is useful to list all the innovative interactions and relationships between the stakeholders that, for economic reasons, could result in **resource optimisation based on product function**.

It is even more fruitful to map out those innovative interactions and relationships in the whole system of products and services that fulfil a particular demand, deliver satisfaction, and that could effectuate **system-satisfaction based resource optimisation**. In our example (Figure 2.2) these include the washing machine and detergent producers, the water and electricity suppliers, those responsible for maintenance, the user and the end-of-life manager.

In the light of the arguments arisen thus far, what are the incentives for companies to enhance system eco-efficiency? Are there economic models where the economic and competitive benefits for a company correspond to a reduction in resource consumption or more in general to a reduction in the environmental impact?

Let us look for innovative elements in the stakeholder interactions and configuration *innovations*.

Both **stakeholder integration** and **extension** of their **interactions in time** could be helpful in both cases.

A) **Stakeholder integration** involves an extension of control and can be:

- *Vertical*: a single stakeholder responsible for the whole product life cycle phases, e.g. a producer of washing machines as well as recycler of the washing machines
- *Horizontal*: one stakeholder is responsible for different products and services within one system of satisfaction, e.g. a producer who sells washing machines as well as washing powder and later deals with their end-of-life treatment

Without going too deeply into this topic we must mention that vertical and horizontal integration also have their own limits due to monopolistic risks and inefficiency enabled by the absence of concurrency.

But the extension of control is not the only way to modify the interactions.

B) **Extending the duration of interactions** and partnerships means that relations between stakeholders do not end with the transaction or sale of the (pre)product:

- *Vertical*: more stakeholders, including the final user, extend their interactions within a given product life cycle
- *Horizontal*: more stakeholders, including the final user, extend their interactions within a particular system of satisfaction

Figure 2.2 **Convergence scheme between the interests of stakeholders in a satisfaction system, working towards system sustainability**

Source: derived from UNEP 2002

In the following section we will see which typology of stakeholder interaction may lead to eco-efficient system innovation.

2.1.4 Eco-efficient PSS innovation typologies

Three major business approaches to system innovation have been studied and listed as favourable for eco-efficiency (UNEP 2002; UNEP 2009):

1. Product-oriented PSS: services providing added value to the product life cycle
2. Result-oriented PSS: services providing 'final results' for customers
3. Use-oriented PSS: services providing 'enabling platforms for customers'

Product-oriented PSS: adding value to the product life cycle (type I)

Let us start with an example of an **eco-efficient** system innovation adding value to the product life cycle.

Klüber lubricants service

Klüber has moved from only selling lubricants to commercial customers to a service providing added value to product use. Using a service called S.A.T.E. Klüber analyses the effectiveness of aerosol treatment plants and sewage treatment. For this purpose, Klüber has designed a movable chemical laboratory, a van that is able to monitor a client's industrial machines directly, to determine the performance of lubricants used and their environmental impact. It also controls noise, vibrations, smoke and many other undesirable industrial impacts. The additional service Klüber offers clients leads to plant improvement in terms of efficiency, guarantees functionality and durability, and enhances environmental protection.

Klüber has broken away from the business-as-usual attitude. Its interests do not rely only on the amount of lubricant sold, but also on service; in fact there has been a reduction in the overall quantity of lubricant consumed per unit of service and thus a reduction in polluting emissions. Other benefits arise from the improved monitoring of performance of various machines, so that any accidental pollution can be avoided. Clients perceive they derive added value from this service because it frees them from the costs and the problems associated in the monitoring and checking of their equipment. Achieving better efficiency from lubricants also provides many economic benefits both in production processes and in improving the life of machines, and plant costs are also reduced.

In summary, a **Product-oriented PSS innovation adding value to the product life cycle** is defined as:

> **a company (alliance of companies) that provides additional services to guarantee an extended life cycle performance of the product/semi-finished product (sold to the customer).**

A typical service contract would include maintenance, repair, upgrading, substitution and product take-back services over a specified period of time.

This reduces the user's responsibility in the use and/or disposal of the product/semi-finished product (owned by her/him), and the innovative interaction between the company and the customer drives the company's economic and competitive interest in continuously seeking environmentally beneficial new solutions, i.e. the economic interest becomes something other than only selling a larger amount of products.

Result-oriented PSS: offering final results to customers (type II)

The following describes an example of an eco-efficient system innovation providing final results to customers.

The 'solar heat service'—pay per hot water

The 'solar heat service' is a full-service providing a final result, consisting of 'selling' hot water as a finished product. Hot water is produced by new equipment that combines sun, energy and methane, with economic and energy savings. Solar plants are designed in order to maximise the contribution of solar energy. Hot water is measured by means of a specific heat meter, and the whole system is monitored in order both to control in real time how the system works and also to apply a Guarantee of Solar Results, a specific contract through which the installer makes a commitment to reach a pre-determined level of efficiency. AMG has already tested this service in a Tennis Club in Palermo, Italy, providing hot water for the dressing rooms. The innovative feature of this Product-Service System is that AMG will not invoice the client for the methane consumed to obtain hot water, but rather, hot water is sold as an entire service. AMG sells heat and calculates the thermal kilowatts consumed by its clients. With AMG the consumer pays for receiving a comprehensive service, from installation, to the thermal-energy meters, and to the transportation of methane to the boilers. With equipment maintenance provided as well, the customer is overall buying a 'final result'.

This new product-service mix is sold as a complete service, which can significantly benefit the environment. The company thus becomes motivated to innovate in order to minimise the energy consumed in use. Billing is by unit of service and not per unit of consumed resources. The less methane consumed (the higher the use of solar energy and the system efficiency) the higher the income for AMG.

A **result-oriented PSS innovation offering final results to customers** can be therefore defined as:

> **a company (alliance of companies) that provides a customised mix of services (as a substitute for the purchase and use of products), in order to provide an integrated solution to meet a particular customer's satisfaction (in other words a specific final result). The mix of services does not require the client to assume (full) responsibility for the acquisition of the product involved. Thus, the producer maintains the ownership of the products and is paid by the client only for providing the agreed results.**

The customer does not own the products and does not operate them to achieve the final satisfaction; the client pays the company to provide the agreed results. The customer benefits by being freed from the problems and costs involved in the acquisition, use, and maintenance of equipment and products. The innovative interaction between the company and the client drives the company's economic and competitive interest to continuously seek environmentally beneficial new solutions, e.g. long-lasting, re-usable and recyclable products.

Use-oriented PSS: offering enabling platforms for customers (type III)

Finally, the following box describes an example of an eco-efficient system innovation as enabling platforms for customers.

Car sharing—Move About by Th!nk

Move About, like many other car-sharing systems, is a service providing an enabling platform of product (car) and services. It is a car-sharing scheme for the general public in Oslo; the fleet of vehicles is made up of 40 electric cars, all from the Norwegian manufacturer Th!nk. Users pay a monthly membership fee plus an hourly rate (including everything from the insurance to the energy to move the vehicle). For car users, a subscription to a car-sharing system provides convenient access to car mobility at lower costs than a traditional car rental agency. The local administration offers various incentives, such as free parking, exemption from road pricing and authorisation to drive in bus lanes.[1] A car-sharing system basically intensifies the use of cars, meaning a lower number of cars are needed in a given context for a given demand for mobility.

In summary a **use-oriented PSS innovation offering an enabling platform to customers** is defined as:

> **a company (alliance of companies) offering access to products, tools, opportunities or capabilities that enable customers to meet the particular satisfaction they want (in other words efficiently satisfying a particular need and/or desire).**
>
> **The customer obtains the desired utility but does not own the product that provides it and pays only for the time the product is actually used. Depending on the contract agreement, the user could have the right to hold the product/s for a given period of time (several continuous uses) or only for one use. Commercial structures for providing such services include leasing, pooling or sharing of certain goods for a specific use.**

The client thus does not own the products and does not operate them to obtain the final satisfaction (the client pays the company to provide the agreed results). Again in this case the innovative interaction between the company and the client drives the company's economic and competitive interest to continuously seek environmentally beneficial new solutions, e.g. to design highly efficient, long-lasting, re-usable and recyclable products.

1 See www.mindsinmotion.net/index.php/mimv34/themes/hybrid_electric/featured/move_about

2.1.5 Eco-efficient PSS potential

All three types of eco-efficient PSS innovation approaches discussed so far (adding value to the product life cycle, offering final results to customers, and offering enabling platforms to customers) present environmentally and economically favourable solutions. In fact, these and other examples show that innovative interaction between the client and the providers and other system production chain stakeholders can reach mutually beneficial solutions, where the same economic interest that led towards innovations reduces the environmental impact.

The bottom line is that, compared to a traditionally produced product, a company can make more money if it can meet the same demand by providing a less resource/service intensive product and related service mix. Cost savings for the producer/service-provider result from reduced quantities of product materials, streamlined managerial costs, and reduced costs from prolonged responsibility for the product, throughout its use and disposal. Of course these potential reductions must be balanced against the possible increase in costs of servicing, transportation, disposal and recycling. In fact, today the cost of labour in industrialised countries may represent a significant barrier for a shift to PSS.

During the **use phase**, the producer has a potential economic interest to reduce the amount of resources consumed, because profit is dependent on the amount being paid per unit of service provided to the customer. Furthermore, since the producer remains the 'owner', or at least retains some responsibility for the product over its life cycle, there is a further economic incentive to extend a product's lifetime. In this way the producer in essence postpones both the disposal costs and the costs of manufacturing a new product.

At the **end of** a product's **life**, the producer has the potential economic interest to re-use or re-manufacture components of disposed products to save on landfilling and new product manufacture. Furthermore, the producer will be motivated to look into other ways to extend material life, such as recycling, energy recovery or composting.

The potential eco-efficiency of the system innovation therefore depends on those economic interests of the stakeholder that favour:

- Product life cycle optimisation, designing to extend the product (and its components') life span and to intensify product (and its components') use[2]
- Materials' life extension, designing in order to valorise material from scrapped products, such that rather than ending up in landfills, they can be

2 Intensifying usage means that a (greater) number of people use the same product (or component) at different times. A product used more intensely than others leads to a reduction in the quantity of product present at a given time or in a given place in order to meet a given/the same demand for a function; i.e. it determines a reduction in environmental impact.

re-processed to obtain new secondary raw materials or incinerated to recover their energy content

- Minimisation of utilised resources, design aimed at reducing the usage of materials and energy of a given product or, more precisely, of a given service offered by that type of product

System eco-efficiency is also increased with:

- Easily adoptable technologies, because the service providers may avoid higher initial investment, e.g. new efficient technology
- Fast substitution of obsolete products with new and more eco-efficient one

2.1.6 PSS benefits for producer/provider and customer

In this section we describe the main benefits seen by the customer and the producer/supplier.

For the customer, a PSS is seen to provide value through more customisation and higher quality. The service component, being flexible, can also deliver new functionality better suited to customer needs and is often described as removing administrative or monitoring tasks away from the customer and back to the manufacturer (Baines *et al.* 2007). Business-to-business customers tend to outsource secondary tasks at any rate, and here they can concentrate on their core competences (Meier *et al.* 2010). Individual consumer customers are also freed from the burden of responsibilities that do not relate to satisfying the particular need in question (e.g. clean clothes).

The advantage on the customer side is a higher level of productivity because of better utilisation of the product's performance and the longer operation possibility. For most reported PSS cases, the customer receives value in a form that is close to current needs; while innovative forms of value are suggested as being possible, few real-life examples are present.

The PSS benefits for companies result from *improved strategic positioning* (UNEP 2002), which is tied to the potential added value perceived by clients. By focusing on the utility delivered from a product-service mix, the company frees the client from the costs and problems associated in the acquisition, use, maintenance and disposal of equipment and products.

More specifically, an improved strategic positioning could be achieved as a result of:

- **New market development**, i.e. a differentiated offer of a new product-service mix providing added value to consumers compared to a product alone; common in industrialised economies
- **Increased flexibility** to respond more rapidly to the changing consumer market, due to new outsourcing relationships
- **Longer-term client relationships** which lead to stronger company/customer relationships and thereby customer retention

- **Improved corporate identity** to respond to the demands for a company to be 'responsible and transparent', by showing its environmental and social benefits
- **Improved market and strategic positioning** because of existing and future environmental legislative requirements or restrictions, e.g. Extended Producer Responsibility, resource taxes, environmental performance

2.1.7 PSS eco-efficiency limits and constraints

Not all PSSs are eco-efficient

It is important to underline that not all shifts to PSS result in environmental benefits: a PSS must be specifically designed, developed and delivered, if it is to be highly eco-efficient. For example, schemes where products are borrowed and returned incur transportation costs (and the resultant use of fuel as well as pollution emissions) over the life of the product. In some specific instances, the total fuel cost and environmental impact may make the system non-viable in the long term.

Furthermore, even when well designed, it has been observed that some PSS changes could generate unwanted side effects, usually referred as **rebound effects**. Society as a whole is a set of complex, inter-related systems that are not clearly understood. As a result, something may happen that turns potential environmentally sound solutions into increases in global consumption of environmental resources at the practical level. One example is the impact of PSS on consumer behaviour. For example, outsourcing, rather than ownership of products, could lead to careless (less ecological) behaviours.

Nevertheless, PSS development seen as a whole presents great potential for generating win–win solutions that promote profit and environmental benefits. It has the potential to provide the necessary, if not sufficient, conditions to enable communities to leapfrog to less resource-intensive (more dematerialised) systems of social and economic systems.

Finally, it is simply better to avoid uncritical research, assuming that new system innovation will automatically produce environmentally friendly solutions without being adequately equipped with enough sensitivity, conceptual vocabulary and operational tools that would allow actual re-orientation towards sustainability and sustainable goals. This means on an operative level we need criteria, methods and tools to orientate design towards system eco-efficient stakeholder interactions and relationships.

Barriers to adopting eco-efficient PSS innovation

Most products involve services and vice versa; change towards a service economy has been ongoing for decades. In other words, PSS is nothing new. Why, then, are eco-efficient PSSs not yet diffused?

The main barrier to adopting eco-efficient PSSs (in industrialised contexts) is the cultural shift necessary for the user to value 'having a need or want met in a sustainable way' as opposed to 'owning a product'. This cultural leap can be made, but it is not straightforward for a consumer or intermediary retailer (as a client) to understand. Wong (2004) argues that to be successful a PSS solution in the consumer market must be sensitive to the culture in which it will operate. He notes that PSS solutions have been more readily accepted in the communal societies of Scandinavia, the Netherlands, and Switzerland.

Businesses face barriers in the design, development and delivery of PSSs, in implementing the changes required in corporate culture and organisation, to support a more systemic innovation and service-oriented business. In this regard, it has been observed that some companies in mature industries see it as an opportunity to survive, while others see it as a way of gaining entry to a new sector.

A further obstacle for business is the difficulty of quantifying the savings arising from PSS in economic and environmental terms, in order to market the innovation to stakeholders both inside and outside the company, or to the company's strategic partners. Other barriers faced by business include lack of knowledge and experience in terms of:

- Service design methods and tools
- New tools which companies can use to orientate, assess and implement eco-efficient PSSs
- Service management systems
- Entrepreneurial personnel who are skilled in service development and provision
- Life-cycle costing methods

Furthermore, businesses may perceive the risks of:

- Conflict with existing internal procedures and tools, e.g. accounting and reporting methods
- A service being easily replicated by a competitor (more easily than a physical product)
- Partnerships and entrepreneurial interdependence leading to reduced control of core competences and reducing the influence of business decisions

Finally, barriers to be overcome may include a lack of external infrastructure and technologies, e.g. for product collection, remanufacturing or recycling.

Per stakeholder type, barriers for the eco-efficient PSS diffusion in industrialised contexts are summarised as follows (Ceschin 2010):

- For *companies* the adoption of a PSS strategy is more complex to be managed than the existing way of delivering products alone. There is a need to

implement changes in corporate culture and organisation in order to support a more systemic innovation and service-oriented business (UNEP 2002); there is indeed resistance by companies to extend involvement with a product beyond point-of-sale (Stoughton *et al.* 1998; Mont 2002). Extended involvement requires new design and management knowledge and approaches. It requires medium-to-long-term investments and is therefore connected with uncertainties about cash flows (Mont 2004). Moreover, a further obstacle is the difficulty of quantifying the savings arising from PSS in economic and environmental terms, in order to market the innovation to stakeholders both inside and outside the company, or to the company's strategic partners (UNEP 2002). Finally, the significant change in the system of earning profit could deter producers from employing the concept, first through limited experience in pricing such an offering, and second through fear of absorbing risks that were previously assumed by customers (Baines *et al.* 2007)

- For *customers/users*, the main barrier is the cultural shift necessary to value an ownerless way of having a satisfaction fulfilled, as opposed to owning a product (Goedkoop *et al.* 1999; Manzini, Vezzoli and Clark 2001; Mont 2002; UNEP 2002). Solutions based on sharing and access contradict the dominant and well-established norm of ownership (Behrendt *et al.* 2003); this is especially true in the B2C market, while in the B2B sector numerous examples of eco-efficient PSS concepts can be identified (Stahel 1997). Product ownership not only provides function to private users, but also status, image and a sense of control (James and Hopkinson 2002). Another obstacle is the lack of knowledge about life cycle costs (White *et al.* 1999), which makes it difficult for a user to understand the economic advantages of ownerless solutions
- For *governments*, on the *regulatory and policy side*, actual laws may not favour PSS-oriented solutions. Environmental innovation is often not rewarded at the company level due to lack of internalisation of environmental impacts (Mont and Lindhqvist 2003). In addition there are difficulties in implementing policies to create corporate drivers to facilitate the promotion and diffusion of this kind of innovation (Mont and Lindhqvist 2003; Ceschin and Vezzoli 2010)

Assuming a broader perspective, we may observe that a diffused inertia regarding consolidated habits is limiting eco-efficient PSS innovation. Namely, PSSs are not simply a leapfrog business strategy: a transition path is often needed.[3] Furthermore, and perhaps most importantly, there is a lack of knowledge on eco-efficient PSS design: we need a new generation of designers (and design educators) and other professionals capable of operating with complex system research and innovation.

3 See Part 2, Section 1.

2.2 Product-Service Systems for emerging and low-income contexts

2.2.1 Can PSS be a promising concept for emerging and low-income contexts?

In 2000 the United Nations Environment Programme (UNEP) set up a group of international researchers[4] to both disseminate worldwide the concept of Product-Service Systems innovation and start exploring new PSS potentialities, which can be summed up in the following queries.

Is Product-Service System innovation (PSS) also applicable in emerging and low-income contexts?

This question arose simply because the development of Sustainable Product-Service Systems studied and achieved thus far did not refer to the socio-ethical dimension of sustainability nor specifically to emerging and low-income contexts (which are by statute within the concern of the United Nations Environment Programme).

This question is the forerunner of another.

(If the answer to the first is affirmative) can a PSS approach favour social equity and cohesion within these contexts together with eco-efficiency?
And if so, with what particular characteristics?

The response to the former two questions given by the international group of experts engaged by UNEP was the following working hypothesis:

> PSS (system innovations) may act as business opportunities to facilitate the process of social-economic development in emerging and low-income contexts—by jumping over or by-passing the stage of individual consumption/ownership of mass produced goods—towards a 'satisfaction-based' and low-resource intensive advanced service economy (UNEP 2002).

To clarify this working hypothesis let us look at an example of Product-Service System innovation in a low-income/emerging context.[5]

4 The work involved a group of researchers (including the author) from industrialised, emerging and low-income countries; it was set up in 2000 and ended in 2002 presenting the main achievements within the publication UNEP (2002) *Product-Service Systems: Opportunities for Sustainable Solutions*.

5 The cases presented in this chapter come from the previously mentioned UNEP booklet of 2002 and from a case databank of the WBCSD, both freely available on their respective websites (www.unep.fr/scp/publications/details.asp?id=WEB/0081/PA and www.wbcsd.ch/publications-and-tools.aspx).

Distributed Solar Energy and electrical devices as an all-inclusive package, Brazil

In 2001, Fabio Rosa began exploring a new business model to provide Brazil's rural people with what they needed: energy services, not just solar energy. Rosa founded both a for-profit corporation, Agroelectric System of Appropriate Technology (STA), and a not-for profit organisation, the Institute for Development of Natural Energy and Sustainability (IDEAAS). To that end TSSFA developed a leasing structure whereby customers pay a monthly fee for the use of cost-effective solar energy packages, a basic photovoltaic solar home system that could be rented for US$10/month plus an initial installation fee. This not only fits with the traditional way people pay for energy, it also saves its customers from paying the 50% sales tax that would be required if they were to purchase the systems instead of renting them. Solar home kits, as TSSFA calls them, include the hardware needed to generate energy, while also providing the installation service and products that use the electricity generated by the solar home system, such as lighting and electrical outlets. All of the tangible inputs are owned by STA and only the services provided by these materials are leased to customers.

The case illustrates Product-Service System innovation as an approach applicable in emerging and low-income contexts. The following arguments can be highlighted in support of this hypothesis (UNEP 2002).[6] First, if PSSs are eco-efficient at the system level it means that they may represent opportunities for a context with fewer economic possibilities to respond more easily to unsatisfied social demands with lower overall costs, as can be seen in the case studies described above.

Second, PSS offers are more focused on the context of use, because they do not only sell products: they open (and/or lengthen) relationships with the end user. For this reason, an increased offer in these contexts should trigger a greater involvement of (more competent) local, rather than global, stakeholders, thus fostering and facilitating the reinforcement and prosperity of the local economy.

Furthermore, since PSSs are more labour and relationship intensive, they can also lead to an increase in local employment and a consequent dissemination of skills.

Finally, since the development of PSSs is based on the building of system relationships and partnerships, they are coherent with the development of network enterprises on a local basis for a bottom-up re-globalisation process. This last issue is clarified in the next section where the model of *distributed economies* is introduced.

6 This hypothesis has also been examined in a series of case studies, collected by the group engaged by UNEP.

2.2.2 Distributed economies: a promising economic model for PSS innovation coupling eco-efficiency with social equity and cohesion

Assuming, as argued and exemplified above, that the PSS approach is applicable to emerging and low-income contexts, a second research question was proposed:

What characteristics does a PSS need in order to foster eco-efficiency together with social equity and cohesion within emerging and low-income contexts?

In this section we argue that an answer to this question could be provided by coupling the two models of *PSS* and *distributed economies*. Similarly to PSS, several authors have argued that *distributed economies* can be a favourable economic model to couple socio-ethical and environmental dimensions of sustainability (Mance 2001; Rifkin 2002; Sachs *et al.* 2002; Johansson *et al.* 2005; Vezzoli and Manzini 2006; Crul and Diehl 2006; Rifkin 2010). The International Institute for Industrial Environmental Economics (IIIEE) in Lund defines distributed economies as a 'selective share of production distributed to regions where activities are organised in the form of small scale, flexible units that are synergetically connected with each other' (Johansson *et al.* 2005).

The mainstream economic model of industrialised contexts, characterised by centralised and large-scale production units, determines dynamics that undermine sustainability, both on environmental and socio-ethical levels. Examples of such dynamics include:

1. Increasing the movement of raw materials and products over longer distances, mainly relying on decreasing unit transportation costs
2. Distancing production from consumers and thereby hiding the environmental and social costs (Dahlberg and Jansson 1998)
3. Weakening the local actors' possibilities to have ownership and control over their immediate economic environment
4. Distorting or destroying cultural identities
5. Limiting diversity in regional economic activities (Johansson *et al.* 2005)

Besides these disadvantages, being large-scale and centralised limits the ability of such production units to respond to rapidly changing demand. In recent decades the adjective *distributed*[7] has been increasingly used in relation to several socio-economic systems: information technologies and *distributed computing*; energy systems and *distributed energy generation*; production and the possibilities of *distributed manufacturing*; and the processes of change and *distributed innovation, distributed creativity, and distributed knowledge*. Finally, in relation to overall

7 To distribute: to divide something into portions and dispense it (from Wiktionary, the wiki-based Open Content dictionary).

socio-technical systems, the term has been used to describe the new economic model of *distributed economies*.

Some of these concepts became mainstream two decades ago (i.e. the 'classic' distributed computing). Some have a strong position in the international arena (such as the concepts of distributed energy generation and distributed manufacturing). Some have emerged, and are emerging, in recent years and have a wide and growing audience (distributed innovation, distributed creativity, and distributed intelligence). In all these cases, what the term *distributed* adds to the substantive to which it is related is the idea that it has to be considered as a web of interconnected, autonomous elements, i.e. elements that are capable of acting autonomously, being, at the same time, highly connected with the other elements of the system.

Let us now look at the fossil fuel resources model from an economic and socio-ethical point of view. Resources from fossil fuels, due to their localisation and the complexity of extraction and transformation processes, have led to a series of highly centralised production and distribution infrastructures, reducing opportunities for access to resources, above all to energy and particularly electricity. It is therefore claimed that the enlarging rift between rich and poor can to a large extent be attributed to the very nature of the fossil fuel energy regime (Rifkin 2002).

As an alternative to fossil fuel, the use of renewable, local resources, such as sun, wind and hydrogen, presents indubitable environmental advantages, due to their reduced greenhouse effect (and its impact), inexhaustibility and lower environmental cost compared to the various processes of extraction, transformation and distribution when using fossil fuels. They are installable and manageable by *small-scale economic entities*, even by a single residential complex or single individuals. If adequately exploited, sun, wind and other renewable sources of energy would enable every human being to have more power and move towards a democratic regime of resource management. Such a decentralised infrastructure supplied by renewable sources, usually referred to as *distributed energy generation*, on the one hand would reduce environmental impact and on the other could facilitate a democratisation of resources and energy, enabling individuals, communities and nations to reclaim their independence while accepting the responsibility that derives from their reciprocal interdependence (self-sufficiency and interdependence).

Renewable energy sources have the characteristics that lead to low environmental impact, decentralised and democratic production systems, but all this may not necessarily happen.

Whether in industrialised, emerging or low-income contexts it will be essential to develop the capacity to gather large masses of producer-users into networks and associations with an adequate, decentralised, bottom-up institutional approach, in order to guarantee more control to community members and power over their

own destiny: for example, in low-income contexts, village cooperatives in collaboration with micro-credit banks.[8]

More generally we can observe that in an interconnected context a principle that double ties the environmental question to social ethics can be summarised as follows:

> use primary local, conservative, regenerative (i.e. locally sustainable) resources and introduce decentralised system networks for the extraction, production and use of those resources.

It has also been observed (Sachs *et al.* 2002; Sachs and Santarius 2007) that when there are local stakeholders involved in the extraction, transformation and sale of resources, then they pay far more attention to preserving (resource) renewability. The obvious underlying reason is that their economic subsistence depends, in the short but also in the long term, on these resources. Therefore they are not in favour of exhausting them quickly.

This theme intertwines with other points of interest in research on so-called forms of alternative economy or alternative enterprises, founded on the concepts of cooperation, collectivity and collaboration (the so-called C factor, Razeto 2002). In particular, it merges with research on *cooperative networks* and *creative communities* (Florida 2002; Manzini and Jegou 2003), characterised by the self-organised activities of aware, critical, motivated citizens who are organised to a greater or lesser extent into networks and solidarity economy districts. It is thereby linked to work on those forms of sustainable social innovation, i.e. solutions of high social quality and low environmental impact, that spring from active, bottom-up social participation.

Euclides Mance approaches the issue from a more solidarity economy-based background. Mance talks about *solidarity cooperative networks* (Mance 2001) as 'networks in which units of production and consumption are articulated in self-propagating and self-feeding nodes in a solidarity collaboration'.

These models can fit under the wide umbrella of distributed economies, having two main characteristics:

- They are *locally based*, i.e. enterprises or initiatives based on sustainable local resources and needs, but could become open to non-local or global systems

8 On a worldwide level, cooperatives are the best organised vehicles to set up and diffuse such economies, able to acquire local resources and make them operative, without the aid of huge transnational companies. Cooperatives are organised on a geographical basis, gathering single producers and consumers together in a participatory non-profit institution. According to the ICA (International Co-operative Alliance) the principles of cooperatives are: the universality of associate member qualification, democratic participation, fair distribution of resources, autonomy, training, cooperation between cooperatives and community commitment. Aggregation of single consumers (and producers) allows them to deal with their suppliers from a position of greater strength (collective bargaining).

- They are *network-structured* enterprises or initiatives, i.e. they can gain critical mass and potentialities by their connections in networks

Finally, to answer the question posed at the beginning of this section the following research hypothesis could be formulated, characterising the former assumption of PSS being applicable to emerging and low-income contexts:

> A Product-Service System innovation (PSS approach) may act as a business opportunity to facilitate the process of social-economic development in an emerging and low-income context—by jumping over or by-passing the stage of individual consumption/ownership of mass-produced goods—towards a more 'satisfaction-based' and low resource intensity advanced service-economy, *characterised by locally based and network-structured enterprises and initiatives, for a sustainable re-globalisation process aiming to democratise access to resources, goods and services.*

In this framework the definition of **a sustainable PSS** proposed by the LeNS project runs as follows:

> **an offer model providing an integrated mix of products and services that are together able to fulfil a particular customer demand (to deliver a 'unit of satisfaction') based on innovative interactions between the stakeholders of the value production system (satisfaction system), where the economic and competitive interest of the providers continuously seeks both environmentally and socio-ethically beneficial new solutions.**

3

Product-Service System design for sustainability

3.1 PSS design for sustainability: a definition

After understanding the opportunities offered by PSS to product/service development, it is time to lead our argumentation towards the role of the designer.

Let us start with a definition of (industrial) design, the one given by the International Council of Societies of Industrial Design (ICSID).[1]

> Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life-cycles […]. Design seeks to discover and assess structural, organisational, functional, expressive and economic relationships, with the task of:

- Enhancing global sustainability and environmental protection (global ethics);
- Giving benefits and freedom to the entire human community, individual and collective;
- Final users, producers and market protagonists (social ethics);
- Supporting cultural diversity despite the globalisation of the world (cultural ethics);
- Giving products, services and systems those forms that are expressive of (semiology) and coherent with (aesthetics) their proper complexity.

1 Definition since 2005, see www.icsid.org.

Particularly relevant to our discussion is that, unlike previous definitions, it considers systems within the scope of design, not only products and processes. In addition, promoting the idea that design considers the 'whole life cycle' makes significant reference to environmental issues.

This definition differs in many ways from the one given by Tomàs Maldonado from the same organisation 40 years ago: 'By industrial design we normally mean the designing of industrially manufactured objects.'

Moreover the new definition includes a PSS approach to sustainability that addresses the widening possibilities for innovation beyond the product, particularly innovation, as we saw, characterised by being:

- Developed/designed and delivered in relation to a particular customer 'satisfaction'
- Radical innovations, not necessarily technological ones, as new interactions/partnerships between the stakeholders of a particular satisfaction production chain
- Innovation in which it is the company/companies' economic and competitive interest that may lead to an environmental impact reduction (system eco-efficiency)

Having understood this, **Product-Service System Design for Sustainability** is defined as:

> **the design of the system of products and services that are together able to fulfil a particular customer demand (deliver a 'unit of satisfaction') based on the design of innovative interactions of the stakeholders (directly and indirectly linked to that 'satisfaction' system) where the economic and competitive interest of the providers continuously seeks both environmentally and socio-ethically beneficial new solutions.**

3.2 PSS design for sustainability: approaches and skills

Thus far, the introduction of PSS innovation for sustainability into design has led design researchers to work on defining new skills of a more strategic nature, which aim at system sustainability through a strategic convergence of interests and are coherent with the *satisfaction-based* approach. 'Strategic' here also refers to the necessary acknowledgement of cultural contexts and inherent opportunities and barriers built into the social fabric. Design research in Asian contexts, for example, take into account traditions and values systems that have underpinned societies for millennia.[2]

2 See Section 3.5 in this chapter for an elaboration on PSS Design for Sustainability in Asian contexts.

In synthesis, the main approaches and skills of **Product-Service System Design for Sustainability** are:

- A **satisfaction-system** approach, i.e. the design of the satisfaction of a particular demand (satisfaction unit) and all its related products and services
- A **stakeholder configuration** approach, i.e. the design of the interactions of the stakeholder of a particular satisfaction-system
- A **system sustainability** approach, i.e. design of such stakeholder interactions (offer model) that continuously seeks new, beneficial eco-efficient and socially equitable, locally based and cohesive solutions

These key elements will be further explored in the following sections.

3.2.1 The design of particular *satisfaction*

The first key point lies in the satisfaction-based approach where the focus is no longer on a single product. It is thus inadequate to merely design or assess a single product, but instead we consider the whole process of every product and service associated with satisfying certain needs and/or desires.

To clarify this concept we can recall the earlier example (UNEP 2002) where the unit of satisfaction was 'having clean clothes', a unit for which we need a washing machine as well as detergent, water and electricity (and the services that supply them), and maintenance, repair and disposal services. The term *satisfaction* is proposed to emphasise the enlargement of the design scope from a single product to the system of products and services (and related stakeholders) that together meet a given demand of needs and desires: in fact a particular **demand for satisfaction**.

The use of this terminology is corroborated by other authors. Meadows (Meadows, Meadows and Randers 2006), for instance, uses satisfaction in a formula[3] to evaluate the limits of growth, in the 30-year update of the previous *Limits to Growth* publication commissioned by the Club of Rome and known worldwide, which had modelled the consequences of a rapidly growing global population and finite resource supplies. Marks *et al.* (2006) argue that among various indicators measuring personal well-being in the framework of transition towards sustainability, satisfaction seems to be preferable.

Finally, in parallel with the introduction of the concept of the *functional unit* (see Introduction) for product *Life Cycle Design*, a **satisfaction unit** could be introduced. If we take the example of a car the following *functional unit* could be defined: the transportation of one person per km (possible with a car). If we consider the

3 In *Limits to Growth: the 30-Year Update* (Meadows, Meadows and Randers 2006) the following formula is used:
Resource & Energy/per year = # of people × (**Satisfaction**/Person – Year) × Resource & Energy/Per **satisfaction**).

satisfaction that a car could provide, we may in fact identify several satisfaction units, for example:

- Satisfaction unit 1: one person having access to her/his working space (per year)
- Satisfaction unit 2: one person having access to public services delivering personal documents (per year)

The concept of a satisfaction unit therefore requires an approach that is at the same time:

- Wider (more products, services, stakeholders to be considered)
- Narrower (looking at one final customer satisfaction)

In the words of Ehrenfeld (2008) a satisfaction approach in design 'is to think more on being (satisfied), rather on having (products to be satisfied)'.

3.2.2 The design of stakeholder interactions

The second key task is to introduce a *stakeholder configuration* approach. If we want to design the *stakeholder interactions*, the system design approach should project and promote innovative types of interactions and partnerships between appropriate socio-economic stakeholders, while responding to a particular social demand for satisfaction.

To clarify this approach we can again recall the example of clean clothes, where the innovation involves all the different socio-economic stakeholders in this satisfaction system: the washing machine and detergent producers, the water and electricity suppliers, the user and those responsible for maintenance and disposal.

To visualise the mode of approach it may be useful to think of and draw a parallel with the design questions that more typically concern a *traditional* designer, who in designing a product defines the technical, performance and aesthetic characteristics of its components and its connections, in order to describe the configuration of the product components that are not characterised by materials (with specific performance functions) and by their connection systems (joining elements). In this way a systems designer for sustainability must imagine and promote innovative types of *connections*—partnership/interaction—between appropriate components—socio-economic stakeholders—of a system responding to a particular social demand for satisfaction. In other words the components of a satisfaction system are characterised by socio-economic stakeholders (with their skills and abilities) and by the interaction occurring between them (partnerships, or more generally, interaction). Therefore designing the configuration of a system means understanding who the best stakeholders (components) are and what the best interrelationships (connections) are.

Figure 3.1 shows a PSS design tool, the *stakeholder system map,* as an example of a design and visualisation tool focused on and aimed at facilitating a stakeholder configuration design.

Figure 3.1 **Stakeholder system map, in this example related to eating satisfaction within a university campus canteen**

3.2.3 The design of a sustainable stakeholder interaction system

It must be re-emphasised that, as stated in the previous chapter, not all system innovations are eco-efficient and/or socially equitable and cohesive. We must remain critical and reflective, in order to avoid the intuitive assumption that any obtainable PSS innovation naturally carries the potential for sustainable development.

For this reason, in terms of the development of new systems it is expedient to operate and adopt appropriate criteria and guidelines. This brings up the great importance to study cases, methods and tools to manage and orientate the design process towards sustainable stakeholder interactions/relationships.

In the clean clothes example, the new stakeholder system configuration could be e.g. towards a pay per wash system (unit satisfaction) and include home delivery of a washing machine (not owned), electricity supply (not directly paid), water supply (not directly paid), detergent supply (not directly paid), maintenance, upgrading and end-of-life collection. The innovative interaction between the companies

and the client drives the companies' interest to design and provide highly efficient (for energy, water and detergent), long-lasting, re-usable and recyclable washing machines.

These approaches require skills and abilities that are relatively new for a designer, but as we stated earlier they are connected to the disciplinary area known as *strategic design* (e.g. Manzini, Collina and Evans 2004), an area already endowed with its own body of theory and its own methods and tools.

For this reason the expression *strategic design for sustainability* has been brought into use (Manzini and Vezzoli 2001). As such considerations give rise to a convergence of *Product-Service System Design for Sustainability* with both *strategic design* and *product Life Cycle Design,* it has also been argued (Brezet *et al.* 2001; Manzini and Vezzoli 2001) that design for environmental sustainability must use and integrate the methods and tools of strategic design (and vice versa).

From this perspective on design, which takes into account all simultaneously active socio-economic stakeholders, designers must likewise equip themselves with the necessary skills to operate in a participatory design context (i.e. among various entrepreneurs, institutions, NGOs, associations and services) for system development that includes the offer (products and services).

As far as design practice is concerned, the first design methods and tools described here have been developed since the beginning of the 2000s, thanks to a series of EU-funded research projects, such as tools for the development of sustainability design-orienting scenarios, for the strategic convergence of different stakeholders, for interaction designing and for the generation of highly sustainable systems ideas. In Asian contexts, educators have been developing and testing tools and frameworks appropriate for and sensitive to local conditions and cultures.

A developed methodology and related tools are presented in Chapter 4.

3.3 Design criteria for and examples of system eco-efficiency

It has been already observed that not every system innovation is eco-efficient. Accordingly it is important to adopt appropriate criteria and guidelines as well as methods and tools for embedding them when designing a new system, in order to steer it towards a sustainable solution. Here we therefore propose several design criteria for system eco-efficiency.

As a starting point, as defined in the MEPSS[4] EU research project, six criteria can be listed according to their orientation towards eco-efficiency:

4 Developed in a European research project entitled MEPSS, Method for Product-Service System development, funded by EU, 5FP, Growth.

1. System life optimisation (section 3.3.1 below)
2. Transportation/distribution reduction (section 3.3.2)
3. Resource reduction (3.3.3)
4. Waste minimisation/valorisation (3.3.4)
5. Conservation/biocompatibility (3.3.5)
6. Toxicity reduction (3.3.6)

An organic set of guidelines developed within the LeNS project[5] for each of these criteria is presented in the appendix.

For a particular unit of satisfaction (e.g. having clean clothes as in the example mentioned), some criteria (and their related guidelines) have higher relevance than others when reducing the environmental impact (e.g. resource reduction and toxicity reduction have a higher priority compared to the other criteria). Therefore in a decision-making process (i.e. designing) it is important to identify the (eco-efficiency) design priorities: namely, the (relative) criteria most relevant in relation to the existing mix of products and services fulfilling a particular satisfaction unit, and which innovative stakeholders' interaction models are most promising with regard to meeting those criteria.[6]

The following sections will present these criteria together with examples.

3.3.1 System life optimisation

System life optimisation refers to the design *of stakeholder interactions* for a particular satisfaction *system* leading to **extending** the sum of the products' **lifespan** and **intensifying** the overall sum of the products' **use**.

A product with a *longer lifespan,* with otherwise similar functions, will generally secure a lesser impact on the environment. A product with a shorter life span will not only generate untimely waste (when the other is still functioning) but will also entail further impact due to the need to replace it (see Figure 3.2). Pre-production, production and distribution of the new product, which would cover the functions of the old one, induce further consumption of resources and creation of emissions. Figure 3.2 compares two products with the same functions but with different lifespans and shows in which precise phase it is possible to avoid these impacts. In other words, if we deliver a product with a longer lifespan compared with one with a shorter lifespan we avoid the impact occurring in the pre-production, production, distribution and disposal phases (see the upper part of Figure 3.2).

5 The LeNS project also developed and tested several other tools and guidelines that were sensitive to local particularities and cultural values. These approaches are described in more detail in Part 2 of this volume.

6 See e.g. Part 1, Chapter 4, Section 4.3.1 Sustainability Design-Orienting toolkit (SDO).

Figure 3.2 **Environmental advantages of a product (system sum) with a longer lifespan**

With regard to the usage stage, in reality extending the lifespan does not necessarily determine an overall reduction of the impact; on the contrary, there could be an increase if the new products are environmentally more efficient. In other words, for some products that have the greatest impact during usage, there could be an optimal length of lifespan. While providing the same service, technological development can therefore offer new, environmentally more efficient products (involving less consumption of energy and raw materials or emission reduction), and there would come a moment when the pre-production, production and distribution of a new product (and the disposal of the old one) would pay off, in terms of the environmental impact balance sheet, due to better performance during the usage stage.

Thus, there is a potential limit for the length of the lifespan, a breakeven point at which replacing the product with a new one (that provides the same service) results in less of a global impact. More precisely, the impact created due to the production/distribution of the new product and disposal of the outdated product is smaller than the reduction due to enhanced efficiency of the new product during use. The main candidates for longer lifespans are goods that consume fewer resources (energy or materials) during utilisation.

Let us look at the more critical case of products that consume large amounts of resources during usage and maintenance, for example, motor vehicles and home appliances. In these cases an interesting strategy could develop that would condition substituting only the components that determine consumption, i.e. enabling their replacement with new components embedding new technologies with lower use consumption. Thus, there would be no need to pre-produce, produce, distribute and dispose the entire product, but only those parts that would decrease the overall environmental impact (Figure 3.2).

Finally, on a system perspective (where we have more than one product) we have to consider the overall and interlinked environmental impacts of the whole of the product's or support products' (system sum) life duration and the potential to avoid environmental impacts.

Optimising the environmental system life can be achieved through *intensifying* the *usage* of the products.

Any product used *more intensely* than other similar ones leads to a reduction in the actual number of those products at a given moment and place, while still answering the demand of their performance: this also determines the reduction in environmental impact. Let us clarify this concept with the help of some diagrams.

Starting with Figure 3.3, which assumes that the lifetime is independent of the actual usage of the product, let us imagine (see above the 'usage in time' arrow) that the product was intensely used by Andrew in periods A1, A2 and A3, by Bernard during B1, B2 and B3 and by Charlie in periods C1, C2 and C3.

Now let us imagine (see under the 'usage in time' arrow) another scenario where every participant has their own product and they use it during the same periods (assuming equal functionality). Schematically, it follows that the main impact is during the pre-production, production, distribution and disposal phases of the additional products. This is true only in the case when a product's lifetime does not depend on the time of actual usage, for example, due to obsolescence.

In other words, if products are used more intensely, their useful lifetime will pass faster without raising the global amount of products and their disposal. Thus, the more occasional the normal usage of the product and the higher its obsolescence (technological or aesthetic), the more the additional production can be reduced while still satisfying the same needs. Indeed, more intensive usage in general leads to a shorter absolute (time between acquisition and disposal) lifetime, but, on the other hand, it increases the time of effective usage (and reduces disposal due to obsolescence).

Figure 3.3 **Environmental advantages of intensifying the usage of the product's system sum (lifespan not dependent on the length of use)**

Let us turn to the case when a product's durability is related (inversely proportionally) to the actual usage, meaning that more intensive usage will effectively shorten its lifespan. Let us take the previous diagram and extend the timeline. Still reasoning with equal functionality (in these two scenarios Andrew, Bernard and Charlie use the products for the same periods of time), we must imagine the substitution of intensely used products (in Figure 3.4 we imagine two substitutions on top of the 'usage in time' line). However, in this case the environmental advantage results solely from the potential of technological progress (greater effectiveness of the pre-production, production, usage and disposal phases) that has become available.

Therefore, one outcome lies in the potential appearance of alternative technologies (with the possibilities of reducing impacts), without increasing the number of additional products to satisfy the same needs.

Moreover, we can also take the intensification into proportional account with the quantity of goods that are produced but not sold. In other words, the smaller the excess, the greater the intensity with which we use a certain productive batch.

Figure 3.4 **Environmental advantages of intensifying the usage of the product (lifespan dependent on the length of use)**

In qualitative terms, an existing system presents problems related to lifespan optimisation when:

- A disposable product or disposable support products are used
- Disposable packaging is used
- Parts of the system tend to be technologically obsolete
- Parts of the system tend to be culturally/aesthetically obsolete
- Some parts of the system tend to wear out more easily (than others)

PSS example of system life optimisation

EGO, Ecologico Guardaroba Organizzato (Organised Ecological Wardrobe)

EGO is an Italian company with two outlets in Brescia and Milan where they offer a system for the shared use of clothes between a closed number of women.

The user, after subscribing, selects 14 clothes (from a sample book) to be inserted in the 'shared wardrobe' (presently the 'shared wardrobe' includes 120 models, divided into eight different styles). Once a week the user goes to the outlet, chooses and withdraws seven pieces of clothing, and at the same time gives back the clothes used during the previous week. The member pays an annual registration fee of €170 plus a monthly subscription of €130. EGO takes care of washing and maintaining the clothes. EGO not only manages the service but also designs the clothes and manages the manufacturing (externalised to Italian companies).

The main environmental benefits are seen in the fact that a clothing sharing system basically intensifies the use of clothes, meaning that a lower number of clothes are needed in a given context for a given demand of clean clothes (system life optimisation through use intensification); in addition, since the producer/provider owns the clothes, they are economically interested in extending their lifespan in order to postpone the maintenance costs and costs for the disposal and manufacture of new products (system life optimisation through product life extension). As a consequence of the system life optimisation, there is a reduction in resources in terms of materials and energy used to produce, transport and dispose of the clothes. In addition the washing of clothes is done using high-efficiency washing machines (since this activity is managed by EGO, they are incentivised to reduce the cost of each single wash, therefore reducing the amount of energy and detergent used). On the other hand it has to be underlined that, compared to the traditional situation in which the user owns the clothes and manages the washing, in the EGO system the number of washes is higher (because clothes are washed after one single use).

3.3.2 Transportation/distribution reduction

Transportation/distribution reduction denotes the design of *system stakeholders' interactions* leading to a reduced amount of transportation and packaging. This type of innovation could be enabled for example by creating partnerships that optimise: long distance activities (use, maintenance, repair), use of local resources (info/data transfer), on-site assembly or production (info/data transfer), and/or remote controlling for maintenance/repair of products.

In qualitative terms an existing system presents problems related to transportation or distribution when:

- There is excessive transportation of goods
- There is excessive transportation of semi-finished products or by-products
- There is excessive transportation of people
- The transportation means in service are not fully used

PSS example of transportation/distribution reduction

Lampi di Stampa - book on demand

Lampi di Stampa offers a book-on-demand service in Italy based on a digital process comparable with offset printing. The innovation implies a transition from traditional offset printing to print-on-demand (i.e. digital). Offset technology involves the production of physical plates as well as the logistics for the delivery and stocking of the books. Digital print technology, on the other hand, essentially entails only one operation, printing the book directly from the file very near or even at the point of sale, hence avoiding several production and logistic phases. The environmental advantages are connected to the reduction in transport, the dematerialisation of some phases of the printing process, and the drastic reduction in the number of copies destined for maceration. In economic terms the print-on-demand process offers a guarantee on the book's presence on the market, depending on the number of orders; an avoidance of warehousing costs; and a guaranteed low-cost modification, meaning that authors can much easier publish their work. The reader can buy books at a low cost, find rare texts or batch editions, and personalise the book to his preference.

3.3.3 Resource reduction

Reduction of resources refers to the design for system stakeholders' interactions that reduce the sum of the resources used by all products and services of the system.

Materials and energy, albeit with different intensity for different products, are used throughout the entire life cycle. For that reason the design approach must aim at reducing consumption of resources at all stages, including design and management activities. It is obvious that a reduction in the use of resources determines the avoidance of environmental impact regarding what is no longer used. Using less material diminishes impact, not only because fewer materials are manufactured, but also due to avoiding their conversion, transport and disposal. In the same way, lower energy use diminishes impact, thanks to a smaller amount of energy that has to be produced and transported.

Finally, from a systems perspective we have to consider the overall and interlinked material and energy reduction of the whole of the product assortment or support products needed to satisfy a certain demand related to needs and desires.

An existing system presents problems in qualitative terms related to amounts of resources when:

- The system consumes high quantities of energy
- The system consumes high quantities of natural resources or absorbs high quantities of consumables
- The products, packaging or support products are highly material intensive

PSS example of resource reduction

Cleaning wiper service—MEWA Textil-Management

MEWA's full service provides reusable cotton wipers to industrial companies, printing plants and repair shops. The textile management system enables its customers to return soiled cleaning wipers. It involves delivering, collecting, washing and replacing wipers. At agreed delivery intervals, the service drivers exchange the soiled textiles for clean ones, which are delivered in special safety containers. After being washed at MEWA's state of the art laundries, the wipers are delivered again. Every wiper may go through this cycle up to 50 times. Although cheap throwaway cloths are available on the market, rising disposal costs for heavily soiled single-use cloths make the MEWA service a very attractive option. In fact, MEWA is now the market leader in the cleaning wiper industry in Germany. The company has not only improved its service but also the material cycles involved. The solvents present in the returned wipers are used in the cleaning process. Water is reused several times sequentially through the washing and drying stages, and the oil present in the waste water is recycled and used to generate energy at the MEWA plant. After being treated at the MEWA plant, the waste water is clean enough to be accepted by normal municipal waste water treatment plants.

3.3.4 Waste minimisation/valorisation

Waste minimisation/valorisation entails the design for system stakeholders' interactions to improve the total amount of the system's recycling, energy recovery and composting and reduce the total amount of the waste produced.

We use the term *recycling* when secondary raw materials are used to manufacture new industrial products and composting when secondary raw materials are made into compost. In addition, waste that can be reintroduced into production cycles at added value, i.e. valorising the waste, can be taken into consideration already early in the design process.

In all these cases the environmental advantage is doubled (see Figure 3.5). First we avoid the environmental impact of disposing of materials in landfills. In the second place resources or energy are made available for production avoiding the impact from the extraction and processing of a corresponding quantity of materials and energy from virgin natural resources. The impact of these avoided processes can be considered as an indirect environmental advantage.

Finally, from a system perspective we have to consider the overall and interlinked (or eventually added) environmental impacts that we can avoid, of all the products or support products needed to satisfy a certain demand.

Figure 3.5 **Environmental advantages of extending the lifespan of materials of all products and support products of a certain system of satisfaction**

A clarification on materials' recyclability must be provided: it is common to hear that a certain material is 100% recyclable. Often these statements have no meaning. In fact, in one way or another nearly all materials are recyclable. Therefore reconcilability obviously depends on the specific material's characteristics, namely the performance's recovery potential and the relative costs: e.g. metals recover their performance better than plastics after recycling.

However the recyclability also depends on the way a material is 'fitted' into a product, if it is easy to separate it from others: we can say that it depends on the

product's architecture. We could have a material capable of well recovering previous performance but very difficult and not convenient to be separated from others. Here they cannot be called recyclable materials.

Similarly recyclability depends on every recycling phase, beginning from collection and transportation. We could have a material capable of recovering its performance, easily separated from others, but much too costly to be collected and transported to the recycling sites, meaning that they are not recyclable materials.

An existing system presents problems in qualitative terms that are related to waste minimisation and valorisation when:

- The products of the system produce high quantities of landfill waste at the end of their service-life
- The packaging and support products produce large quantities of landfill waste

PSS example of waste minimisation/valorisation

Pay Per Page Green—Ricoh

Ricoh offers a package deal (Pay per Page Green) and installs, maintains and collects at the end-of-life the printers and photocopiers (not owned by the customer); the customer pays for the number of delivered pages and copies. The *innovative interaction* between the company and the client provides the company's economic interest to provide (and design) long-lasting, re-usable and recyclable photocopiers.

Components are tested and functional parts are re-manufactured or directly re-used in a new photocopier. Damaged components are directed to material recycling. Ricoh products are designed to allow component compatibility between different models and to facilitate the whole processes of re-using or re-manufacturing.

3.3.5 Conservation/biocompatibility

Conservation and biocompatibility entails the design for system stakeholders' interactions that improves the overall amount of the system's resource conservation or renewability.

An explanation is needed on resource renewability. Timber is a renewable material, but the same type of wood can be procured from two different areas, where one is under planned and controlled exploitation and the other not, leading to deforestation. The very same material can qualify as renewable in the first case and not renewable/non-reproducible in the other case. It can be summarised that renewability depends on specific re-growing speed and extraction frequency. Therefore we can define that:

> a resource is renewable when the consumption rate is smaller than the natural re-growing rate.

Finally, from a systems perspective we have to again consider the overall and interlinked level of renewability of all the materials, products or support products needed to satisfy a certain demand.

An existing system presents problems in qualitative terms related to conservation and biocompatibility when:

- All the energy produced is derived from exhausting resources (e.g. fossil fuels)
- The system uses depleting and/or non-renewable materials for products, support products, packaging, and infrastructure

PSS example of conservation/biocompatibility

Qurrent, the Netherlands

Qurrent's mission is to create an energy-neutral society. Therefore, Qurrent stimulates fair, clean and local energy consumption. It aims to change consumer behaviour. As times are changing, people more and more feel the need to be independent and are open to build decentralised energy communities. Qurrent offers them the opportunity to make their own choice, generate their own energy and use less energy. As a result consumers become independent.

Changing customer behaviour starts with knowing what the actual energy consumption is and what the standard of an average household is. 'Mijn Energie' offers this insight on a daily, weekly, monthly and yearly basis. The Qbox also registers the performance of solar panels. The data is collected via the Qbox.

To enable customers to consume less energy Qurrent also supplies solar panels, insulation and energy saving products such as LED lights. As Qurrent is an advocate of independence, the Qbox is easy to install and works with every energy company.

The benefits of the Qbox:

- Savings of up to 10% on your energy bill
- Easy to install yourself
- Compatible with any energy supplier you have
- Insight into how your solar panels perform
- Comparisons with other households

3.3.6 Toxicity reduction

Reduction of toxic emissions involves the design for system stakeholders' interactions that reduce or avoid the gross total of toxicity and harmfulness among the resources utilised or emitted by the system.

Regarding this criterion it is important to remember that a truly effective approach must always refer to the entire life cycle and to every concurring process of the whole of the products and the support products of a particular system of satisfaction. This means that various technologies for transforming and treating materials (some of them involving toxic or noxious emissions while others, equally effective, might not) have to be considered along with distribution systems that cause the least harm to the environment and products designed to use energy and consumable resources less invasively. Finally, we must orientate our choice of materials (and additives) towards minimising the emissions that occur during disposal.

To illustrate materials' environmental impact, we have to understand that except for toxic materials (such as asbestos, which must be avoided) the environmental impact depends upon both:

- The material-specific characteristics, and
- The product-specific characteristics

Let us take as an example a composite material such as a polymeric matrix filled with fibres. Though it is used to manufacture disposable dishes, it is a bad material in terms of environmental impact, since it causes many problems in the disposal phase and is resource-intensive in production.

On the other hand, the same composite material could have a lower environmental impact if used to produce some parts of a product needing to be transported, having the greater impact in the usage phase due to e.g. fuel consumption. While this material is probably lighter than others, it will, by reducing the overall weight, reduce the whole transportation consumption. Therefore it may also be a good or at least better material in environmental terms.

For this reason alone it would be misleading to propose a scaled environmental impact ranking of different materials.

Finally, from a systems perspective we must consider the overall and interlinked toxicity of all the materials and processes and all the products or support products needed in satisfying the particular demand.

An existing system presents problems in qualitative terms related to toxic and harmful resources when:

- The processed resources are toxic or potentially toxic for the workers
- The processed resources are toxic or potentially toxic during distribution
- The processed resources are toxic or potentially toxic for the user
- The products, support products, packaging or infrastructure are toxic or potentially toxic during after-service treatments

PSS example of toxicity reduction

Chemical distribution: Dow Chemicals

The Safe-tainer System is a closed-loop delivery system that combines the supply of fresh chlorinated solvents—trichloroethylene, perchloroethylene and methylene chloride—and the collection of used solvents with the professional management and disposal of the waste. The Safe-tainer System includes double-skinned containers that protect the solvent and the waste from accidental damage during transport, handling, storage and use of the containers. The container is actually a drum within a steel container that is fitted with special leak-free couplings to prevent spills, leaks or vapour emissions during use. There are two types of containers: Safe-tainer for fresh solvent, designated for the transport of virgin solvent of the same product and grade, ensuring highest product quality; and Safe-tainer for used solvent, designated for the collection of used solvent (waste) out of the cleaning equipment at the end-use customer, preventing any accidental exchange with the container for fresh product. Dow delivers virgin bulk solvent to filling stations, normally located at the distributor's site, where it is stored in tanks and poured into Safe-tainer containers. The distributor delivers the container for fresh solvent together with the one for used solvent to their customer. The customer connects the container to his cleaning

equipment (degreaser or dry cleaning machine) using special connections. The used solvent is pumped into the designated containers, which are collected by the distributor when full. The waste is extracted from the containers, collected and sent to a recycling station for professional management, i.e. recycling of the used solvent and the disposal of the distillation sludge. The recycled material is re-stabilised and returned to the market at a lower cost than virgin solvent. The Dow subsidiary SafeChem Germany manages the delivery, collection and recycling of the chlorinated solvents using the Safe-tainer product in Europe. SafeChem supplements the Safe-tainer system with educational training for its clients on the optimisation of application use for chlorinated solvents as well as correct methods for handling and recycling. It is the management of the Safe-tainer system through SafeChem that is key to the system innovation. The Safe-tainer system was introduced to help meet customers' needs by virtually eliminating emissions to the environment. Due to environmental legislation and the decline in chlorinated solvent use in Germany, Dow Chemicals Germany entered into a joint venture with a recycling firm, RCN, to form the company SafeChem. The Safe-tainer system was specially designed for SafeChem to allow companies that use the chlorinated solvents in metal and surface cleaning lines to handle the solvents safely and to meet both the performance and environmental demands of their operations. With this system, chlorinated solvent users can improve their solvent operations by implementing safer handling of solvents and effective waste management.

3.4 Design criteria for and examples of social equity and cohesion

PSS presents an opportunity to couple eco-efficiency with social equity and cohesion, as we argued earlier in this volume.[7] Nevertheless, not all system innovations are socio-ethically sustainable. Thus it is important to study cases, develop criteria and guidelines as well as methods and tools, and embed them to manage and orient the design process towards socio-ethical solutions.

In response to this, a set of criteria for designers was developed that serves as one starting point towards ensuring socio-ethical sustainability:[8]

1. Improve employment/working conditions (see section 3.4.1 below)
2. Improve equity and justice in relation with stakeholders (3.4.2)
3. Enable responsible/sustainable consumption (3.4.3)
4. Favour/integrate the weak and marginalised (3.4.4)

7 See Part 1, Chapter 2
8 See the SDO toolkit (www.sdo-lens.polimi.it).

5. Improve social cohesion (3.4.5)
6. Empower/valorise local resources (3.4.6)

A set of guidelines developed for each of these criteria is presented in the appendix.

For a given satisfaction system, some criteria (and their related guidelines) have higher relevance than others. Therefore in a decision-making process (i.e. designing) it is important to identify the socio-ethical design priorities by determining the relative relevance and/or *appropriateness* of each criterion for each system type, meaning the most promising stakeholder interactions.[9]

The following sections will present these criteria together with some examples.[10]

3.4.1 Improve employment/working conditions

When speaking about employment/working conditions we mean a system design that promotes and enhances these conditions (within the enterprise but also at suppliers), e.g. job security, health and safety at work, adequate working hours, fair wages, and conditions enhancing the satisfaction, motivation and participation of the employees.

The role of the designer may be marginal in this case: employment and working conditions are issues determined by company goals and requirements. Nevertheless the designer must be aware of relevant issues and active when possible in terms of enhancing, through e.g. various communications means, fair employment and working conditions.

An existing system presents problems related to employment/working conditions in qualitative terms, when:

- There is forced or child labour
- There are problems with occupational health and safety
- There are problems of discrimination in the workplace
- There are problems with work overload or inadequate wages
- There are problems with freedom of association and right to collective negotiation

9 See Part 1, Chapter 4, Section 4.3.1 Sustainability Design-Orienting toolkit (SDO).

10 The collection of cases of the European research project EMUDE, *Emerging User Demands for Sustainable Solutions,* has provided much valuable information.

PSS example of improving employment/working conditions

Sustainability Accountability, SA8000® certification

Social Accountability International has established one of the world's preeminent social standards—the SA8000 Standard for decent work, a tool for implementing international labour standards—that has improved the lives of over a million workers. SA8000 guides employers to consider the importance of each job and to recognise the equal dignity of each person involved in the supply chain, from the worker to the retailer to the consumer. The SA8000 Standard leverages the power of business and consumer to purchase products made from workplaces that enrich, not denigrate, the livelihoods of people.

Benefits for workers, trade unions and NGOs are:

- Enhanced opportunities for organising trade unions and collective bargaining
- A tool to educate workers about core labour rights
- An opportunity to work directly with business on labour rights issues
- A way to generate public awareness of companies committed to assure humane working conditions.

Benefits for business are:

- Enhances company and brand reputation
- Improves employee recruitment, retention and productivity
- Supports better supply chain management and performance.

Benefits for consumers and investors are:

- Clear and credible assurance for ethical purchasing decisions
- Identification of ethically made products and companies committed to ethical sourcing
- Broad coverage of product categories and production geography

3.4.2 Improve equity and justice in relation to stakeholders

Equity and justice in relation to stakeholders refers to design promoting and enhancing fair and just relations (outside the enterprise): within the partnerships, upstream, downstream and in the community where the offer takes place. It includes for example promoting and enhancing fair and just partnerships; equal and just relations with suppliers, subcontractors and sub-suppliers; equal and just relations with clients and/or end-users; equal and just relations affecting the community where the offer takes place; and equity and justice with local institutions/agencies.

An existing system presents problems related to equal and just relations between stakeholders, when:

- There are stakeholders criticising the supply system
- There is a client/final user criticising the supply system
- There are unjust relations between the partnerships
- There are unjust relations with suppliers, subcontractors and sub-suppliers

PSS example of improving equity and justice in relation to stakeholders

CTM Altromercato Consortium, for fair trade

Established in 1988, Altromercato is the main Italian body for fair trade organisations and the second largest worldwide; it is made up of 118 cooperatives and non-profit associations that manage 300 Botteghe Altromercato (World Shops) in Italy. Botteghe Altromercato are locations where fair trade products are offered and information and education is given. Fair trade is based on a 'fair' price paid to the manufacturer and on an equal relation between small groups of democratically organised manufacturers and Altromercato purchase central. Altromercato is registered with the World Fair Trade Organization and today collaborates with 170 organisations in 50 countries, involving local artisans and farmers. The project stands for respecting manufacturer rights and facilitating trade with emerging and low-income countries. Altromercato guarantees equitable prices on products according to real production costs and salaries, promoting continued cooperation in commercial activities, fostering production of organic produce, while promoting projects dedicated to social and environmental development. Altromercato products include handmade products, clothes, food, and cosmetics which can also be found in supermarkets, local shops, bars, herbalists and other services. In 2010 Altromercato launched a new brand

Solidale Italiano Altromercato, dedicated to domestic fair trade. Altromercato will soon open an online shop.

3.4.3 Enable responsible/sustainable consumption

To enable responsible and sustainable consumption entails a design promoting and enhancing responsible and sustainable client or final user choices or behaviour. This can involve for example making transparent and enhancing the social sustainability of all the stakeholders, providing the information and/or learning experiences to educate the client or end-user on responsible/sustainable behaviour, developing offers that enable responsible/sustainable participation of the client or end-user, or involve the client/end-user in the design, decision process, production, implementation, and/or customisation of his/her own product-service system towards responsible/sustainable behaviour.

An existing system presents problems related to responsible and sustainable consumption, when:

- The client/final user is not able to acknowledge clearly and easily the social (un)sustainability along the whole value production chain
- The client/final user is not able to understand responsible/sustainable behaviour by the supply system

PSS example of enabling responsible/sustainable consumption

Solar panel self-building courses by Tattle group

The Tattle group organises courses on solar panel assembling in Italy. At the end of the course, the students can design their own solar plant and ask the Tattle group to order materials. In order to reduce transportation expenses, the group addresses their supplier—the Austrian AEE cooperative warehouse—only when a fair number of orders has been accumulated and delivers them to the users in one supply schedule. During the course a handbook that includes

software for plant design is available, compiled by the same AEE cooperative. These workshops aim to make solar energy technologies more accessible, while reducing the plant cost by up to 50% with the average price of 2,600 euros, and they train self-sufficient users who are in this way able to save on design, building and maintenance and to spread ecological conscience and awareness.

3.4.4 Favour/integrate the weaker and marginalised

When speaking about favouring and integrating the weaker and marginalised, we mean a system design promoting and favouring (in order to integrate) people such as children, the elderly, the differently abled, the unemployed, the illiterate or any other minority or marginalised social group. This can happen for example by involving and improving the conditions for weaker social strata and marginalised persons, involving and facilitating introduction of foreigners into the social context, developing systems to extend access to goods and services to all social strata, developing systems of shared usage and/or exchange of goods and services to increase their accessibility and developing systems which allow easier access to credit (for companies).

An existing system presents problems related to weaker and marginalised groups when:

- The supply system creates obstacles or limits access to people with weaker social status (e.g. children, the elderly, differently abled, etc.)
- The offering system is not accessible to people with lower incomes
- The offering system favours in some way people's marginalisation

PSS example of favouring/integrating the weaker and marginalised

Co-housing for over 55s—Aquarius, Eindhoven housing society

Aquarius is a community of 45 ageing people in the Netherlands who live in separated but nearby houses, helping one other according to their capacities. The community block is made up of 30 private two-storey houses with a garden, plus a large common room with shared kitchen and a large park. The Aquarius association has, among its duties, that of knowing new potential users and of making a first selection. The preference goes to persons between 55 and 65

years old, active and capable of self-help. Living in a community stimulates social relations and activity; it provides inhabitants with a safe feeling, benefiting themselves and their families; and it lightens some of the heavy care burden off the already stressed public sector.

Image courtesy EMUDE—Emerging User Demand for Sustainable Solutions_ EC FP6

3.4.5 Improve social cohesion

Improving social cohesion denotes a design promoting and favouring systems that facilitate social integration: in neighbourhoods, between generations, between genders and between different cultures. This could happen for example by promoting neighbourhood systems of sharing common goods and maintenance, co-housing systems or co-working systems.

An existing system presents problems related to social cohesion, when:

- The offering system is creating or favouring forms of intra-gender, intra-cultural, or intra-generational marginalisation
- The system is creating/favouring forms of discrimination, e.g. sexual, religious, cultural, or gender

PSS example of improving social cohesion

Flat-sharing between pensioners and students—Associazione Auser Como (Association for self-management and solidarity services), Como, Italy

The project conciliates students' needs (affordable lodging near the university) with those of retired persons (socialisation and fellowship, safety, daily housework help), facilitating communication between people of different generations. The programme provides, for a small payment, the possibility to find lodging in homes of pensioners who live in Como (Italy), for students who are not Como residents. The 'Abitare insieme' project has proved to be an important occasion to promote solidarity and civil economic cohabitation. It is also a way to create interpersonal relations between the aged and youths.

3.4.6 Empower/enhance local resources

Empowering/enhancing local resources denotes a design promoting and favouring systems that regenerate and empower local economies. This could happen for example by respecting or enhancing peculiar local cultural characteristics, developing systems to encourage and foster local economies, regenerating or enhancing unused and discarded artefacts, adapting or promoting systems using regenerated local natural resources, and promoting local-based and network-structured enterprises or initiatives.

An existing system presents problems related to local resources, when:

- The current reference system impoverishes local cultural values and identities
- The current system offers only one solution/few variations for all regions and cultures

- The current system has a negative impact on the social well-being of the local community
- The current system is impoverishing local economies
- The system is absorbing local non-renewable resources

PSS example of empowering/enhancing local resources

Organic food delivered to your home: Local food link Van Group

Local Food Van Link, in association with other groups, helps increase local food production in Skye, Scotland, by distributing produce around the local community. Skye and Lochalsh Food Link is a voluntary association of local producers, caterers, retailers and consumers with an interest in promoting fresh, locally produced food. A shared van links the network and distributes local produce all over the island. The group was initiated in April 2000 by a couple of local producers who decided that rather than delivering every product themselves, they would use a van to drive a set route twice a week, picking up the orders from the producer and delivering them to their customers. By doing so, not only could one save on petrol but also ensure the delivery of local produce all over the island, creating a more sustainable community. The solution both ensures the future of local food producers by distributing their goods and promotes important aspects of economic and environmental community life and the health benefits of locally grown fresh produce. The Skye environment is said to produce some of the best quality food in Britain, free from pollution, genetic modification and other harmful substances. The use of one shared vehicle for a group of 40 farmers clearly minimises congestion and pollution. Detrimental environmental impacts of conventional agribusinesses can be avoided through the promotion of small-scale local production that underpins the notion of healthy and communal living on the island. The consumption of fresh and seasonable food reduces the need for energy for cooling and freezing.

Image courtesy EMUDE—Emerging User Demand for Sustainable Solutions_ EC FP6

3.5 PSS design for sustainability in Asia

3.5.1 PSS design for sustainability in China

It is evident that the future sustainable development of China depends on a radical transformation of the current model of development. China has paid heavy costs for its rapid development over the past three decades, and the ecological crisis and social justice issues have become the most obvious problems. An increasing number of people realise that if the economic development pattern with over-reliance on materialised production and consumption continues, China will inevitably encounter a 'glass ceiling' and reach the limit to its growth in future. In sum, the nation is currently confronting a great crisis, and even the term 'Wei ji' (crisis) in the Chinese language is somewhat mystical, meaning 'danger' but implying 'opportunity' as well.

> To deal with crisis, discussion is important, but action is more important than discussion; action is important, while direction is more important than action. The value guiding our action is a matter concerning the rise and fall of the human being (Sheri 2010).

During this transformation, design innovation based on the idea of sustainable development will play an unprecedentedly significant role. How to construct a theory from Chinese traditional culture, while fit for the contemporary Chinese context, and use it to efficiently instruct innovative system design is a key issue in design research and cultivation of life philosophies and wisdom for the next generation.

In China, even the concept of 'sustainable development' itself is a somewhat exotic concept, a kind of reflection and correction of an unsustainable economic development mode for contemporary Western society: fundamentally a way of thinking that is in essence a subject-object dichotomy. The logic behind it is that since humanity has polluted nature, then humans must govern and protect nature again. However, according to the ancient Chinese thinking of 'harmony between human and nature', human and nature is not a relationship of protection and protected: humanity itself is an integral part of nature. Therefore, if humanity and nature form a symbiotic and harmonious unity, humanity will certainly destroy itself if claiming to be the master of nature.

The concept of sustainability in ancient China is a systematic idea that takes the ecological environment as the core and the harmonious development of mankind and nature as the vision. Accordingly, the core concept of traditional Chinese 'design' can be summarised as the objective to respect heaven and cherish resources, take delight in Tao, value harmony, and stop before going too far. Heaven means 'super nature'; respecting heaven means that 'design' should imitate and follow natural law, make full use of resources and minimise unnecessary waste. 'Tao' is a description of the mighty law of nature in ancient China, and it governs

everything on earth. Thus only by understanding and following the Tao can people gain wisdom and truth and reach an ultimate realm of freedom. 'Harmony' emphasises the social nature of human activities, which is the fundamental principle of traditional value and view of happiness of China. 'To stop before going too far' refers to a consumption concept that encourages a content, cheerful and moderate lifestyle, as the Chinese tradition always shuns excessive luxury. A holistic design approach based on this thinking could truly contribute to humanity's well-being and long-term development.

Current Chinese design theories, for example design Matterology,[11] are deeply rooted in traditional Chinese philosophy, seeking to develop a systematic and comprehensive solution—the way (Tao) of planning matters—rather than focusing merely on materialised product design (see also Xin 2010; Xin and Jikun 2011). This coincides with the current concept of sustainable PSS design. Therefore the essence of Design for Sustainability should be to 'reconstruct the knowledge structure and industry chain, so as to integrate resources and innovate mechanisms, and guide human society to a healthy, rational and sustainable way of living and development' (Guangzhong 2009; see also Guangzhong 2006).

The sustainable development of human society, the earth's limited resources, and constraints on any ideal of infinite expansion of 'individuality', all force us to understand profoundly that the evaluation criteria must be 'appropriateness' and 'moderation': in other words, 'enough is enough', as in ancient Chinese philosophy. 'Wei ji' awareness is a prerequisite for any transformation. In order to deal with crisis and achieve transformation, the opportunity for design in China lies in learning from traditional Chinese wisdom.

3.5.2 PSS design for sustainability in Thailand

In Thailand, the Sufficiency Economy Philosophy (SEP) was first developed by His Majesty King Bhumibol Adulyadej in 1974.[12] The SEP was initiated as an approach toward strengthening Thailand's economic foundation, by assuring that the majority of the population has enough to live on as well as offering a way to avoid various imbalances that cause failures or crisis as found in other countries. It is a generic approach implementable in all areas: from daily life to agriculture, from business to state policy. The philosophy establishes that the SE governs everything from motivation to criteria, to behaviour, and to systems, and addresses all issues within a dynamic setting. Thus its implementation should also be extended to the design discipline. However, applying SEP in the design sector is still relatively underdeveloped.

11 See Part 2, Section 4.
12 See also Part 2, Section 4.

Among the various approaches to Design for Sustainability, Product-Service System (PSS) thinking is comparable to the Sufficiency Economy Philosophy's holistic concept—in the sense that both approaches are concerned with preserving the environment; both favour the development of a system as a whole rather than designing a single product or service; and both set priorities on stakeholder interactions. Notably, while preserving the environment is the inevitable objective, social and economic aspects can never be left out.

Unique aspects of DSE

While the approach of Design for a Sufficiency Economy (DSE) has some similarities to existing DfS approaches, there are aspects unique only to DSE. One of these is the role of designers, which is two-fold. First, DSE helps measure users' behaviour to see whether the existing conduct is compliant with the principles of the SEP. Subsequently, once the designers have observed and identified users' needs, these needs are then prioritised based on the SE principles. The design processes, i.e. of the stakeholder interactions and the components supporting the new system, are then carried out. In other words, the first role of Sufficiency Economy designers is to assess 'how sufficiently our users are conducting their lives at present'. The second role is to put themselves in the company's shoes and explore 'how we (as a company or a service provider) provide a set of products, services or systems that encourage our users to conduct their lives sufficiently'. Simultaneously they ask, 'while doing so, how do we conduct our business to achieve a holistic management of our resources while existing harmoniously with nature and within society?' These roles are achievable by using the DSE's methods, tools and guidelines.[13]

Challenges

The SEP approach is 'strategies oriented' and considered as a means, not the end result. Research on DSE explores how the Sufficiency Economy Philosophy complements design thinking and creates outputs that sufficiently satisfy people in more sustainable ways. Thus the DSE methodology aims to steer the designers' mind-set towards system designing that encourages users to conduct their lives in line with the Philosophy, while the tools and worksheets are used to help designers realise the

13 These guidelines were developed by a group of researchers from the Department of Design, Faculty of Architecture at King Mongkut's Institute of Technology Ladkrabang (KMITL) during the LeNS project period. The group was led by the project manager, Assistant Professor Sompit Moi Fusakul, together with colleagues Praoranuj Ann Siridej and Pwinn Rujikietkhumjron. Section 4 in Part 2 of this volume elaborates upon the SEP and DSE.

concept.[14] The methodology has been tested and further developed in academia and research settings, but thus far only to a limited extent in professional practice.

There are several obstacles to the implementation of the SEP in design that have emerged thus far. The most challenging ones are interpretations and misconceptions. The SEP is considered by many to be an abstract theory for a 'way of living', who therefore find themselves unable to comprehend how the philosophy could be applied in the designing of any products or services. Furthermore, it has been misconceived as a philosophy suitable for guiding rural lives and thus not relevant when it comes to designing for urban lifestyles and business sectors. There is also a misconception that when a person adopts the Philosophy in life s/he must return to the most basic lifestyles and former behavioural patterns, such as growing their own rice, cultivating their own cotton, spinning their own yarn and weaving their own cloth. Such a misconception leads to the misunderstanding that the way of sufficient living clashes with the way of life in modernised cultures.

In fact, the SEP stresses the middle path as an overriding principle for appropriate conduct by the populace at all levels. It enforces the conditions wherein people are to possess honesty and integrity, while conducting their lives with perseverance, harmlessness and generosity. The Philosophy entails ways of thinking that encourage the implementer to be reasonable and be moderate in their actions as well as to develop a resilient immunity, one focused on achieving balance, thus ensuring a readiness to cope with fast or extensive changes. This mind-set should be useful to all conducts and applicable not only in design but also in all areas, eras, cultures and circumstances.

The SEP therefore prepares implementers to meet the challenges and changes arising from globalisation while pointing the ways toward recovery (in case of failure), leading to a more resilient and sustainable economy. This attribute is relevant and challenging, especially in the midst of global threats of destabilised economies, cultural turbulence, environmental deterioration, resource depletion, political turmoil, and so on. The DSE approach is a new interpretation on how the Sufficiency Economy can be applied to the design area, placing the realisation of sufficient well-being within reach.

3.5.3 PSS in India: Gandhi's contributions to design thinking

The Indian contribution to PSS thinking emerges from the knowledge innovations of historic, local movements that challenged the industrial regime of the British Empire and the condition of social and economic oppression it gave rise to. As critical responses, these movements were multiplex, which rejected the new mode of capitalist production, introduced into Indian society by the colonial rulers, as unsustainable on the ecological and political plane. For M.K. Gandhi who

14 See Part 1, Chapter 4 for more details on the DSE methodology. Worksheets and instructions are available for download from the LeNS Tools database (www.lens.polimi.it).

spearheaded the peaceful revolt, serving the poorest person's needs and satisfactions through promoting local manufacture was the key to achieving freedom itself. Clothing and feeding a foreign or urban market while going hungry and naked oneself was morally unacceptable to him in a modern society. Khadi—home-grown, hand-spun and hand-woven cotton cloth—became for him the natural focus of the nationalist Swadeshi or Self-Reliance campaign, serving and providing for the Self, while boycotting the production, distribution and consumption of mill cloths that had invaded Indian markets. PSS thinking, not just practice, remained at the heart of the Spinning Wheel revolution (Brown 2010).

The success of the khadi movement as a political programme for change was presupposed on the sustainability of its praxis and not the other way round. The mass protest it raised to British imperialism was simultaneously questioning the entire product design thinking behind industrial manufacture. Khadi's local, systems approach to social change located 'design' and the designing of products not in the research lab but in the community. The need to re-look and redefine the industrial expert or industrial research professional through 'appropriate' and 'intermediate' technology tools, methods and processes, as they came to be known, was its strong intellectual message to the world, especially all non-Western countries encountering modernity (Prasad 2010).

The model of endogenous innovation demonstrated in the khadi movement not only believed in knowledge as common property but in the production of goods through large-scale people's participation. The revival of arts and crafts initiatives, cooperative systems of rural enterprise, participatory technology innovation and community-based resource use, all an integral part of the khadi movement, served as precursors for contemporary PSS thinking. Recent attempts in India to extend Gandhian ideas to propose an alternate science and technology manifesto have PSS ramifications.[15]

The manifesto suggests the need to design science, technology and industrial policies on the triad of justice (including cognitive justice), plurality and sustainability—all stated aims of PSS thinking (Prasad 2010). The important thing to remember is that business or wealth creation was not left out of Gandhi's programme for change.

Khadi clearly was only one of a continuing tradition of several indigenous knowledge systems, which had, under the rubric of 'development', to contend with obsolescence through modern technology adoption in India. Yet, given the new and complex challenge of climate change today and its disastrous implications for the future, it is these very 'obsolete' knowledge systems which might hold the idea and hope for eventual human survival. PSS initiatives conceived in the west can thus look at design afresh through mutual learning and knowledge dialogues with what

15 See www.kicsforum.net/kics/kicsmatters/Knowledge-swaraj-an-Indian-S&T-manifesto.pdf.

these 'defeated' Asian and European systems have to offer. Outlined below are the various strands of PSS thinking encapsulated in the concept of khadi which continue to have significance for design theory today.

The agricultural model

Gandhi's expressed wish to promote khadi cloth, not in competition with British industry but as an enterprise closer to agricultural production, was indicative of its PSS prefiguring. Khadi's link with village society, which not only grew the cotton but also provided the food for the poor person's subsistence and capacity to labour/serve the nation, was for him absolutely central to recovering India's wealth and subsequent economic freedom from British rule. India, it should not be forgotten, was an early market and trade partner with Britain, the first nation to industrialise, and the pioneering capitalist product—textile—became therefore a worthy battleground for khadi's sustainable alternative. By targeting the villagers' needs, satisfactions and capacities, as the genuine measure of khadi's success, Gandhi brought agriculture and rural society into central thinking on Indian industry.

His notion of spinning as Bread Labour was related to this understanding because even though 'productive bodily labour' related most immediately to agriculture, everyone in modern society was not in a position to take it up and one had to make do with alternatives, always keeping in mind, however, their approximation to the ideal. His confessed learning on the subject of Bread Labour from the Russian writer Leo Tolstoy (himself indebted to the peasant writer T.M. Bondaref) and the English economist John Ruskin is significant in the historical context of British–India relations and the slow but inexorable wiping out of agriculture by industrial capitalism in the developed economies of the west (Gandhi 1960a). A life of labour or artisanal work, all differently argued, did not end with the acquisition of a modern education. In a similar light, modern specialist professions could never completely replace the need for bodily effort with their mental or intellectual achievements. The former remained a necessary corollary to a life of service, and indeed helped free it from purely selfish, livelihood concerns. It was in India however, under the leadership of Gandhi, that these provocative, counter-intuitive ideas of modern times achieved spectacular success through helping achieve a non-violent political freedom from British rule.

It was the emphasis on *service* that brought khadi closer to agriculture as a model for sustainable thinking. As early as 1932, Gandhi had asked himself while imprisoned in a British jail:

> What is the kind of *service* that the teeming millions of India most need at the present time, that can be easily understood and appreciated by all, that is easy to perform and will at the same time enable scores of our semi-starved countrymen to live?

The answer he gave himself and the world was khadi, or: 'the *universalising* of the spinning wheel' (1932: 37) (emphasis added).

Stated in contemporary terms, PSS does not deem manufacture and production alone as prime movers of the economy. Its renewed emphasis on service makes it distinct from mainstream industrial design thinking. By emphasising Bread Labour, Gandhi was only pre-figuring Europe's eventual recognition of sustainability as a possibility to be reclaimed from its own agricultural past.

The business idea of trusteeship

Interestingly, Gandhi's discussions on sustainability retained a space for business and the necessity for the creation of wealth in Free India. By arguing that the rich do not truly 'own' their wealth but are only trustees of it, meaning thereby that they have to manage business profits for the benefit of the community, Gandhi kept capital and capitalists central to his programme for political and social change (1960b). Clearly, the fundamental idea behind the concept of trusteeship was about equity and sustainable growth, not simple-minded charity or philanthropy. The challenge of this concept therefore, and the difficulty faced in adopting it, lay in the radical re-arrangement of society it called for.

Inequality and distinction of rank was not restricted to only differences in the quantum of material possessions owned by the rich and the poor but the perceived capacity of the former to live on the services of others without labouring themselves. Giving up wealth in trust was consequently difficult because it entailed the simultaneous giving up of an entire way of life. Gandhi canvassed for a voluntary change in this mind-set when he addressed the rich and exhorted them to accept the obligation of productive, i.e. Bread, labour. Even a millionaire, he argued, could not be completely inactive and routinely induced hunger through exercise, in order to eat. Why, then, should the rich not labour productively for some portion of the day and remove the basic underlying inequity in society by sharing in the life of the vast majority?

> There is a worldwide conflict between capital and labour and the poor envy the rich. If all worked for their bread, distinctions of rank would be obliterated; the rich would still be there but they would deem themselves only trustees of their property and would use it mainly in the public interest (1932: 22).

When viewed from this lens, a trusteeship approach is a precursor of CSR or corporate social responsibility which today in management circles puts emphasis on reconfiguring social and business structures so that people feel both individually empowered and inclined to act in the common interest. Rejected in independent India as idealistic and based on irrational principles of self-sacrifice, trusteeship has today re-emerged as a valid corporate mission, to meet the challenge of a destabilised and valueless economic and financial system that controls us. Put

very simply, trusteeship asks for a change of perspective on what it means to be wealthy or the owner of capital. It does not deny the role of wealth and capital in today's world for building sustainable institutions but changes the focus of surplus wealth or profit to serving the public good, after satisfying one's own needs. The latter, it is argued, is a prerogative of the capitalist and poor farmer alike who must keep a certain proportion of food and cotton grown, for the Self, before selling to others. Without this injunction, clearly, the khadi movement would not have touched the lives of the agricultural, labouring poor and become the mass movement it did.

Historically, even trusteeship, like CSR, did not mean re-distributing goods through welfare and philanthropy but changing the very structures of capitalist business and industry in such a way that they raised the economic value of social consciousness. A typical recent example is the fair trade movement to which many advanced economies are signatory. Equally, the power of trusteeship is evident in the Global Compact of 2000,[16] introduced by Kofi Annan who helped establish it as Secretary-General of the UN. This argued for businesses to move beyond profit as a measure of value, to metrics that take non-financial aspects into account—putting a new onus on the ability of economists and policy planners to manage and measure progress. As Gandhi had earlier similarly argued, 'True economics stands for social justice, it promotes the good of all equally, including the weakest, and is indispensable for a decent life.'

If equitable distribution of wealth was the measure of an economy's success, rather than the current standard which encourages high income disparities, trusteeship builds a case for CSR being embedded within the very business values of the private sector, wherein distribution of wealth is not about charity but about sustainability. By ensuring basic human dignity, businesses no longer see themselves as distinct from society, nor as serving the interests of production and distribution alone. Even innovation is to be viewed as a social process and user-driven (von Hippel 2005).

With the tempering of capitalist self-interest with social consciousness or responsibility as it is known today, the business idea of trusteeship becomes integrally linked to service provision and not goods accumulation—fundamental tenets of PSS thinking. Inherent too in the trusteeship philosophy are PSS solutions to many of the challenges of the 21st century (Rana 2010):

1. Consuming only what is enough for one's needs without ignoring the needs of others
2. Viewing natural resources as a trustee, where what has been freely provided by nature is taken care of for future generations

16 www.unglobalcompact.org

3. Equitable distribution of goods and services, so people who work for industry and society at large are taken care of
4. Achieving human dignity and growth through satisfaction and well-being, not capital accumulation

The Hindu theory of Varnashrama

Finally, Gandhi's interventions in the industrialism of modern life sought to clarify the theoretical principles underlying the concept of Varnashrama in Hinduism, as a reminder of the socially embedded nature of the economy (Granovetter 1985). He was strongly against the caste customs that engendered 'execrescences' like untouchability, based on the permanent divide between mental and physical or bodily services. But Varnashrama, as a model, held out truths that for him were ecologically, morally and socially sustainable (Gandhi 2009).

Sociologists and environmentalists today are beginning to see Hinduism's caste rules not as rigid monopolies on one's own family work traditions and taboos on others but as a system of self-imposed restraints, which over time curtailed natural and human resource-use and helped conserve regional eco-systems. Madhav Gadgil, for instance, has documented systems of ecological 'prudence' among different groups of people. An ecologically prudent community exercises restraint in the exploitation of natural resources such that the yields realised from any resource are substantially increased in the long run even though restraint implies forgoing some benefit at the present (1985a: 190).

Serving local society and one's neighbours first in the area of one's competence, without robbing the others' livelihood, was at the heart of the Swadeshi or Self Sufficiency principle which provided khadi with its overarching framework. The protection it offered to the poor in the past is evident from the converse that prevails today. Menial labour or service such as washing clothes, waste managing, scavenging, hair cutting, personal grooming and the like, has been taken over by the urban educated, through processes of occupational diversification, leaving large swathes of the illiterate population jobless. Indeed, even skilled, high-value traditional occupations such as the healer/doctor, the architect/carpenter and creative artiste have been usurped by members of the upper castes, educated in English-language based university disciplines. Earlier de-barred from taking up these areas of work because of their association with the bodily, material base of human life, upper castes are today the elite service professionals of modern India.

The poor and the lowly have lost out twice over in the modern economy. Earlier, as Leach demonstrated *at the systemic level*, the socio-logic of caste inverted the privileged class hierarchy authorised historically in the west (Leach 1960). Unlike European feudalism, which was based on a pyramid of wealth status and power with the aristocracy—the minority—at the top, the Hindu varna system gave power to the lowest rung by providing the masses a monopoly over services, which no one

else could or would perform *as livelihood*, in the public domain. This village culture of socially embedded economic transactions also curtailed material and technology use to a much lower level than was current in consumerist, DIY cultures.

Mont and Plepys have convincingly argued against the proliferation of power tools which are seen by middle-class westerners as an essential part of a household's garage or workshed equipment. They are rarely used (2004). Design obsolescence on the industrial plane is the overt partner of this 'hidden' disuse. Many products are produced to be discarded in design labs even before they are used. Today, the time that products disappear from the shelves to be replaced by new ones is steadily decreasing. The rate of obsolescence of products, in other words, is steadily growing, with disastrous consequences for the limited resources of the world.

Hindu caste society, predominantly developed in a village-based economy, was autonomous enough to have been stereotyped as a 'little republic' by the British administrators (Baden-Powell, 1957). The villagers' daily and ceremonial needs were met by households, whose services were pooled and shared by all. The technologies and tools of the trade consequently did not proliferate but remained concentrated in the hands of the servicing households. The civilisational value of material possessions, which negotiate the body's exchange with nature, did not therefore need to be optimised because satisfaction could be achieved without any personal, product-based intervention. Eating on a banana leaf, sleeping on a straw mat, the absence of cutlery and crockery and the wearing of unstitched garments were in any case local, daily practices which not only presumed but produced a culture of an enormously lowered resource and technology consumption.

In a celebrated essay (1958), Charles and Ray Eames, the design thinkers who provided the moving force behind the setting up of the National Institute of Design (NID) in Ahmedabad after Indian independence, identified this culture of minimalism in the *lota*, a vessel with tremendous material variety and potential for multipurpose use. The ease of transporting, storing and dispensing of water for ritual, culinary and ablutionary needs in the *lota* made it score high on the axes of material conservation, economy, utility and beauty. These design traditions, they argued, should be supported in modern Indian training against earlier approaches, which westernisation and English education had introduced in Indian society, whereby having and using objects became a sign of social, even spiritual, advancement.

Giving evidence of this imported mind-set, C.W. Leadbeater, the Theosophist who 'discovered' the philosopher J. Krishnamurthy as a boy on the beach, swimming with his brother, wrote to Annie Besant, a fellow Theosophist and Congress worker in India that he had received instruction from on high to take on the boys:

> They have lived long in Hell; try to show them something of Paradise… Teach them to use spoons and forks, nail brushes and tooth brushes, to sit at ease upon chairs instead of crouching on the ground, to sleep rationally on a bed, not in a corner like a dog (Jenkins 2000: 84).

This training, instilling a comfort level in the boys with the material requirements of everyday life in the west, was to be given prior to Krishnamurthy's presentation to the world as the Messiah. The contrast with Gandhi's understanding of self-advancement is more than evident from his adopted 'half-nakedness' the moment he returned to India from South Africa and took up public service as a vocation.

The point being made here is that in a culture where product exchange is inextricably linked to service exchange through persons and their interpersonal, intergroup activity, not the direct market, the proliferation of things is bound to decrease. Gandhi tried to remind us of the principles that lay behind these ways of life which had been changed forever by capitalist colonial rule. PSS thinking is doing very much the same to bring about sustainability today.

4

Methods and tools for system design for sustainability

4.1 Criteria, methods and tools

Before introducing and describing methods and tools, let us summarise the main issues understood so far. It has been argued that a potential role exists for *design for sustainability*, in promoting and facilitating *system innovation* resulting in environmentally beneficial, economically viable, and socially equitable/cohesive enterprises/initiatives offering a mix of products and services, especially when based on a network-structured and locally based model.

A first key point is the approach to the design of the stakeholders' configuration, committed to creating and promoting innovative types of interactions and partnerships between appropriate socio-economic stakeholders of a system responding to a particular social demand. Consequently new skills are required from the designer:

- A designer must be able to design together products *and* services, related to a given demand (needs and/or desires), i.e. a *satisfaction unit*
- A designer must be able to find, promote and facilitate innovative configurations (i.e. interactions/partnership) between different *stakeholders* (entrepreneurs, users, NGOs, institutions, etc.), i.e. a satisfaction system related to a given demand (needs and/or desires) as a *satisfaction unit*
- A designer must be able to operate/facilitate a participatory design process among entrepreneurs, users, NGOs, institutions, etc., orientating this process towards sustainable solutions

A second key point, given that not all system innovations will have eco-efficient or socially equitable and cohesive results, underlines that the design process should always be oriented towards sustainable solutions. Consequently these new skills are also required from the designer:

- The ability to orientate the system design process towards *eco-efficient* solutions[1]
- The ability to orientate the system design process towards *socio-efficient* solutions[2]

In order to learn how to use methods and tools to orientate design towards sustainable solutions it is useful to use as a benchmark a simplified scheme of the development phases of products, services or systems, where those phases can be underlined that lead to design of the system concept, then to detailed design of the system, and finally lead to the related system engineering.

Figure 4.1 **General action plan for the designing process of a product-service system, where sustainability-orienting tools can be integrated into the various stages of the design process**

In the case of system development the configuration of actors in this system, or rather the design of their interactions, should be defined during the conceptual phase. Obviously integrating the necessary requisites for a sustainable outcome,

1 Encompassing both environmental and economic sustainability.
2 Encompassing both socio-ethical and economic sustainability.

i.e. appropriate methods and tools, during the first phases of the development is more efficient. In this chapter we will describe a series of tools that have been developed that can be applied during different phases of development. Besides the singularities, more generally they are meant to assist the designer to accomplish three specific objectives:

1. Setting the sustainability priority (existing system assessment)
2. Generating a sustainability-focused idea (innovative system development)
3. Checking/visualising the sustainability improvement/worsening of developed concept/s (comparing the existing and innovative system)

Various research projects have been funded by the European Union and one by the United Nations Environment Programme (UNEP)[3] over the past few years with the aim of developing and testing methods and tools for system design, the main ones being SusHouse,[4] ProSecCo,[5] HiCS,[6] MEPSS,[7] and SusProNet.[8]

In this chapter the *Methodology for System Design for Sustainability* (MSDS) is described, together with its tools for system design for sustainability. This is one of the results of the LeNS project, integrating and updating what was produced in those projects together with other tools linked to other approaches to system design for sustainability (such as designing for the Sufficiency Economy Philosophy). Both methodology and tools have been tested during a set of pilot courses as part of the LeNS project as well as in several company consultancies. The latter includes *Less waste: other ways of doing things*, commissioned by ASM Brescia to draw up scenarios and system concepts for the prevention at source of trash production in food and paper chains,[9] another project commissioned by KONE (elevator) to develop eco-efficient system concepts,[10] and a further project with the same aim commissioned by Tetra Pak (food packaging).

It is important to stress that experimentation both in applied research projects and in teaching (LeNS) has been fundamental and will continue to be so in future in order to allow methods and tools to be assessed, honed and improved.

3 Design for Sustainability (D4S): A Step-By-Step Approach (UNEP funded, 2005–2009) (see Tischner and Vezzoli 2009).
4 SusHouse: Strategies towards the Sustainable Household (EU funded, 1998–2000) (see Vergragt 2002).
5 ProSecCo: Product-Service Co-design (EU funded, 2002–2004).
6 HiCS: Highly Customerised Solutions (EU funded, 2001–2004) (see Manzini, Collina and Evans 2004).
7 MEPSS: MEthodology for Product Service System development (EU funded, 2002–2005) (see Van Halen, Vezzoli and Wimmer 2005).
8 SusProNet: Sustainable Product-Service co-design Network (EU funded, 2002–2005) (see Tukker and Tischner 2006).
9 For further information on how the method was implemented in the project see Ceschin and Vezzoli (2007) and Vezzoli and Ceschin (2009).
10 See Cortesi, Vezzoli and Donghi (2010).

4.2 MSDS: a modular method for system design for sustainability

The MSDS method aims to support and orient the entire process of system innovation development towards sustainability. It was conceived for designers and companies but is also appropriate for public institutions and NGOs. It can be used by an individual designer or by a wider design team. In all cases special attention has been paid to facilitating co-designing processes both within the organisation itself (between people from different disciplinary backgrounds) and outside, bringing different socio-economic actors and end-users into play.

The method is organised in **stages**, **processes** and **sub-processes**. It is characterised by a flexible **modular structure** so that it can easily be adapted to the specific needs of designers /companies and to diverse design contexts and conditions. Its modular structure is of particular interest in the:

- *Procedural stages:* all the stages can be used or certain stages can be selected according to the particular requirements of the project
- *Tools to use:* the method is accompanied by a series of tools (many of them elaborated within the above-mentioned European and UNEP research projects). It is possible to select which of these to use during the designing process
- *Dimensions of sustainability:* the method takes into consideration the three dimensions of sustainability (environmental, socio-ethical and economic). It is possible to choose which dimension to operate on
- *Integration of other tools and activities:* the method is structured in such a way as to allow the integration of design tools that have not been specifically developed for it. It is also possible to modify existing activities or add new ones according to the particular requirements of the design project

The basic structure of MSDS consists of four main stages:

- Strategic analysis
- Exploring opportunities
- Designing system concepts
- Designing (and engineering) a system

A further stage can be added, across the others, of drawing up documents to report on the sustainability characteristics of the solution designed:

- Communication

The following table shows the aim and processes for each stage.

Table 4.1 **The stages of MSDS with their relative aims and processes. Sustainability-oriented processes are in bold; Design for a Sufficiency Economy processes are in bold italic**

MSDS method		
Stage	**Aim**	**Processes**
Strategic analysis	To obtain the information necessary to facilitate the generation of sustainable system innovation ideas	Analyse project proposers and outline the intervention context Analyse the context of reference Analyse the carrying structure of the system **Analyse cases of sustainable best practice** **Analyse sustainability of existing system and determine priorities for the design intervention in view of sustainability** ***Sufficiency need assessment***
Exploring opportunities	To make a 'catalogue' of promising strategic possibilities available or, in other words, a sustainability design-orienting scenario and/or a set of sustainably promising system ideas	**Generating sustainability-oriented ideas** ***Sufficiency opportunity exploration*** Outline a design-oriented sustainability scenario
Designing system concepts	To determine one or more system concepts oriented towards sustainability	Select clusters and single ideas Develop system concepts **Environmental, socio-ethical and economic assessment** ***Sufficiency system design***
Designing (and engineering) system details	To develop the most promising system concept into the detailed version necessary for its implementation	Detailed system design Sufficiency development of system implementation **Environmental, socio-ethical and economic assessment** ***Sufficiency design evaluation***
Communication	To draw up reports to communicate the general and above all sustainable characteristics of the system designed	Draw up the documentation for communications of sustainability ***Sufficiency design communication***

The following sections present each stage describing its component processes. Particular attention has been paid to sustainability-orienting processes.

4.2.1 Strategic analysis

The aim of the first part of the method is to collect and process all the background information necessary to the generation of a set of potentially sustainable ideas. The objective is two-fold: on the one hand to understand the existing situation and find out more about the project proposers, the socio-economic context in which they operate and the dynamics (socio-economic, technological and cultural macro-trends) that influence that context; on the other hand, to process information by which to steer the designing process towards the generation of promising solutions. The processes are outlined below.

Defining the context of intervention and analysing the project proposers

Given that the project proposers may be companies, public institutions, NGOs, research centres, or a mix of these, the *aim* of this activity is first and foremost to define the scope of the design intervention, or rather the demand for well-being to be met (e.g. move around the city comfortably and conveniently or have clean clothes). At this point the characteristics of the project proposers are examined carefully: their 'mission', their main areas of expertise, their strength and weaknesses, opportunities and threats, in relation to the area of intervention. In addition, particularly if the proposer is a company, the value chain will be analysed to understand how this is structured, what actors come into play, what problems (environmental, socio-ethic and economic) may be met.

Key questions:

- What is the demand to be met?
- What are the key areas of expertise of the project promoters?
- What are their main strengths and weaknesses?
- Who are the main actors? What is the relationship between/among them?
- What are the main environmental, socio-ethical and economic problems associated with the value chain?
- What is the value for the client and/or end user?

Analysing the context of reference

The *aim* of this activity is to analyse the context, or rather the socio-technical regime, of which the new innovation will become a part. First of all, the structure of the production and consumption system (the scope of intervention) is analysed: what actors come into play (companies, institutions, NGOs, consumers etc.) and

what the relationships are between them, as well as what specific dynamics (technological, cultural, economic and regulatory) characterise the system itself. Special attention is also paid to current and potential competitors (analysing their characteristics and offers) and to clients and/or end users (analysing their needs).

Key questions:

- How is the entire production and consumption chain structured in relation to the scope of intervention (satisfaction unit)? Who are the main actors (public and private) and their respective interests?
- What are the technological, cultural and regulatory dynamics influencing, or of potential influence to, the characteristics of the production and consumption chain?
- Who are the main competitors? What are their offers and how do these differ from those of the project proposers?
- Who are the potential clients and end users? What are their needs? Are their needs satisfied?

Analysing the carrying structure of the system

The *aim* of this activity is to identify and analyse the general macro-trends (social, economic and technological) that lie behind the reference context. It is important to understand these in order to understand what potentially influences the context (or socio-technical regime) that will be the object of the intervention.

Key question:

- What are the main social, economic and technological macro-trends? How may these influence the reference context and consequently the design options?

Analysing cases of excellence for sustainability (best practices)

The *aim* of this activity is to analyse in detail cases of excellence (not necessarily concerning the area of intervention) that could act as a stimulus during the generation of ideas. The *result* will be a document summarising the offer in each case of excellence, interactions with the user, the offer producers and providers, and its sustainability characteristics. The supporting *tools* include the *SDO toolkit* for analysing sustainability characteristics, the *System Map* and the *Interaction table* for the general case description.

Key questions:

- What is the offer, in terms of products and services? How does the user interact with the offer?
- Who are the actors in the offer system? What are their intentions?
- What are the environmental, socio-ethical and economic advantages?

Analyse sustainability of existing system and determine priorities for the design intervention in view of sustainability

The *aim* of this activity is to analyse the existing context from an environmental, socio-ethical and economic point of view in order to identify the design priorities (in other words, where it is most important to intervene in order to reduce the environmental, socio-ethical and economic impact to the greatest degree). This operation is fundamental to steering the design process towards the solutions that are the most able to foster sustainability. The *result* will be a document summarising the environmental, socio-ethical and economic analysis and defining design priorities. One supporting *tool* for this process is the *SDO toolkit* (section Checklist, Existing system).

Key questions:

- What is the situation in the existing context regarding environmental, socio-ethical and economic sustainability?
- What are the design priorities for each dimension of sustainability?

Sufficiency need assessment

The *aim* of this activity is to thoroughly assess the existing situation with respect to the Sufficiency Economy Philosophy (SEP)'s three components: Reasonableness, Moderation and Self-Immunity. It is the first stage in the Design for a Sufficiency Economy (DSE) approach: planning/design and implementation processes aimed at achieving sufficient living and sustainable well-being for individuals, communities and societies.[11] The assessment should yield robust knowledge on the current situation: who the stakeholders are within the system; their behaviours and interactions; and how the existing system operates. It is also essential to detect any recent changes that may lead to a particular future trend. The most crucial task is to assess whether the conducts (both of users and product/service providers) in the existing situation are aligned with the principles of the SEP. The *result* will be a document that clarifies the current sufficiency level and illustrates if the existing system displays a balance (or imbalance) in the four dimensions of People, Planet, Profit and Technology, an imbalance implying weak aspects that need to be addressed. *Tools* for this step include task analysis, DSE Checklists (Part 1), and Evaluation of the Sufficiency Levels (Part 2).

11 For more on the Sufficiency Economy Philosophy and DSE, see Part 1, Section 3.5.2, and Part 2, Section 4.

Table 4.2 **Strategic analysis: processes, sub-processes, results and tools. System design tools for sustainability described in detail in the following sections are shown in bold**

	Process	Sub-process	Results	Tools
Strategic analysis	Project promoter analysis and definition of intervention context	Defining scope of design intervention	Document specifying scope of intervention and design brief	
		Project promoter analysis	Summary of project promoter analysis: *Mission* *Main expertise* *SWOT* *Value chain* *(actors, structure, etc.)*	Preparatory company questionnaire[12] **miniDOC** SWOT matrix[13] **System Map**[14]
	Reference context analysis	Production and consumption system analysis for the scope of design intervention	Summary of production and consumption system analysis for the scope of intervention: *Identification of actors and their interactions* *Identification of technological, cultural and regulatory dynamics*	**System Map** **miniDOC**
		Competitor analysis	Summary of competitor analysis: *who are the competitors and what are the most innovative offers; how is the market segmented* *competitive position analysis*	Model 5 Porter forces
		Client and/or end user analysis	Summary of client/end user needs: *Analysis of expressed and latent needs*	Exploring Customer Needs[15] **miniDOC**

12 Created during the MEPSS research project (www.mepss.nl/index.php?p=tool&l4=W02).
13 For an example of a SWOT analysis, see the tool packet created during the MEPSS project (www.mepss.nl/index.php?p=tool&l4=W05).
14 A tool similar in purpose to the *System map* is the *Actor network map*. For further information see Morelli (2006a).
15 Created during the MEPSS project (www.mepss.nl/index.php?p=tool&l4=W17).

	Process	Sub-process	Results	Tools
	System carrying structure analysis	General macro-trend analysis	Report on (social, economic and technological) macro-trends and their influence on the reference context	
Strategic analysis	**Analysis of cases of excellence for sustainability**	Identification and analysis of cases of excellence	Summary of cases of excellence analysis, describing: *Offer composition and interaction with the user* *Actors who produce and deliver the offer* *Sustainability characteristics*	**Interaction table (storyboard)**[16] **Animatic** **System Map** **Sustainability Design-Orienting (SDO) toolkit**[17]**—*checklist best practice***
	Analyse sustainability and determine priorities for the design intervention in view of sustainability	Existing context analysis from an environmental, socio-ethical and economic point of view	Summary of the existing system analysis	**SDO toolkit—*checklist existing system***
		Defining the design priorities	Definition of the design priorities for each dimension of sustainability	**SDO toolkit—*checklist existing system***
	Sufficiency need assessment	Observing users and conducting task analysis	Summary of user behaviour and how the existing system operates	DSE Worksheet 1: User observation Task analysis flow chart
		Defining the material products/ immaterial services, actors and flows in the existing system	List of products/services and actors (stakeholders) in the existing system	DSE Worksheet 2

16 A tool similar in purpose to the *Interaction table* is the Use cases. For further information see Morelli (2006b).

17 Another tool that can be used to analyse the sustainability characteristics of a Product-Service System is the INES, Improving New Services, tool created during the 'Eco-efficient PSS' research project, funded by the Austrian Ministry of Transport, Innovation and Technology.

	Process	Sub-process	Results	Tools
Strategic analysis		Mapping the current stakeholder interaction	System maps that illustrate the stakeholder relationships in the current system	DSE Worksheet 3 (System Map)
		Detecting key changes/drivers related to the existing situation	Summary of future trends related to the existing situation	DSE Worksheet 4 (PESTE Analysis)
		Assessing whether existing conducts are in line with the principles of the SEP Assessing the current Sufficiency level	Summary of the Sufficiency Level of the existing situation on a scale of 0–6	**DSE Worksheet 5:** ***Part 1 Checklists Part 2 Sufficiency level***
		Assessing the 'BALANCE' of the existing situation	Visualised Sufficiency Level 'balance' of the existing situation *regarding both the 4 dimensions (People, Planet, Profit and Technology) and the 3 components within each dimension (Reasonableness, Moderation and Self-Immunity)*	**DSE Worksheet 13:** ***Sufficiency Economy Balance Tool***

4.2.2 Exploring opportunities

The aim of the second stage is to identify possible orientations for the development of promising systems. This takes place through a participatory process whereby the various actors generate ideas.

It must be stressed that the aim of this idea-generating process is not to come up with incremental improvements at product or service level, but rather to come up with possible innovations at system level, characterised by radical improvements from an environmental, socio-ethical and economic point of view. At the same time, Design for a Sufficiency Economy qualifies this by encouraging *step by step* development, where 'radical' innovations or changes are welcome only when 'appropriate'. To achieve this, an application of knowledge with due consideration and prudence is essential.

The specific aim is therefore to use all the information collected and processed during the previous stage to outline a 'catalogue' of promising strategic possibilities, in other words a *sustainability design-orienting scenario (SDOS)*, consisting of sustainability-oriented *visions* and *innovative ideas*. This scenario, with its visions

and ideas, constitutes the basis for the future development and implementation of sustainable system innovations. Three exploring opportunities processes are outlined below.

Generating sustainability-oriented ideas

On the basis of the information previously acquired, a set of potentially sustainable ideas is generated through an idea-generating workshop. The starting point is the definition of the satisfaction unit to be met by designing. It must be made absolutely clear that the idea generation must be orientated towards satisfying a specific demand for well-being (e.g. clean clothes). In this sense particular attention is paid to coming up with system level ideas, i.e. ideas regarding: 1) the products and services that constitute the offer; and 2) the configuration of actors able to produce/deliver that offer. Special design guidelines have been drawn up to steer idea generation towards sustainable system solutions (e.g. the idea-generating tables from the Sustainability Design-Orienting toolkit software). It is also useful to have a collection of cases of excellence available as a further stimulus, and a map of the actors who may potentially become part of the satisfaction system.[18] The *result* of this process will be a document listing the satisfaction unit and subsidiary satisfactions and a set of system ideas with their environmental, socio-ethical and economic sustainability characteristics.

Key questions:

- What is the satisfaction unit to be met by design?
- Who are the actors who may potentially be involved in the satisfaction system?
- What potential product and service systems are capable of bringing radical improvements (from an environmental, socio-ethical and economic point of view)? What actor system will be able to produce and deliver such an offer?

Drawing up sustainability design-orienting scenarios (with their visions and clusters of ideas)

The aim of this process is to map out the ideas generated previously, using a purpose designed polarities diagram.[19] This diagram, together with the mapped ideas, constitutes what it is known as a sustainability design-orienting scenario, i.e. a set of visions of how a context could evolve if certain dynamics (economic, regulatory

18 This tool is called a *Satisfaction system map*; for a more detailed description see Section 4.3.7—Satisfaction system map.

19 See description of the tool in Section 4.3.10—Polarities diagram. Here it suffices to say that it is a diagram with two polarity axes (e.g. user participation: enabling offer vs. full-service offer; system organisation: centralised system vs. distributed system), on which it is possible to position and organise ideas.

and socio-cultural) took place and if certain design options were adopted. Therefore the scenario outlines a set of visions, or better, possible promising design orientations. Every vision in turn is described by a set of single ideas and clusters (sets of ideas with basic elements in common). These visions, single ideas and clusters, constitute the basis for discussion by which to identify the most promising directions in which to orientate system innovation.

Sufficiency opportunity exploration

The aim of this stage in the DSE process is to enable designers to define the strengths, weaknesses, opportunities and threats (SWOTs) of the company or system provider, as well as to identify the drivers, goals and objectives of the project. After exploring the competences of the project, the DSE guidelines (Worksheet 8) and SWOT Search Field Matrix techniques (Crul and Diehl 2006: 36-37) are used to generate ideas in the four dimensions: People, Planet, Profit and Technology.

Table 4.3 **Exploring opportunities: processes, sub-processes, results and tools. System design tools for sustainability described in detail in the following sections are shown in bold**

	Processes	Sub-processes	Results	Tools
Exploring opportunities	**Generating sustainability-oriented ideas**	Defining satisfaction unit	Document specifying satisfaction unit and sub-satisfactions	
		Workshop for generating sustainable system ideas	Sets of system ideas with environmental, socio-ethical and economic sustainability characteristics	Stimulus tools for generating ideas: **SDO toolkit—sustainability idea tables** **Satisfaction system map** PSS innovation matrix
	Outline a design-oriented sustainability scenario	Defining clusters and single ideas, identifying promising polarity diagrams, polarising ideas and defining visions	Polarity diagram with polarised ideas. Polarity diagram with visions. Polarity diagram with clusters of ideas. Description of single clusters and single ideas. Audiovisual documents that can visualise concepts and sequences and promote collective conversations	**Polarity diagram** **Offering diagram** **Animatic,** **System concept** **Audiovisual**

	Processes	Sub-processes	Results	Tools
Exploring opportunities	***Sufficiency opportunity exploration***	Identification of the strengths and weaknesses that exist now and future opportunities and threats Analysis of company SWOT in relation to Sufficiency Economy principles	SWOT analysis SEP-relevant SWOT analysis	DSE Worksheet 6 (SWOT matrix) DSE Worksheet 9 (SWOT analysis relating to Sufficiency Economy)
		Identifying company drivers, design goals and objectives	Document identifying design drivers Document defining goal and objective of design (as a company or a system provider)	DSE Worksheet 7 (Company's Drivers and Goal and Objective)
		Generating knowledge and morality-oriented system ideas	List of knowledge and morality promising ideas	**DSE Worksheet 8 (Guidelines: knowledge and morality)**
		Generating Sufficiency promising system ideas	Document of ideas and sketches generated	DSE Worksheet 10 (Search Field Matrix)
		Visualising Sufficiency promising system ideas		DSE Worksheet 11 (Sketch exploration for new Sufficiency PSS)

4.2.3 Designing system concepts

Starting with the scenario (with its visions, clusters of ideas and single ideas) elaborated previously, the aim of this stage is to select the most promising clusters and single ideas through a participatory process whereby actors involved are called to express their opinions. The clusters and single ideas selected are sorted into various groups, each one representing a system concept in an embryonic form. These groups of ideas are then developed in greater detail, defining the set of products and services that make up the offer, together with the actor system that produces and delivers it, and the potential environmental, socio-ethical and economic improvements it offers are assessed. Processes for designing system concepts are discussed below.

Selecting clusters of ideas and/or single ideas

The most promising ideas are selected and combined through a participatory process, possibly supported by purposefully designed tools (see Table 4.4). Each of these combinations will then be developed into a system concept.

Key questions:

- Which ideas are the most promising from an economic point of view and in terms of technological feasibility and user acceptability?
- Which ideas are most promising from an environmental and socio-ethical point of view?

Developing system concepts

One or more system concepts will emerge from the combinations of ideas previously singled out. The following elements are then defined for each of these system concepts: the set of products and services that make up the offer and the functions it fulfils; the actor system (primary and secondary) that produces and delivers the offer; and the interaction between user/client and the offer system. Various tools may be used in support of the designing and visualisation of these elements (see Table 4.4).

Key questions:

- What products and services make up the offer? What functions does it fulfil? What is the value perceived by the user? How does the client/end-user interact with the offer system?
- How is the socio-economic actor system (and their interactions) structured in producing and providing the offer? Which are the principal and which the secondary actors?

Sufficiency system design

The aim of this DSE stage is to refine the ideas generated in the Opportunity Exploration stage while retaining a systemic, holistic, people- and nature-centred approach. The ideas generated in the previous phase are visualised using basic sketching techniques. Relevant ideas are combined in order to construct concepts for the new Sufficiency PSS. Various tools may be used to support the designing and visualisation of the system elements.

Table 4.4 **Designing design concepts: processes, sub-processes, results and tools. System design tools for sustainability described in detail in the following sections are shown in bold**

	Processes	Sub-processes	Results	Tools
Designing system concepts	Selecting clusters and single ideas	Selecting the most promising ideas and/or clusters (from the point of view of economics, technological feasibility and user-acceptability	Polarity diagram with the ideas and clusters of ideas selected Document explaining the selection	**Polarities diagram** Portfolio diagram, Go/no go evaluation criteria[20]
	Developing system concepts	Defining the interactions between actors and the new system	Map of actors in the new system and their interactions (material, information and money flows	**System Map**
		Defining the product and service concepts[21] that make up the offer	Images + texts summarising the main functions delivered to the user	**Offering diagram** AD poster
		Narration of user interactions with the system and the interactions of the other actors in delivering the offer	Sequence (images+texts) of the interactions that occur during the production and delivery of the offer Audiovisual documents that can visualise alternative points of view Audiovisual documents that can visualise action sequences	**Interaction table** **Interaction storyboard** **Animatic, System concept Audiovisual**

20 Tool developed during the European research project SusProNet (2002–2005, 5th Framework Programme).

21 For an example of product concept generation see the MPDS method and its specific tools described in Vezzoli, Ceschin and Cortesi (2009a) *Metodi e strumenti per il Life Cycle Design*.

	Processes	Sub-processes	Results	Tools
Designing system concepts	***Sufficiency system design***	Creating concepts by selecting the relevant ideas and combining them into themes. Selecting the most promising theme and further developing it using tools relevant to system design (e.g. System Map)	Sketches of ideas for new Sufficiency PSS (SE-PSS) System maps, etc.	DSE Worksheet 11 (Sketch exploration for new Sufficiency PSS developed further from previous stage) **System Map** (as above)
	Environmental, socio-ethical and economic assessment	Environmental, socio-ethical and economic improvement potential assessment for the system concept	Description of the improvement potential for every criterion of each dimension	**SDO toolkit—checklist concept**
		Visualising the environmental, socio-ethical and economic improvements	Environmental, socio-ethical, economical radar diagrams showing improvements. Visualisation of the interactions that support sustainability improvements	**SDO toolkit - radar** **Sustainability interaction story-spot**

Environmental, socio-ethical and economic assessment

The *aim* of this process is to assess the potential improvements that the system concepts could generate from an environmental, socio-ethical and economic (Planet, People, Profit) point of view. This process is fundamental in order to understand whether there are still any unresolved critical points and also, if more than one concept has been developed, to decide which one is more promising. The *result* will be a description, for each concept, of the potential improvements offered (for every criterion of each sustainability dimension); a visualisation of these improvements by means of a radar diagram; and a visualisation of the interactions that illustrate improvements. Suitable *tools* include the *SDO toolkit* (section on Checklist Concept and radar) for the first two points and the *Sustainability interaction story-spot* for the third point.

Key questions:

- What are the potential environmental, socio-ethical and economic improvements that the system concept can generate?
- Does the system concept have any critical points from an environmental, socio-ethical and/or economic point of view? Do any of its elements need redesigning?

4.2.4 Designing (and engineering) the system

The aim of this stage is to itemise the specific requirements of the system concept to enable its implementation.

The processes connected to this stage are described below.

Detailed system design

The *aim* of this activity is to develop the system concept in detail, defining: the set of products and services that make up the offer; all the actors (both primary and secondary) involved in the system together with their roles and interactions; all the interactions between actors and client/end user that occur during delivery of the offer; all the elements (both material and non-material) required for delivery of the offer and who will design/produce/deliver them. Various tools may be used to support the designing and visualisation of the various aspects (see Table 4.5).

Key questions:

- What products and services make up the system? What are the main primary and secondary functions delivered? What value is perceived by the user? How does the client/end user interact with the offer system?
- Who are the actors (both primary and secondary) that take part in the system? What kind of interactions (partnerships, agreements) do they have? What are their respective roles and interactions in delivering the offer?
- What material and non-material elements are required to deliver the offer? Who will design/produce/deliver them?

Sufficiency system implementation

The *aim* of this DSE stage is to refine the details of the new Sufficiency PSS concept regarding its operational steps, the roles of both the system providers and the users,

and solutions that are necessary in the operation. It is then clarified what components are needed to support each operating step of the new system, classified into five categories: tools, interaction rules, required competences, supplied information and context.

Environmental, socio-ethical and economic assessment

The *aim* of this activity is to assess more accurately the environmental, socio-ethical and economic improvements that the system innovations will produce once implemented. The *result* will be a more detailed description of the potential improvements for each project (for every criterion of each sustainability dimension), a visualisation of these improvements by means of a radar diagram, and a visualisation of interactions that illustrate the improvements. Suitable *tools*, as above, include the *SDO toolkit* (section Checklist Concept and radar) for the first two points and the *Sustainability interaction story-spot* for the third.

Key questions:

- What environmental, socio-ethical and economic improvements can be expected from the implementation of the system innovations designed?

Sufficiency design evaluation

The aim in this DSE stage is to evaluate the results of the newly designed system in two aspects: the 'improvement' of the new Sufficiency PSS and the 'balance' of its sufficiency improvements. To achieve this, the first step is to visualise the new Sufficiency PSS's Sufficiency Level 'balance' of each dimension: People, Planet, Profit and Technology (using four separate bar charts). The designer then makes a comparison whether the existing situation becomes enhanced or worsens with the newly designed system regarding the three components of sufficiency: Moderation, Reasonableness, and Self-Immunity. The second step is to evaluate whether the offers in the new Sufficiency PSS have improved each stakeholders' conducts and behaviours in the system and the improvements in all dimensions have been developed in equilibrium (using only one overall bar chart). The *tool* to support this is the Sufficiency Economy Balance Tool.

Table 4.5 **System designing and engineering: processes, sub-processes, results and tools. System design tools for sustainability described in detail in the following sections are shown in bold**

	Processes	Sub-processes	Results	Tools
Designing (and engineering) a system	Detailed system design	Defining the specifics of interactions between (primary and secondary) actors in the new system	Detailed map of the principal and secondary actors and their relationships (material, information and money flows)	**System Map**
		Defining the specifics of the set of products and services that make up the offer (primary and secondary functions)	Images and texts of the principal and secondary functions delivered to the user	**Offering diagram**
		Defining the specifics of services to the user and the interactions of the other actors during delivery of the offer	Narration of the sequence of all the interactions occurring in the production and delivery of the offer	**Interaction storyboard Animatic, System concept Audiovisual**
		Specifying the role, contribution and motivations of each actor	Matrix indicating the contribution made by each actor to the partnership, the expected benefits and potential conflicts	**Motivation matrix**
		Defining material and non-material elements required for delivery of the offer (and defining who will design/ produce/deliver it	Map indicating the elements required by the system and the role of the actors in designing, producing and delivering it	**Solution element brief**
	Sufficiency system implementation	Constructing a thorough plan of operation	Document and storyboards that detail the new Sufficiency PSS regarding its operation, roles, solutions and what components are needed in each operating step	**Interaction storyboard** (as above)
		Defining and designing components	List and design of the components that support the new Sufficiency PSS in five categories: tools, interaction rules, required competences, supplied information and context	DSE Worksheet 12 (List of Components)

	Processes	Sub-processes	Results	Tools
Designing (and engineering) a system	**Environmental, socio-ethical and economic assessment**	Defining environmental, socio-ethical and economic improvements to be expected from implementation of the system	Definition of improvement potentials for every criterion of each sustainability dimension	**SDO toolkit—*checklist concept***
		Visualisation of results	Radar diagram indicating improvements Visualisations of interactions	**SDO toolkit - radar** **Sustainability interaction story-spot**
	Sufficiency design evaluation	Evaluating the Sufficiency of the new PSS	Visualisation of the degree of 'improvement' of the new Sufficiency PSS in comparison to the existing one on a scale of 0–6	**DSE Worksheet 5:** ***Part 1: DSE Checklists*** ***Part 2: Defining Sufficiency level*** ***Part 2: Evaluate the Sufficiency Improvement***
		Evaluating the degree of Sufficiency in terms of 'balance' and in comparison to the existing system (in each component as well as overall balance of all 4 dimensions)	Visualisation of the 'balance' of the new Sufficiency PSS's Sufficiency Level in four dimensions (People, Planet, Profit and Technology) and in comparison to existing system	**DSE Worksheet 13:** ***Sufficiency Economy Balance Tool***

4.2.5 Communication

The communication stage, which works across all the others, aims to communicate the general characteristics of the solution designed, and above all those regarding sustainability, to the outside world. Some of the tools used in the previous stages to design and visualise the various elements of the solution are also used in this stage to support communication.

The basic aim is to provide a document indicating:

- **The design priorities for sustainable solutions.** The priority criteria are shown for each dimension of sustainability (as concerns the existing system), to steer the designing process towards sustainable solutions
- **The general characteristics of the product-service system.** The elements that make up the system innovation are described: i.e. the set of products and services that the offer consists of; the primary and secondary actors involved in the system and their respective roles and interactions; and the interactions between the actors and client/end-user

- **The sustainability characteristics of the product-service system.** The potential improvements (from an environmental, socio-ethical and economic point of view) to be gained from the implementation of the solution are shown, with an indication of the elements of the system that will deliver these improvements
- **Sufficiency design communication.** This step is vital in the DSE process, as the concepts of PSS and DSE are unfamiliar to most designers. The *aim* is therefore not only to communicate the new system to clients and stakeholders with respect to how the system operates, it is also to convince the clients and/or service provider to accept the newly designed Sufficiency PSS. Effective tools include the Interaction storyboards and story-spot.

Table 4.6 **Communication: processes, sub-processes, results and tools. System design tools for sustainability described in detail in the following sections are shown in bold**

	Processes	Sub-processes	Results	Tools
Communication	Drawing up the documentation for the sustainability communication	Communicating design priorities for sustainable solutions	Document indicating design priorities for each dimension of sustainability	**SDO toolkit—radar**
		Communicating the general characteristics of the product-service system	Document with the general characteristics of the innovation actors making up the system and their interactions set of products and services making up the system interactions between user and offer Audiovisual document providing diverse mental images involved in developed system concepts	**System Map** **Offering diagram** **Interaction storyboard / spot** **Animatic** **System concept** **Audiovisual miniDoc**
		Communicate sustainability characteristics of the product-service system	Document with the sustainability characteristics of the solution Environmental, socio-ethical and economic improvements Elements of the system bringing improvements	**SDO toolkit—radar** **Sustainability interaction story-spot**

4.3 Design tools for SDS

This section describes several tools that may be used to support the various stages of the MSDS (Methodology for System Design for Sustainability). The tools can be classified into two basic groups:

- Sustainable system design steering tools
- Stimulus and support tools for the generation of ideas and strategic to system design

The first group, **sustainable system design steering tools**,[22] consists of tools developed to steer the system design process towards environmentally, socio-ethically and economically sustainable solutions.

These tools are intended to:

- Facilitate the identification of design priorities: Sustainability Design-Orienting (SDO) toolkit—section 'Set Priorities'
- Steer the generation of ideas towards sustainable solutions: *SDO toolkit—section 'Orientate Concept'*
- Define the potential (environmental, socio-ethical and economic) improvements delivered by the solutions designed: *SDO toolkit—sections 'Check Concept' and 'Radar'*
- Visualise the sustainability characteristics of the system innovations designed: *Sustainability interaction story-spot*

It is important to stress that if the aim is to define sustainable solutions, it is more effective for the purposes of the end results to integrate these tools during the initial stages of the designing process.

The second group includes **tools** developed, on the one hand, **to support and stimulate idea generation at system level** and on the other **to facilitate their organisation and communication**. Among the tools we shall be describing we particularly highlight the *Polarities diagram* and the *Satisfaction system map*.

The **strategic tools for system design**[23] have been developed to facilitate the co-production and visualisation of the various elements in a (product-service) system innovation. More specifically, these tools are aimed at designing and visualising:

22 Besides the tools listed here there are others with similar purposes. These tools will not be described in this publication; the full range can be found on the website www.lens.polimi.it in the 'Tools' section.

23 Besides the tools listed here there are others with similar purposes. These tools will not be described in this publication; the full range can be found on the website www.lens.polimi.it in the 'Tools' section.

- The functions delivered by the set of products and services that make up the offer: *Offering diagram*
- The structure of the system (actors and their interactions) required to produce and deliver the offer: *System map*
- The interactions occurring between the client/end-user and the system during offer delivery and those that occur between the various actors in the system during its production and delivery: *Interaction table, the Interaction storyboard, the System concept Audiovisual*
- The relationships between the various actors in the system: *Stakeholder motivation matrix*
- The role of the different actors in the design/production/delivery of the various (material and non-material) elements that make up the system: *Solution element brief*

As well as supporting the visualisation/designing of the various system elements, these tools have also been created to facilitate a co-designing process between the various actors.

The design tools will be described according to:

- Their aims
- Their integration into the MSDS design process
- How they are used
- Their results
- Their availability and resources required

The tools will be presented in the following order.

First, tools to orientate the design process towards sustainable system innovation:

- Sustainability Design-Orientating tool-kit (SDO)
- Sustainability interaction story-spot
- Sufficiency Economy Checklists
- Sufficiency Economy Guidelines
- Sufficiency Economy Balance Tool

Subsequently other tools, to design system innovations in general:

- Stakeholder system map
- Satisfaction system map
- Interaction table (storyboard)

- Offering diagram
- Polarity diagram
- Solution element brief
- Stakeholder motivation matrix
- MiniDOC
- System concept audiovisual
- Animatic

4.3.1 Sustainability Design-Orienting toolkit (SDO)[24]

Aims

The objective of this tool is to orient the design process towards sustainable system solutions. This happens thanks to the different functions of the tool, which is able to support designers in: setting sustainability priorities; analysing best practices; using sustainable design-orienting guidelines; and checking and visualising the potential improvements in relation to an existing reference system.

It is basically a tool that is able to support several functions, with a modular structure so that it can be used as a whole or in part, according to the special needs and circumstances of each design project.

The purpose of the tool is:

- To define the *design priorities* for all three dimensions of sustainability (e.g. for the environmental dimension, to ascertain whether it is more important to optimise the life of the system, or to reduce resources, etc.). This is done by using checklists to analyse the existing system (*SDO section: 'Set Priorities')*
- To stimulate the *generation of ideas* for potentially sustainable systems. This is done by using design criteria and guidelines oriented towards sustainability (*SDO section: 'Orientate Concept')*
- To *assess potential improvements*, or any *worsening*, associated with the three dimensions of sustainability compared to the existing system. This is done by using checklists to compare the designed solution and the existing system, and radar diagrams to visualise the results of the analysis (*SDO section: 'Check Concept'* and *'Radar')*

24 A tool developed by Carlo Vezzoli and Ursula Tischner included in the MEPSS EU 5th FP, Growth projects, updated once for the UNEP project and updated once more for the LeNS EU-funded project.

It is important to stress that these three basic functions of the tool, which refer to all three dimensions of sustainability, integrate with the different stages of the designing process in increasing detail.

Let us now review how the tool is structured. The key elements in the *SDO* structure are the criteria and guidelines, set up in a multi-dimensional structure. As shown in Figure 4.2, the three sustainability dimensions are taken into consideration, environmental, socio-ethical and economic, and for each dimension there are six *criteria*. Each of these criteria is used both as a way of assessing a given system and as a way of steering the design process, and each in turn groups together a series of *guidelines*.

Figure 4.2 **SDO structure: sustainability dimensions, criteria, guidelines**

Criteria for the environmental dimension:

- Life optimisation
- Reduction in transport/distribution
- Reduction in resources
- Minimisation/valorisation of resources
- Conservation/biocompatibility
- Non-toxicity

Criteria for the social-ethical dimension:

- Improvement of employment/working conditions
- Justice and equity on the part of stakeholders
- Enabling of responsible, sustainable consumption
- Fostering and integration of the weak and marginalised
- Improvement of social cohesion
- Reinforcement/valorising of local resources

Criteria for the economic dimension:

- Market position and competitiveness
- Profitability/added value for businesses
- Added value for clients
- Long-term business development
- Partnership/cooperation
- Macro-economic effect

This tool has been developed to be a 'bridge' between the language, data and tools of the sustainability assessment 'world' and the designer's 'world'. It is essentially a qualitative tool applicable to complex systems.

Integrating the tool into the MSDS designing process

The *SDO* has been developed for use in all stages of the methodology:

- In **Strategic analysis,** the *SDO* can be used to:

A: identify design priorities for all dimensions of sustainability
B: analyse cases of excellence from an environmental, socio-ethical and economic point of view

- In **Exploring opportunities,** the *SDO* can be used to:

C: generate sustainability-orientated ideas (at system level)

- In Designing system concepts, the *SDO* can be used to:

C': generate sustainability-orientated ideas (at product and service level)
D: check and visualise potential improvements
D': if necessary, redefine design priorities

- In System designing and engineering, the *SDO* can be used to:

D": check and visualise potential improvements

Figure 4.3 **Integrating SDO into the MSDS designing process**

How to use the tool

The following describes how to use the tool with reference to the stages of the MSDS methodology.

Start up

Create a new project on the opening screen by clicking on 'New', inserting the title, and clicking on 'Ok'. (To access the project again select 'Load', insert the project name, and click 'Ok'). A page called 'Project Record' will appear, where it is possible to insert general information about the project, indicate the satisfaction unit (i.e. the demand for well-being to be met), and the reference context (or existing system).

Figure 4.4 **SDO toolkit: opening screen**

Figure 4.5 **SDO toolkit: enter starting data**

1. Strategic analysis

A. Identifying design priorities

The aim is to analyse the existing system in order to define design priorities according to the three dimensions of sustainability. These priorities form the basis for steering design decisions towards potentially more sustainable solutions.

For each dimension of sustainability the system is assessed by answering a series of checklists grouped under six different criteria. To do this, you must select a dimension (e.g. environmental) and click on 'Set Priorities': six corresponding criteria appear, each associated with a series of checklists; for every checklist it is possible to write replies and comments in the field provided.

After answering the various checklists it is possible to define a design priority for each criterion by clicking on 'H' (= High), 'M' (= Medium), 'L' (= Low) or 'N' (= No) priority.

Figure 4.6 **SDO toolkit: analysing existing system and defining design priorities**

By clicking on the 'Environmental' radar it is possible to visualise the graphic result of the process. The radar diagram shows the design priorities for each criterion. In addition, it is possible to fill in the white spaces corresponding to each criterion with the most critical elements of the existing system; the visualisation may be used as a brief to support the subsequent generation of ideas.

We must stress once more that the importance of defining design priorities lies in being able to identify the most important design criteria on which to focus during the actual designing stage.

B. Analysing cases of excellence with sustainability characteristics

In order to have sustainable inputs and insights for the design process, existing sustainable solutions should be examined. The *SDO* tool enables us to compare these solutions with the existing system so as to highlight the environmental, socio-ethical and economic qualities.

Figure 4.7 **SDO toolkit: visualising design priorities**

The assessment process is similar to that described in point A. By selecting a dimension and clicking on 'Set Priorities' and then on 'Case Study', six corresponding criteria will appear, each one associated with a series of checklists; it is possible to enter replies and comments in the field provided for each checklist.

After responding to the various checklists it is possible to indicate the improvement on the existing situation for each criterion by choosing between: radical improvement (++), incremental improvement (+), no significant change (=), and worse (–).

By clicking on 'Radars' and selecting the radar area corresponding to the case study, it is possible to visualise the improvements for each criterion. In this case, too, the text boxes can be used to enter the key elements of the solution; the visualisation can be used as a stimulus for the subsequent generation of ideas.

The *SDO* allows two cases of excellence to be entered.

Figure 4.8 **SDO toolkit: visualising improvements on the existing system shown in a case of excellence**

2. Exploring opportunities

C. Generating sustainability-oriented ideas

The aim is to facilitate the generation of sustainability-oriented ideas. To do so, we can use a series of design guidelines for each criterion, for support and stimulus.

Within the *SDO*, in the menu on the left, select a sustainability dimension (e.g. environment) and click on 'Orientate Concept'; at the top, select 'System'. Again at the top, six design criteria will appear, and by clicking on these it is possible to see the priorities assigned previously, with a set of corresponding guidelines. These guidelines will stimulate the generation of ideas, which can be noted on the virtual 'post-its' to be found at the sides of the screen.

Obviously, as mentioned, the idea generation session must focus mainly on the highest priority criteria. For example, if *Resource reduction* is a high priority, you should start with the idea table referring to this criterion, getting inspiration from the related guidelines. At the same time, if *Transportation/distribution reduction* has a low priority, you will give less attention to it (or even no attention if it has 'No' priority).

Figure 4.9 **SDO toolkit: (system level) idea generation table for the environmental dimension**

3. Designing system concepts

C'. Generating sustainability-oriented ideas

The idea is to facilitate the generation of sustainability-oriented ideas at product and service level.

In the menu on the left, select the sustainability dimension and click on 'Orientate Concept'; at the top select 'Service'. As in the generation of ideas at system level, it is possible to select the various design criteria, visualising the priority level assigned and the associated guidelines. The guidelines are used to support idea generation; ideas can be noted on the virtual 'post-its', which can be opened at the sides of the screen.

D. Checking and visualising potential improvements in the system concept developed

The aim is to analyse the system concept to identify its potential improvements over the existing system.

Select a sustainability dimension (e.g. environment) and click on 'Check Concept'. At the top, click on 'Concept Description' and enter a summary of the system concept developed in the text field provided. Answering the checklists helps to define the improvements offered by the designed solution over the existing system. For each criterion it is possible to select: radical improvement (++), incremental improvement (+), no significant change (=), or worse (–).

Going through the checklists also helps us to ascertain the level of improvement offered by the designed system compared to the benchmark excellence case, as well as how this too might be open to improvement.

By clicking on 'Radars' and selecting the 'Concept Check' radar area you can visualise the potential improvements on the initial system, or case study, for each criterion. Here too the key elements of the solution can be written up in the text boxes.

Figure 4.10 **SDO toolkit: radar with potential product-service system**

C''. Generating sustainability-focused service ideas (guidelines level 2)

In the 'Sustainability Dimension' section of the 'Menu', choose a dimension and go to 'Orientate Concept'; select 'Service' on the top. The criteria are visualised, with the related priorities you defined and with a series of related guidelines (level 2–service). Perform a brainstorming session starting from those criteria having both the highest priorities (reference existing system) and the lowest improvements (System concept): write up the emerged ideas in the 'post-it' boxes (click on the circles on the left and right sides).

Figure 4.11 **Image of ideas table/guidelines level 2—service with some ideas written in the 'post-it' boxes**

D'. Check and visualise sustainability improvements of developed product-service system concept

In the 'Sustainability Dimension' section of the 'Menu', choose a dimension and go to 'Check Concept'. Write in the text box a synthesis of the system concept developed (if updating what was written for the System). The button 'Check Concept' of each one of the sustainability dimensions leads you to the *checklists* (one for each of the dimensions), which will help you to define (if updating what was written for the System concept) the improvement in relation to the existing system.

Mark the improvement: worsening (–), equal (=), incremental improvement (+), radical improvement (++).

Going through the checklist you may realise how the System concept can be improved or changed; if so click on 'Concept Description' to modify the concept description and update the previous concept definition.

If you go to the 'Radar' section you can visualise the graphical result of the improvement. Select the concept and the sustainability dimension you are interested in. The radar diagrams will enable a visualisation as an area (shaped like a boat sail) which represents the improvement of the System concept in relation to the existing system (bold circle) or to the case study.

4. Designing and engineering the system

D". Checking and visualising the potential improvements offered by the product-service system

As for point D', for each criterion answer the checklist and mark the improvement: radical improvement (++), incremental improvement (+), no significant change (=), or worse (–).

By clicking on 'Radar' you can see the graphic result of the improvements.

Results

The possible results from the various *SDO* functions are as follows:

- Definition of the design priorities (from an environmental, socio-ethical and economic point of view) for the existing system
- Definition of different sets of sustainably oriented (system, service and product) ideas
- Radar diagram visualisations of the existing system to be derived from the designed solution
- Radar diagram visualisations of the potential environmental, socio-ethical and economic improvements that characterise a case of excellence

Tool availability and resources required

The *SDO toolkit* is open-source, copyleft software that can be used online (www.sdo-lens.polimi.it[25]) or downloaded (from www.lens.polimi.it, 'Tools' section) and installed for use on a local area network (LAN).[26]

The tool may be used by a single designer, though the support of a multidisciplinary team is preferable. It is also advisable to involve the various system actors, clients and/or end-users.

This tool requires at least:

- 30 minutes to define design priorities (for each sustainability dimension)
- 30 minutes to generate ideas (for each dimension)
- 60 minutes to assess improvements (both for the designed solution and for a case of excellence)

25 Versions available in Italian, English, Portuguese and Chinese.

26 Since the locally installable version is open-source it can be translated into other languages and modified according to project needs.

4.3.2 Sustainability interaction story-spot[27]

Aims

The *Sustainability interaction story-spot* is a co-designing tool, above all for visualising. Its purpose is to describe, succinctly and effectively, the salient elements of a product-service system in relation to given objectives (e.g. how the solution designed achieves certain environmental and socio-ethical aims).

It is basically an *Interaction table* focusing only on specified interactions. The display, to be visualised on a single screen/page, contains the following key elements:

- The key interactions of the client/end-user with the offer delivered by the system
- The key *interactions of the various actors* during production and delivery of the offer
- How *the designed solution achieves given aims* (e.g. how the solution produces the desired environmental and socio-ethical improvements)

The tool is also useful when it is necessary to visualise and communicate several hypotheses of system concepts to the actors involved. On such occasions it is more effective to synthesise and communicate only the key elements of the various system concepts.

Integrating the tool into the MSDS design process

The *Sustainability interaction story-spot* may be used:

- In System concept designing and in System designing (and engineering) to:

Visualise the key elements of the designed product-service system succinctly and effectively, and highlight the environmental, socio-ethical and economic improvements it offers

27 The tool was developed by the Design and System Innovation for Sustainability research unit (Dipartimento INDACO, Politecnico di Milano). For further information see Vezzoli (2010).

Figure 4.12 **Integrating the Sustainability interaction story-spot into the MSDS design process**

How to use the tool

The tool requires the use of graphic image processing software and slide show software (e.g. Microsoft PowerPoint or the equivalent in Open Office) for the visualisation.[28]

The composition, which must be visualised on a single screen, shows two lines of interaction: one focusing on the user and the other on the actors delivering the offer; these two lines of interaction are differentiated by background colour (Figure 4.13). Each individual interaction consists of (Figure 4.14):

- An image in which the colour of the actor matches the background (for suggestions about how to process the image see the section dedicated to the *Interaction table*)
- A brief description

At the bottom of the visualisation it is possible to enter notes and link these to the corresponding interaction (Figure 4.15).

28 It is possible to download a basic model of the Interaction story-spot from www.lens.polimi.it, in the 'Tools' section, with a guide to its use.

Figure 4.13 **Two lines of interaction are shown in the Sustainability interaction story-spot: front office and back office. The different background colour differentiates the two lines**

Figure 4.14 **The elements that make up a single interaction in the Sustainability interaction story-spot are the images, background colour, characterising text and description**

Figure 4.15 **The bottom part of the Sustainability interaction story-spot is dedicated to notes linked to the corresponding interaction**

Results

The result is a visualisation that shows the key elements of the product-service system succinctly and effectively, linking them to specified aims (e.g. environmental or socio-ethical improvements etc.).

Tool availability and resources required

The *Sustainability interaction story-spot* requires the use of graphic image processing software and slideshow software. Alternatively, if the *Interaction table* (see Section 4.3.8) has already been created, it is possible to start with this, created with spreadsheet software, selecting only the key interactions.

As far as using the tool is concerned, basic graphic skills are required to create the images (using photo editing software). The *Sustainability interaction story-spot* can be managed within the slideshow software (or spreadsheet software) by any member of the design team.

The creation of a *Sustainability interaction story-spot* requires an approximate minimum technical time of:

- 4 hours if starting from zero
- 30 minutes if starting with an existing *Interaction table*

4.3.3 Sufficiency Economy Checklists

Aims

The Sufficiency Economy Checklists support assessment of people's way of living/behaving at all levels towards the middle path (i.e. Sufficiency), and they help to define the sufficiency level of the existing system. The checklists cover four dimensions (People, Planet, Profit and Technology) within the three core components of the Sufficiency Economy Philosophy (Reasonableness, Moderation, and Self-Immunity).

The three common dimensions in the definition of sustainable development, People (socio-ethical), Planet (environmental) and Profit (economic), are thus present in DSE with an additional focus on Technology. Choosing an appropriate technology is clearly one of the most critical conducts that can prevent imbalance of a system, a lesson learned from a past of inappropriate investments, technology push and resultant negative impacts.

Integrating the tool into the MSDS design process

The *Sufficiency Economy Checklists* may be used:

- In Strategic analysis to:

Assess the Sufficiency Level of the existing situation (to see if or how users' or system providers' conducts are in line with the principle of the Sufficiency Economy Philosophy, SEP)

How to use the tool

There are two steps when using the Checklists.

Step 1: Analysing Sufficiency Level through Sufficiency Economy Checklists

The designer goes through Worksheet 5 Part 1 and ticks ✓ the boxes ☐ beside the relevant points in the checklists, in the four dimensions: People, Planet, Profit and Technology (see Figure 4.16).

Step 2: Defining Sufficiency Level of existing system

The designer evaluates the Sufficiency Level of the existing system, indicating the defined Sufficiency Levels in the evaluation box on a scale of 0–6 (Worksheet 5 Part 2).

Sufficiency Degree:

0 = unable to survive/sustain

1 = almost sufficiency at the household level

2 = sufficiency at the household level

3 = almost sufficiency at the community level

4 = sufficiency at the community level

5 = almost sufficiency at the national level

6 = sufficiency at the national level

Salient issues are jotted down in the 'note' box.

An example of checklists and the assessment is partly illustrated in Figure 4.16.

Figure 4.16 **Defining Sufficiency Level**

Results

The checklists assess the sufficiency level according to two aspects: how the users conduct their lives and how the system provider conducts its business.

Conducting life:

How to conduct one's life

How to treat other people

Responsibility to the community

Conducting business:

How to run/operate a business

How to work with shareholders

How to manage employees

How to treat customers

How to cooperate with partners/alliances/competitors

How to deal with stakeholders

How to contribute to the community

This process generates ideas that can be noted down and used in subsequent stages.

Tool availability and resources required

The Design for a Sufficiency Economy Worksheets are available for download (from www.lens.polimi.it, 'Tools' section). The Worksheets are based on spreadsheet software (e.g. Microsoft Excel or the equivalent in Open Office).

4.3.4 Sufficiency Economy Guidelines

Aims

The Sufficiency Economy Guidelines consist of statements that steer designers towards developing a framework or mind-set based on the Sufficiency Economy Philosophy (SEP). The guidelines help designers to come up with strategies suitable for specific situations as well as potential ideas and directions for the new system. By exploring the competences of the 'company' or organisation, opportunities to design a new Sufficiency PSS can be identified that acknowledge two conditions of the SEP.

> Condition 1: Knowledge (wisdom) includes accumulating information with insight in order to understand its meaning with care and prudent usage.
>
> Condition 2: 'Morality' is essential and includes virtue, ethical behaviour, honesty, tolerance, and perseverance where one does not exploit others.

The objectives of the Guidelines are therefore to assist designers in creating a holistic concept of products/services/systems or ways of life involving moderation and contentment while emphasising the wise use of knowledge with due consideration. In addition, they seek to explore the potential of users and companies to build on values such as integrity, diligence, harmlessness and sharing.

The Sufficiency Economy Guidelines assist designers to explore new ideas on achieving sufficient ways of living at three stages of the Sufficiency Economy: sufficiency at household level, at community level, and at national level. At the time of writing, the tool was developed up to the point of providing guidelines at community level.[29]

Integrating the tool into the MSDS design process

The *Sufficiency Economy Guidelines* may be used:

- In Exploring opportunities to:

Generate ideas oriented to the SEP conditions of knowledge and morality

How to use the tool

The worksheet (Worksheet 8) is completed by the design team, in the same way as the Sufficiency Economy Checklists (see Section 4.3.3).

Examples of the guidelines, at household level and community level, are partly illustrated in Figure 4.17 and Figure 4.18.

Figure 4.17 **Sufficiency Economy Guidelines: condition of knowledge (at household level)**

2 CONDITIONS of Sufficiency Economy	Components			
	People	Planet	Profit	Technology
	To make a betterment, can we.....?			
Knowledge: (wisdom) includes accumulating information with the insight to understand its meaning with ca re and prudence usage.	At household level			
	Conducting Life	Conducting Life	Conducting Life	Conducting Life
	Conducting Business	Conducting Business	Conducting Business	Conducting Business
	Notes:	Notes:	Notes:	

29 The guidelines at national level are not yet defined as this will require a great deal of involvement from governmental bodies.

Figure 4.18 **Sufficiency Economy Guidelines: condition of knowledge (at community level)**

2 CONDITIONS of Sufficiency Economy	Components			
	People	Planet	Profit	Technology
	To make a statement, can we.....?			
Knowledge: (wisdom) includes accumulating information with the insight to understand its meaning with ca re and prudence usage.	At community level			
	Conducting Life	Conducting Life	Conducting Life	Conducting Life
	Conducting Business	Conducting Business	Conducting Business	Conducting Business
	Notes:	Notes:	Notes:	

Results

The results are a set of ideas generated from and inspired by discussion around the guidelines, as noted in the Worksheet. The design team can then proceed to the design of the system concept and components.

Tool availability and resources required

The Design for a Sufficiency Economy Worksheets are available for download (from www.lens.polimi.it, 'Tools' section). The Worksheets are based on spreadsheet software (e.g. Microsoft Excel or the equivalent in Open Office).

4.3.5 Sufficiency Economy Balance Tool

Aims

As the ultimate aim of the SEP is to seek to achieve balance and sustainability, when evaluating the success of the outcome emphasis is thus placed on keeping a **balance** among all four dimensions: People, Planet, Profit and Technology.

While the Sufficiency Economy Design Guidelines were developed to help steer new mind-sets in order to design a more sufficient system, the Sufficiency Economy Balance Tool was designed to evaluate and visualise the balance of such progress.

Integrating the tool into the MSDS design process

The *Sufficiency Economy Balance Tool* may be used in various stages of the methodology:

- In **Strategic analysis**, the *Balance Tool* can be used in need assessment to:
  - Visualise the existing situation's Sufficiency Level 'balance' (both regarding the four dimensions, People, Planet, Profit and Technology, and regarding the three components within each dimension: Reasonableness, Moderation and Self-Immunity)
- In **System designing and engineering**, the *Balance tool* can be used to:
  - Visualise the 'balance' of the new Sufficiency PSS's Sufficiency Level (in four dimensions: People, Planet, Profit and Technology)
  - Evaluate whether the offers in the new Sufficiency PSS have been improved over the existing system and the improvements in all dimensions are in equilibrium

How to use the tool

This worksheet is used during the design process in two steps:

- **A. Need assessment:** to visualise how sufficient the existing system is at present
- **B. Design evaluation:** to visualise the development of a new Sufficiency PSS in two aspects

The **first aspect** is to evaluate the *improvement* of the Sufficiency Level. To do this, the designer must:

- Go through the Sufficiency Economy Design Checklists again in Worksheet 5 Part 1, but this time tick off ✓ the achieved points in red ○. Important notes should be jotted down in the box
- Evaluate the Sufficiency Improvement (Worksheet 5 Part 3) of the new SE-PSS on a scale of 0–6 (Figure 4.19). The analysis in this step will reveal whether the new system is better or worse than the existing one
- Feed the values from the Sufficiency Level analysis (on a scale of 0–6) of both the 'existing system' and 'new Sufficiency System' into the datasheet (Worksheet 13) (using the Chart tool in Microsoft Office Excel or equivalent open source spreadsheet program). See Figure 4.20

Figure 4.19 **Evaluating Sufficiency Improvement**

- A bar chart created from the values above will comprise three bi-directional bars, each bar signifying the Sufficiency level of the three components (Reasonableness, Moderation and Self-Immunity). The left side of the bars signifies the existing system while the right side signifies the new Sufficiency System. Figure 4.21 illustrates four separate bar charts showing the improvement of the Sufficiency Level of each dimension
- Compare the result of the 'Sufficiency Level' of the existing and new system with respect to '*the improvement*' of benefits in *each* component. See Figure 4.22

Figure 4.20 **Feeding values into the datasheet**

1. People dimension	Existing System	New Sufficiency PSS
Moderation	2	4
Reasonableness	1	4
Self immunity	3	4
Average People	2.0	4.0

Figure 4.21 **Sufficiency Level of each dimension**

Evaluate improvement of sufficiency level .....People

	Existing System (-)	New Sufficiency PSS (+)
Moderation	-2	4
Reasonableness	-1	4
Self immunity	-3	4
Average People	-2.0	4.0

Evaluate improvement of sufficiency level .....Planet

	Existing System (-)	New Sufficiency PSS (+)
Moderation	0	4
Reasonableness	-1	4
Self immunity	-2	3
Average Planet	-1.0	3.7

Evaluate improvement of sufficiency level .....Profit

	Existing System (-)	New Sufficiency PSS (+)
Moderation	-1	4
Reasonableness	-3	4
Self immunity	-2	3
Average Profit	-2.0	3.7

Evaluate improvement of sufficiency level .....Technology

	Existing System (-)	New Sufficiency PSS (+)
Moderation	-4	3
Reasonableness	-4	3
Self immunity	-3	3
Average Technology	-3.7	3.0

Figure 4.22 **Improvement of Sufficiency Levels (of the 'People' dimension)**

The **second aspect** is to evaluate the *Balance of the Sufficiency Level* of the overall system. To do this, the designer must:

- Feed the values from the Sufficiency Level analysis (on a scale of 0–6) of both the 'existing system' and 'new Sufficiency system' into the datasheet (using the Chart tool in Microsoft Office Excel or equivalent open source software). The values inserted into the datasheet are the average values of each component. According to the example in Figure 4.20, the average value for this step would be 2.0 [(2+1+3)/3]
- A bar chart will display four bars; each bar signifies the Sufficiency level of each dimension. Check the 'balance of the sufficiency bars **of the existing system**' in comparison to the 'balance **of the new Sufficiency system**'. See example in Figure 4.23
- Compare the result of the 'sufficiency level' of the existing and new system **both** with respect to '*the improvement*' of benefits in **each** dimension (PPP&T), and with respect to the '*equilibrium balance*' of benefits in **all** four dimensions. See Figure 4.24

Figure 4.23 **Overall Balance of Sufficiency Level (of all four dimensions)**

Evaluate the Improvement of Sufficiency Levels and the Overall Balance

Balance	Existing System	New Sufficiency PSS
Average People	2.0	4.0
Average Planet	1.3	3.7
Average Profit	1.3	3.3
Average Technology	3.7	3.0

Figure 4.24 **Comparing the result of the Overall Balance**

Results

The tool supports understanding of both the current system and the new system in the form of bar charts, illustrating all important elements inherent in the Sufficiency Economy Philosophy. The focus is especially on how the new system design improves over the existing system. Improvement of benefits in each dimension is encouraged (as shown in Figure 4.21). However, the success of DSE in practice is not measured by how much we can radically reduce the frailties or increase the values that result in a more beneficial offer to users in *each dimension separately*. Instead we measure the success of any sufficiency system by *the overall balance* of the benefits we created in *all of the four dimensions*. It is therefore not absolutely necessary that there is some degree of improvement in each dimension.

A sufficient system must hence offer **both** *the improvement* of benefits in **each** dimension (PPP&T) and at the same time keep *a more balanced equilibrium of benefits* in **all** four dimensions. For example, after taking everything into consideration, sometimes a positive aspect of the existing system (such as a highly economical profit) is best reduced, for the sake of keeping the balance of the overall system as a whole and enabling the users to live harmoniously with nature and within society (or, if in exchange, so that other social benefits could be gained).

Tool availability and resources required

The Sufficiency Economy Balance Tool and instructions are available for download (from www.lens.polimi.it, 'Tools' section). The tool is based on spreadsheet software (e.g. Microsoft Excel or the equivalent in Open Office).

4.3.6 (Stakeholder) System Map[30]

Aims

The purpose of the *System Map* is to support the (co)-designing and visualisation of the system structure, indicating the actors involved and their interactions.

It is basically a graphic representation showing:

- The *socio-economic actors* involved in the system (both main and secondary)
- The different *interactions between the various actors*: material and/or product flows and those of information, money and work

The *System Map* is a representational tool that can be described as both *codified and progressive*.

It is a *codified* system in the sense that it is a 'technical drawing' of the actor system representing alternative systems in a reproducible and comparable way. In this sense, it consists of a fixed format of representation (a map), an open library of graphic elements (icons, arrows, ...) and a set of rules (layout, syntax, ...).

It is *progressive* in the sense that it is a 'formalisation-in-progress' of the solution actor map giving an increasingly accurate picture of the project as it develops. In this sense, the details of the actor system are gradually specified at each step of the designing process.

It is therefore a support tool for:

- *Designing*, because representation is a means of structuring thought and facilitating the resolution of problems
- *Co-designing*, because a standard language is used, which can therefore be shared by all the design team members or the different actors involved, supporting the strategic conversation among them
- *Communication*, because it enables unambiguous visualisation of the designed solution (as well as its evolution)

Integrating the tool into the MSDS designing process

The *System Map* is used at various stages of the designing process. In particular:

- In **Strategic analysis** it can be used to describe:
  - The production and consumption system in the scope of the design intervention

30 The tool was developed by Francois Jégou in the HiCS research project Highly Customerised Solutions, Solution-oriented design, production and delivery systems (European Research, GROWTH Programme/European 5th Framework). For further information see Jégou, Manzini and Meroni (2004); van Halen, Vezzoli and Wimmer (2005); and www.mepss.nl/index.php?p=tool&l4=W21.

  - The value chain (existing system) of the business(es) involved in the project
  - The organisation of the system (actors and roles) in a case of excellence

- In **Designing concept systems**, it can be used to:
  - Formalise the initial system ideas emerging (Figure 4.26)
  - Itemise the initial ideas emerging, identifying the main and secondary actors and their interaction flows (Figure 4.27)

- In **Designing and engineering the system**, it can be used to:
  - Itemise the configuration of the system further, defining all the actors involved and their interactions (Figure 4.28)

Figure 4.25 **Integrating the System Map into the MSDS designing process**

Figure 4.26 **When designing a system concept, the initial ideas (deriving from the visions and clusters of ideas developed previously) are formalised: only the main actors and flows are shown at this level**

Figure 4.27 **The initial system ideas sketched out previously are now set out in detail: only the main and secondary actors are shown at this level, with their interactions**

Figure 4.28 **While designing (and engineering) the system, the system map is set out in detail, specifying all the main and secondary actors with their interaction flows. The key parts of the map are itemised in further detail. The example zooms in on the Food Atelier (a key component of the system map in Figure 4.27), specifying the component sub-elements**

How to use the tool

The tool requires the use of slideshow software (e.g. Microsoft PowerPoint, or the equivalent in Open Office). With this software it is possible to define and modify the actor map using a standardised set of purpose created icons (see Figure 4.30 to Figure 4.32).[31]

The tool is based on widely used, easy-to-use software; this facilitates the involvement of all participants in the project in the designing process and speeds up the exchange, modification and presentation of the various steps in the evolution of the solution.

The following text presents the format, library of graphic elements and the set of rules used to represent an actor map.

The *System Map* is built up on a single slide (Figure 4.29). By convention the limit of the slide is the boundary of the system, and a rectangle drawn on the slide shows the system platform boundaries: core actors performing the system are situated inside and the secondary actors outside. The latter are positioned in relation to the system life cycle: from left (beginning) to right (end).

31 It is possible to download a basic model with various icons, together with a user guide, from www.lens.polimi.it.

Figure 4.29 **System layout and platform outline**

Each actor is represented by one icon, made of three elements:

- The *structure*, which indicates the typology of actor: e.g. company, public institution, home, etc. (Figure 4.30 and Figure 4.31)
- The *characterisation*, which defines the actor activity: e.g. food producer, transporter, etc. (Figure 4.32)
- The *slogan*, which specifies the actor activity: organic food producer, supplier of logistic services, etc.)

Figure 4.30 **The structure identifies the typology of actor**

Figure 4.31 **The size of the structure indicates a main or secondary actor**

Figure 4.32 **A set of pictograms can be used to represent the actor activity**

The icon resulting from putting together these three standardised elements is able to specify an actor and differentiate him from the others on the map (Figure 4.33).

Figure 4.33 **Constructing an icon: basic structure + pictogram + slogan**

The nature of the flows between the different actors is marked by different arrows (Figure 4.34):

- The full, thick arrow indicates material flows (components, products etc.)
- The fine, square-dotted arrow indicates information flows
- The fine, round-dotted arrow indicates money flows
- The full, thick arrow with a diamond at its tip indicates work flows

It is possible to distinguish between one-way and two-way flows. In addition the colour of the arrow indicates whether it is a primary flow (dark grey) or secondary flow (light grey).

Figure 4.34 **Different flow types: material, information, money, work**

The actors and flows are positioned during the construction of the map. In order to make the system organisation easier to understand, it is necessary to specify the various flows and define a reading order by indicating a starting point and numbering the progression of the various flows (Figure 4.35). In general only the main flows are numbered.

Figure 4.35 **Constructing a system map: various actors and flows are positioned; the flows are described and main flows numbered**

Results

The result is a map that shows the various socio-economic actors that form part of the system and their interactions (in terms of material, information, money and work flows). This map becomes more and more detailed as the project evolves.

Tool availability and resources required

The tool is based on a layout and set of standardised icons, usable with slideshow software (e.g. Microsoft PowerPoint, or the equivalent in Open Office). From this base it is possible to modify the various icons and add new ones.

The tool was developed for use by any design team member since no particular graphic skills are required.

The technical time required to set up a *System Map* is approximately 30 minutes.

4.3.7 Satisfaction system map[32]

Aims

The *Satisfaction system map* is a support tool for the generation of system ideas.

The purpose of the tool is to identify and visualise the potential socio-economic actors who could be involved in the satisfaction of a given demand for well-being. This visualisation is used during the ideation process as a stimulus to understanding which actors could potentially take part in the satisfaction system.

In other words the map is used as a stimulus to steer the generation of ideas towards solution ideas that, through the involvement of different socio-economic actors, will be able to satisfy a given demand for well-being.

It is essentially a visualisation containing the following key elements:

- Indication of the *satisfaction unit* object of design (e.g. having clothes)
- Indication of the *sub-satisfactions* that make up the basic satisfaction (e.g. having clean clothes for domestic use, having clean clothes for special ceremonies, etc.)
- Indication of the *reference context* (e.g. the home, the neighbourhood service centre, etc.)
- The *actors* who can potentially be involved in each sub-satisfaction

Figure 4.36 **Elements that make up a Satisfaction system map**

32 The tool was developed by the System Design and Innovation for Sustainability Research Unit (INDACO department, Politecnico di Milano).

Integrating the tool into the MSDS designing process

The *Satisfaction system map* can be used:

- In Exploring opportunities to:
  - Visualise succinctly the potential actors who can be involved in satisfying a given demand for well-being, and use this visualisation as a stimulus in generating ideas

Figure 4.37 **Integrating the Satisfaction system map into the MSDS designing process**

How to use the tool

The tool does not require the use of any specific software; however, to facilitate its management and modification, it is advisable to use slideshow software (e.g. Microsoft PowerPoint, or the equivalent in Open Office).[33]

It is basically a map that can be visualised on a single page/screen. The satisfaction unit to be met by the project is indicated at the top (in the example shown, this

33 It is possible to download a basic model, with its use guide, for drawing up a Satisfaction system map in the 'Tools' section of www.lens.polimi.it.

is 'to move and move things inside and outside the office'[34]); the reference context is shown in the centre (continuing with the same example, this is the office); and the various sub-satisfactions are shown radially (reaching the office, being reached by colleagues, being reached by internal documents, etc.). The actors who may potentially come into play to satisfy the given demand for well-being are shown in the areas bordering the sub-satisfactions; the actors are positioned in order of importance from the centre to the edge of the map. The actors who are generally involved in all the sub-satisfactions are positioned at the bottom. It is advisable to use the same icons as in the *System Map*.

Results

The result is a visualisation identifying, succinctly, the potential actors who can be involved in satisfying a specified need.

Tool availability and resources required

The *Satisfaction system map* can be drawn up on paper without using any software. It is however advisable to use slideshow software, in order to facilitate management and modifications.

The tool can be set up without any specific graphic skills, so it can be done by any member of the design team. When using it during brainstorming sessions, it is advisable for a facilitator to be present whose task will be to underline the salient elements on the map and use them as a design stimulus.

A *Satisfaction system map* requires the following approximate minimum technical time to set up:

- 2 hours to indicate sub-satisfactions
- 2 hours to position the actors

4.3.8 Interaction table and Interaction storyboard[35]

Aims

The purpose of the interaction table is to support the (co)designing and visualisation of a sequence of interactions between the user and the product-service system designed. The tool visualises and shows the sequence of interactions

34 The example of a *Satisfaction system map* shown here is from a project that the DIS Research Unit at the Politecnico di Milano was carrying out for KONE Elevator, with the purpose of defining eco-efficient product-service systems based on KONE elevators.

35 The tool was developed by Daniela Sangiorgi during the MEPSS European research project (Methodology for Product Service Systems) Growth Programme / European 5th Framework. For further information see Jégou, Manzini and Meroni (2004); Sangiorgi (2005); and www.mepss.nl/index.php?p=tool&l4=W22.

occurring at *front-desk* level (interaction of user with the offer system) and at *back-stage* level (interactions between the various actors in producing and delivering the offer).

Specifically the aim of the tool is (in increasing detail as the project evolves):

- To describe and visualise the sequence of *main user interactions with the offer* system
- To describe and visualise the sequence of *interactions and roles of the various actors* (involved in the production and delivery of the offer) and the user
- To describe and visualise in further detail the sequence of *interactions and roles of the various actors* (involved in the production and delivery of the offer) *and the user*

Basically the tool consists of a graphic representation showing:

- A sequence of images (accompanied by brief descriptions) showing the various interactions (of the user and other actors in the system) during the production and/or delivery of the offer
- An indication, for every interaction, of additional information: e.g. who the various actors involved are, their roles and the elements (material and non-material) required to complete it

When the aim is to show a *fluent* narration of the functioning system the interaction table is not the most effective tool. In this case the narration storyboard is recommended.

The interaction storyboard consists of a graphical representation containing in *one single row* the sequence of images plus the texts, representing (in time) the main interactions of the different stakeholders; it is in essence an abstract of the interaction table.

Integrating the tool into the MSDS designing process

The *Interaction table (storyboard)* evolves in more and more detail during the designing process:

- In **Strategic analysis,** the *Interaction table (storyboard)* may be used to:
  - Describe a case study, visualising the interaction sequence of the user with the offer system (Figure 4.39)
- In **System concept designing**, the *Interaction table (storyboard)* may be used to:
  - Describe, even partially, how the user should interact with the initial ideas of the product-service system. The representations are simple and succinct (image sequences accompanied by brief descriptions) that

should visualise the core function offered by the system and how the user interacts with it (Figure 4.40)

  - Itemise the interactions of the user and other actors involved during the production and delivery of the offer. The representation becomes richer as the role of the various actors, and the (material and non-material) elements required to complete it, are specified for each interaction. Several ways to visualise can be used: it is possible to keep a single line of interaction (Figure 4.41); to have one line of interaction for the user and another for the system actors (Figure 4.42); or use a line of interaction for each actor involved (Figure 4.43)

- In **System designing (and engineering)**, the *Interaction table (storyboard)* may be used to:
  - Describe in detail all the interactions of user and actors involved in the production and delivery of the offer. Unlike the previous visualisation, a more detailed, in-depth description for every single interaction is required, in order to process all the information necessary for the solution's implementation. Each interaction is blown up in a series of interaction steps that should be carried out in order to complete the interaction itself. The role of the various system actors is itemised; to the interaction line (which separates the user actions from those of the front office) is added the visibility line (which separates the front office actions visible to the user from back office actions), and the internal interaction line (which differentiates the back office actions from the secondary support processes). Every *interaction step* is itemised separately, specifying all the components required to complete it: tools (support products, signs, etc.), interaction rules (rules that guide how the interaction should take place), expertise (which the user and actors should have in order to be able to interact), and information (required during the interaction both by the user and by the other actors)

This type of representation helps the design team to work in parallel, both on the system interface (interaction between user and front office) and on the organisation of the system itself (Figure 4.44).

Figure 4.38 **Integrating the Interaction table into the MSDS design process**

Figure 4.39 **In the example the Interaction table is used to describe the user's experience from the point of view of passenger and driver**

Figure 4.40 **First description of user interaction with the offer system**

Figure 4.41 **Detailed description of the user's interaction with the actors involved in the production and delivery of the offer. Visualisation with one line of interaction**

Figure 4.42 **Detailed description of the user's interaction with the actors involved in the production and delivery of the offer. Visualisation with two lines of interaction**

Figure 4.43 **Detailed description of the user's interaction with the actors involved in the production and delivery of the offer. Visualisation with a line of interaction for each actor**

Figure 4.44 **Final version of the Interaction table with all the specifications for implementation. The diagram shows the various interaction steps that make up interaction 3**

How to use the tool

The tool requires the use of spreadsheet software (e.g. Microsoft Excel, or the equivalent in Open Office).[36] The tool is thus based on widely used, easy-to-use software; this facilitates the involvement in the designing process of all participants in the project and speeds up the exchange, modification and presentation of the various steps in the evolution of the solution.

Specifically, a spreadsheet is used to support the elaboration of an *Interaction table*. Graphic elements (interaction visualisations) and text elements (descriptions of interactions, actor roles, etc.) can be entered into the cells. It is also possible to colour the cells differently in order to e.g. differentiate interaction lines. In addition, the software enables you to hide or visualise rows and columns depending on the elements you wish to make visible.

The software also enables you to add comments to single cells, in order to facilitate teamwork and build a work-in-progress document where the various project participants can add suggestion and comments.

To visualise the interactions we recommend that:

- The image background represents the context where the action will take place
- The actors illustrated in the images are highlighted against the background
- The images contain only the necessary elements, so as to reduce semantic confusion as far as possible
- The accompanying text (usually in the third person) is a concise description of what the actor is doing
- The image sequence preserves rhythm and chronology
- Only the most significant actions are shown in the sequence (this only for the visualisations of the initial ideas of the product-service system)

Results

The result is a visualisation, made up of images and text elements, that shows the interaction sequence between the various actors who make up the system and the user, during production and delivery of the offer. This visualisation evolves in greater and greater detail during the entire designing process.

36 It is possible to download a model of the Interaction table, with its use guide, from the 'Tools' section of www.lens.polimi.it.

Tool availability and resources required

The tool is based on spreadsheet software (e.g. Microsoft Excel, or the equivalent in Open Office).

Basic graphic skills are required to create the images (using photo editing software). However, management of the *Interaction table* inside the spreadsheet can be undertaken by any member of the design team.

The time required to set up an *Interaction table* varies according to the complexity of the project and the designing stage it is used in. It is therefore difficult to assess the exact timing of its application; we can say approximately that it will require a minimum technical time of:

- 1 hour to draw up a simple *storyboard* visualising only the key interactions (initial step in the System concept designing stage)
- 8 hours to draw up a detailed *Interaction Table* specifying the interactions of the various actors (final step of the System concept designing stage)
- 2 hours for each interaction to be blown up into *interaction steps* (System designing and engineering)

4.3.9 Offering diagram[37]

Aims

The *Offering diagram* is a static representation of the system functions; it can be used both as a design and a visualisation tool. The tool is useful to the design team for defining in ever-increasing detail the functions that the system delivers to the user.

It is basically a graphic representation, made up of images and text elements, showing (in ever greater detail as the design process evolves):

- The *core function*, i.e. the function that characterises the offer (e.g. customised meal delivery)
- The *basic functions*, i.e. the functions required for the execution of the core function (e.g. ordering, paying, etc.)
- The *added value functions*, i.e. functions associated with the core function able to enrich and increase its value (e.g. dietary advice)
- The *sub-functions*, which describe the way in which the functions will be delivered (e.g. the function 'dietary advice' can be itemised in 'online dietary advice', 'dietary information on products' etc.)

37 The tool was developed by Francois Jégou during the MEPSS European research project (Methodology for Product Service Systems) Growth Programme / European 5th Framework. For further information see: van Halen, Vezzoli and Wimmer (2005), and www.mepss.nl/index.php?p=tool&l4=W23. The descriptive text here is taken from: www.mepss.nl/index.php?p=tool&l4=W23.

Integrating the tool into the MSDS designing process

The *Offering diagram* becomes increasingly detailed throughout the entire designing process:

- When **Exploring opportunities**, the *Offering diagram* can be used to:
  - Describe the various clusters of ideas that make up the scenario. These idea clusters can be associated with a particular core function. It may be useful to give these clusters a title, a brief to-the-point description and propose a characterising image
- When **System concept designing**, the *Offering diagram* may be used to:
  - Itemise the basic and added value functions, starting with the core function. The system concept is outlined in this stage, so the offer system must be developed. In this sense the *Offering diagram* is both a design tool supporting designers in itemising their offer system and a visualisation tool that facilitates communication in the team and between different actors (Figure 4.46)
- When **Designing (and engineering) the system**, the *Offering diagram* may be used to:
  - Describe and list all the single functions and relative sub-functions required to implement the designed solution. This means that every basic function and every added value function must be itemised in sub-function clusters (which describe and specify how the functions will be delivered) (Figure 4.47)

Figure 4.45 **Integrating the Offering diagram into the MSDS designing process**

Figure 4.46 **During the system concept designing stage the Offering diagram helps evolve the basic functions, and those of added value are defined around the main functions**

Source: van Halen, Vezzoli and Wimmer (2005), with English translation

How to use the tool

The tool does not require any specific software; the *Offering diagram* can be drawn directly on paper. However, if the tool is used for communication purposes it is advisable to use graphic image processing software and slideshow software to draw up the images.

The *Offering diagram* is drawn up positioning the core function (represented by a significant image, a title and possibly an accompanying text) at the centre of the layout.

The basic and added value functions are positioned around the core function; these too can consist of an image accompanied by an explanatory text. You can also play with the size of these images to communicate whether the function is basic (larger) or added value (smaller).

The sub-functions are positioned, in text form, around their relative functions.

Figure 4.47 **During the system designing stage the Offering diagram evolves further: every single function is itemised in sub-functions**

Source: van Halen, Vezzoli and Wimmer (2005), with English translation

Results

The result is a diagram that visualises the functions (core, basic and added value) and sub-functions offered by the systems. There may be different diagrams according to the various system concepts developed.

Tool availability and required resources

The *Offering diagram* can be drawn directly on paper. However, it is preferable to use slideshow software to draw up the diagram, together with graphic image processing software. In this way it can more easily be modified by the various members of the design team. Basic graphic skills are required to create the images (using photo editing software).

The time required to create an *Offering diagram* varies with the complexity of the design project. However, we can approximately estimate a minimum technical time of:

- 1 hour to create a simple *Offering diagram* showing only the core function
- 2 to 3 hours to add basic and added value functions to the diagram
- 2 to 3 hours to add all the sub-functions

4.3.10 Polarities diagram[38]

Aims

The *Polarities diagram* was developed to 'explore' the possible and promising directions in which current systems may evolve. In other words it is a tool that supports the definition of how the existing system can be reshaped, starting with specified design choices: it supports the generation of ideas and facilitates their organisation and presentation. It is used, in particular, at the start of the designing process to define and visualise what we call a *sustainability design-orienting scenario*, i.e. the set of possible and promising reconfigurations that a system may take.

In practice it is a diagram constructed by crossing two polarities (Figure 4.48); one polarity shows a possible variation in the product-service system in two opposite directions (e.g. the user involvement may be low, and therefore on one side we have *full-service offers*, or high, and so on the other side we have *enabling solutions*).

On the one hand the tool facilitates the positioning and organisation of the ideas in the diagram; on the other it stimulates the generation of further ideas, e.g. by asking what would happen if an idea were moved from one quadrant to another.

Figure 4.48 **Example of polarity diagram showing its component elements**

Source: images processed by Vezzoli, Orbetegli and Ceschin 2006

38 The tool was developed during the MEPSS research project, Methodology for Product Service Systems (Growth Programme / European 5th Framework), with the aim of supporting scenario building. For further information see van Halen, Vezzoli and Wimmer (2005), and www.mepss.nl/index.php?p=tool&l4=W19.

Integrating the tool into the MSDS designing process

The Polarity diagram is used:

- In **Exploring opportunities**, to support the building of *a sustainability design-orienting scenario*, in other words the set of possible configurations that the new product-service system could take

The scenario in turn includes four *visions* (one per quadrant), schematic descriptions of how a context could evolve if certain design choices were adopted (Figure 4.52). Each vision is described in more detail by the set of ideas positioned inside the relative quadrant; for the sake of organisation and communication these ideas can be regrouped in clusters, i.e. groupings of ideas sharing basic characteristics (Figure 4.53). It is important to stress that polarity diagrams are used in the MSDS method to support the organisation of potentially sustainable ideas generated through the *SDO toolkit* (see Section 4.3.1—SDO toolkit). For this reason the resulting scenarios and visions are considered to be sustainability-oriented scenarios and visions.

Figure 4.49 **Integrating the Polarities diagram into the MSDS design process**

How to use the tool

The tool does not require any specific software; it can be drawn up on paper or in digital form (e.g. using slideshow software).[39] Four steps can be identified: *Generating ideas, Identifying promising polarity diagrams and polarising ideas, Defining visions, and Defining clusters of ideas.*

Generating ideas

Sustainability-oriented ideas are generated in brainstorming sessions. In the MSDS methodology this process is supported and facilitated by, for example:

- Sustainable idea generating tables (*SDO toolkit*, see 4.3.1—SDO toolkit)
- A *Satisfaction system map*, i.e. a representation visualising the different socio-economic actors who can potentially be involved in satisfying a specified demand for well-being (see 4.3.7—Satisfaction system map)
- Analysis of cases of excellence

The various ideas can be described in text (title, key words, extended description) and/or visual elements (images, sketches, etc.).

Identifying promising polarity diagrams and polarising ideas

In this step the *Polarities diagram* is drawn up in such a way that the emerging ideas can be spread over all the quadrants.

When drawing up the diagram it is possible to: 1) choose from various already defined polarities; and 2) define them again according to the needs of the project.

Figure 4.50 **Examples of polarity that can be used in drawing up polarity diagrams**

39 It is possible to download a basic model for creating Polarity diagrams, and a use guide, from www.lens.polimi.it, the 'Tools' section.

At this point it is possible to position the ideas on the diagram. It must be stressed that this operation does not only aim to organise and present ideas, but also to stimulate the generation of further ideas. It is possible to shift ideas from one quadrant to another to potentially bring out new ideas.

Figure 4.51 **Composition of polarity diagram, idea positioning, and generation of further ideas**

Source: reworked image from Vezzoli, Orbetegli and Ceschin 2006

Defining visions

Once all the ideas have been positioned it becomes possible to define *visions*, which, as we said, represent schematic descriptions of how the context could evolve if certain design choices were adopted. Each vision (one per quadrant) will represent a potential, promising orientation on which the system could evolve.

Usually each vision is described by means of a title and a more extensive description.

Definition of idea clusters

Parallel to the definition of visions it is also possible to cluster emerging ideas, i.e. create groups of ideas with shared characteristics. This is particularly advisable when a very large number of ideas have to be managed, to improve their organisation and presentation.

The amalgamation of several clusters of ideas (also from different quadrants) constitutes the starting point for the generation of one or more system concepts.

Figure 4.52 **Definition of the visions that make up the scenario**

Source: reworked image from Vezzoli, Orbetegli and Ceschin 2006

Figure 4.53 **Definition of clusters of ideas**

Source: reworked image from Vezzoli, Orbetegli and Ceschin 2006

In short, the process just described starts with idea generation and leads to the definition of the *Polarities diagram* and relative visions. In reality it is also possible to proceed in the opposite direction, and so:

- Define a *Polarities diagram* (starting with existing polarities or create them ad hoc)
- Define *visions* by describing the four emerging quadrants
- Use the *Polarities diagram* and relative *visions* to stimulate idea generation

Results

The result is a diagram describing a sustainability design-orienting scenario, with relative visions and idea clusters.

Tool availability and resources required

The diagram can be drawn up on paper. However, it is advisable to use slideshow software, in order to facilitate integration and modification.

Use of the tool does not require any particular graphic skills, so it can be managed by any member of the design team.

The use of *Polarities diagrams* accompanies all activities from polarising ideas to defining visions and clusters of ideas. The time it requires therefore varies according to the particular project. However we can approximately estimate a minimum technical time of:

- 30 minutes to define polarities and draw up the diagram
- 2 hours to position the ideas and generate further ideas
- 2 hours to define visions
- 2 hours to define idea clusters

4.3.11 Solution element brief[40]

Aims

The *Solution element brief* is a (co)designing and visualisation tool. Its purpose is to describe the elements (material and non-material) required by the system and which of the system actors must design/produce/deliver these elements. The tool basically helps to define the roles of the individual actors in developing and delivering the solution.

It is basically a graphic representation, structured as a two-way table, where:

- The material (products, equipment, etc.) and non-material (information, services, etc.) *elements* necessary to implement the solution are visualised along the horizontal axis. These elements are usually represented by pictograms
- The *actors* involved in the system are visualised along the vertical axis
- By crossing the *elements* with the *actors* the contribution made by the single actors in designing, producing and delivering the various elements is visualised

40 The tool was developed during the HiCS research project Highly Customerised Solutions, Solution-oriented design, production and delivery systems (European Research, GROWTH Programme / European 5th Framework). For further information see: Jégou, Manzini and Meroni (2004).

Integrating the tool into the MSDS designing process

The *Solution element brief* is mainly used:

- In **Designing (and engineering) the system**, to define succinctly and effectively the contribution made by each actor in the system to the designing, production and delivery of the single elements

Figure 4.54 **Integrating the Solution element brief into the MSDS designing process**

How to use the tool

The tool does not require the use of any particular software; however, to manage the various graphic elements more effectively it is advisable to use spreadsheet software (e.g. Microsoft Excel or the equivalent in Open Office).[41]

Widely used, easy-to-use software facilitates the involvement of all project participants in the designing process and speeds up the exchange, modification and presentation of the various steps in the evolution of the solution.

It is possible to enter various graphic and textual elements into the cells of the spreadsheet.

The parts that make up the visualisation are:

41 It is possible to download a basic model for creating a Solution element brief, and a use guide, from www.lens.polimi.it, the 'Tools' section.

- The *functions* required for the system to work
- The *elements* that make up the single functions (these can be represented by pictogram or, more simply, by descriptive texts)
- The *actors* who are part of the system (these can be represented by a .jpg created from the icons used in the *System Map*, or simply their names can be used)
- The *roles* that the different actors play in designing, producing and delivering the various elements (these can be represented by symbols, as shown in the key)

Figure 4.55 **Example of Solution Element Brief. At the top we can see the elements necessary for implementation of the solution (individual elements are described in a key). Each element is associated with various actors in the system: a cross indicates that the actor will contribute to designing that particular element; a square indicates that the actor will produce or deliver the element; a combination of cross and square indicates that the actor will contribute to both designing and production and delivery**

Source: Ceschin 2006

Results

The result is a graphic representation structured as a two-way table, showing the (material and non-material) elements required for implementation of the system and the roles of the various actors in designing, producing and delivering each element.

Availability of tools and resources required

Image processing software is required to create the icons. The use of spreadsheet software is advisable for drawing up the *Solution element brief*, so as to facilitate integration and modification.

Basic graphic skills are required to create the images (using photo editing software). However, management of the *Solution element brief* inside the spreadsheet software can be undertaken by any member of the design team.

The time required to draw up a *Solution element brief* varies according to the complexity of the project. However we can approximately estimate a minimum technical time of:

- 4 hours to create the icons (to save time, icons can be replaced by text descriptions)
- 4 hours to process the Solution element brief

4.3.12 Stakeholder motivation matrix[42]

Aims

The *Stakeholder motivation matrix* is a (co)designing and visualisation tool. Its purpose is to represent the solution from the point of view of the *motivations* of the single actors for taking part in the system. It is basically a tool for defining the role and the contributions each actor can supply to the general partnership, and to each of the other actors.

It is a two-way table where the various actors are positioned on both sides; by crossing the various actors it is possible to see, for each actor, what are (or could be):

- The *motivations* for taking part in the system
- The *contribution* made to the partnership in general, and to other single actors in particular
- The *contribution* received from the partnership and from other single stakeholders
- The potential areas of *synergy* or *conflict* with the various actors

42 The tool was developed in the HiCS research project Highly Customerised Solutions, Solution-oriented design, production and delivery systems (European Research, GROWTH Programme / European 5th Framework). For further information see: Jégou, Manzini and Meroni (2004). The description in this section was taken from: Jégou, Manzini and Meroni (2004).

Integrating the tool into the MSDS designing process

The *Stakeholder motivation matrix* can be used:

- In **System concept designing**. In this case the project proposers can use the tool first of all to define their own motivations, potential contributions and expected benefits to be derived from being part of the system. It can also be used to describe hypothetical partners to identify and involve in future (Figure 4.57)
- In **Designing (and engineering) the system**. The *Stakeholder motivation matrix* evolves together with the designing process: the hypothetical actors (previously identified) are replaced by real actors; their intentions, contributions and expected benefits are redefined and itemised; and the synergies between the actors are reinforced and any conflicts reduced and resolved (Figure 4.58)

Figure 4.56 **Integrating the Stakeholder motivation matrix into the MSDS designing process**

Figure 4.57 **Using the Stakeholder motivation matrix in the System concept design stage**

Source: reworked image from Ceschin 2006

	Milan municipality	Politecnico di Milano	Legambiente	Producers
Milan municipality	>>PSS coherent with its environment policies	>> Design opportunity	>>Opportunity to see sustainable practices in the area	
Politecnico di Milano	>>Design expertise required to create a PSS that takes account of the needs of the Municipalities	>>opportunity to continue research with a concrete experience in the field of sustainability		>>design expertise >>possible certification of company sustainability
Legambiente	>>design opportunity >>further considerations on environment related issues >>return on image	>> design opportunity >>further considerations on environment related issues >>return on image	>>PSS coherent with its (environmental and social) values)	>>possible certification of company sustainability
Producers		>>production capability and expertise		>>new market opportunity >>return on image

Figure 4.58 **Use of Stakeholder motivation matrix in the System designing and engineering stage**

Source: reworked image from Ceschin 2006

	Milan municipality	Politecnico di Milano	Legambiente	Producers	Assembly center	Warehouse	Partnership
Milan municipality	>>PSS coherent with its environment policies	>> Design opportunity	>>Opportunity to see sustainable practices in the area		>>PSS coherent with its environment policiess	>> Design opportunity	>>visibility to PSS >>spaces (assembly centre and warehouse) >>can procure funding
Politecnico di Milano	>>Design expertise required to create a PSS that takes account of the needs of the Municipalities	>>opportunity to continue research with a concrete experience in the field of sustainability		>>design expertise >>possible certification of company sustainability		>> technical tools (software and logistics), for warehouse management	>> theoretical knowledge and research activities >> technical expertise Specific sustainability expertise
Legambiente	>>design opportunity >>further considerations on environment related issues >>return on image	>> design opportunity >>further considerations on environment related issues >>return on image	>>PSS coherent with its (environmental and social) values)	>>possible certification of company sustainability			>> visibility ti PSS >> experience in service management Promotes campaigns and events
Producers	>>production experience	>>production capability and expertise	>>production capability and expertise	>>new market opportunity >>return on image	>>technical training >>tools	>>technical training >>tools	>> specific technical and production expertise >> product assembly espertise
Assembly center		>>design feedback			>>stable work opportunity		>> space for assembly and refurbishing
Warehouse		>>design feedback				>>stable work opportunity	>> space to apply the logistic design
Partnership	>>opportunity to carry through a design project able to improve the urban environment >training and experience	>>opportunity to carry through a design project >>training and experience	>>opportunity to carry through a design project in line with its values >>training and experience	>>new economic opportunity >>visibility >>ties with university and institutions	>>Work and training opportunity >>training and experience	>>Work and training opportunity >>training and experience	>>carry out sustainable practices in the area

How to use the tool

The tool does not require the use of any particular software; however, to manage the various graphic elements more effectively it is advisable to use spreadsheet software (e.g. Microsoft Excel or the equivalent in Open Office).[43]

The widely used, easy-to-use software facilitates the involvement of all project participants in the designing process and speeds up the exchange, modification and presentation of the various steps of the tool.

It is possible to enter various graphic and textual elements into the cells of the spreadsheet.

The parts that make up the visualisation are:

- The *actors*, positioned on both sides of the two-way table (these can be represented by a .jpg created from the icons used on the *System Map*, or simply their names can be used)
- The *motivations*, *contributions* and *expected benefits*, to be entered for each pair of actors

The table is read by crossing the actors positioned on the left side with those positioned at the top.

Figure 4.59 **The elements that make up the Stakeholder motivation matrix and how to read it**

43 It is possible to download a basic model for creating a Stakeholder motivation matrix, and a use guide, from www.lens.polimi.it, the 'Tools' section.

Results

The result is a graphic visualisation structured as a two-way table, where for each actor in the system, the motivations, contributions, expected benefits and potential conflicts and synergies deriving from being part of the system are described.

Tool availability and resources required

Image processing software is required to create the icons (the icons can be created from those used on the *System Map*). The use of spreadsheet software is advisable for drawing up the *Stakeholder motivation matrix,* so as to facilitate integration and modification.

Basic graphic skills are required to create the images (using photo editing software). However, management of the *Stakeholder motivation matrix* inside the spreadsheet software can be undertaken by any member of the design team.

The time required to draw up a *Stakeholder motivation matrix* varies according to the complexity of the project. However we can approximately estimate a minimum technical time of:

- 2 hours to draw up an initial version of the matrix (with main actors only)
- 2 hours to update the matrix with the secondary actors

4.3.13 miniDOC[44]

Aims

Audiovisual tools have great potential to promote dialogue through the practice of storytelling. MiniDOC is a video tool able to support internal dialogue among decision-makers involved in a system co-design process.

In a short length of time (about five minutes) the tool visualises the key aspects that emerge from analysis work by involving:

- Identification of case studies and best practices
- Video interviews with stakeholders
- Research on historically and contemporary iconographic repertoires useful to reconstruct memory and stimulate imagination

The specific purpose of the tool is to:

- Explore and map the context
- Build and promote new imaginary ideas about the research field
- Facilitate dialogue among the stakeholders

44 It is possible to see examples of *miniDOC* developed during the *Imagine Milan* project on the MovieDesignPolimi channel www.youtube.com/user/MovieDesignPolimi/featured.

Integrating the tool into the MSDS designing process

The *miniDOC* can be used as audiovisual output of the analysis phase.

- In **Strategic analysis**, the *miniDOC* may be used to:
  - Describe and visualise the key aspects (strengths and weaknesses) that emerged in the research phase. It may be useful to identify contexts, actors and clusters in a format that serves as a good starting point for a dialogue among decision-makers, as audiovisual material is easy to access and understand (see Figure 4.60)

Figure 4.60 **Concept table to describe key aspects of the context and frame extract from a miniDoc visualisation**

How to use the tool

The tool requires the use of editing and compositing software. It is thus based on narrative structures.

The *miniDOC* not only allows all stakeholders to be involved in the material collection (iconographic repertoires and video interviews), but it also forces designers to gather and organise the key elements into narrative and aesthetic clusters. Hence the context investigated becomes a source of inspiration for the development of the project.

Materials can be collected with different devices (video cameras, mobile phones, or cameras) that edited can easily convey the complexity of information. Designers can present different interactions by combining recorded materials, infographics and audio. It is also possible to transmit these outputs onto the net to manage online discussions (e.g. conference calls).

Table 4.7 **Phases in use of the miniDOC tool**

Phase	Activity
Concept	Listening Script Storyboard Aesthetic language
Pre-production	Historically and contemporary iconographic repertoires Video interviews
Production	Shooting Animation
Post-production	Editing Compositing

Results

The result is an audiovisual format based on a narrative structure able to show the current state of the art of the explored field.

Exploiting the potential of audiovisual storytelling, *miniDOC* allows stakeholders to produce reflections that become the source of inspiration for the subsequent design project.

Tool availability and resources required

The tool requires the use of editing and compositing software (e.g. Adobe Premiere, Final Cut or others for editing and After Effects or the equivalent for compositing).

Good communication and technical skills are required to create the storyline and the editing.

It is therefore recommended that a communication designer is employed who is able to translate the information gathered during the analysis with expertise that goes beyond visualisation.

The time required to set up a *miniDOC* varies according to the complexity of the project and is directly related to the output quality:

- A minimum technical time of 30 days for basic work (sufficient image quality, editing and storyline) that can be achieved with devices at one's disposal (e.g. mobile and free editing software)
- 40 days or more to achieve a good analysis output (good image quality, editing and storyline) for which technical and storytelling skills and structured goals are required

4.3.14 System concept Audiovisual[45]

Aims

The *System concept Audiovisual* is a visualisation tool conceived for idea generation; it is able to bring tangibility to ideas in order to shape the design project.

This tool, as well as *miniDOC*, enables production of a project output that visualises concepts, which become the starting point for a discussion among the actors.

In particular, the tool is a short video format (usually around three minutes) based on a three-act narrative structure:

- The first part shows the context
- The second part asks the typical design question for an envisioned future: 'what if…?'
- The last part visualises a possible solution

The aim is to show possible concepts and to stimulate imagination and conversation among different actors.

System concept Audiovisual has been developed to be a useful tool for the design process enabling the sharing of concepts among the various project participants.

Integrating the tool into the MSDS designing process

The *System concept Audiovisual* becomes increasingly detailed throughout the designing process.

- When **System concept designing**, the *System concept Audiovisual* may be used to:
  - Visualise possible design concepts to encourage comparison among different points of view. This allows stakeholders to identify needs and to develop a shared path with the design team
- When **Communicating**, the *System concept Audiovisual* may be used to:
  - Visualise developed design concepts to communicate and disseminate results. It allows relation of different mental images that are involved in the construction of a shared concept (see Figure 4.61)

45 *System concept Audiovisual* is usually known as Audiovisual Scenario: for further theoretical information see Piredda 2008.

Figure 4.61 **Example of how the System concept Audiovisual communicates results**

How to use the tool

To support the most effective and creative dialogue, it is recommended that a communication designer works with the design team on these activities:

- Listening—organising the key functions (strengths and weaknesses) into narrative and aesthetic clusters
- Script and storyboard—definition of the storyline and storyboard
- Production of the audiovisual visualisation

In *System concept Audiovisual* the stakeholders have the main role and cooperate with the design team on the definition of the ideas themselves: they are able to enrich the images' meaning with their ideas, knowledge and experiences.

Table 4.8 **Phases in use of the System concept Audiovisual tool**

Phase	Activity
Concept	Listening Script Storyboard Aesthetic language
Pre-production	Material search (images, photos, drawing…)
Production	Shooting Animation
Post-production	Editing Compositing

Results

The result is an audiovisual output able to visualise ideas (using aesthetic languages appropriate to the objective) that are generated during the design process: hence communication design can provide an epistemological and aesthetic contribution to envisioning a possible future.

Tool availability and required resources

The tool requires good communication, storytelling and technical skills.

For the listening activity the involvement of all participants is suggested for the organisation of the key functions and the generation of ideas.

Good writing and graphic skills are required to create the storyline and the images for the storyboard, which could be directly drawn on paper or created using photo editing software.

For Pre-production, Production and Post-production activities good skills in editing and compositing are necessary.

The time required to create a *System concept Audiovisual* varies with the complexity of the visualisation. These are semi-finished products that overlap sketches and drawings with photographic backgrounds, in which the audiovisual format allows the multiplication of points of view in time and space. It will therefore require

- A minimum technical time of 5 days. This type of *System concept Audiovisual* requires good listening and storytelling skills, where technical skills are related to the aesthetic quality of the visualisation. A good technique can be the integration of heterogeneous materials that are collected with new devices: the *Mash-up*

- A minimum technical time of 15 days for a *System concept Audiovisual* able to visualise complex ideas and tales that require a sophisticated image culture and advanced technical skills (e.g. Rendering or Fiction). This type of *System concept Audiovisual* can be used in the final step of System concept designing and in the Communicating stage

4.3.15 Animatic

Aims

The *Animatic* is a visualisation tool able to support the co-design process.

It is an animated interaction storyboard that edits images with dialogues and sounds. This audiovisual tool allows the design team to visualise a detailed sequence, giving an idea of the action time. It could be created after and on the basis of a (static) interaction storyboard and could make the same narration more effective.

In essence the tool is an audiovisual representation able to:

- Visualise a detailed sequence
- Add information about actions' duration
- Promote a collective conversation among the actors involved

Integrating the tool into the MSDS designing process

- When **Exploring opportunities**, *Animatic* can be used to:
  - Visualise the different phases of a new idea to make it understandable and facilitate the learning process. It is a semi-finished product that can represent process and relations in a schematic way and can promote a collective conversation
- When **System concept designing**, the *Animatic* may be used to:
  - Describe a draft concept, visualising an action sequence with an indication of time and space. This simulation allows the design team to gather different points of view on the project (see Figure 4.62)

Figure 4.62 **Example of a work-in-progress Animatic, a simple video-collage with dialogues and sounds**

How to use the tool

Animatic can be used as an internal communication and co-design tool. It is a simple video-collage obtained from a linear editing of drawings and images coming from an interaction storyboard, with dialogues and sounds. For graphic elements it is advisable to use graphic image processing software. For drawing up a storyline able to render the gathered materials the use of slideshow software (e.g. PowerPoint or the equivalent in Open Office) or basic editing software is recommended.

Table 4.9 **Phases in use of the Animatic tool**

Phase	Activity
Concept	Script Storyboard
Production	Search material (images, photos, drawings…) Images processing
Post-production	Linear editing

Results

The result is an audiovisual output made up of heterogeneous materials collected with different devices. It is a step beyond an animated storyboard that can visualise ideas to promote dialogue among stakeholders. *Animatic* can evolve in greater and greater detail during the design process up to the complexity of the *System concept Audiovisual* tool.

Tool availability and required resources

The tool requires basic graphic, storytelling and technical skills.

The time required to create an *Animatic* varies with the complexity of the visualisation and the narrative quality. It will require approximately:

- A minimum technical time of 2 days for a video-collage derived from a linear editing of drawings and images coming from the storyboard with dialogues and sounds (e.g. slideshow or simple video). This tool requires basic graphic skills to create the images (sketches, drawings or photo background) and basic storytelling expertise. Technical skills are related to the aesthetic quality of the visualisation

Table 4.10 **Time requirement approximations when using the Animatic tool**

Phase	Activity	Time
Concept	Script Storyboard	6 hours to define a simple storyboard
Production	Search material (images, photos, drawing…) Record dialogues and sounds	4 hours to select images from storyboard and other materials 5 hours to record dialogues and sounds
Post-production	Linear editing	8 hours to edit the collected materials

The following chapters in Part 2 of this volume will present a range of perspectives on PSS research: the research frontiers in Product-Service System Design for Sustainability.

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Appendix I **Design criteria and guidelines for system eco-efficiency**

In this appendix for each of the six environmental criteria identified in the previous chapters an organic set of guidelines are highlighted, intended to steer idea generation towards eco-efficient system solutions (e.g. the idea-generating tables from the Sustainability Design-Orienting toolkit software). These guidelines are thus aimed at supporting the idea-generating process where the objective is not to develop incremental improvements at product level but rather to propose possible innovations at system level, characterised by radical improvements from an environmental, socio-ethical and economic point of view. In this sense when defining the guidelines particular attention is paid to producing system level ideas, i.e. ideas regarding: 1) the products and services that constitute the offer; and 2) the configuration of actors able to produce/deliver that offer.

System life optimisation

- Complement product or infrastructure with services for their maintenance, reparability, substitution
- Complement product or infrastructure with services for their technological upgradeability
- Complement existing product or infrastructure with services that increase/enable their aesthetical or cultural upgradeability
- Complement product or infrastructure with services that increase their re-configurability (adaptation in new location)
- Offer shared use services for products or infrastructures
- Offer service delivery platform for product sharing/re-use/second-hand selling

Transportation/distribution reduction

- Use digital infrastructures (i.e. internet) for transferring/accessing information
- Create alternative partnerships that enable long distance activities (use, maintenance, repair)
- Create partnerships optimising the use of local resources (info/data transfer)

- Create alternative partnerships that allow on-site production (info/data transfer)
- Merge the product/infrastructure offer, with services for their on-site assembly
- Create partnerships to reduce/avoid transportation and packaging of products or semi-finished products
- Merge the product/semi-finished product with the service of its transportation to optimise distribution
- Enable clients to re-use packing and reduce transportation
- Offer service that allows remote controlling for maintenance/repair of products

Resource reduction

- Complement energy/materials/semi-finished products, with support services for their optimal use
- Offer access to products or infrastructures (enabling platform) through payment based on the unit of satisfaction
- Offer access to products or infrastructures (enabling platform) through payment based on the annual fixed fee per given period of time
- Offer full-service (final result) to client/final user, through payment based on the unit of satisfaction
- Provide resource-saving technologies and practices to upgrade existing equipment, where the investment is financed via realised resources savings
- Offer collective use of products and infrastructures
- Outsource activities when higher specialisation and technological efficiency of products/infrastructures are available
- Create partnerships to use/integrate existing infrastructures/products
- Outsource activities when higher scale economies are feasible
- Add to product/infrastructure the design of their adaptation in the context of use aiming at resources optimisation
- Complement product/infrastructure, with design services for their adaptation to use in variations of resource requirements
- Offer products/semi-finished products on availability
- Offer products/semi-finished products on pre-determined demand

Waste minimisation/valorisation

- Complement product/infrastructure, with take back services aimed at re-using or re-manufacturing
- Complement product/infrastructure offer, with take back services aimed at recycling
- Complement product/infrastructure offer, with take back services aimed at energy recovery
- Add to product withdraw services aiming at composting
- Create localised alliances/partnership aiming at symbiotic/cascade approach for secondary resource use

Conservation/biocompatibility

- Create partnerships aiming at decentralised and renewable energy resources
- Create partnerships that increase the utilisation of local renewable and bio-degradable materials and produces
- Increase the utilisation of passive energy resources for infrastructure and products functioning
- Create partnerships that increase the utilisation of local recycled materials

Toxicity reduction

- Create partnerships with other producers to re-use or recycle toxic or harmful substances
- Complement the product, infrastructure, or semi-finished products with services that minimise/treat toxic or harmful emissions they cause in use
- Include end-of-life treatments when selling toxic or harmful substances
- Offer toxic management services to client/final user, through payment based on the unit of satisfaction

Appendix II **Design criteria and guidelines for social equity and cohesion**

As in Appendix 1, for each of the six socio-ethical criteria identified in the previous chapters an organic set of guidelines is highlighted, intended to steer idea generation towards social, equitable and cohesive system solutions (e.g. the idea-generating tables from the Sustainability Design-Orienting toolkit software).

Improve employment/working conditions

- Promote and enhance the protection of working conditions
  - Avoid/eliminate forced and under age work
  - Avoid/eliminate all forms of discrimination in the workplace
  - Provide freedom of association and right to collective negotiation
  - Define and adopt tools and standards of social and ethical responsibility certification of the companies
- Promote and enhance health and safety in working conditions
  - Improve the health and safety of workers
  - Define and adopt tools and standards of social and ethical responsibility certification of the companies
- Promote and enhance adequate working hours and fair wages
  - Guarantee that wages are fair and adequate to the amount of working hours (in the whole value chain)
  - Guarantee an adequate number of working hours
- Promote and enhance satisfaction, motivation and participation of the employees
  - Offer a work place adequate to employees' capacities
  - Guarantee a continuous formation and training period for workers
  - Avoid alienating jobs in favour of creative ones
  - Involve workers/employers in decision processes
  - Create a working climate that takes into consideration innovations suggested by the workers
  - Collaborate with colleagues to offer good working conditions in the whole value chain

Improve equity and justice in relation to stakeholders

- Promote and enhance fair and just partnerships
  - Support and involve partners in developing or emerging contexts
  - Support and involve partners active in social activities
  - Involve organisations engaged in the diffusion of social equity standards
  - Promote and facilitate the knowledge exchange inside partners' relationships
  - Extend to partners the definition and/or the adoption of standards and tools for social and ethical responsibility certification
  - Offer to stakeholders an adequate information flow
  - Increase stakeholders' productive capacity
- Promote and enhance equal and just relations with suppliers, subcontractors and sub-suppliers
  - Join the system of fair trade activities/development of aid activities
  - Promote cooperation projects in emerging and developing countries
  - Consider stakeholders' expectations and potentialities and give answer to suppliers/subcontractors needs and interests
  - Involve suppliers, subcontractors and sub-suppliers in design (and decision) processes
  - Promote/require that other companies which take part in the value chain safeguard the working conditions
  - Promote/require that other companies which take part in the value chain safeguard health and safety
  - Promote/require the adoption of social certification systems by suppliers, subcontractors and sub-suppliers
  - Define and/or adopt standards and tools for companies' social and ethical certification
- Promote and enhance equal and just relations with clients and/or end-users
  - Offer products and services which guarantee to the clients/final users' health and safety
  - Promote systems to improve health and safety conditions and reduce discrimination and marginalisation

  - Enhance the health and safety in working conditions of the products and services offered
  - Define and/or adopt standards and tools for the certification of social and ethical responsibility in relation to final users
- Promote and enhance equal and just relations affecting the community where the offer takes place
  - Verify that the offer does not have any rebound effects
  - Promote and enhance the quality and accessibility of common goods
- Promote and enhance equity and justice with local institutions/agencies
  - Support democratic structures through the system to be offered (e.g. in developing countries)

Enable a responsible/sustainable consumption

- Make transparent and enhance the social sustainability of all the stakeholders
  - Adopt standards in order to increase the transparency of supply, underlining its social sustainability
- Provide the information and/or learning experiences to educate the client/end-user on responsible/sustainable behaviour
- Develop offers that enable responsible/sustainable participation of the client/end-user
- Involve the client/end-user in the production/implementation/customisation of his/her own product-service systems towards responsible/sustainable behaviour
- Involve the client/end-user in the design/decision process, of his/her own product-service systems towards responsible/sustainable behaviour

Favour/integrate the weaker and marginalised

- Involve and improve the conditions for weaker social strata
- Involve and improve the conditions of marginalised persons
  - Involve and improve marginalised (e.g. unemployed) persons offering them qualifying jobs which enhance their competences
- Involve and facilitate introducing foreigners into the social context/space

- Develop systems to extend the access to goods and services to all social strata
  - Develop products or services for free or at a cost accessible even for people of low-income
  - Diversify the offer allowing higher or lower costs, to increase the access capacities
- Develop systems of shared usage and/or exchange of goods and services to increase their accessibility
  - Develop systems with shared economic property
  - Develop systems which promote labour services with equitable access/exchange
  - Develop systems (e.g. cooperatives) which involve product sharing and cost reductions
- Develop systems which allow easier access to credit (for companies)

Improve social cohesion

- Promote systems enabling neighbourhood social integration
  - Promote neighbourhood systems of sharing common goods and maintenance
  - Promote systems enabling inhabitants in common goods co-design
  - Promote co-housing systems
  - Promote co-working systems
- Promote systems enabling social integration between generations
- Promote systems enabling gender integration
- Promote systems enabling social integration between different cultures

Empower/enhance local resources

- Respect/enhance peculiar local cultural characteristics
  - Respect and encourage cultural identities and diversities
  - Encourage different tastes and aesthetics

- Develop a system to encourage and foster local economies
  - Reinforce the role of the local economy creating services in the same place where they will be used
  - Favour any development that enhances the local capacities for collaborated production of goods that contribute to the common goods and external economies
- Regenerate/enhance unused and disposed artefacts
  - Renew/regenerate urban artefacts that have fallen into disuse (e.g. involving weak persons)
  - Renew/regenerate industrial, domestic and urban dismissed products and materials
- Adapt/promote systems using regenerated natural, local resources
- Promote local-based and network-structured enterprises/initiatives
  - Promote/rely on distributed renewable energy generation network
  - Promote/rely on people collaborating (open and peer-to-peer) networks
  - Promote/rely on artefact collaboration (open and peer-to-peer) networks.

PART II

THE NEW DESIGN FRONTIERS OF PRODUCT-SERVICE SYSTEM DESIGN FOR SUSTAINABILITY

Section 1

New Ways to Deliver Satisfaction and Manage the Transition

1

An aesthetic for sustainable interactions in Product-Service Systems?

Fabrizio Ceschin
Politecnico di Milano, Design Department, Design and system Innovation for Sustainability (DIS), Italy
Brunel University, School of Engineering and Design, Department of Design, UK

Carlo Vezzoli
Politecnico di Milano, Design Department, Design and system Innovation for Sustainability (DIS), Italy

Salvatore Zingale
Politecnico di Milano, Design Department, Communication Design (D.COM), Italy

1.1 The limited diffusion of eco-efficient Product-Service Systems

Eco-efficient Product-Service Systems (PSS, in which the economic interest of the stakeholders involved in the offer continuously foster the optimisation of environmental resource consumption) represent a promising approach to sustainability. However, despite their potential win–win characteristics, the application of this concept is still limited. One key reason is that eco-efficient PSSs are often radical innovations and their adoption usually challenges existing customers' habits (cultural barriers), companies' organisations (corporate barriers), and regulative framework (regulative barriers).

Starting from these considerations this chapter first investigates the barriers that affect the attractiveness and acceptance of eco-efficient PSS alternatives. A debate

is then opened on the aesthetics of eco-efficient PSSs and the way in which aesthetics could enhance specific inner qualities of eco-efficient PSSs, i.e. facilitating and enhancing their wider diffusion. Through the analysis of several case studies, and integrating insights from semiotics, the chapter then outlines several research hypotheses on how the aesthetic elements of an eco-efficient PSS could facilitate user attraction, acceptance and satisfaction.

1.2 Eco-efficient Product-Service System (PSS): user acceptance barriers

Consumption behaviour is a matter of individual choice, influenced by social norms and institutional settings. The diffusion of alternative eco-efficient PSS solutions is hindered by the current and dominant consumption behaviours. Let us summarise the most important factors that determine this opposition (in industrialised contexts); we will follow Mont's (2004) line of thought, dividing them into economic and socio-psychological factors.

From an **economic perspective**, Røpke (1999) states that current consumption behaviours are first determined by the entire history of industrial development. The Industrial Revolution led to increased production volumes and reduced product prices, determining the need to sell more and more new products. This in turn encouraged creation of demand for all the produced artefacts, and therefore strategies were defined to boost consumption. In relation to this, Kilbourne *et al.* (2001) state that economic and political institutions have persuaded people to believe that higher material prosperity is the expected behaviour.

Another cause that contributes to reinforcing material consumption levels is related to so-called externalities. Since environmental and social costs connected to products are not included in their market prices, it can become difficult for eco-efficient PSS solutions to compete with industrially produced products (Mont and Lindhqvist 2003; Ceschin and Vezzoli 2010). Moreover the prices of labour-intensive solutions (and eco-efficient PSS is often included in this category) are increasing, and therefore it is cheaper for customers to buy product-based offers (e.g. washing machines) instead of PSS-based offers (e.g. clothing care services).

In addition users show a lack of knowledge and understanding about life cycle costs (Mont 2002). It is therefore sometimes difficult for users to understand the potential economic benefits of PSS-oriented solutions. PSS-based offers are usually (and erroneously) perceived by the end-user as more expensive if compared to the purchase of products (even if sometimes the contrary is true), since the total cost of ownership (including use, maintenance, repairs and disposal costs) is not taken into consideration in the purchase of a product.

Economic studies are traditionally based on the assumption that consumers are rational decision-makers whose choices are driven by utility maximisation, with price and income factors as most important in making choices. However, as

underlined by Mont and Plepys (2008) consumer behaviour has been found to be far more complicated than merely a rational response to prices, being influenced by different internal and external drivers induced by **human psychology**, **social norms** and **institutional settings**.

Sociological studies underline the role of *habits* in influencing consumption behaviour, arguing that consumption choices are dependent on prior consumption patterns. In relation to eco-efficient PSS, the problem is that solutions based on sharing and access contradict the dominant and well-established norm of ownership (Behrendt *et al.* 2003), making consumers hesitant to accept ownerless-based solutions. This is especially true for particular types of satisfaction (e.g. for washing our clothes we are not accustomed to the idea of a washing machine in our home that does not belong to us), while in other cases ownerless-based solutions have entered into our routines (e.g. the use of public transport services).

Another barrier to the diffusion of ownerless-based solutions is the fact that the quantity and quality of accumulated goods is perceived as a measure of success in life because they represent an indicator of a certain position in society (Mont 2004). Moreover, as underlined by Halkier (1998), the current trend towards individualisation is boosting consumption demand because a person's identity is no longer defined by a community but rather by the goods s/he owns (goods that represent the signals of one's own identity). In addition, hesitation towards offers based on ownerless access and sharing can be linked to the perception of independence, hygiene and intimacy usually connected to one's own products.

Even if there are barriers that hinder the acceptance of ownerless-based offers, there are also windows of opportunity (Mont 2004) that can be exploited to favour the acceptance of such solutions. First, while traditional economics argues that users demand physical products to satisfy their needs, the works of some sociologists (e.g. Max-Neef 1991) tell us that needs can be fulfilled by material and non-material 'satisfiers'. Moreover material consumption is not linked to happiness; in fact more materialistic people are not always happier than less materialistic people (Belk 1985; Max-Neef 1995). In addition, some studies state that an increase in consumption levels represents the need to satisfy psychological and social aspirations rather than material ones (Jackson and Marks 1999). On the same line of thought, Hacker (1967) argues that the purchase of the same brand represents a substitute for a lost sense of community. Moreover, in relation to goods possession, if it is true that this is perceived as a measure of a certain social status, it can also be proposed that ownerless solutions may represent a certain status; let us consider for example the use of a taxi or access to education or cultural events (Mont 2004).

We have seen that different barriers on a user level may be obstacles to the acceptance and the satisfaction related to ownerless-based solutions. At this point several key questions arise.

- How is it possible to help the user to accept the (radical) behavioural changes linked with this kind of solution? How is it possible to encourage the embedding process into his/her habits?

- During the purchase choice, how could we help the user to be more attracted by an eco-efficient PSS rather than a traditional product-based offer?
- During use, how could we help the user to perceive an eco-efficient PSS as more satisfying than a traditional 'product-based' offer? In other words, how can an eco-efficient PSS be perceived as a solution that produces more comfort, pleasure in use, etc., than a traditional offer?

1.3 A potential role for aesthetics?

We know that aesthetics has an important role in product design and in user acceptance and satisfaction. Moving on to the system innovation level the question is: in what sense is it possible to consider an aesthetic of an eco-efficient PSS? As we have seen previously, an eco-efficient PSS is quite a complex artefact, made up of different elements: **products**, **communication**, **services** (interactions between the user and the producer/provider) and more in general **interactions** (between the different socio-economic stakeholders involved in the PSS value production system). The attraction, acceptance and satisfaction related to a PSS therefore depend on how its system of products, services, communication and interactions are perceived by the user. We therefore argue it is fundamental to focus on the way in which the different elements of an eco-efficient PSS are perceived. We could talk of a **system aesthetic**, i.e. an aesthetic as the integrated perceptions of the *expression forms* of the different elements of the PSS: an aesthetic that therefore integrates in a coordinated way the aesthetics of products, communication, services and interactions. How, then, can the aesthetic elements of an eco-efficient PSS facilitate user attraction, acceptance and satisfaction? In order to try to outline a framework for possible answers, we will analyse several cases of eco-efficient PSS to gain some insights and put forward several working hypotheses.

1.3.1 Insights from case studies

Wash bar

Wash bar (Tamborrini 2009) is a LG Electronics laundry, established in 2005 in Paris. Users have access to washing machines and dryers, but also to a bar and various recreational-cultural services, such as a Wi-Fi internet connection, short film showings, and participation in organised events. The interior spaces appear like a bar or a games room in which washing machines and dryers are integrated.

The environmental benefits connected to this kind of solution are clear. What, then, are the differences between Wash bar and traditional laundries? First of all in Wash bar the intention is to appeal to a wider range of users to adopt this kind of solution. The strategy is simply to make the waiting time during the washing and drying cycle more pleasant. The various elements of the system (the furniture

elements, the communication elements and the service elements) are considered and arranged in order to create a sense of hospitality. Users can feel at home: they can read, listen to music, and surf the internet.

The main aspect of interest in the solution is therefore the social dimension. The tangible elements (sofas, armchairs, tables, etc., and their layout) coupled with the various available services (bar, Wi-Fi connection, etc.) together determine the possibility for users to develop interpersonal relations. This relational aspect represents the key point of the PSS solution. It is the social quality of the innovation that could potentially contribute to make the solution perceived as more satisfying compared to traditional laundries (and perhaps even to domestic laundry).

Figure 1.1 **Wash bar: pictures of the interior spaces**

Source: Tamborrini 2009

Car sharing/pooling system for the Vehicle Design Summit project

The second case we present is an urban mobility system that integrates car sharing and car pooling, developed as a Master's degree thesis by Lorenzo Davoli within the research project Vehicle Design Summit.[1] In synthesis (Vezzoli and Ceschin 2008) it is a system through which users have access to a fleet of low-environmental-impact cars and in which users are encouraged to share trips with others. The user, once registered, receives a smart card that allows access to the fleet of electric cars as well as to public transport. The reservation of the car (located in dedicated parking lots made available by the municipal administration) is made via the internet or cell phone. During the use of the vehicle a GPS system suggests to the user the shortest and least crowded route. Payment for the service is based on the kilometres covered.

1 Vehicle Design Summit is an international consortium made up of 27 universities and coordinated by MIT of Boston. The consortium objective is to design and realise a low-environmental-impact and 'open-source' car, as well as to define the conditions for its market introduction through innovative and sustainable mobility offers. The role of the Politecnico di Milano team (Lorenzo Davoli, Francesca Fiocchi and Jun Lin, coordinated by Carlo Vezzoli and Fabrizio Ceschin) was to design an innovative and eco-efficient business model, as well as a transition path to introduce and diffuse this model onto the market (cf. Davoli, Fiocchi and Lin 2008).

The peculiarity of this system is that through the internet the user can create and manage his/her own network of contacts (friends, colleagues, relatives, neighbours, etc.) and through this network organise his/her own journeys and plan to share them. Moreover, via cell phone it is possible to know in real time the location of friends that are using the car in order to ask them for a lift (sharing the service costs).

Figure 1.2 **Car sharing/pooling system designed for the Vehicle Design Summit project: storyboard of one of the possible user interactions**

Source: Vezzoli and Ceschin 2008. With kind permission from the authors.

The environmental advantages of car sharing/pooling systems compared to the use of a private car are obvious. What, then, are the differences between this system and traditional options? As in the previous case, there is the intention to make the solution more satisfying if compared to traditional car-sharing systems and the use of private cars. Also in this case the fulcrum is linked to the inherent relational qualities. The key point is the possibility to create and manage a network of contacts to share trips. In this way users can build new contacts as well as feel part of a community. And it is this social dimension of the service that could act as a stimulus to modify user habits and behaviours.

Importantly, to support this change, the system is designed to also create awareness about environmental issues. The service on one hand supports the user in choosing the less crowded routes (with consequent resource saving) and on the other explains the environmental benefits connected to the system. This represents

a further element potentially capable to strengthen the satisfaction generated by these kinds of solutions.

1.3.2 A design research working hypothesis

At this point this key question emerges: what effects should the aesthetic of an eco-efficient PSS have on the user?

First it must be remembered that eco-efficient PSSs are satisfaction-based offers, meaning that what is designed is a *satisfaction* rather than the product that aims to fulfil it.[2] From this perspective:

- The aesthetic dimension, and the delivery of the perceived value, can be designed into the ultimate and profound level of the offer, i.e. the satisfaction, rather than the various means to reach it. In this sense the same aesthetics (as attraction, acceptance, and satisfaction) is more *honest* and *transparent* to the user

Moreover, as we have seen previously, since eco-efficient PSSs are most often based on access (to products or final results) and sharing (of products), it is necessary to focus on the advantages connected to these characteristics if we want such solutions to be perceived as better than the traditional product-based offers. In particular eco-efficient PSSs can potentially favour:

- The interactivity between the various users (of the PSS). The sharing of products between more people can lead to the development of new interpersonal relations (as seen in the cases described above). The direct contact between people that takes place during the use of a PSS can determine a greater participation by the user, who can feel 'part of a community': consider, for instance, solidarity purchasing groups (organised groups of people who buy food directly from local farmers) and the relations that take place between the users
- The interactivity between the user and the PSS producer/provider, because the relationship does not end after the purchase (as happens in traditional product-based offers) but extends over the length of the stipulated contract/agreement

These elements—the relational qualities that can be built between the users of a PSS and between the users and the producer/provider—are precisely those elements that cannot usually be found in traditional product-based solutions. Therefore they represent distinctive traits of eco-efficient PSS solutions. Consequently, these relational qualities should be the elements to be valorised if we want to enhance user attraction, acceptance and satisfaction.

This is coherent with what we have seen previously. In fact, if goods purchase can be linked to the need to satisfy social aspirations (Jackson and Marks 1999), and

2 For example, having access to mobility instead of cars; thermal comfort instead of boilers and methane; clean clothes instead of washing machines and detergent.

sometimes represent a substitution for a lost sense of community (Hacker 1967), it is especially on these social processes that a PSS should focus, in order to be perceived as better than a product-based offer.

In addition to these elements, an eco-efficient PSS is characterised by its intrinsic environmental and economic benefits. However the problem is that, as underlined in the first section, most often the user is not aware of these qualities. As a consequence it is necessary to also focus on these aspects if we want to enhance the attraction and acceptance of these kinds of solutions. In particular:

- It is necessary to facilitate users' understanding of the environmental and economic benefits connected to the use of eco-efficient PSS solutions
- As a consequence, users will become aware of having adopted a more responsible and sustainable behaviour, and this could represent a leverage point for wider diffusion of the solution because users could inform others and stimulate them into doing the same

Furthermore eco-efficient PSSs, compared to traditional ownership-based solutions, usually bring further benefits to users, such as:

- Release from the problems and costs connected to the product's maintenance, repair and disposal

This aspect should therefore also be emphasised and made more visible to the users.

Finally eco-efficient PSSs must not only create satisfaction during the use phase, but they have also to be more attractive (compared to ownership-based offers) during the purchase choice. In other words an eco-efficient PSS should be able to 'invite' and 'intrigue' users (and attract their interest) more than the product-based solutions.

In synthesis, how can the aesthetic elements of an eco-efficient PSS strengthen user attraction, acceptance and satisfaction? Some working hypotheses (to be verified) are listed below:

- During the purchase choice, the aesthetic elements of an eco-efficient PSS should stimulate users, attracting them and inviting their interest and highlighting the physical product non-ownership qualities
- During the use phase, the aesthetic elements of an eco-efficient PSS should valorise its relational qualities (stimulating interactivity between users, and between the users and the PSS producer/provider)
- During the use phase, the aesthetic elements of an eco-efficient PSS should facilitate users in understanding the advantages of freedom from the problems and costs connected to the product's maintenance and disposal
- During the use phase, the aesthetic elements of an eco-efficient PSS should also facilitate users in understanding and enjoying its various economic and environmental benefits

1.4 Semiotics, aesthetics and eco-efficient PSS

1.4.1 A sense of relations

The case studies presented here clearly show that benefits for the environment and for the users result from the ability to design *relationships*, together with artefacts: relationships of use and social relations. They can be considered in terms of semiotic relationships, because the meaning of things arises from the way the different elements of human experience meet and associate. Both in text analysis and in product and service design, a particularly important type of relationship is that between the *expression plane* and the *content plane* (cf. Hjelmslev 1943). The expression concerns the way in which things occur: the form they take, the syntactic arrangement of their components, and the materials of which they are composed. Expression is both the logical organisation of the products and their perceptible appearance. The plane of content, on the other hand, covers the entire semantic background of the artefacts: the range of their possible meanings and the meaning of their existence.

But when we talk about products and services, the semantic dimension must also be considered according to the *pragmatic dimension*: the user's response, the ability of artefacts to influence behaviours, the level of satisfaction that they are able to generate, and the user's own purpose of purchase and use of a particular product or service. The artefacts do not only *say*, but also *do* or *make one do*.

1.4.2 From the 'product of sense' to the 'effect of sense'

The satisfaction obtained by using a product, whatever it is, is of paramount importance to the user. It is not difficult to see how the satisfaction degree of a product is largely determined: 1) by the relationship between the sensory nature of expression and the cognitive nature of content; 2) by the dialogical relationship between different semantic worlds and between different communicative intentions; and in design, 3) by the relationships between the *aim of sense* (what the designer intends to propose), the nature of the *product of sense* (as a product is) and the *effects of sense* (the consequences of the use on the user) (Zingale 2009).

In the case of the Wash bar from LG Electronics, the designer/provider's aim of sense is to make sure that the washing machine reduces energy consumption; the effect of sense is to generate from this experience a pleasant moment for the users, turning, in this case, work time into free time. Finding a 'sense of hospitality' in washing laundry means the feeling of being in a good relationship with the environment, with the space and the furniture and, as a consequence, with other users.

In this case, the artefacts and the environment's way of expression has a material nature, even if the service's organisation is largely immaterial, and yet *mediated* by communication tools, organised environments, forms of social transactions, etc. Here, the semiotic mediation is aimed at influencing decisions on lifestyles and behavioural practices to adopt. The elements are no longer merely products to be

owned, but also actions to be implemented together. Indeed, in PSS the form of the items, the shape of communication and the form of service are a single set of factors that interfere with each other.

This interference set involves an update of the aesthetic-semiotic approach to design. The problem arises when it is necessary to study the sense of a product, taking into account not only its structure, like the text, but particularly the open set of its possible effects. In other words, we must consider not only its shape but the consequences that can arise from it (cf. Peirce 1878, CP 5.402).

1.4.3 Observation of experience

If, in this way, a product can be thought of as a 'text' defined by boundaries, with its own semantic consistency and syntactic cohesion (cf. Marrone 2009), then, on the other hand, a product-service is indeed a 'semiotic text' but with its borders variable and its outcome undefined. It is a text open to occasional events of experience, in which the interaction between service suppliers and users appears as the decisive value.

The semiotic study, in this case, approaches ethnographic observation methods where the user experience is being investigated. This observational character may be applied in three phases:

1. **Before the project**, in the observation, ethnographic or ethno-semiotic (cf. Marsciani 2007), of existing social practices
2. **During the project**, in the verification and testing phases of the PSS
3. **After the project**, in the analysis of already tested PSS case studies, with more or less positive results

In particular, observation of the user experience should include:

- **Levels of understanding**. How the service offered is understood by the user
- **Expectations about the expected benefit**. What the user shows he/she is able to do or wants to get
- **Attitudes**. How the user approaches it and what types of conduct he/she puts in place
- **Choices of action**. What the user chooses to do and why
- **Programmed responses**. Whether and how the user respects the order of actions in the design programme
- **Interpretative cooperation**. What the user can add to the modality use of the service
- **Interpretative responses**. The reactions and judgements made about the service received

1.4.4 From experience to design

Such a procedure can be well illustrated in the car sharing Vehicle Design Summit case study. Here the action of design can be seen as key to giving an ecologically oriented sense to our ordinary habits, which are so entrenched and often heedless of critics. Nonetheless, we must *learn to observe*: the things we do, the way we do them and through which tools.

Here, the semiotic way of looking at things helps to *translate* the observed data into social practices, into design choices that can outline innovative, efficient and satisfactory solutions. The difficulty of this translation is mainly in the degree of novelty of the PSS, or in the implicit request to break behavioural patterns and models. As regards the use of products, individual and social habits are quite entrenched, as mentioned above, and generally implemented on the basis of automatic or traditional adjustments.

Therefore, a PSS innovation requires:

1. **Cognitive shift** towards unknown habits and programmes of use
2. A **semantic reformulation** and subsequently a reconfiguration of the values traditionally associated with artefacts
3. A **didactic clearness** of the PSS's forms of communication

Therefore, a semiotic contribution to the elaboration of plausible solutions will mainly concern the way in which the PSS is able to design the new use of artefacts, marking a difference with tradition. In particular:

- **New habits** that the subject-users must make their own
- **Access roads** to the PSS, which deviate from traditional ways of acquiring a product
- **Sharing rules** of the PSS, or the idea of shared and inter-subjective ownership
- **Learning forms** of new use modalities
- **Elements of satisfaction** derived from the PSS, and which only this one can provide

1.4.5 Sense and satisfaction

This last aspect leads us to the heart of one of the most critical points in the PSS proposal. Indeed, if the PSS marks a discontinuity with traditional forms of use and consumption of products, and if this discontinuity is aimed at transition to more sustainable forms, in which aspects of PSS will a user identify the source of the actual benefit? We therefore return to what was said on semiotic relations at the beginning. The plane of expression plays a strategic role in all forms of communication. It is both what *represents* the content and what *introduces* the content.

The problem exists in the relationship between the plane of expression and the plane of content. How can the sensible and material aspect of a product persuade a user into a particular content? In PSS the contents that are relevant can be basically collected from two *semantic lines*: the *area of interest* (services and benefits offered, demand of actions of use, etc.); and the *area of utopia* (lifestyle change, sharing of goods, control of consumption, etc.) But these contents carry the risk of remaining inefficient if the PSS does not activate or request also a *pragmatic line*, the one that concerns the action of the product on the user, activating the effects of sense (what I understand, what I should do, what I should choose, etc.) and thus the degree of acceptance/rejection of a product.

1.4.6 Aesthetic mediation

Some may say that the existence of this third line of sense is what has always characterised design, which has entrusted to the aesthetic sphere the task of giving an exclusive and differential value to industrial products. What changes here is, however, the role of the *aesthetic function* and the way we understand it. Perhaps the role that is typically assigned to the aesthetic sphere of products is still influenced by the artistic model. But design is not art. There are many characteristics that unite these two fields, but there are many that also set them apart. Overlapping the two models is a very serious error of 'design'.

If we then assume that the aesthetic function has the task of stimulating the user's cognitive and sensory attention to a product, it must be said that in design in general and in a PSS in particular it should be conceived and developed:

- As an **access road** that helps the user-receiver to understand the overall sense of the PSS
- As a form of **introduction to the instructions** and to the way the user enters into a new and innovative idea of consuming
- As a strategy for **maintaining contact** between user and product

Therefore, we must start from the premise that understanding the deep values of the eco-efficient project resides largely in the role assigned to the *aesthetic function* of the products. According to Jakobson (1963), in an act of communication the aesthetic function is the one related to the message form. However, it is only one of six functions implemented in any communicative process, and it cannot be considered as a single one. The other five are related, in fact, to irremovable factors of the process: to the identity of the sender (*expressive function*), to the type of action applied to the receiver (*conative function*), to the nature of the conventional code (*metalinguistic function*), to the semantic context (*referential function*), and to the communication channel (*phatic* or *contact function*).

By careful examination, in the scheme proposed by Jakobson, the term *function* is presented mainly in the mathematical sense: when one of the variables changes (x), the others also change (y, z, ...). The same linguist points out that in

any speech event the six functions tend to be distributed in a hierarchical way and all the functions are always present, even if with different weight and importance each time. We can add that often the existence of one function is, in a manner of speaking, a function of another function. For example, consider when letters and words are scanned properly (aesthetic function) to facilitate the understanding of what is said (conative function as a function of the referential function).

In design, the aesthetic function is primarily concerned with:

- The type of sensory response (of liking or repulsion) that a product produces, beyond taste or trends
- If this response is able to shift the user's attention to other aspects of the product (recognition of the producer's identity, the legibility of the product, etc.)
- If those aspects that the aesthetic function emphasises are actually needed in the design phase and under the expected measures and manners

1.4.7 The function game

To better frame the role of the aesthetic function in PSS, we present here Jakobson's model of language functions with some graphic variation, hoping to make clear what we call the *functions game*:

Figure 1.3 **Jakobson's functions of communication**

Source: adapted by the authors

In this reworking, the model makes a clearer difference between the two axes through which the communicative process passes. We call the horizontal one the *dialogic axis*: due to the product-service, it makes the company assets, the service's suppliers and the users communicate. We call the vertical one the *cognitive axis*,

because it refers both to the comprehension of the product-service as well to the competences necessary for the product-service's use.

At the centre of the two axes, and at their intersection, the aesthetic function is placed. This means that *everything passes through the aesthetic function*. Each function, and thus every practical or mental action performed by the user, is 'switched on' by this function. Between the aesthetic function and all the others it is therefore possible to presuppose a sort of game of reciprocal influence and determination.

Let us examine how the graph can be described and the game that comes from it.

The *expressive function* (so called because it exhibits a way of thinking or feeling) has the aim to present the origin and identity of who offers the PSS product. This is what makes explicit what we call in semiotics the *subject of enunciation*, in our case the customer and/or designer. Nevertheless this function also identifies the cultural context of a product, so it defines, additionally, the research fields from which the product comes. In the PSS this function plays a strategic and, in a manner of speaking, 'contractual' role. Leading the subject-user to know from which research field the offered product-service comes means: 1) inviting him/her to adopt innovative forms of consumption and relations with the products; and thus 2) involving him/her in a sort of co-design, i.e. participating in the project of transition to sustainability.

If the expressive function is weak, or badly mediated by the aesthetic function, it is reasonable to think that the subject-user may tend to see a low value in the PSS. This happens because he/she does not feel part of a strong bargaining and planning.

This has to do with what we find on the opposite side of the dialogue axis: the *conative function* (from the Latin *conari*, 'to strain'). This function concerns all those actions that, explicitly or implicitly, the product or product-service does to the user so that he/she can also implement other functions and other actions: become aware of the nature of the proposal, recognise the type of product, identify its advantages, understand how it should be used, etc. Also in this case, there is a clear dependence of this function on the aesthetic nature of the product: the more this last one is 'well formed' and 'well designed', the more it should increase its capacity to involve the subject-user in the eco-sustainable project.

Despite this, such an involvement requires decision-making and a consequent action. The subject-user cannot be simply seduced and captured, but he/she should be also guided. It is for this reason that on the horizontal axis there is also the *phatic* or *contact function*. This is the function that allows and supports not only the cognitive and physical relation between product and user, but also the product's ability to guide the user through the various stages of use.

Again, the relations of contact and guidance can be fostered or inhibited by the aesthetic dimension of the product. As an example, this may mean the product's material, colour or size. An object that is too small or too big will be poorly handled. A sign that is too close or too far, as well as too dark or too light, cannot be seen. In these and similar cases it is not only important how a product is formally designed, but the way in which its form was designed considering the relation with

the user. If this does not happen, the functions that we have discussed so far are active, but inhibited, out of the game.

To the game between the functions on the horizontal axis of the graph must be added the game developed on the vertical axis: the one between the *aesthetic function*, the *referential function* and the *metalinguistic function*. Through the *referential function* (which has a semantic value: it makes us understand what kind of a product it is) the user should be able to distinguish a product within a vast offer, to recognise it, to give it meaning and value. The *metalinguistic function* (which has a normative valence: it instructs how to use a product) concerns all the types of knowledge, instructions, procedures that the user must possess when he/she intends to use a certain product.

Also on the vertical axis *everything passes through the aesthetic function*. Distinguishing the semantic nature of a product and its social value, or determining the knowledge needed to use it, requires a semiotic act of passage or access: from the level of expression to the level of content, from what it *seems* to what it really *is* (or what it would like to be).

1.4.8 Pragmatics of the aesthetic function

To conclude, this is also an opportunity to overturn the common sense of seeing the aesthetic sphere as only consigned to the quality of materials and the forms of objects. This is an old problem, already discussed, among other things, in the famous Plato dialogue, the *Hippias Major*. It deals with the commonplace view that sees beauty as a property of things but spaced away from the body and the actions of the user: it is not by chance that beauty is mainly related to visual pleasures. Beauty in this sense means do not touch, do not change.

The use of PSS requires getting to the heart of the product-service system instead. It requires not only touching, but also the possibility to adapt, to remodel, to rearticulate to one's own liking the forms of the system. Hence the proposal of a pragmatic vision—and not merely formal and syntactic—of the aesthetic function: this proposal we summarise in two points.

1. In design, what we usually call beauty is intended as a *pleasantness* of the product, as its acceptance, and thus as a search for the *satisfaction* one feels when using the product. In either case, sensorial primacy is given to the sense of touch (and by this it passes to the sense of smell, sometimes to the sense of taste), as an immediate and absorbed perception. The sense of touch may become a phatic guide, a sort of help or service; otherwise it can be offered as a seduction (with regards to the shape and position of affordance and to the material that piques the desire of perception). Cognitive primacy is given here to the sense of desire fulfilment and surprise about the solution of a problem: what happens is pleasant and satisfying, for the way it happens and for what makes it happen. This is, among other things, because we no longer speak about the product, but the product-service. And therefore the

project focuses not only on the form of the product but also on the form of the interaction

2. In PSS, the aesthetic function extends from the objectivity of things to types of relationships between social subjects (between service providers and users, between users of the same service)

But what does 'taking care of the aesthetic function in human relations' mean?

It means, first of all, emphasising the dialogical nature of these relationships and, therefore, drawing attention to the forms in which dialogicity is expressed. As an example, this is done through the different perspectives that subjects-users have to develop while using products: a perspective not only inter-subjective, but a collective and shared subjectivity. Any use, as a matter of fact, leaves a trace of the user on the objects. In shared artefacts these traces do not disappear; they are, on the contrary, foreseen by the structure of the product: it belongs *to everyone* and it is *for everyone*. The PSS should be thought of as the semiotic place where the user interacts, directly or by implication, with other users; it is the place where he/she can feel part of a community. The user does not have a benefit; he/she participates in one.

Aesthetical attention requires the product-service to be designed as part of a common language, a language that everyone can speak and, above all, through which each subject has the opportunity to communicate with other subjects. The product is no longer exclusive, nor purely inclusive; it is shared and dialogic. It is designed to pass from one hand to the other, to make experiences to converge, to last and to be subjected to a collective subjectivity.

This effect of sense (community feeling) is the major content of design. It must be communicated through the form of expression of a product-service, a sensible form that represents and introduces such content.

1.5 Conclusions and future research directions

Eco-efficient Product-Service Systems (PSS) represent a valuable offer model for decoupling economic value from material and energy consumption and more generally negative environmental impacts. However, these innovations are in most cases radical and their introduction and diffusion usually encounter various cultural, corporate and regulative barriers. This chapter focused on the barriers that affect the attractiveness and acceptance of eco-efficient PSS alternatives and opened the debate on the role that aesthetics can play in stimulating users to perceive PSS alternatives as more satisfying than traditional 'product-based' offers—both during the purchase choice and during use. In particular the key research question that this chapter put forward is: how can aesthetics facilitate user attraction to, acceptance of and satisfaction with an eco-efficient PSS?

This key question, in fact, entails other two main questions.

The first is a more general question concerning design research in general. Since PSS innovations are at their base innovations of stakeholder interactions, the need emerges for a more defined knowledge base geared to a service-oriented society: definitions for the *aesthetics of stakeholder interactions* and, when the interaction is with the customer, for the *aesthetics of services*.

The second question is related to the specific characteristics of eco-efficient PSS innovations, such as the non-ownership of physical products. As highlighted in Section 1.3.2, we hypothesise that the aesthetic elements should serve various purposes during both the purchase decision (such as attracting a user's interest) and the use phase (such as valorising and highlighting the offer's relational qualities, the advantages of freedom from ownership, and the environmental and economic benefits).

In this chapter we have outlined a possible new frontier for the research bridging the design and semiotic domains. The working hypotheses we defined must of course be consolidated. However the opinion of the authors is that this is an important and fertile research ground.

This stance is especially justified because of the role that aesthetics can and must play in the transition towards sustainability. It is not enough to merely develop sustainable innovations; it is necessary that these innovations are perceived as better than the existing and unsustainable panorama of artefacts. Moreover this new frontier is important because it opens a debate that involves not only sustainability, but is related to the foundation of the role of design itself.

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2

Sustainable consumer satisfaction in the context of clothing

Kirsi Niinimäki
Aalto University School of Arts, Design and Architecture, Finland

2.1 Introduction

During the last three decades industrial manufacturing has decreased its environmental load through technological development. On the other hand increased production volumes and simultaneous growing consumption has caused the rebound effect: the growth of material consumption (Throne-Holst *et al.* 2007). Hertwich (2005) sees this as a backfire effect, i.e. efficiency and cheaper prices lead to increased demand. Accordingly products' cheap prices and low quality tempt consumers into unsustainable consumption behaviour: impulse shopping, short use time of products and easy product disposal. Even while it is technically possible to manufacture durable products, the practice is hindered because of economic, institutional or psychological reasons (Mont 2008).

The current economic and industrial system is based on products' fast replacement and planned obsolescence. Hence products are not designed for long-term use and it is no longer worthwhile to repair products. Accordingly most products are throwaway articles in the Western world; increasing numbers of products do not last the optimum use time and are discarded prematurely (Mont 2008). Products are discarded not only because they are worn out, but because consumers actively seek novelty. Nevertheless product durability and long-term use are

prerequisites for sustainable consumption (Cooper 2005). Cooper (2005) argues that consumers associate durability with high quality and not with environmental impact, yet it is most essential to **extend products' life span** in the context of sustainable development.

The clothing industry is a good example of the planned obsolescence existing in the current industrial system. Clothing design and manufacturing is based on extremely fast cycles of fashion and consumers' unsustainable desires. This unsustainable way of manufacturing is also becoming more common in the area of everyday commodities. Low quality, short-term use, frequent clothing replacement and increasing textile waste contribute greatly to the environmental burden. In the UK clothing and textile waste is estimated to be the fastest growing waste stream between the years 2005 and 2010, and currently it amounts to 1.5 to 2 million tonnes annually (Defra 2008). This is a direct consequence of the increase in textile and clothing consumption, which rose over 30% in the period 1995–2005 in the UK (Defra 2008). It is estimated that fast fashion with its low quality currently accounts for 20% of the British market, and it doubled its growth between the years 1999 and 2006 (Defra 2008).

Effective marketing systems create new temptations and desires for consumers in the form of fashion and trends. Fast-changing trends contribute to psychological obsolescence, which according to Burns (2010) can be divided into aesthetic and social obsolescence.[1] Burns (2010) argues that consumer products that relate to our appearance and self-construction are evaluated on both aesthetic and social grounds. Products have a symbolic meaning to us, connected to psychological satisfaction through an emotional response; e.g. clothing and fashion enable consumers to gain social acceptance, affiliation with particular groups, and emotional beauty experiences.

Earlier studies have shown that Western European consumers purchase garments for the following reasons, in order of priority: change in trends and fashion, attractive price, need for new clothing for special occasion, brand, purchase habits and to replace old, worn-out garments (e.g. Vezzoli 2000: 8). Consumers fulfil many unconscious needs by consuming, alongside their practical or utilitarian needs. Therefore decreasing consumption is a challenging task. Consumers' emotional needs also have to be fulfilled in sustainable ways, and we thus need to acquire more knowledge on ways to extend the product life span through deeper **consumer satisfaction**. It is therefore important to study consumers' satisfaction in long-term product relationships and moreover define the determinants for short-term use: i.e., why people discard clothing. Only a few attempts to develop scenarios for sustainable consumer behaviour in the context of clothing have been made, e.g. the SusHouse project (Vezzoli 2000: 4).

This chapter hence investigates consumer satisfaction with regard to clothing from the industrialised, usually Western, point of view. Furthermore the knowledge

1 Technological obsolescence is not as relevant in the context of clothing.

on consumer satisfaction is framed by design strategies and PSS thinking, providing a discussion on how services can deepen the satisfaction process and accordingly profoundly affect sustainable consumption. This chapter takes both a micro and a macro view on satisfaction: a narrow and wide approach. First the narrow approach is used to provide novel consumer-centred research knowledge about satisfaction in the context of clothing and second a wider approach is used to include design strategies and service aspects into the satisfaction discussion. By doing so the chapter provides both deep empirical insight into consumer satisfaction and a more open and conceptual discussion on satisfaction through PSS thinking.

2.2 Consumer-based eco-efficiency

Until recently consumer satisfaction has not been widely researched in the context of clothing and in the design discipline. Hence knowledge on how to deliver sustainable satisfaction for consumers in different product groups is still largely lacking. The **satisfaction** approach is proposed to enlarge the design focus from a single product to the system of products and services and further to include into this satisfaction system all different stakeholders that together fulfil a given demand of needs and desires: i.e. a given demand for satisfaction (Vezzoli 2010).

Throne-Holst *et al.* (2007) argue that in the sustainable transformation process to change consumption patterns, there is a need to understand consumption more deeply. The sustainable consumption and production (SCP) agenda concludes the same: the balance in sustainable development needs research and understanding on both sides, production and consumption. The eco-efficiency approach has focused on the production side only, generally meaning 'doing more with less': improving technologies and systems towards less resource intensity often also resulting in cost savings. It involves a techno-economic and engineering approach that attempts to decrease the environmental impact of industrial manufacturing. Industry's interest in eco-efficiency since the 1990s has nevertheless not led to a significant development towards sustainability, as it forgets the dimension of human needs in current unsustainable consumption patterns. In short, even while industry has moved towards more effective processes, the volumes of production and consumption have increased due to the cheap prices of commodities (Michaelis 2001).

Park and Tahara (2008) argue that eco-efficiency can be used only as an evaluation tool for design alternatives, not to identify key sustainability issues in products. They propose that *producer-based* eco-efficiency needs to be combined with considering *consumer-based* eco-efficiency in order to better identify key eco-design issues. In this process not only the environmental aspects of a product are analysed, but also product quality and consumer satisfaction can be assessed. Consumer satisfaction is best addressed by offering good performance in those

attributes and dimensions that are important to the consumer and by increasing intrinsic product quality. This entails robust knowledge on what consumers truly expect and value, which is not based on what they actually currently purchase.

2.3 Consumer satisfaction

Earlier studies on **product attachment** have shown that positive emotions, memories, special meanings and reflective levels operating between the product and user create deep attachment (e.g. Csikszentmihalyi and Rochberg-Halton 1981; Mugge *et al.* 2005; Niinimäki 2010a). The reflective level of product attachment comprises feelings, emotions, self-image, personal satisfaction, memories and cognition, and it is constructed during a longer period (Norman 2005). Therefore these emotional attachments are very individual and related mainly to old garments that may no longer even be in use (Niinimäki 2010a). We have less knowledge about the consumer–product relationship during ownership or use, even though this phase is critical for understanding product replacement (Mugge *et al.* 2010).

Several studies have pointed out that stimulating a positive **product experience** must be examined more profoundly. Positive product experience refers to the product's capacity to provide a satisfying experience through enjoyable use, psychical attributes, style and utility (Forlizzi *et al.* 2003); through operative dimensions relevant during the use phase (Margolin 2002); and intrinsic quality attributes (Schifferstein and Zwartkruis-Pelgrim 2008).

2.3.1 Clothing satisfaction

Studies on product satisfaction have focused on the (dis)confirmation paradigm, i.e. consumers have certain expectations to be satisfied regarding product performance and when the product performs worse than expected dissatisfaction will result (Churchill and Surprenant 1982; Oliver 1980). According to Oliver (1980) consumers' product expectations create a frame of reference against which the consumer makes his/her product judgement. This evaluation frame of reference is connected to the use situation, and hence it differs according to product and each type of use situation: in other words the use situation and the symbolic meanings of the product define the attributes related to expectations. For example clothing in the official work environment must meet certain expectations regarding social acceptance and social codes expressing professional status. In the home environment clothing provides a relaxed and soft tactile feeling, and this experience symbolises safety. In sport clothing important aspects are functionality and durability. Moreover a consumer's own personal factors influence the evaluation frame of reference and what satisfaction attributes are important to each consumer.

According to Swan and Combs (1976) clothing performance can be **instrumental** or **expressive**: the instrumental performance of clothing interlinks with its

physical properties, fulfilling our physical needs for protection and functionality (Kaiser 1990), while the expressive performance is linked to the consumer's psychological response to the garment. Instrumental requirements must be satisfied first, but fulfilling only the instrumental requirements will not result in satisfaction. Therefore, consumers' emotional needs regarding the clothing also have to be met if the consumer is to be fully satisfied (Swan and Combs 1976). Clothing as fashion is a symbolic production that merges us with our emotional needs; fashion expresses our inner individual personality via external symbols and status items (Kaiser 1990). The aesthetic experience, which relates to expressive performance, is important in clothing satisfaction. We experience clothing aesthetics in a multisensorial way. The beauty of clothing is not only visual, but also entails tactile, olfactory and kinetic experiences, such as the feeling of comfort and the weight of the material against our body (Niinimäki 2010a).

To gain more information about clothing satisfaction in long-term use, a survey was conducted in Finland in 2010.[2] The survey findings confirm, for example, the deep contradiction between consumer wishes and reality—offerings do not meet consumers' wishes. We know that in Western countries, for instance, currently about 90% of garments are imported (Defra 2008) while 44% of consumers would prefer to buy a domestically manufactured garment. In analysing the questionnaire responses, a division was made according to respondents' environmental interest and readiness to actualise their sustainable values during clothing purchasing. Respondents with a *high sustainable commitment* said that they always take sustainability issues into account when purchasing garments; i.e. ethical, safety (free of toxic chemicals) and environmental issues always affect their garment purchasing decisions.[3] Respondents with a *low sustainable commitment* are those for whom ethical, safety and environmental issues in clothing do not affect their purchasing behaviour.[4] How these aspects affect consumer satisfaction is described in more detail later in this chapter.

In the questionnaire respondents were asked to evaluate their latest garment purchases. According to the questionnaire, aesthetic aspects were important to consumers, while fit, colour, tactility and the beauty experience were important in clothing satisfaction.

On the other hand the life span of the product seemed to trouble consumers, as well as the product information, which includes information on the manufacturing location ('Made in'), material consistency and consumer care instructions. The location of manufacturing specifically relates to quality evaluation during purchasing and it is an important extrinsic quality cue for consumers (described in more

2 The questionnaire was based on a 'snowball sampling' method with 204 respondents. Most of the respondents belonged to the age group under 35 years old and 70.4% of the respondents were women.

3 n=37

4 i.e. they totally or somewhat disagreed with the statement or did not know if these aspects affect their purchasing (n=77).

detail in Section 2.3.4). Clothing satisfaction is also fundamentally connected to clothing **quality**.

2.3.2 Long- and short-term use

In the Finnish survey, when asked what aspects in clothing worry them, 78% of women and 68% of men were worried about the short life span of garments. When asked to estimate the life span of their oldest and most used garments 74% of men and 66% of women answered over five years. When asked to estimate the shortest time they have used some garments 10% of men and 22% of women answered less than one month. Moreover the consumers' interest in socio-ethical and environmental issues affected the life span of garments: 84% of those consumers whose sustainable commitment was high reported using garments for more than five years while only 14% reported using some garments for less than one month. Of the respondents with low sustainable commitment, 59% reported using a garment for over five years and 22% said that they have used a garment for less than one month. In summary, the respondents' sustainable values are connected with how long they tend to use their garments.

In this questionnaire 51% said that the reason to buy a new garment had been the need to renew their appearance.[5] Of those respondents who actualise a sustainable value base while purchasing clothes (respondents with a high sustainable commitment), 19% said that their latest garment purchase had been impulse shopping, compared to 31% of respondents with a low sustainable commitment.

Some respondents commented that they had bought a cheap garment with low quality on impulse, which they had not even expected to last a long time. Moreover some respondents reported that less consideration is used for cheap garments during purchasing. Several statements were made in the open answers that impulse shopping had resulted in the wrong purchase decision. Consumers noticed that the garment did not fit in a satisfying way, the colour was strange or wrong, the material felt uncomfortable in use, or that the garment did not fit into the existing wardrobe: i.e. the expressive performance did not fulfil consumers' expectations. These kinds of garments purchased in error may not be used at all, according to the responses. Accordingly cheap prices tempt consumers into impulse purchasing, which often results in dissatisfaction and garment disposal.

In general respondents mainly related good quality with high prices and low quality with low prices in their comments. Furthermore consumers gave more thought before buying when the product price was higher. Respondents also gave reasons for long-term use, such as the longer life span of seasonal or festive clothing that are not in frequent use (e.g. winter/summer garments, festive dresses). In the following sections the three key determinants of the long-term use of clothing are described: quality, aesthetics and functionality.

5 77% of the respondents answered that the main reason for the latest purchase had been a real need for a new garment.

2.3.3 Quality

Ophuis and Trijp (1995) raise the topic of *perceived* quality, where quality evaluation depends on the consumer's judgement. According to the authors, perceived quality is a result of four factors: the process of perception, factors related to the person, the use context and product performance. They also divide quality into quality cues and quality attributes. Quality cues are product characteristics that can be observed without actual use or consumption, while quality attributes can only be experienced during use. Ophuis and Trijp also add to the aforementioned intrinsic and extrinsic levels, where the intrinsic level is linked to the product's physical characteristics. The extrinsic characteristics are also related to the product, but they are not physically part of it, e.g. price.

Consumers thus form judgements about products' quality attributes experienced during use situations and *credence* quality attributes that stay at the cognitive level and cannot be experienced directly from the appearance of the garment or use experience (Ophuis and Trijp 1995). Credence quality attributes in clothing can include values such as ethical manufacturing and low environmental impact, and their importance ranking depends on the consumer's own individual values (Ophuis and Trijp 1995). Consumers who have a high interest in environmental issues place a higher value on eco-materials, ethical manufacturing and a long garment lifetime than other consumers (Niinimäki 2010c).

The quality attributes as experienced by the consumer are essential to the long-term use of clothing. According to the Finnish questionnaire good quality was the most significant reason for longevity in clothing. Respondents further described high quality to mean durability, durable materials and high manufacturing quality. In the respondents' answers some noteworthy comments were made, which define the determinants for the short-term use of clothing. Several connected low quality with short-term use. Furthermore there were several comments that some garments may stay in use only until the first wash, after which the garment has lost its fit, size, or colour or the material simply looks old after laundering. Many consumers experienced changes in the fit (e.g. garments wrinkling or stretching sideways) or problems in colour fastness during the first laundering. Some garments had come apart even before or during the first laundering. Low durability and especially weak maintenance quality seem to be key determinants in consumer dissatisfaction, and they lead to the short-term use of clothing.

2.3.4 Aesthetic aspects

Consumers' need to have an aesthetic beauty experience is obvious in clothing choices, and this is connected to clothing evaluation in the social context. When asked in the questionnaire what need they were addressing with their latest garment purchase, 38% of female and 8% of male respondents were yearning for beauty. In the same question 13% of men and 6% of women said that social pressure for a certain kind of appearance affected their latest garment purchase. When

asked about the important factors in their latest garment purchase respondents answered that style (69%), fit (67%), suitability to existing wardrobe (51%), material (44%) and colour (42%) were important factors. All these characteristics are aesthetic attributes, and some of them are even more important factors than price (64%) and quality (54%) when purchasing garments.

Aesthetic attributes correspond to the expressive performance in clothing satisfaction and relate to the psychological response to clothing. Respondents respect aesthetic attributes also in the long-term use of clothing. In the open answers the following attributes associated with clothing longevity were mentioned: good fit, personal cut, nice colours and comfortable materials. Tactility in garments is important to the wearer, and some respondents even commented that the comfortable feeling some materials provide becomes even nicer (i.e. the material is softening) during long-term use. Consumers also pointed out that garments stay in use because of their more classical style or colour, which looks good even when fashions change. As one of the respondents described, garments that are 'trend free' stay long-term in use. Accordingly an obvious reason for the short-term use of clothing is too trendy a look or a feeling that the garment is out of his/her own style. This psychological obsolescence results in premature disposal of a product even if the product is still functional. On the other hand some respondents pointed out that a garment has been kept because of a certain beautiful colour or special style. In these situations the expressive performance has been above average, resulted in satisfaction and has become the reason to keep the garment.

A pleasant, aesthetic garment ageing process requires not only a more classical style and high quality, but also durable materials. Some materials look old even after a rather short use time: e.g. because of pilling. Respondents also commented that garments needing frequent washing may look old rather fast, faster than materials that need less frequent laundering. Some textile materials age in a more aesthetically pleasing way than others. Earlier studies have shown that in high quality wool the ageing process does not obviously show, and real leather is considered to age in an aesthetic way (Niinimäki 2010a). When asked about the material from which the respondents' long-term garments were made, 83% of respondents said cotton, 68% wool, and 40% leather. Polyester, which currently has the largest share of global fibre production (62% in 2000; Sipilä 2003), was mentioned by only 18% of respondents.

2.3.5 Functionality

When asked in the questionnaire which attributes enable one to become attached to clothing, most respondents, 84%, chose the option 'I become attached to textiles and clothing and use them [for a] long [time] because they fit perfectly or they are suitable for the use situation'. Practicality and functionality were also mentioned several times in the open answers in connection with clothing longevity. Good design was mentioned above all in specialised clothing, e.g. sports garments or extreme hobby clothing. Sports clothes are designed for heavy use, and

the material and manufacturing must be durable. Consumers purchase sportswear even for everyday use, because of its high quality and durability. One respondent commented that the best garments are those in which durability and functionality have been designed into the garment and the consumer can experience the high quality in design, as is the case in e.g. clothing for sailing or mountaineering.

Easy maintenance was also mentioned in the open answers as an attribute for longevity in clothing. Products that do not need frequent washing or can be refreshed by airing (e.g. wool) appeal to consumers. Good care was also given as a reason why the garment had stayed long in use. Good care refers to gentle washing and repairing of the garment or even modifying it to postpone its replacement.

2.3.6 Summary of longevity in clothing

The respondents' answers highlight the following **attributes for longevity in clothing**: quality aspects, including durability in use; functional aspects, such as satisfying use experience; and aesthetic attributes such as beauty and tactility. Good design can be related to all these attributes. For those consumers who have a strong interest in ethical and environmental issues the following values are important in clothing choices, and they also play a role in clothing satisfaction: local or ethical production, eco-materials and long life span of garments. These environmental attributes are linked to a consumer's individual values and are defined to be credence quality attributes. For these consumers, sustainability attributes are included in their individual frame of reference of product expectations against which the consumer makes her/his product judgement. Their expectations regarding the garment's sustainability dimensions also have to be fulfilled in order to achieve deep product satisfaction. Consumers also report that they would be ready to pay more for higher quality and a longer product lifetime if it were possible to estimate these aspects at the time of purchasing,[6] characteristics that are difficult to evaluate at that point. Even so, currently there is no information on the quality of the clothing or its optimal use time; such information could make the quality visible and it would be possible to set a price on high quality and the durability and long lifetime of the product (Niinimäki 2010b).

2.4 Satisfaction through design strategies and PSS

Thus far this chapter has examined consumer satisfaction in the context of clothing using a narrow approach and consumer-centred knowledge. Next a wider

6 Eighty-three per cent of respondents in the study somewhat or totally agreed with this statement.

perspective on satisfaction will be adopted to move into the area of design strategies and PSS and their possibilities to deepen the satisfaction the consumer experiences with the product or through a service approach. This will entail a conceptual discussion on how to extend product life spans or decrease the environmental burden inside this industry through various design strategies. Section 2.4.7 will summarise the consumer interest in and potential acceptance of these strategies.

2.4.1 Multiple life cycles

McDonough and Braungart (2002) have established the principle of cradle-to-cradle, which takes into account the product's next life cycle. The benefit is a decrease in the use of virgin materials and in energy consumption during the manufacturing process. Steinhilper (2006, cited by Gray and Charter 2007: 14) argues that **remanufacturing** uses approximately 85% less energy than the manufacturing process using virgin materials. A significant reduction in CO_2 emissions is thus also possible: e.g. the Japanese Tenjin Fibers Ltd. reports a 77% reduction in CO_2 when manufacturing polyester from recycled material.[7] Remanufacturing concepts, however, require deep consideration when designing the original product. The product has to be suitable for easy disassembly after its first use, and it cannot include parts or mixed materials that cannot be recycled again. In clothing recycling is currently problematic, as most garments are made of mixed materials and constructed in such a way that they are not easy to disassemble. Furthermore the quality of today's clothing is so low that recycling is no longer profitable inside this industry. Currently about 70% of clothing waste ends up in landfills, and the rest is re-used or recycled (Fletcher 2008).

The essential issue in remanufacturing is quality. During the recycling process, the quality of material reduces over time, as does the value of the product and the material—this is known as down-cycling (McDonough and Braungart 2002). Some materials are better suited to go through remanufacturing cycles (e.g. polyester, nylon and polypropylene) while others face significant reduction in quality in the following rounds and can be recycled effectively only once (e.g. cotton). Focusing strongly on multiple life cycle strategies, however, can steer the textile industry to polyester production, which is conditional on non-renewable oil production.

Existing examples of this concept can be seen in e.g. the Austrian company Backhausen's 'Returnity' Trevira CS fabric, which is made to be recycled and according to an environmentally friendly chemical process.[8] The fabric can be returned to the factory after the first use phase. Similarly, the Swedish Houdini Sportswear has organised the take-back of its garments through a recycle box at the retailer shops or directly to the manufacturer.[9] In an eco-efficient, multiple life cycle strategy, the purchase could include a deposit from the consumer, encouraging him/

7 www.teijinfiber.com/english/products/specifics/eco-circle.html
8 www.returnity.at
9 www.houdinisportswear.com/en

her to return the goods to the store after use (based on Niinimäki and Hassi 2010); e.g. the Swedish company Klättermusen offers a deposit for returning the clothes to the shop.[10]

Since, according to the study being discussed here, 61% of respondents considered the environmental impact of textiles when disposing of the garment and a further 76% of respondents were worried about the short lifetime of the garment, the multiple life cycle approach could offer value for the consumer through which they can become satisfied with their garment choices. Recycling as such does not extend the use time of clothing, but it offers an environmentally healthier way to produce new garments than the currently existing system. It offers consumers an easy route to decreasing their own environmental impact but it does not demand any significant changes in their consumption patterns; this approach is therefore easy to accept by consumers and manufacturers. However it also entails new approaches to designing garments that are suitable for recycling and the need to construct effective recycling system for garments and textile materials.

2.4.2 Local production

Moving production of raw materials and manufacturing of the product closer to the end market reduces carbon emissions from transportation. Focusing on locality also offers diverse options in textile materials and manufacturing patterns. For example flax, nettle and hemp can be cultivated in Finland. These fibres need little or no fertilisers and pesticides as long as water is available. Bast fibres (linen, hemp, and jute) can be cultivated on land that is unsuitable for food production (Härkäsalmi 2008; Fletcher 2008). In bast fibre processing enzymes can be used to avoid pollution. Enzymes act as biocatalysts, and they can be used in different fibre processing states such as flax softening. Without enzymes these processes need more energy and chemicals (Nieminen *et al.* 2007).

Recently there has been a visible trend towards **local production** by small design companies whose interest lies in ecological thinking and who use the benefits of global eco-material production to sell their products effectively through networks and online. For example the company Muru in Finland uses Indian eco-cotton, which is dyed in Germany using an ecologically friendly process, and the design, industrial knitting of the material and sewing work is then done in Finland in small-scale processes.[11] This design-centred way of producing small collections by combining contemporary design, imported eco-materials and local production with online selling is popular among young designers.

Since local production is a value for a rather large group of consumers, it would be worthwhile to offer this alternative. Consumers evaluate the quality and the environmental impact of clothing manufacturing according to the location of the manufacturing, and hence it is a credence quality attribute for consumers.

10 www.klattermusen.se
11 www.muru.fi

Manufacturers often fail to even offer information about the location of the garment manufacturing, and consumers see this as a negative aspect in clothing. In other words, consumers assume that manufacturers disregard their opinions and values. This means that consumers' expectations are not fulfilled, and consumers stay dissatisfied at this informational level.

2.4.3 Slow/Fast

For environmental reasons it would simply be best to consume less. However, most consumers are not willing to reduce consumption. The concepts of **slow and fast fashion** design accept this situation as the starting point and take into account the needs of these two different consumer groups. By optimising material choices and maintenance needs according to the intended life span of the product, it could be possible to minimise the environmental impact of textiles and clothing and address the preferences of the two opposing consumer groups in a more sustainable manner. Information about the product's intended life span should be included in consumer information.

Garments' use times have shortened. In the study discussed here, respondents were asked about the shortest time they have used some garments: 18% of respondents estimated that they have worn some garments for less than one month, 10% said one to two months, 29% three to six months, and 27% seven to twelve months. One study done in the Netherlands found that the average piece of clothing stays in the wardrobe for 3 years and 5 months. The customer has worn it for 44 days during that time, and it is worn for 2.4 to 3.1 days between washings (Uitdenbogerd *et al.* 1998, cited by Fletcher 2008).

Clothes frequently washed have the highest environmental impact and optimising this phase decreases the environmental burden of passionate fashion consumers. The maintenance phase can use energy and cause environmental impacts that may add up to two-thirds of the whole energy consumption and environmental load of the life cycle. Depending on the material and product, the use phase may consume as much as six times more energy than the actual manufacturing process (Talvenmaa 1998; Franklin Associates 1993, cited by Fletcher 2008). As the use of polyester in clothing production has increased so has the need for laundering.

Slow fashion is designed to aim for longer utilisation, a longer life span of products through durability and high quality. It is also made in an ethical way, e.g. locally in small batch processes, in good working conditions, and mainly from eco-materials. The design lasts over time: styles and colours are classical and the materials age well, which affects aesthetic longevity (Niinimäki 2009a, Fletcher 2008). A good example of slow fashion is the German company Hess Natur. On the basis of a customer survey Hess Natur designed a collection with the following aims: durable design from healthy and natural materials, fashionable and aesthetic, high quality, easy to use, update-able, repairable and multifunctional. Their clothing collection 'Longlife' guarantees that the clothes last a certain period of time (e.g. three years), and this information is presented in the consumer information (Paulitsch 2001).

A product with a long lifetime appeals to consumers with a high sustainable commitment. High intrinsic quality in the product and a 'lifetime guarantee' will bring satisfaction to environmentally interested consumers.

The fast fashion concept is more appropriate for consumers who need to follow trends closely and build a personal identity with external fashion symbols (especially younger consumer groups); hence the product life span is short. To be able to meet the needs of this customer group in a more sustainable way, the product has to be optimised for its real lifetime, the impact of the maintenance phase has to be minimised (e.g. no or minimum laundering during the use phase), and the materials must have a low environmental impact and be recyclable or biodegradable. Fast fashion may be worn only for a couple of months and then returned to an effective recycling system or to an exchange network or stocks e.g. operating through the internet (Niinimäki 2009a, Fletcher 2008).

Mugge *et al.* (2005) point out that it may be wise to combine different eco-design strategies to promote sustainable consumption. In clothing design this means e.g. combining slow fashion with local production to achieve high quality and sustainable value. Moreover adding into this approach a design service element (see the following section) could result in long-term product satisfaction and even in a strong attachment between the consumer and product. On the other hand fast fashion must be combined with multiple life cycle strategies that benefit the consumers, e.g. including reverse logistics. Adding services to the aforementioned concepts, e.g. an online garment exchange system, may intensify the garment's use and extend its use time, thereby lowering the environmental burden of the younger and not as stable consumer group.

2.4.4 Uniqueness and achievement

Products carry symbolic meanings through which consumers construct their own individuality. According to Norman (2005) products are a medium we use to express ourselves, and they may serve as a symbol of some characteristic, uniqueness or value we want to connect to ourselves. Govers and Schoormans (2005) argue that consumers prefer products with a product personality that matches their self-image and self-concept. Chapman (2009) points out that if products are easily personalised, there is an opportunity to create deeper product satisfaction and an emotional product relationship. This is an opportunity to extend the product's lifetime.

Design services are one opportunity to add consumer satisfaction through connecting the design outcome deeply with the consumer's personal needs and aesthetic preferences. By using digital textile technologies that offer possibilities for individual design, meaningful uniqueness can be designed (Niinimäki 2009b). Mass customisation uses flexible digital manufacturing technologies, and the aim is to satisfy both the manufacturer's and the individual user's needs in fragmented markets (Pine 1993; Lee and Chen 2000). Furthermore unique design and 'made-to-measure' services offer better product satisfaction by meeting a consumer's individual needs and preferences better than mass-manufactured garments.

According to Norman (2005) personal achievement has a strong connection to a positive sense of self. A 'made by me' element in design offers the consumer positive experiences through a sense of effort and achievement and the opportunity to realise her own creative skills. If the user builds the product herself, she acquires a deeper knowledge of the product and therefore will also be able to repair the product if needed (Papanek 1995). Products could be designed in a modular structure, which enables the consumer to sew the clothing together or even create a unique style.

Stimulating a sense of uniqueness and achievement through design services or 'self-making' approaches is a promising route to deeper consumer satisfaction. Through satisfaction it is possible to create or strengthen the emotional bond between the product and consumer, and this meaningful attachment in turn is the best way to postpone the product's disposal. When the product or its use is somehow special to the consumer, she will take good care of it to extend its enjoyable use time.

2.4.5 Services for longer and intensive utilisation

As consumers' needs and aesthetic preferences change over time, the question is how to avoid the **psychological obsolescence** of garments, as was highlighted earlier in this chapter. The challenge in extending product lifetimes is in achieving continuing satisfaction with the product. Van Nes (2003) proposes the following design strategies for products' longevity: design for reliability and robustness, design for upgradeability, design for repair and maintenance, design for product attachment, and design for variability. Many of these strategies are based on good product quality and durability. If the garment is of high quality and it is expensive, it becomes worthwhile to take good care of it, repair it, modify it or even redesign a new garment from it. A high-quality product can also be targeted for shared and intensive utilisation, e.g. renting and leasing. Other services, such as upgrading or modifying, can also offer service possibilities in place of new product manufacturing, thus dematerialising the satisfaction of consumer's wants and needs. Chapman (2009) argues that new elements act as a stimulus to sustained interaction with the product. A modular clothing structure can offer the possibility of upgradeability to the consumer. Internet pages that advise on 'how to refashion old garments yourself' also encourage consumers to extend the use of clothing. Moreover garment exchange services operating through the internet can offer change and novelty and they suggest new business models.

Services that aim for product life extension offer new business opportunities both at local (e.g. renting, upgrading) and global level (e.g. mass-manufacturing, online exchange stocks, and do-it-yourself concepts). Operating online allows manufacturers to be in direct contact with the consumers and better address their wishes, and it eliminates distributors (Stahel 2001). Guaranteed satisfaction at a guaranteed service per unit thinking offers consumers a sustainable way to fulfil their needs. It also offers flexibility in utilisation, which ownership does not. Accordingly ownership of goods should be questioned whenever

possible, and we should focus on offering more services, function and satisfaction than products.

2.4.6 Co-creation

Co-creation offers multiple stakeholders, including end-users, the opportunity to co-create: to collectively solve problems (Fuad-Luke 2009). This process can result in a more satisfying design outcome, as the consumer has the opportunity to take part in the design process or decision-making. When the user is in an active role s/he forms an attachment to the product more easily and feels emotional fulfilment and satisfaction through partaking in the design process. Through the internet, for example, manufacturers have the opportunity to activate their customers and develop new possibilities to hear individual consumers' opinions through for example voting or rating systems. Until now manufacturers have used the internet mainly as an information channel, for example in CSR issues and the socio-ethical dimensions in clothing manufacturing. New PSS systems could be developed exploiting the strengths of the internet: for example, different kinds of manufacturing systems according to consumers' values and wishes, systems for lifetime guarantee of garments, environmental impact calculation systems for consumers, and so on.

Some interesting internet solutions have been developed (e.g. for customising) but mainly only to sell more products, not to profoundly offer any new role for consumers in decision-making in the context of sustainable development. The American company Threadless is an example of a business concept based on co-creation: customers send their designs to the website where the entire customer base evaluates the most interesting ones, places their orders, and once a design has a sufficient number of buyers, it is sent to be printed. The company therefore knows exactly what kind of clothing to produce and how much.[12]

In addition open source fashion is a recent phenomenon driven by the internet. Fashion designers can still sell their design skills through patterns and construction information, but the end-users implement the design outcome. This approach changes the consumer's role from a passive user to an active maker and offers wider decision options for the consumer: in other words, it opens up the fashion business and makes it more democratic.

2.4.7 Consumer interest in PSS

Relatively little has been studied regarding consumers' interest in PSS. With regard to product ownership some products are easier to rent and the consumer can simply focus on utilisation. In the context of clothing, the element of intimacy, the deep connection to construction of self and one's own identity, and how clothing is

12 www.threadless.com

evaluated in social contexts all make this product group less suitable for e.g. long-term renting. On the other hand these issues and the symbolic meaning of clothing open up opportunities for design services and personalisation of the garment.

The Finnish survey also explored respondents' interest in various design strategies and services in the field of clothing. The results showed that women were more interested in these issues than men, but the overall picture suggests opportunities to develop new PSS approaches and business models in the clothing area. **Repair and modification services**, **upgradeability**, and **customisation** interested both male and female consumers. Short-term renting is familiar to most consumers, for example festive dresses, but it could be expanded to other use categories as well. This needs radical innovation and a significant change in the consumer's role so that s/he can participate in the innovation process. This is more likely to result in social acceptance of radical new PSS innovations. Consumers were also most interested in garment exchange systems. Moreover garment recycling interested consumers and can easily find acceptance, as a recycling strategy needs no significant changes in their own consumption habits.

Consumers were not attracted to the approach of optimising a garment's short use time, but in reality, some garments stay in use for an extremely short time as was shown previously in this chapter. **Optimising the use phase** of short life span garments would decrease the fashion lovers' environmental burden.

Those consumers with high interest in ethical and environmental issues were more interested in an individual look in their clothing and home textile choices, and **modification possibilities** for uniqueness and design services interested these consumers more than others (Niinimäki 2009b, 2010c). This interest in sustainability could be exploited to promote these services as a more sustainable alternative than traditional, industrial mass-manufactured products. As most Western consumers are worried about the environmental impact of current industrial manufacturing systems, the sustainable way to offer consumer satisfaction can be seen as a benefit in marketing and it offers new business opportunities.

2.5 Discussion

Earlier studies have shown (e.g. Niinimäki 2010c) that consumers' **ethical commitment** affects the meaning of clothing and the important determining aspects when purchasing garments. Those consumers whose ethical and environmental interests are high prioritise eco-values and ethical aspects, long life spans in clothing and local production. In the current study 70% of those consumers who said they always actualise their sustainable attitude when purchasing garments reported that the ecological aspect was also an important factor in their latest garment purchase (only 7% of respondents with a low sustainable commitment chose this option). If the consumer knows that his/her choices are sustainable and this connects to his/her own individual values (environmental concerns), this leads to emotional

and ideological satisfaction. Accordingly manufacturers taking a sustainable PSS approach should strongly emphasise and communicate the environmental benefits to consumers, as a better choice than traditional products. Any change made through new, innovative PSS approaches will not be valid, even if more sustainable, if consumers do not accept these changes.

Present ways to design and manufacture textiles and clothing do not take into account consumers' wishes, values and environmental interest. To change the patterns in manufacturing and consumption we need to engage consumers more deeply in the discussion on new sustainable **value creation** through PSS. As both clothing and the consumer's appearance are always evaluated in a social context, discussion on new sustainable values may make sustainable PSSs more attractive among consumers also in the context of clothing. Considering the consumer as one of the stakeholders in the design process widened with service thinking provides important insight into the satisfaction opportunities in different product groups. Combining offers with values according to different consumer groups' values offers opportunities to better fulfil consumers' utilitarian and psychological needs: e.g. offering a long-life guarantee for environmentally interested consumers or exchange stocks for fashion lovers with a need for constant change. However, consumer-based eco-efficiency needs consumer-centred research knowledge through which it is possible to identify satisfaction attributes and opportunities to define the **satisfaction unit** in different use contexts.

Park and Tahara (2008) emphasise that product value has to be defined in the use context, not only at the point of purchase. If this is accomplished, price should then be profoundly connected to quality, durability and utilisation of the product; in turn, the product value should be connected more deeply to consumer satisfaction and sustainability aspects, e.g. the environmental impact of a product or its use. Based on this the product or service value can be defined according to the satisfaction unit. It is then possible to change the design focus from aesthetic aspects and product manufacturing to its use and moreover to the satisfaction the use of the product provides to the consumer. In this process the sustainable attributes of products can also be seen as values that enable deep consumer satisfaction. Consumer satisfaction results in more loyal consumers (Jacobs 2007), and accordingly it should also be regarded as a value for the enterprise. This is simply further evidence that a focus on consumer satisfaction is a future way to do sustainable business.

2.6 Conclusions

This chapter has brought consumer-based knowledge into the discussion on consumer satisfaction and furthermore it identifies the attributes associated with longevity in clothing. It is essential to identify those dimensions through which the consumer makes an evaluation of the product in each product group and different

use contexts and to aim for good product performance in those attributes that are important to the consumer. It is thereby possible to slow consumption and increase the longevity of products by designing product-service strategies related to intrinsic product durability, good product maintenance and deep consumer satisfaction.

Furthermore this chapter has shown that through services there is an opportunity to extend the enjoyable use of the product or connect the product more deeply to the consumer's identity construction; through these strategies deeper satisfaction can be delivered to the consumer. PSS thinking can postpone psychological obsolescence of garments through offering new kinds of services, e.g. upgradeability, modification services, or exchange stocks. PSS thinking as such guides manufacturers to consider more profoundly the utilisation, functionality and durability of the product while in a PSS the consumer purchases functions, product meanings and satisfaction instead of products. However it is most important to include consumers in the innovation process of more sustainable products connected to PSS. This is important in two ways: first to gain deep insight about consumer satisfaction attributes and the meaning of the product or its use from the consumer point of view; and second participatory innovation processes enable a sustainable change process in individual consumers' consumption habits and at the level of societal acceptance. New PSS models that combine satisfying quality products with services to extend the enjoyable use time of products could create sustainable consumer satisfaction and dematerialise consumer satisfaction in the design field.

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3

Developing new products and services in entrepreneurial contexts

Duygu Keskin, Renee Wever and J.C. Brezet
Delft University of Technology, Faculty of Industrial Design Engineering, The Netherlands

3.1 Introduction

Research on sustainable PSS thus far, as also seen in this volume, has created an understanding of what role design might play in creating sustainable solutions for society and what tools and approaches designers might adopt. Nevertheless, integrating sustainability into the design process is not an easy matter. As York and Venkataraman (2010) state, '…larger environmental dilemmas, such as human-induced climate change, inherently involve uncertainty'. The existence and severity of issues related to sustainability are controversial, exacerbating the difficulty to identify the best solutions to address them. This challenge requires 'actions in the face of ambiguity' (York and Venkataraman 2010).

While established firms often prefer a design space with a clear vision and pre-defined objectives, ambiguity is the essence of the entrepreneurial context. Entrepreneurial action is driven by uncertainty in order to transform it into opportunity. In this way 'an alternative future is created rather than anticipated' (York and Venkataraman 2010). Therefore, the aim of this chapter is to explore how new ventures develop PSS innovations that contribute to sustainability and to investigate the role of design in this process.

3.2 Models of product innovation and PSS innovation

The innovation process might unfold in various fashions depending on the level of uncertainty involved in respect to the technology and market. As Hellman (2007) points out, in the case of radical innovations the uncertainty might be due to the immature state of technology development (i.e. technical uncertainty), as well as the difficulty in predicting if and when markets will adopt the new product (i.e. market uncertainty). The higher the level of novelty and uncertainty, the more complex, disorderly and uncontrollable is the process (Van de Ven *et al.* 1999). The following paragraphs review the various models of the product innovation process. The *rational* models (e.g. Roozenburg and Eekels 1995; Cooper *et al.* 2002) mainly stem from research on established organisations, are goal-oriented, suggest an analytic logic and are visualised in a linear fashion. On the other hand, *non-rational* models (e.g. Thomke *et al.* 1998; Lynn *et al.* 1996) stem particularly from radical innovation research, suggesting an experimental logic involving a process of learning.

In early representations, the innovation process is commonly characterised as an orderly, chronological process (Buijs 2003). An early model developed by the design theorist Bruce Archer (1971) includes six successive steps of strategic planning, research, design, development, manufacturing and marketing setup, and production. Similarly, the Delft Design Method, developed by Roozenburg and Eekels (1995), consists of diverging and converging steps of policy formulation, idea finding, strict development and realisation. Each step consists of a sequence of analysis, synthesis, simulation and evaluation. The process starts with the analysis of the design situation, followed by a synthesis of possible solutions and a simulation in order to judge the possible solutions against the original design situation. The final step is the evaluation of the design solution. While the divergence is oriented towards getting as many alternatives as possible, the convergence is oriented towards choosing the best and most promising of those alternatives. At the Faculty of Industrial Design Engineering at Delft University of Technology, specific design tools are taught to improve the performance of these diverging and converging activities. For example, 'brainstorming' and 'morphological boxes' are creativity tools that support the diverging idea generation phase and 'program of requirements' is a tool that helps to converge and screen the multiple ideas created in prior phases (Buijs 2003). Within the field of New Product Development (NPD), a similar model is Cooper *et al.*'s (2002) frequently cited 'stage-gate' process model that starts with the definition of a problem and ends with the commercialisation of an end product.

These *linear* models suggest that the innovation process is a sequence of activities that starts with the definition of a problem and ends with the commercialisation of an end product (Archer 1971; Roozenburg and Eekels 1995; Dorst 1997; Buijs

and Valkenburg 2000; Cooper *et al.* 2002; Buijs 2003). The NPD process is often portrayed as a linear model where a product proceeds from one phase to the other (Roozenburg and Eekels 1995) and is thus goal-oriented and visualised in consecutive steps.

Similarly, the PSS innovation process has so far been conceptualised as a linear model. Based on Rozenburg and Eekels's (1995) product development process, Brezet *et al.* (2001) have developed the 'Design of Eco-efficient Services' (DES) methodology in order to enable service and product designers in Eco-efficient Service (ES) design using a systematic approach (Figure 3.1). The process starts with an exploration phase involving various actions such as forming a project team of companies and partners, formulating a vision and goals, analysing the environmental impact of the current situation and identifying future users. The expected outcome of this phase is a business coalition or a new business with a mission. The steps that follow the exploration phase are similar to the product innovation models explained above: policy formulation, idea finding, strict development, realisation and evaluation. The process is driven by analysis requiring the use of various business, design and environmental impact assessment tools, such as market research, strategy and policy tools (e.g. SWOT = Strengths, Weaknesses, Opportunities, Threats), a quick environmental assessment tool (META-matrix = Materials, Energy, Toxic substances, Added value), benchmarking, backcasting, Life Cycle Assessment scenarios, stakeholder analysis, Ecocosts/value, blueprinting, and other tools (Brezet *et al.* 2001).

Throughout the process one or more sub-processes might be required. For example, due to a lack of expertise a company might outsource part of the development or even the whole product development. Such a sub-process has been depicted in Figure 3.1.

Similarly, the most up-to-date PSS methodology 'Methodology for System Design for Sustainability (MSDS)' described in Part 1, Chapter 4 of this book is organised in stages, processes and sub-process (Table 4.1, Part 1). The new approaches and insights developed throughout the LeNS project are integrated into this methodology, i.e. 'Sustainability-Orienting Processes' and 'Design for a Sufficient Economy Processes'. The MSDS starts with a phase of analysis on project proposers, the socio-technical regime, macro trends, cases of excellence for sustainability, design priorities, and a sufficiency need assessment. The following steps are similar to the approaches mentioned above: exploring opportunities, selecting the most promising ideas (based on detailed environmental, socio-ethical and economic criteria), designing system concepts, designing and engineering the system, and communicating. Each of these steps includes various tools for sustainability assessment, stakeholder analysis, future trends analysis, checklists and guidelines (see Part 1, Chapter 4, Section 4.2). The methodology is analysis and assessment driven and oriented towards a goal, i.e. a set of products and services that makes up the most sustainable offer.

Figure 3.1 **DES methodology**

Source: Brezet *et al.* 2001

Despite the analytic logic and linear representations outlined above, in practice the innovation process is more chaotic and unstructured (Buijs 2003) and may require an experimental logic (Hellman 2007). This is true particularly in the case of radical innovations; as Lee *et al.* (2004) suggest, 'experimentation is fundamental to solving problems for which outcomes are uncertain and where critical sources of information are nonexistent or unavailable'. Moreover, integrating sustainability into the process makes it more complex since issues of sustainability deal with future options and often require action in the absence of concrete performance data, particularly regarding the social and environmental consequences of the innovation in development. Therefore, the non-rational view of the innovation process is illustrated as a learning process with intermediate outcomes (Schön 1967; Lynn *et al.* 1996) unlike a single product as illustrated in NPD models. Considering the technological and market uncertainties involved within radical innovations, 'the innovation process is characterised as a highly uncertain journey of exploration and learning and modeled as a dynamic process of parallel activities in technology development, early applications and continuous learning' (Hellman 2007). In order to decrease the uncertainty linked to radical innovation, some

scholars have proposed different management practices such as 'experimentation', 'trial and error' and 'probe and learn' (Garud and Van de Ven 1992; Thomke *et al.* 1998; Lynn *et al.* 1996).

Experimentation 'is often carried out using simplified versions of the eventually-intended test object' (Thomke *et al.* 1998). When experiments are carried out in succession, the process is called 'trial and error' (Garud and Van de Ven 1992; Thomke *et al.* 1998). However, as Silberzahn (2011) emphasises, trial and error has limits with regards to the actual learning it provides because the experiments are conducted with prototypes in controlled conditions. Therefore, the reliability of these prototypes is open to debate.

On the other hand, 'probe and learn' involves experimentation in real markets. It requires probing with the immature versions of the products, i.e. introducing an early version of the product to an initial market, learning from that experiment and probing again (Lynn *et al.* 1996). A probe in this process is a means for learning about the technology and markets. For example, a probe might reveal information on if and how the technology can be scaled-up and/or which market segments are more interested in certain product features (Lynn *et al.* 1996). 'Trial and error' and 'probe and learn' have similar characteristics such as being iterative and proceeding in successive affordable steps; however a probe is more effective than a trial in resolving market-related uncertainties (Silberzahn 2011).

In essence, all of these practices point to the difficulty of making rational decisions in an uncertain context based on only research and analysis due to the limited information they reveal. There is a need for experimentation of various forms in order to decrease the technical and/or market uncertainty, as well as uncertainty related to the sustainability performance of the innovation. But how does this happen in an entrepreneurial setting characterised by few resources?

3.3 An emerging theory of entrepreneurship: effectuation

The concept of uncertainty has recently been addressed in the domain of entrepreneurship though an emerging theory called *effectuation*. Taking the study of Knight (1921) on 'risk' and 'uncertainty', Sarasvathy (2001) examines how expert entrepreneurs address uncertainty through a series of stakeholder 'commitments'.

Differentiating 'risk' from 'uncertainty', Knight (1921) describes risk as a measurable uncertainty in which the probability of an outcome in a set of future states is known through calculation or past experience. On the other hand, in the case of uncertainty the set of future states does not exist due to the uniqueness of the situation; hence it is impossible to predict the distribution or probability of the outcome. This makes planning a difficult and irrelevant activity (Burns and Stalker 1961). Therefore, Sarasvathy (2001) proposes an effectual logic: i.e. getting

the commitment of stakeholders at early stages of business development helps reduce the uncertainty. She claims that this type of reasoning is particularly useful and effective in domains such as the introduction of new products and services in new markets, where traditional marketing techniques are ineffective (Sarasvathy 2001).

Effectual logic is the inverse of causal logic (i.e. predictive reasoning), which is predominantly taught in business schools (Sarasvathy 2001) and often in design schools (see the product design methodologies presented in the previous paragraphs). Causal logic is goal driven; means are selected in order to achieve a given goal. In contrast, effectual logic does not begin with a pre-defined goal. Goals emerge from a given set of means, and therefore the process is means driven. Entrepreneurs, pragmatically, start thinking of what they *can* do with their given sets of means. They start with three categories of means: 1) who they are (their skills and abilities); 2) what they know (their education and expertise); and 3) whom they know (their social and professional networks). They then begin to imagine and implement possible effects that can be created and are worth creating (Sarasvathy 2001). They move almost directly into action and interaction with other people. Those who commit to the new venture bring in new means and goals (Figure 3.2). The result is an expanding cycle of means and converging cycle of goals. This is how a future market is co-created, and the core mechanism of this process is the commitment of a growing network of stakeholders to the venture (Sarasvathy 2008).

Figure 3.2 **Dynamic model of effectuation**

Source: Sarasvathy and Dew 2005. With kind permission from the authors

Effectuators see the product (idea/concept) as transformable and not completely pre-determined. According to Sarasvathy (2008: 113), alternatives matter in a different way in effectual transformations from those in search and selection processes. In a search and selection process, alternatives are selected from a set of all possible alternatives. In this process, commitment to a product is committing to it as the goal of action and the resources are allocated between alternatives to achieve the pre-selected goal. In an effectual process, on the other hand, alternatives are seen as possible transformations of existing realities. In other words, committing to a product means committing to a certain course of action that may or may not lead to any envisioned product (Sarasvathy 2008).

In other words, when a particular effect has already been chosen such as a target market segment or specific product functionality, the entrepreneurs will search for stakeholders based on that pre-defined effect. Effectual logic, however, does not assume such pre-existent markets or products. People that entrepreneurs are able to bring together determine the markets and products that are created (Sarasvathy 2001).

3.4 PSS innovation process in effectuation

The previous paragraphs explained how new ventures are created effectually in uncertain contexts. The objective of this section is to illustrate the role of design iterations within the model of effectuation and explain why design-inspired effectuation might be a suitable approach to developing PSS innovations.

Within the context of product innovation, as well PSS innovation, when developing new businesses, entrepreneurs not only go through a cycle of stakeholder interactions, but also a cycle of design iterations. It is not only stakeholders' commitments but also design iterations that enable entrepreneurs to converge goals, decrease uncertainty and transform the product or PSS. Figure 3.3 shows how design iterations are integrated into Sarasvathy's (2008) dynamic model of effectuation. The cycle of stakeholder interactions represents the model of effectuation and explains how goals emerge from the varied and diverse aspirations of the entrepreneurs and the people with whom they interact. Commitment is the core mechanism to this process (Sarasvathy 2008).

Design iterations, on the other hand, are cycles of developing capabilities and competences of the entrepreneurial team; at the same time they are cycles of learning about the limitations and opportunities related to the technology at hand. The outcome of a design iteration might be a sketch, a computer rendering, a prototype or a probe that enables the team to learn about what it actually can deliver. While the purpose of a design iteration might be learning about the technology and its potential, it can also be ensuring the commitment of stakeholders (i.e. demonstrating the proof of principle).

Each innovation process is unique and there is no one formula that can explain how and why the events happen as they do. In an innovation process, design iterations and stakeholder interactions might occur in parallel and/or one after the other. They occur in varying frequencies and sequences. A stakeholder interaction might be the trigger of a design iteration and the outcome of a design iteration might be the trigger for a stakeholder interaction. The aim of the model of design-inspired effectuation is to illustrate this difference and variety as well as to introduce design iterations as an important factor in venture development.

Figure 3.3 **PSS innovation within the entrepreneurial context**

3.5 SDC case

This section will illustrate the model with a case study. The Sustainable Dance Club (SDC) was initiated in 2005 as a project by Rotterdam-based network organisation Enviu and architecture firm Döll. The project started with the aim of making the clubbing scene more sustainable through reducing the environmental impact of clubs and inspiring young people to adopt a sustainable lifestyle.

During the initiation period, the project team had developed various ideas related to energy, waste, materials and water in clubs. The initial business idea was to develop various products in order to decrease the environmental impact of the clubs while offering consultancy services to help clubs achieve this. SDC as a company started in 2006 when an energy generating dance floor was selected as the most promising product idea (Figure 3.4). The Sustainable Dance Floor (SDF) uses people's movement as a sustainable source of energy. The energy produced through movement is converted into electricity and used for LED lights embedded within the floor. The floor thereby interacts with the dancers and contributes to

the collective experience. The feedback system is thus one of the most important aspects: people dancing on the floor must understand that they are the ones powering it and therefore the floor lights up when stepped on.

Figure 3.4 **The Sustainable Dance Floor**

Source: Sustainable Dance Club

The initial business idea was to offer the floor in a rental scheme, i.e. as a 'use-oriented PSS innovation' (for more on PSS innovation typologies, see Part 1, Chapter 2, Section 2.1.4). Meanwhile, a seven-step approach to successfully implementing sustainability for the clubbing and events market has been developed. The approach includes helping clients to establish ambitions, analyse their current business, set goals, organise workshops in order to develop solutions to achieve the agreed goals, as well as translate those solutions into actions.

When the development of the dance floor was initiated, the company aimed at developing a floor that would generate sufficient electricity for the energy needs of a whole club. In 2006, the feasibility of the idea was tested through a preliminary concept developed by a design student of the Faculty of Industrial Design Engineering at Delft University of Technology (DI_1). The first prototypes were not as efficient as anticipated: the amount of human power transformed into electricity by dancing is not huge. Meanwhile, SDC started interacting with various clubs in order to establish their reaction to the concept of an energy generating dance floor (SI_1) and learned that energy is not high on the clubs' priority lists. The clubs' main

costs are actually the drinks, personnel, communications and artists, while energy is only a fraction of the expenditure. For clubs, it is more important to attract people to the club than save energy. Second, the club owners supported the idea of sustainability provided it was not too expensive: the price of the floor for buying or renting was not considered affordable. Third, the unique selling point of the floor is its power to attract people, i.e. 'we are a sustainable club, and we offer sustainable entertainment'. But it was not clear to clubs whether an SDF—compared to the alternative products/services—was the most effective and cost-efficient way of attracting clubbers.

Although the first prototypes were not as efficient as expected and the clubs were reluctant to buy the product, SDF was still presented to the public at various events throughout 2006 and 2007. The idea of an energy-generating dance floor received enormous national and international media attention. Particularly, businesses, museums and event organisations were eager to use the floor to showcase sustainability in public events. In addition, the SDF concept received very positive reactions from clubbers who participated in user tests (SI_2).

The limitations in transforming human power into sufficient energy for a whole club (*outcome of* DI_1), the reluctance of clubs to buy the floor (*outcome of* SI_1) and enormous positive feedback from media and clubbers (*outcome of* SI_2) stimulated SDC to shift its market and business focus. The company decided to put its efforts into making the floor an attractive promotion medium for large organisations that like to showcase sustainability in public events. This direction would further emphasise the sustainability aspects of the floor and communicate sustainability to the audience in a more effective way. Currently, the main business of SDC is to rent and, when possible, sell the floor to event organisations and museums. Meanwhile, the company has concentrated effort into the development and optimisation of the technology in terms of cost and performance with the aim of fitting it into the requirements of the clubs (DI_2).

The idea of an energy-generating dance floor has continued to receive attention of various organisations (SI_3). This has stimulated the idea of using the technology at locations with large volumes of people walking, such as stadiums, airports, railway stations, shopping centres, (public) buildings and city squares (*outcome of* SI_3); see Figure 3.5. Since 2010, SDC has been developing the Sustainable Energy Floor (SEF) for cost-effective, large-scale applications (DI_3). The electricity produced through SEF can be fed back into the grid or used to power local systems such as (LED) streetlights or information and signage systems. A small amount of the energy can also be used to give feedback to users, e.g. by illuminating parts of the floor modules.

Figure 3.5 **The Sustainable Energy Floor illustrated in a shopping mall**
Source: Sustainable Dance Club

3.6 Conclusions

Earlier approaches to the design and development of products and services for sustainability have contributed to the understanding of what role design might play in creating a sustainable society. Nevertheless, the tools and approaches developed thus far tend to be rather conceptual, normative and prescriptive (Berchicci 2005). Furthermore, the high levels of uncertainty involved in sustainable innovation and the organisational context in which it is embedded have implications for the innovation process and how it is managed. Links to current organisational and entrepreneurial theories need to be strengthened. Therefore, this chapter aimed at explaining why 'design-inspired effectuation' is a suitable approach in developing product and PSS innovations in an entrepreneurial context. Although integration of design into the effectuation is not yet well researched, this chapter presented a first model of design-inspired effectuation, which is illustrated within a case study. In addition to the goal-driven product and PSS methodologies, effectuation offers an alternative approach to be considered when developing sustainable products and services.

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4

The societal embedding of sustainable Product-Service Systems

Looking for synergies between strategic design and transition studies

Fabrizio Ceschin

Politecnico di Milano, DESIGN Department, Design and system Innovation for Sustainability (DIS) unit of research, Italy

Brunel University, School of Engineering and Design, Department of Design, UK

4.1 The problem of implementing and diffusing eco-efficient PSSs

A wide variety of research projects in the field of PSS and sustainability supported by EU funding in the last 15 years have contributed to a better understanding of the concept of eco-efficient PSS, clarifying its characteristics, potential benefits, drivers and barriers and possible rebound effects. Moreover several methods and

tools have been developed to support the design of eco-efficient PSSs.[1] However, despite this accumulated knowledge as well as the potential win–win characteristics, the application of this concept is still limited. An important reason is that eco-efficient PSSs are in most cases radical innovations[2] and the adoption of such business strategies encounters significant corporate, cultural and regulatory barriers (Ceschin 2012b).

Schot and Geels (2008) consider radical innovations always immature when they enter the market because they encounter a dominant socio-technical context (and its established and stable rules and networks of actors). Eco-efficient PSS innovations are in most cases a radical innovation (Tukker and Tischner 2006a) because they challenge existing institutions, customers' habits and lifestyles, companies' organisational structures and regulative frameworks. As a result they have high probability to be rejected under mainstream market conditions. For this reason, for those companies that do see PSS innovation as key to their future, there are still significant challenges to be faced, not only in developing a promising PSS concept, but also in understanding the contextual conditions in which it is introduced and identifying the best strategies and development pathways to implement and scale it up in the market.

Against this background the focus of this chapter is on the implementation and diffusion of eco-efficient PSSs. In particular the key questions to be addressed are as follows:

- What are the dynamics and factors that facilitate and hinder the implementation and diffusion of eco-efficient PSSs? How can the process of introduction and diffusion of this kind of innovation be effectively managed?
- What could be the role of strategic design in supporting and orienting this process?

In order to answer these questions we propose to learn from the field of *innovation studies* and in particular from the field of *transition studies*. Recent explorations in these fields (in particular the contributions from *Strategic Niche Management* and

1 For example the Kathalys method for sustainable product-service innovation (Luiten, Knot and van der Horst 2001); DES, Design of eco-efficient services methodology (Brezet *et al.* 2001); PSS innovation scan for industry (Tukker and van Halen 2003); HiCS, Highly Customerised Solutions (Manzini, Collina and Evans 2004); MEPSS, Methodology for Product Service System development (van Halen, Vezzoli and Wimmer 2005); Practical guide for PSS development (Tukker and Tischner 2006b); SPSD, Sustainable Product Service Development (Maxwell, Sheate and van der Vorst 2006); Modular design for technical PSS (Aurich, Fuchs and Wagenknecht 2006); MSDS, Method for System Design for Sustainability (Vezzoli, Ceschin and Cortesi 2009; Vezzoli 2010), described in Part 1, Chapter 4.

2 It must be underlined that not all eco-efficient PSSs are radical innovations. PSSs providing enabling platforms and PSSs providing final results (in particular in the B2C sector) can usually be considered radical innovations.

Transition Management approaches) have focused on socio-technical transitions and how to facilitate the introduction and diffusion of radical innovations. According to these theories, the introduction of radical innovations requires the creation of partially protected socio-technical experiments, shielded from the mainstream market selection environment to allow incubation and maturation. This chapter explores how these theories can provide insights to manage the process of introducing and diffusing eco-efficient PSSs and what role strategic design can play in this process.

4.2 Insights from transition studies

Transition theorists refer to *system* or *radical innovations* as major changes in the ways societal functions such as transportation, communication, housing and feeding are fulfilled (Rip and Kemp 1998; Geels 2002). System innovations are complex and long-term processes that require changes in the social, economic, technological and policy domains. Through historical socio-technical case studies, transition scholars have analysed how system innovations take place and have elaborated a model called *the multi-level perspective on transitions* (Geels 2002) that describes the dynamics regulating these complex and long-term processes. The multi-level perspective distinguishes three analytical concepts (Geels 2002):

- The **socio-technical regime**, which can be defined as the dominant way of innovating, producing, distributing and consuming, etc. It refers to a dynamically stable set of culture, practices and institutions (Rotmans *et al.* 2001) related to a specific field (e.g. mobility or energy). Regimes are relatively stable and resistant to change because their practices, rules and institutions guide regime actors in a specific direction discouraging the development of alternatives
- The **niche**, a protected space that is 'isolated' from the influence of the dominant regime, where radical innovations can be tested and nurtured, become more mature, and potentially challenge and change regime practices and institutions
- The **landscape**, that is, the relatively stable social, economic and political context in which actors interact and regimes and niches evolve. It represents the background for regimes and niches. It includes structural socio-economic, demographic, political and international developments, but also events such as wars or environmental disasters. It can influence the regime and the niches but cannot be influenced by them (at least in the short term)

The distinction between the three levels is analytical and not ontological; in other words the levels are useful for categorising and better understanding socio-technical changes rather than being real entities 'out there' (Raven *et al.* 2010). What is important to underline is that transitions occur through the fruitful coupling of developments at all three levels (Rip and Kemp 1998; Geels 2002): when the regime is sufficiently *open* to accept radical innovations; when there is sufficient pressure from the landscape for change; and when radical innovations have been developed in niches that can be used to exploit the opportunities for change (Raven *et al.* 2010).

Niches are therefore a fundamental part of transitions but not sufficient. Moreover, even if niche developments can hold great promise, they do not immediately live up to expectations because they are immature when they enter the market and because they conflict with the way society is organised. In this sense, if immediately exposed to market competition, it is highly probable they will not survive. For these reasons a protected space should be created where continuous experiments can bring them to maturity (Schot and Hoogma 1996). Niches can thus act as 'incubation rooms' for radical novelties (Geels 2002), where experimentations and learning processes take place.

An important prerequisite to the introduction of radical innovations is the creation of partially protected **socio-technical experiments** (Kemp *et al.* 1998, Hoogma *et al.* 2002; Van der Laak *et al.* 2007; Brown and Vergragt 2008; Raven *et al.* 2010; Van den Bosch 2010). These protected experiments allow the incubation and maturation of radical socio-technical configurations by partly shielding them from prevailing cultural, organisational and regulatory rules (the incumbent socio-technical regime). Sequences of socio-technical experiments can be used as a strategic arena for experimenting, learning, shaping future expectations and establishing new social networks in order to gain momentum for diffusion and challenge and change prevailing regimes (Raven 2005).

The use of experiments is recognised to be crucial also in *innovation management studies*. For Laredo *et al.* (2002) the development of radical innovation projects cannot be explained in terms of a sequence of states (e.g. concept, pilot, prototype, and industrial development) which projects are expected to go through but rather in terms of *trials* that projects subject themselves to in the course of progressively testing the innovation characteristics. Latour (2000) defines these kinds of trials as *collective experiments* or *socio-technical demonstrations,* the role of which is to test the technical, social, political and economic configuration of the innovation. Along the same line, Brown *et al.* (2003) underline the importance of small-scale *Bounded Socio-Technical Experiments (BSTE)*, while Lynn *et al.* (1996) speak about the *'probing and learning' strategy*: market try-outs with early prototypes used as a vehicle for learning about the new technology in its real life context, followed by adjustment in technology design and marketing approach. (At the same time the

exposure to early prototypes influences the expectations, needs and behaviour of potential customers and other stakeholders.)

In sum socio-technical experiments represent an important strategic opportunity to initiate and foster wider transition processes. How exactly these experiments can successfully bring about the diffusion of radical alternatives has been more deeply investigated in the field of Strategic Niche Management (SNM), which individuates three key internal processes (Kemp *et al.* 1998; 2001; Hoogma 2000; Hoogma *et al.* 2002).

The first process is the **establishment and development of a broad socio-economic network**. A broad network means it includes not only the actors more directly linked with the innovation (such as firms, partners and users) but also other relevant actors from the science, policy and societal domains (e.g. research centres, governmental institutions, NGOs and special interest groups)[3] (Raven 2005). In other words it should be a heterogeneous network with relevant scientific, social, economic, political and cultural actors, including:

- Those that can mobilise knowledge and financial and managerial resources to develop such alternative innovations (such as outsider firms) (Van de Poel 2000)
- Those that can introduce new designs, criteria, approaches and concepts (such as scientists, research centres, and universities) (Van de Poel 2000)
- Those that can give experiments legitimacy and stability (such as governmental institutions)
- Those that have the power and willingness to directly influence the dominant culture, practices and institutions (such as ministries, policy-makers and politicians) (van den Bosch 2010)
- Those that may (in)directly influence the regime because they have an interest in embedding new sustainable practices in society (such as NGOs, lobby groups, and consumer groups) (van den Bosch 2010)
- Those that can spread information on the innovation (such as media, opinion leaders and NGOs)
- Those that may support the scaling-up of the innovation (such as potential industrial partners, industrial associations or consortia)

3 This is coherent with what has been argued by some radical innovation scholars; for example Callon (1991) underlines the importance of involving 'a coordinated set of heterogeneous actors—laboratories, technical research centres, financial organisations, users, and public authorities—which participate collectively in the development and diffusion of innovations, and which organise, via numerous interactions, the relationships between research and the market place'. Callon (1991), Callon *et al.* (1992), and Laredo and Mustar (1996) refer to this set of heterogeneous actors as the 'techno-economic network'.

Second, a key process is the **convergence of actors' expectations into a shared long-term vision**. As mentioned, the process of experimenting with and embedding radical innovations in society requires the involvement of many actors from different domains, who may hold different expectations about a particular innovation. Therefore it becomes fundamental to manage the diversity of expectations and their negotiation and alignment (Raven *et al.* 2008). This convergence helps give strategic orientation and legitimacy to the innovation development (Kemp *et al.* 1998; Raven 2005) but also can attract new actors and resources (Raven 2005). The creation of a shared project vision can contribute to articulating expectations, formulating agendas and action plans, and coordinating the strategies of the actors involved (Kemp and Rotmans 2004). Future scenarios and visions are in fact crucial to committing actors and orienting their actions (De Laat 1996; Akrich 1992; Berkhout 2006; Quist *et al.* 2006). It must however be emphasised that expectations are not fixed (Van Lente 1993; Hoogma 2000; Raven 2005): actors can change their views and expectations, as a result of the negotiation processes with other actors but also in reaction to changes in the external environment. As a consequence it is fundamental to continuously refine and re-orient the project vision (i.e. a flexible vision open to adjustment).

The third key process is an **effective learning process** among the actors involved. Learning takes place when individuals assimilate new information and apply it to their subsequent actions (Hall 1993). It is therefore crucial in the process of inducing change towards the adoption and diffusion of radical innovations, in which new basic beliefs, behaviours and rules are required (Van de Kerkhof and Wieczorek 2005). An adequate learning process is considered key because it enables adjustments of the innovation and increases chances for a successful diffusion (Raven *et al.* 2010). An adequate and effective learning process should be:

- **Broad** (Weber *et al.* 1999; Raven 2005), focusing on many dimensions of the problem: not only the technical and economic aspects of the innovation, but also the cultural (societal beliefs, values and habits), regulative (government policy and regulatory frameworks), and institutional (rules and norms) dimensions
- **Reflexive** (Hoogma and Schot 2001; Raven 2005), implying that both first and second order learning occur. First order learning can result in a correction or resolution of a certain problem (e.g. technical issues). Second order learning (Hall 1993) leads to a paradigm shift, which refers to a change in the problem definition, basic assumptions, norms, values and interpretive frames which govern the decision-making process of individuals, communities and organisations

The better these three processes are managed, the greater the possibility that experiments can develop into a market niche, influence and transform the existing regime or become a viable alternative to it.

4.3 A conceptual framework for the implementation and diffusion of eco-efficient PSSs

Even though the school of transition studies uses a more sociological approach (looking at the actors involved, consumer expectations, etc.), it is commonplace to take a technological artefact as the starting point and see social developments as a derivative of technological innovation (Hegger *et al.* 2007). An eco-efficient PSS is not a technological innovation; of course it can include technological artefacts, but the innovative element is mainly related to the social dimension. In fact, rather than a new technological artefact, an eco-efficient PSS can be seen as a new form of social organisation. Hence, a crucial question is this: are the insights from transition studies valuable also for the specificities of eco-efficient PSS innovations? Can they be extended to manage the introduction and diffusion not only of technological innovations but also of eco-efficient PSS innovations?

A research case study that investigated the innovation journeys made by six companies introducing their eco-efficient PSS concepts to the market confirmed this hypothesis (Ceschin 2012a, b). Building upon the results of this case study a conceptual framework for the implementation and diffusion (introduction and scaling-up) of eco-efficient PSSs can be drawn up (see Figure 4.1). In synthesis, the entry point of an eco-efficient PSS innovation is a project vision (I): a PSS idea or concept developed to overcome a societal/environmental/business challenge. This project vision provides a direction for the societal embedding process (II), in which a broad network of actors (III) experiments and learns how the project vision can be realised. The societal embedding process is based on the implementation of small-scale socio-technical experiments, the development and empowerment of a niche, and the scaling up of the PSS innovation (and its related new set of culture, practices and institutions) in the regime. The process is characterised by dynamic adaptation: what is learnt by actors leads to a continuous and mutual adjustment of the project vision, the transition path, and the actor network itself (IV).

In other words the process of introducing and scaling-up eco-efficient PSS innovations should be managed as a process in which *design*, *developing*, *testing* and *implementing* are activities carried out simultaneously. In this sense the *learning-by-doing* approach should be the underlying philosophy.

Within this process setting up sequences of **socio-technical experiments** is a promising strategy to support, speed up and orient the incubation, testing and maturation of radical innovations. In other words the process of introducing and scaling up eco-efficient PSSs should be seen as a *transition path*, characterised by:

Figure 4.1 **Conceptual framework for the introduction and scaling-up of eco-efficient PSS concepts**

Source: Ceschin 2012a

- An **incubation** phase, in which the conditions needed to start the societal embedding process are understood (identification and involvement of needed actors; discussion and negotiation to achieve a common consensus on the PSS concept as well as on the potential strategies to socially embed the concept)
- A **socio-technical experimentation** phase, in which sequences of experiments take place with the aim of learning and exploring how to improve the PSS innovation and how to contribute to its societal embedding
- A **scaling-up** phase, in which the PSS innovation (and the related new practices, behaviours and institutions) increases its momentum and starts to influence the socio-technical regime (i.e. the initially unusual PSS innovation increasingly becomes part of the dominant way in which a societal need/desire is satisfied)

In this transition process a crucial role is played by the establishment and development of a proper **network of actors**: a broad and dynamic network able to protect, support and foster the innovation. This wide network should involve not only the actors belonging to the PSS value chain (e.g. producer, partners and suppliers, and customers/users) but also other actors: for instance universities and research

centres (that can give scientific support), institutions and public administrations (that can promote the innovation and give political support), NGOs (that can be partners of the project), and also media (that can give visibility to the innovation). The dynamism of this network must be underlined: the composition and even the role of each actor evolve in time. For instance some actors may have more relevance in the first phases and disappear in the later phases (e.g. a public administration can be involved only in the beginning to provide incentives and protection to the innovation).

It is also fundamental to build up a long-term **vision** shared among the actors involved in the project. A shared project vision can provide direction for the societal embedding process and therefore direction for the stakeholders' actions. Project visions can therefore be used as guides to formulate strategies, but also to attract, persuade and involve new potential partners and stakeholders to join the project.

Finally, it is crucial that room is created for **broad learning** (learning about the PSS innovation as well as about the different dimensions of the context in which the innovation should be introduced) and **reflexive learning** (learning resulting in changes in actors' reference framework, beliefs, behaviours, practices etc.). Learning processes are strictly related to how experiments are designed and managed. Experiments that not only focus on exploring and testing the technical aspects, but also ones related to usability, policy, regulations, social acceptance, etc. easily lead to broad learning processes. Reflexive learning is fundamental to breaking down actors' accepted assumptions and routine behaviours and inducing changes in culture, practices and institutions.

It must be emphasised that this approach should not be seen as a 'recipe for success'. Scaling up in practice requires favourable conditions and circumstances (e.g. there should be enough pressure from the landscape, the regime should be sufficiently open to accept radical innovations, etc.). Companies or small networks of actors may not be able to directly (or indirectly) influence these conditions and circumstances. Therefore the process from incubation to scaling-up becomes increasingly more uncertain, less manageable, and more influenced by project-external events and dynamics. However the adoption of an *experimental-, learning-, and network-based management approach* can increase the chances of success (i.e. speed up and increase the possibilities to set up a market niche in which the innovation is commercialised). Within this process socio-technical experiments play a strategic and crucial role in the process of triggering and catalysing radical innovations. Because of their importance it is useful to clarify the concept of socio-technical experimentation and its potential to contribute to transitions.

4.3.1 Socio-technical experiments and their importance in triggering transition processes

A socio-technical experiment can be defined as a partially protected environment where a broad network of actors can learn and explore (I) how to incubate and improve radical innovations and (II) how to contribute to their societal embedding.

These experiments represent strategic opportunities to develop and bring to maturity highly risky innovations such as sustainable PSSs without the direct pressure of the mainstream market selection environment. A socio-technical experiment is, however, not a simple pilot or demonstration project.[4] The main characteristics of a socio-technical experiment are described below.

- First, **experiments are conducted with radical innovations**: innovations that require substantial changes on various dimensions (socio-cultural, technological, regulative and institutional). Not all PSSs are radical innovations and therefore not all PSSs require the adoption of a strategy based on the setting-up of socio-technical experimentation
- Second, the experiments are not simple tests undertaken inside a company's laboratory but are implemented in **real-life settings**. The idea is that only this kind of experience, outside R&D (Research & Development) settings, can truly lead to testing and improving radical innovations. Moreover these experiments take place at a small scale but strive to trigger changes at a wider scale
- Third, these experiments not only include the actors more strictly linked to the innovation (such as producers, partners and suppliers). Instead, **a broad variety of actors is involved**, including also users, policy-makers, local administrations, NGOs, consumer groups, industrial associations, research centres, and so on. In other words the aim is to recreate a whole socio-technical environment in a small scale. In this sense these experiments are characterised by a broad participatory approach: i.e. a variety of actors is involved in discussing, negotiating, co-creating and developing the innovation
- Fourth, the experiment is implemented in a **space protected from the mainstream selection environment**. The idea is to temporarily shield the innovation from the selection pressure (which consists of markets and institutional factors), creating an alternative selection environment. There are different forms of protection: financial protection (such as strategic investments by companies, tax exemptions, and investment grants) and socio-institutional protection (such as the adoption of specific regulations). The crucial dilemma of protection measures is to find the right balance between the need to nurture the innovation and the need to prepare it for the selection pressures of a market environment (Weber *et al.* 1999)

4 The concept of socio-technical experiments, as intended here, also differs from the concept of living labs. Living labs are 'situated in real world environments, are user-driven, and collaborate with research organisations, companies, and public and civic sectors with the aim to collaboratively develop new services and products' (Björgvinsson, Ehn and Hillgren 2010). Compared to living labs, the concept of socio-technical experiments is broader. It includes not only the idea of setting up a participatory approach to developing new solutions in real-life scenarios and creating a protected space where the innovation can be incubated, but also working towards stimulating changes in the socio-technical context.

- The aim of these experiments is to **learn about and improve the innovation on multiple dimensions**, not only the technical, economic, market demand and usability aspects, but also the political, regulative, environmental, cultural and social dimensions. In this sense the innovation is maintained in order to be open to continuous adjustments and refinements. In general experiments can also serve to identify the various resistances and barriers (institutional, regulative, economic, etc.) that can potentially hinder future implementation and diffusion and understand how to address them
- Moreover, and this is a crucial aspect, socio-technical experiments are not only aimed at testing and improving the innovation, but also at **stimulating changes in the socio-technical context**, in order to create the most favourable conditions for the PSS innovation. In other words experiments are also strategically used to influence contextual conditions in order to favour and speed up the societal embedding process (for example, by influencing local administrations to adopt policy measures that support the innovation or stimulating potential users to change their behaviours and routines)

Within this framework three main mechanisms through which socio-technical experiments can contribute to transitions can be identified (Van den Bosch and Rotmans 2008; Van den Bosch 2010) (Figure 4.2):

- **Deepening**, which means learning as much as possible about an innovation within a specific context. Deepening enables actors to learn about local shifts in culture (ways of thinking, values, reference frameworks, etc.), practices (habits, ways of doing things, etc.) and institutions (norms, rules, etc.). The result of deepening is the development and reinforcement of the new set of culture, practices and institutions related to the PSS innovation
- **Broadening**, which means replicating the experiment in different contexts and linking it to other projects and initiatives. Since learning within an experiment is limited, experiments should be repeated in other contexts, in order to learn about different designs in different settings. Broadening is related to the idea that different experiments carried out simultaneously can build on each other and gradually reinforce themselves (Raven 2005; Geels and Raven 2006). It is also important to strengthen synergies with other local, similar projects and initiatives. Through processes of broadening, the deviant set of culture, practices and institutions is (I) tested and extended to a variety of contexts and (II) linked to other existing projects and initiatives
- **Scaling-up**, which means embedding the innovation in dominant ways of thinking, doing and organising. It relates to moving the innovation (and its initially new socio-technical practices) from a local experimental level to a mainstream level. As underlined by Van den Bosch (2010), scaling-up is less about scaling up products, services or users and more about scaling up perspectives, ways of thinking, routines, legislation, institutions, and so on

On the basis of these considerations socio-technical experiments, in order to contribute to transition processes, should be conceived in order to act as the following (Ceschin 2010, 2012a; Ceschin *et al.* 2011) (Figure 4.2):

- **Labs**, to test, learn about and improve the PSS innovation on multiple dimensions (technical, usability, regulative, political, economic, and socio-cultural) and in relation to different contexts (in order to learn about different PSS configurations in different settings)
- **Windows**, to raise interest in the innovation project and the related actors, disseminate results, build up synergies with existing similar projects/initiatives, and attract and enrol new actors (e.g. new users or potential partners)
- **Agents of Change**, to influence contextual conditions in order to promote and quicken the societal embedding process. Experiments should be conceived to introduce and diffuse new ideas and knowledge to the community and stimulate various social groups (users, public institutions, companies, etc.) to change their perspectives, beliefs, and lifestyles. Experiments should in fact represent a stimulus to induce actors to change their behaviours and interpretative frames (for example, they can stimulate users to change their routines or push governmental institutions to implement proper policy measures to favour the PSS innovation)

Figure 4.2 **Three main mechanisms through which socio-technical experiments can contribute to transitions (deepening, broadening and scaling-up) in relation to the concepts of experiment as a Lab, Window and Agent of Change**

Source: author, inspired by Van den Bosch and Rotmans (2008)

4.4 Implications for design: a new role for strategic design for sustainability

If an experimental-, learning-, and network-based management approach represents a promising strategy to successfully incubate, test, develop and bring to maturity eco-efficient PSSs, the questions at this point are: what are the implications at the level of design? What could the role of strategic design be?

We know that several methods and tools have been developed to support designers in ideating eco-efficient PSS concepts. However, if designers want to act as effective agents of change they should be aware of the mechanisms and dynamics that regulate the implementation and diffusion of this kind of innovation—and how it is possible to guide and orient them. In short, if designers want to play a more effective role in the transition towards sustainability, they cannot limit themselves to proposing eco-efficient PSS concepts; they should also indicate the most promising pathways for the implementation and diffusion of such radical innovations: in other words, strategic design for sustainability can also play a role in designing transition paths to support and facilitate the introduction and diffusion of the concepts it generates (Vezzoli, Ceschin and Kemp 2008; Ceschin 2010, 2012a). In this sense designers could guide and support a company, an institution or a network of actors in the process of introducing and gradually embedding eco-efficient PSS concepts in society. In order to do this a new *design approach* and new *design capabilities* are required.

4.4.1 A new strategic design approach

In this new approach, designers would first need to focus on a **broader design scope** where the ideation of sustainable PSS concepts should be coupled with the designing of appropriate transition paths. In particular the design scope should be extended to:

- The **strategic design of the sequence of steps** that can lead to gradually reinforcing/improving the PSS innovation and fostering its societal embedding (incubation, socio-technical experimentation, and niche development and scaling-up)
- The **identification and involvement of the actors** that can support the societal embedding process in the various steps of the transition path (i.e. identification of actors and related roles)

The designing of transition paths therefore requires the adoption of a **multi-term design attitude**. This attitude allows designers to simultaneously focus on:

- The **project long-term goal**: the achievement of a future in which a sustainable PSS innovation is part of the normal way in which a societal need is fulfilled (project vision)

- The **short- and medium-term actions** to be undertaken in order to orient the societal embedding process towards the long-term goal

Second, a **broader strategic design attitude** is required. This means that strategic designers should focus not only on the PSS innovation but also on the contextual conditions that may favour or hinder the societal embedding process. Strategic designers should therefore adopt a strategic attitude oriented at making the socio-technical context more conducive for the PSS. This is achieved by involving those actors that, directly or indirectly, could affect regime practices and institutions and/or by stimulating changes in actors' behaviours and practices. The transition path is thereby seen as a process not only aimed at testing and bringing the PSS innovation to maturity, but also aimed at *influencing the socio-technical context* in order to foster the societal embedding of the PSS.

Third, a broader strategic design attitude requires a **broader system stakeholder approach**. Strategic designers working on a PSS level are adept at adopting a system design approach. This means that their design activity is focused not only on the PSS offer (the integrated set of products and services), but also on the socio-economic stakeholders to be involved in the PSS and the relations among these stakeholders (in other words the PSS value chain or net). In this case strategic designers should focus not only on the *PSS value chain* but also on the *socio-technical context* in which the PSS should be introduced. This means that the actors to be taken into consideration are not only those more directly linked with the innovation, but also other relevant actors from the science, policy and societal domains: i.e. a broad network characterised by scientific, social, economic, political and cultural linkages. Establishing and developing a broad and heterogeneous socio-economic network is in fact crucial to protecting, supporting and fostering radical innovations. In general it is considered important to involve different groups of insiders and outsiders (in relation to the regime), incumbent and new actors, in order to build fruitful relations in a network and between the network and the outside context.

Fourth, an **experimental- and learning-based attitude** is required. Since we are dealing with highly complex and uncertain innovations, the process to socially and societally embed them cannot be based on a preconceived and fixed solution. In this sense the societal embedding process should be seen as a path based on exploring, searching and learning. From this perspective it is clear that a crucial role for strategic designers is the *designing of the sequences of socio-technical experiments* (as Labs, Windows and Agents of change) that could potentially lead to a gradual societal embedding of the PSS innovation.

Finally, the adoption of an experimental- and learning-based based approach requires a **flexible and dynamic management attitude**. A project vision is not a static outcome to be achieved; it is continuously adjusted as a result of what is learnt by actors during the societal embedding process (in particular during socio-technical experiments). Hence, since the transition strategy is oriented towards the achievement of the project vision, adjustments in the project vision lead to modifications in the transition strategy. Even the network of actors involved in the societal

embedding process is dynamic: the composition, as well as the required tasks for each actor, continuously evolve in time, as the different phases in the transition path require different network compositions. For instance the process of networking in local socio-technical experiments differs from networking in scaling-up. In other words we are dealing with a *flexible and dynamic process* characterised by the mutual adjustment of the long-term vision, the transition path and the actors' network (mutual adjustment as a result of the learning processes). It is therefore crucial for strategic designers to adopt a flexible and dynamic approach to managing this continuous adjustment and redirection.

4.4.2 New design capabilities required

Based on the explanations above this new design approach requires innovative design skills as described below.

- **Translating the PSS concept vision into a transition strategy**: Strategic designers must learn to translate a PSS concept vision into the steps needed to support its implementation and scaling-up. In other words they must learn to design transition paths: the sequence of steps between the present situation without and a future situation with the PSS implemented. Within these transition paths a crucial role is played by socio-technical experiments. Strategic designers must therefore learn to design these kinds of experiments and in particular how to design sequences of experiments with the aim of learning and exploring how to improve and refine the PSS innovation and how to favour its societal embedding. The design of the PSS concept should be combined with the strategic identification of the steps to be undertaken in order to orient the innovation development towards the achievement of the vision itself
- **Designing the actor network configurations** needed to support the societal embedding process: Strategic designers must learn to identify the proper actors to be involved in the various phases of the process: to design a dynamic network of actors in which the composition, as well as the required tasks of each actor, continuously evolve in time. Moreover strategic designers should be capable of adopting a broad system approach and think not only in terms of the PSS value chain (producers, partners, suppliers, users, etc.), but also about the actors that have the power and willingness to directly influence the dominant regime (for example ministries, policy-makers and politicians, and incumbent organisations) as well as the actors that may indirectly influence it (for example NGOs, societal pressure groups and the media). Strategic designers should thus be able to act as *networkers* (capable of establishing bridges and links between different actors) and as *negotiator/facilitators* (capable of managing controversies and conflicts within the network)
- **Facilitating the building up of a shared project vision and action plan**: Strategic designers must learn to facilitate the strategic conversation between

the actors involved, in order to develop (and adapt in time) a shared project vision and action plan. Strategic designers should therefore be able to facilitate a participatory approach, involving a variety of stakeholders in discussing, negotiating, co-creating and developing alternatives. It is therefore crucial that strategic designers are able to organise the complexity of the information that must be exchanged and support effective communication activities among stakeholders; encourage and stimulate the various actors in taking part in strategic conversations; and manage the diversity of their expectations as well as their negotiation and alignment. These skills are thus fundamental: being a *communicator* (capable of effectively illustrating complex information such as project visions and action plans) and a *negotiator* (capable of facilitating the convergence of actors' expectations)

- **Managing the dynamic adaptation of the societal embedding process**: Strategic designers should learn to manage the continuous adaptation and evolution of the project vision, the transition path and the actor network. The project vision is not a static result to be achieved, the transition strategy is not a fixed roadmap to be strictly followed, and the composition of the actor network is not pre-defined: they continuously evolve in time in relation to what is learnt by the actors. It is therefore crucial for strategic designers to be able to dynamically manage the interactions between project vision, transition strategy and actors' network, not as a project with a fixed result, but rather as an open search and learning process. As a result it is necessary to break with the dichotomy between designing and implementing: design, development and implementation should be carried out simultaneously and in continuous interaction

This strategic design approach has been recently applied in several research projects coordinated by the unit of research *Design and system Innovation for Sustainability (DIS)* of *Politecnico di Milano*. One of these, run in collaboration with the South African *Cape Peninsula University of Technology (CPUT)*, is called Cape Town Sustainable Mobility Project. The following section briefly describes the design process and approach adopted in the project and the main results achieved.

4.4.3 A design experience: the Cape Town Sustainable Mobility project

Background

The project involves, as main actors, Shonaquip (a small South African company producing wheelchairs and mobility equipment for disabled people), BEN Bikes (a local association aimed at promoting sustainable mobility projects and initiatives), the Cape Peninsula University of Technology (CPUT), and Politecnico di Milano (Polimi). The aim of the project is to introduce and diffuse a sustainable mobility PSS for the disabled and elderly people in the suburban areas of Cape Town.

In particular the system is expected to offer disabled and elderly people increased mobility services from their homes to the nearest public transport stops, or to local schools, hospitals, etc. Technically, the mobility system is designed around a solar, electric and human-powered light vehicle[5] prototyped by Politecnico di Milano and IPSIA 'A. Ferrari' Maranello in 2006. This mobility system is especially conceived to create benefits in suburbs such as those in Cape Town, which are often characterised by substantial mobility problems due to a lack of high-quality public transport services. The initial PSS concept was developed by Hazal Gumus for her Master's degree thesis (Gumus 2009), conducted in collaboration between Politecnico di Milano and CPUT. The thesis project raised the interest of Shonaquip and in July 2009, a process to socially embed the PSS innovation officially started.

Incubation

The process began with the first formalisation of the project vision, on the basis of the initial PSS concept, by Polimi, Shonaquip and CPUT. The aim was to translate the project idea into a set of visual artefacts that clearly and effectively communicated the PSS innovation's characteristics and its potential benefits to different types of actors. A set of tools was used to support this task:[6] 1) the *offering diagram*, to visualise which customer needs are addressed by the PSS; 2) the *interaction table*, to visualise how the PSS providers deliver the service and how the customers are to be satisfied; 3) the *system map*, to visualise the structure of the value chain; and 4) the *sustainability diagram*, to visualise the environmental, socio-ethical and economic benefits.

The next step was the development of a draft action plan, to identify the main steps between the present situation and a future situation with the PSS implemented. This activity was performed by Polimi in interaction with Shonaquip and CPUT. The following step was the identification of actors to be involved in strategic discussions. It was decided to first include a restricted group of actors (the ones considered crucial to start discussing and strengthening the PSS concept and the action plan) and later extend participation to a wider variety of actors such as the Cape Town municipality, the local public transport company, and local media. Actors initially involved were potential users, local citizens, technology experts from CPUT, and two local NGOs: Disability Workshop Enterprise Development, DWDE (active in providing job opportunities to disabled people), and the Reconstructed Team (an association aimed at reintegrating into society former drug addicts and criminals).

To accomplish this, a two-day workshop was organised in September 2009 where the first day focused on discussing and adjusting the project vision and the second day focused on the action plan. In the workshop, the PSS concept and the transition

5 Designed by Fabrizio Ceschin (the author) for his Master's degree thesis, Politecnico di Milano, Faculty of Design, 2006.

6 See Part 1, Chapter 4, in this volume for full explanations of these tools.

path were adjusted, implementation barriers were identified, new actors were recommended, and actors' tasks were agreed upon.

In phase 2 the socio-technical experiments were designed and implemented.

The **first experiment** was implemented in the Athlone district (Bridgetown), in collaboration with the Reconstructed Team, and was aimed only at testing and improving the technical and usability aspects of the PSS innovation. An existing rickshaw was used to test the service of transporting the elderly in the neighbourhood, involving them in identifying critical issues and suggesting potential improvements, and subsequently, once the vehicle prototype was completed, a series of technical tests took place (Figure 4.3).

Figure 4.3 **First socio-technical experiment: photo taken during technical test of the vehicle (August 2011)**

Source: Ceschin 2012a

After settling the vehicle's technical problems and collecting the first feedback on the service, a **second experiment** (much more articulated) was implemented in collaboration with BEN Bikes in October 2011 and is still running. It was designed and organised in order to act as a *Lab*, *Window* and *Agent of Change*. The following paragraphs will respectively illustrate these three 'functions'.

The first aim of the experiment was to test and improve the PSS innovation (**experiment as Lab**). A service for the transportation of elderly, sick and disabled people from their home to any point of interest around the Lavender Hill community (such as to the hospital, church or the post office) was implemented and is currently running. The main role of the local BEN Bikes centre is to manage the service as well as take care of vehicle maintenance. The experiment is currently used to: *test and improve the vehicle*; *test and improve the service* (using questionnaires and semi-structured interviews); *test and improve the PSS configuration* (in terms of stakeholder value chain and business model); and *identify barriers* (on multiple dimensions including socio-cultural and regulative). For the latter, various actors

(such as the local community, local institutions and NGOs) are involved to express their opinions, remarks and suggestions, in order to identify further potential barriers not already identified in the previous steps. It must be stressed that the approach adopted is aimed at favouring broad participation in the design choices. All the involved actors (from the potential users to the local community and the local institutions) are asked not only to evaluate and provide feedback on the project, but are also stimulated to propose adjustments and alternatives.

The experiment was also designed to raise interest in the innovation project and attract and enrol new potential users and other relevant actors (**experiment as Window**). With respect to this the BEN Bikes centre has been conceived as a sort of 'open gallery' to allow visitors to see, touch and acquire information about the project. Interested people can freely visit the centre and better understand the features of the project and its environmental, socio-ethical and economic benefits. Moreover demonstration visits are organised with specific actors (for example potential users but also potential future partners, local institutions, etc.). BEN Bikes personnel have been trained to be able to effectively describe the project and in particular to illustrate the potential advantages for different kinds of actors. This was considered particularly important by project promoters because there was the need not only to disseminate information about the project but also to stimulate changes in actors' behaviour and routines (for example stimulate potential users to reflect on their mobility habits and consider the benefits that the solution could provide to them). This is clearly connected to the third function of the experiment: *experiment as Agent of Change*.

The experiment was also conceived to stimulate changes in actors' behaviour and habits and create favourable conditions for the introduction and diffusion of the PSS (**experiment as an Agent of Change**). Therefore, in October 2011 an event for relevant actors was organised. The aim of this event was to officially launch the experiment, illustrate the potential future developments, and discuss with invited actors how to support and accelerate the project. The event took place at the Lavender Hill BEN Bikes centre.

The actors invited to the event were the *Cape Town municipality* (in particular the Transport department and the Environmental Resource Management department), because of their potential interest in the project and their direct influence on local transport regulation; *local actors* potentially interested in implementing specific mobility services based on the MULO vehicle (in particular local schools and the local clinic Philiza Abafazi Bethu); and *local media*. The results of the event were positive. First, local actors evaluated the project as valuable for local communities, because of its potential to bring tangible economic, environmental and socio-ethical benefits. Second, one of the actors involved, the local clinic, stated its interest in implementing a service for the transportation of patients as soon as possible. Third, the Transport department of Cape Town confirmed its interest in strengthening synergies between the PSS and the suburban bus lines. In addition the Transport department stated that it put meetings in its agenda to discuss the policy measures needed to support and foster the particular vehicle typology adopted in the PSS.

Because the second socio-technical experiment is still ongoing, it is currently not possible to develop definitive overall conclusions regarding the entire Sustainable Mobility project. Nevertheless, it is possible to say that the whole journey strengthened the stakeholder network, served to refine and improve the PSS concept, and created important opportunities for future developments.

4.5 Towards a new way of designing and implementing eco-efficient PSSs

On the basis of the hypothesised strategic design approach, and taking into consideration the intermediate results of the Cape Town Sustainable Mobility project, a first tentative *design and implementation process* to support the introduction and diffusion of eco-efficient PSSs is proposed.

Figure 4.4 provides an overview of this process (Ceschin and Raven 2011; Ceschin 2012a). It is proposed that it is used by strategic designers, project managers and consultants to support and guide a company (or a small network of actors) in managing and enhancing the societal embedding process of an eco-efficient PSS innovation. In particular the approach facilitates the adoption of an *experimental-, learning-, and network-based design and management attitude*, with the aim of increasing the chances of successfully introducing and diffusing eco-efficient PSSs. The whole process comprises five activity clusters and three phases. The activity clusters are the following:

- **Vision building and expectation shaping** (*WHAT* the project network wants to achieve). Activities related to building up and formalising a project vision shared among the actors and social groups involved in the project
- **Action plan development** (*HOW* the vision could be achieved). Activities related to translating the vision into the steps needed to support and favour societal embedding of the PSS concept
- **Actors' network establishment and development** (*WHO* has to be involved in the project). Activities related to establishing, managing and developing the network around the project
- **Action plan implementation** (*DO* what is planned). Activities related to implementing the actions identified in the strategic plan
- **Monitoring, evaluation and learning** (*LEARN* from activities undertaken). Activities related to monitoring and evaluating the transition process and identifying the adjustments to be carried out

The phases consist of *incubation*, *socio-technical experimentation* and *scaling-up*, which are briefly presented in the following sections (Ceschin and Raven 2011; Ceschin 2012a).

Figure 4.4 **Process to support the societal embedding of eco-efficient PSSs**
Source: author

4.5.1 Phase 1: incubation

The incubation phase sets up the conditions to initiate the societal embedding process. The starting point is an eco-efficient PSS concept developed by one or more PSS promoters. The first step is to formalise the project vision in order to communicate in a clear and effective way the aims of the project, the main characteristics of the PSS innovation, and its potential (environmental, economic and/or socio-ethical) benefits.

The next step is to explore how the concept could be socially embedded. This involves making a comparison between the present situation without the PSS and the future situation in which the PSS concept is implemented. It is essential to adopt a strategic attitude in order to identify the short and medium-term actions to be undertaken in order to create the most favourable operable conditions. Actors potentially interested in the concept, as well as actors that could give protection and support to the innovation, are identified. This step produces a first formalised draft action plan (identification of the actions to be undertaken, the actors to be involved, and their roles).

The third step is the involvement of the identified stakeholders in strategic discussions: in this stage meetings and workshops are organised with the actors previously identified. The aim is to collect and confront the different actors' expectations, discuss and adjust both the project vision and the action plan, and achieve a common consensus.

As a result of these meetings and workshops the project vision, the action plan and the actor network are adjusted. The output of this phase is the establishment of a project network that agrees on a project vision and on an action plan.

4.5.2 Phase 2: socio-technical experimentation

In this phase small-scale socio-technical experiments are implemented in real settings with the aim of learning and exploring how to improve the PSS innovation and how to contribute to its societal embedding.

This phase begins by designing the experiments such that they are protected from the mainstream competition environment and act as *Labs*, *Windows*, and *Agents of Change* (see previous sections). The design of the experiment includes: the identification of an implementation area and the appropriate financial and socio-institutional protections, the technical aspects of the PSS, as well as identification of the socio-economic organisation to protect and support the innovation (identification of actors to be involved and related tasks).

During the experiment monitoring and evaluation activities are undertaken. These include the experiment (technical and usability aspects, acceptability of the PSS by the various social groups involved in the project, implementation and diffusion barriers, etc.); the actors directly and indirectly involved (their roles, behaviours, expectations, conflicts and convergences); the project vision agreed on and the action plan (and their evolution and adjustment in time).

Evaluation results are then translated into new actions. Through a learning-by-doing approach, the evaluation may lead to an adjustment of the experiment, action plan and the broader project vision, as well as increased understanding of the need for contextual changes and ways to achieve them.

Following this process, different experiments can be executed in different contexts and/or testing new functions.

4.5.3 Phase 3: niche development and scaling-up

In this phase the aim is to increase momentum of the PSS innovation (and the related new practices, behaviours and institutions) and begin to influence the socio-technical regime. It is a process that leads the innovation to increasingly become part of the mainstream way in which a societal satisfaction is delivered.

The first step is the identification of appropriate actions to enhance the development and reinforcement of the pathway of experiments. It is essential to link the PSS innovation to a broader context, in order to make it relevant beyond the local scale. Key issues are:

- To repeat the experiments in other contexts and create synergies with similar projects and initiatives. The aim is to share experiences and stimulate and reinforce network building on a broader scale (e.g. within a sector or at a national level)
- To disseminate information/project results and stimulate media attention at a national level
- To stimulate actors at a strategic level to influence the socio-technical context in order to create the most favourable conditions for the scaling-up of the PSS innovation

In sum, the aim is to establish deeper linkages with relevant political, industrial and social actors: those that have the power and willingness to directly influence the dominant culture, practices and institutions;[7] those that (in)directly may influence the regime because they have an interest in embedding new sustainable practices; those that can spread information on the PSS innovations; and those that may support the scaling-up of the innovation, such as potential industrial partners, industrial associations or consortia.

During the process monitoring and evaluation activities continuously take place. Evaluation targets include the progress of niche development and scaling-up (e.g. connections with other experiments, enrolment of new actors, dissemination of project results, connections with regime actors, and introduction of the PSS innovation in niche markets), the actors involved, the project vision and the action plan. The evaluation process can lead to adjustment of the actions to favour niche development and scaling-up, as well as to re-orient the project vision and adjust the actor network and the action plan.

4.6 Conclusions

Eco-efficient PSS innovation represents a valuable concept for enhancing company competitiveness and at the same time providing environmental benefits. However, these innovations are in most cases radical, and their introduction and diffusion usually encounter the opposition of existing cultural, corporate and regulative barriers. Hence, if immediately exposed to the mainstream market environment, it is highly probable they will not survive. An important challenge is therefore not only to conceive sustainable PSS concepts, but also to understand the contextual conditions in which they are introduced and explore the most suitable strategies and development pathways to embed these concepts in society. Building upon insights from the *transition studies* field, this chapter put forward a conceptual framework for the introduction and scaling-up of eco-efficient PSSs. A crucial role is given to

7 As suggested by Van den Bosch (2010)

the implementation of sequences of socio-technical experiments, partially protected spaces where broad networks of actors incubate, test, develop and bring the innovation to maturity without the direct pressure coming from the market environment. Theoretical and empirical evidence supports the proposal that, in order to effectively contribute to transition processes, socio-technical experiments should be conceived as *Labs*, *Windows* and *Agents of Change*.

Strategic design could thereby play a role not only in generating eco-efficient PSS concepts, but also in designing transition paths to support and facilitate the introduction and scaling-up of the concept itself. The chapter also discussed the new design approach and new design capabilities required by designers to operate at such a level.

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5

Our common nature

Insights from the 'moral faculty' and its potential role in system design for socially and environmentally sustainable outcomes

Hussain Indorewala

Kamla Raheja Vidyanidhi Institute of Architecture and Environmental Studies, Vidyanidhi Marg, Juhu Scheme, Mumbai, India

Carlo Vezzoli

Politecnico di Milano, Design Department, Design and system Innovation for Sustainability (DIS), Italy

5.1 Our common nature/future

In 1996, the Food and Agricultural Organisation (FAO) organised a summit where the heads of 185 states made various pledges, one of them to eradicate world hunger. The aims were reaffirmed at the UN Millennium summit in 2000 where 191 member states signed the Millennium Declaration, committing all of them to: 1) reduce by half, from 1990 to 2015, the percentage of persons living in extreme poverty; and 2) grant a full and productive employment and a dignified job for all, including women and youngsters. But ten years later, the general director of the FAO, Jacques Diouf, at the Food and Agriculture Organisation (UN) conference, presented an annual report that conceded the number of starving people was *increasing* by 4 million each year. Our civilisation is unique in that this is perhaps

the first time in history in which a third of the species is food insecure while more than a sixth, about 1.02 billion, live in starvation (FAO 2009).

Other social indicators too present a grim picture of the world today: the richest 2% own about half the global household wealth whereas the bottom 50% own just 1% (Oziewicz 2006). A third of the world's urban population lives in slums, some in degraded but most in appalling conditions, and this number is projected to increase to about 2 billion people by 2030 (UNHSP 2003). Climate change has already been causing about 300,000 deaths a year and affecting about 3 million people, projected to increase to about 500,000 a year by 2030 (Vidal 2009). The rate of species extinction has reached 100–1,000 times the rate that existed before humans inhabited the planet. The rate could increase to about 10,000 times by 2030 according to Harvard biologist E.O. Wilson (Jowit 2010).

A superficial observer peering through an interstellar microscope onto our planet might be tempted to conclude that we are pathological creatures, ravaging our own means of survival to produce mostly for wasteful and suicidal purposes, the useful little being distributed in a glaringly unjust manner. Unsurprisingly, many of us accept this theory readily. But there is much more to us than meets the eye. It has long been accepted that just as we are endowed with the capacity for language that can develop into different sounds and grammatical structures, we are also born with an innate 'moral capacity' that develops into very diverse moral systems depending on our environment and education. Hauser (2006b) presses this analogy with language when he calls such a capacity 'our universal moral grammar'. Such a capacity is essential in all social animals, not only in humans, as without it we would be sociopaths and any form of social life would be impossible. In fact, individuals who have suffered damage to the pre-frontal regions of the brain lose their capacity to feel empathy, become emotionally deficient, and 'abnormally utilitarian' in their judgements (Koenigs *et al.* 2007). Emotions such as empathy, shame, guilt, anger and disgust turn out, when considered deeply enough, to be mechanisms to enforce social cooperation and sanction non-cooperative behaviour. But we are unique, not only for our 'moral capacities' but also in our ability to formulate norms of conduct, shape and create social systems based on these norms, and identify ourselves with unrelated or non-kin groupings such as nations, religions, and linguistic groups (Bowles and Gintis 2003).

In the UN report *Our Common Future* (UN 1987) the concept of sustainable development was introduced. It defined sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. It stressed the 'essential needs' of the world's poor and the limitations that 'the state of technology' and 'social organisation' imposed upon the environment. It also mentioned the equity principle, or that every person has the right to a fair share of the global natural resources or environmental space. We could say that we need to extend this definition, in that every person must have not only access and availability of material goods, but also the 'satisfaction' attainable from such goods (Vezzoli 2010a).

Our aim is to show that to accomplish 'our common future' we should better understand 'our common nature' and define and implement institutions and strategies being aware of it (and synergistic with it). A basic hypothesis here is that, though 'rational' goals have been universally identified and assumed for a sustainable social and economic development, the ways humankind has defined its institutions and strategies have been quite inconsistent with the dictates of such a 'moral faculty'. Hence, if better understood, new and more effective institutions and strategies could be defined that could help us achieve our most urgent sustainability goals (Millennium Development Goals to eradicate poverty, for instance) and alleviate our most pressing social problems. This issue will first be discussed with a very broad overview of the history of our understanding of morality. Next, we will briefly discuss findings from some recent studies in this area. Finally, we will propose a new research frontier for design research in system design for sustainability and the role for design in innovative stakeholders' interactions coherent with insights from these recent findings.

5.2 Fragments from the history of morality

In the 17th century Thomas Hobbes gave a famous account of 'human nature' in his works, and his assessment was not very encouraging. Men are 'wolves' to one another, with a 'natural proclivity' to 'hurt each other' and their 'natural state' before they entered society was 'war of all men, against all men' (Hobbes 1651: 17). Hence, to be able to live in society, men must come together under a social 'covenant' and willingly submit themselves to an absolute ruler who will protect their lives and property by demanding unconditional obedience.

Thomas Malthus in his *Essay on the Principle of Population* claimed that a population tended to increase too rapidly for the earth to support the growing number of new claimants, and poverty and starvation was the only real check to this uncontrolled increase. Hence, it was of no use trying to reform human institutions to remove inequalities, as poverty was a natural *law*. Due to the 'inevitable laws of our nature', he said, 'some human beings must suffer from want. These are the unhappy persons who, in the great lottery of life, have drawn a blank' (Malthus 1798: 71). Since Malthus made his predictions about 'gigantic inevitable' famines, the world population has increased six times and food output and consumption is higher than ever before (Sen 1994). Many recent books on the subject have become quite famous; the most well-known among them, Paul Ehrlich's *The Population Bomb*, warns the world about the 'cancer' that is the 'uncontrolled multiplication of people', requiring 'brutal and heartless' decisions to rescue us from this dangerous disease. In a well-known essay, 'The Tragedy of the Commons', the American sociobiologist Garrett Hardin argued that as 'a rational being' Man seeks to 'maximize his gain', and in a world with scarce resources, he will destroy the very resources

on which his existence depends. This 'tragedy', the rush to pursue one's 'own best interest in a society that believes in the freedom of the commons', will lead to 'ruin'. Hardin then sums it up with the pithy phrase: '[f]reedom in a commons brings tragedy to all' (Hardin 1968). As Peter Linebaugh notes, Hardin accepts all the premises of neoclassical economic theory, of 'absolute egoism', failing to notice 'several millennia of experience in the mutuality and negotiation of commoning' (Linebaugh 2008: 9-10). In fact, using Hardin's arguments to explain the destruction of the planet and its resources is to 'blame the victims' (Patel 2009: 93) and a failure to understand the structural causes of this destruction.

Immanuel Kant is well known for his emphasis on the role of 'pure reason' in human morality. He wished to create an ethic based on *reason*, as distinct from ethics based on *intuition* or *utilitarian* considerations. Every human being must be considered as an end in himself and not as a means to something else. To Kant, moral acts are only those that follow from obedience to a moral law, not from self-interest or benevolence (Russell 1975: 683). The Utilitarians (Bentham, James Mill) on the other hand held that the ethics must be concerned with *utility* or any action that increases the happiness of the community rather than diminishes it (Bentham 2000: 89).

Malthus's doctrines inspired Darwin's *Origin of Species* (1859) and its principle of 'the struggle for existence', though he warned that he used the phrase in a 'large and metaphorical sense'. Nevertheless, Darwin also attempted to explain moral conscience from an evolutionary perspective. He saw the source of moral behaviour 'in the social instincts' which 'lead the animal to take pleasure in the society of its fellows, to feel a certain amount of sympathy with them, and to perform various services for them'. It is this 'sympathy' that is the 'foundation-stone' of the social instinct. He argued that the social instincts, even though 'acquired by man in a very rude state' by his 'ape-like progenitors', still provide the 'impulse for some of his best actions' (Darwin 1871: 86, 95; Kroptokin 1902).

Very soon, Darwin's 'struggle for existence' became 'survival of the fittest' in its popular interpretation, with his own disciple, Thomas Huxley, leading the way. In an essay written in 1888 Huxley wrote that to a moralist, the animal world resembles 'a gladiator's show' where the 'strongest, swiftest and cunningest live to fight another day'. Among the primitive humans, said Huxley, 'the weakest and stupidest went to the wall' and the 'toughest and shrewdest…survived'. The story of civilisation was the attempt of the human race to escape 'the Hobbesian war of each against all' which was its natural state for 'thousands and thousands of years' (Huxley 1888: 204). Later, in his famous lecture titled *Evolution and Ethics* delivered in 1893, Huxley stressed that though in nature there was 'ruthless self-assertion…thrusting aside…treading down', laws and moral precepts are built in human society to curb these destructive instincts (Huxley 1888: 81-82). In our own time, Richard Dawkins gives similar advice in his book *The Selfish Gene* when he says, 'A predominant quality to be expected in a successful gene is ruthless selfishness' which will 'usually give rise to selfishness in individual

behaviour'. Hence 'let us try to *teach* generosity and altruism, because we are born selfish' (Dawkins 1989: 2-3).

Adam Smith, the apostle of free market economics, in his *Theory of Moral Sentiments* wrote about what he assumed to be an inherent moral impulse in human beings. He called such an impulse 'sympathy', which is the 'source of our fellow-feeling for the misery of others'. It is this 'inhabitant of the breast' that makes our happiness dependent upon the well-being of our fellows. He wrote that when we 'prefer the interest of one to that of many' we make ourselves 'the proper object of the contempt and indignation' of others (Smith 1759). Even his *Wealth of Nations* was a moderate, balanced work, arguing for free markets only because he believed it was 'the very simple secret' to establish 'perfect justice, perfect liberty and perfect equality' (Smith 1759). His devotees today have fanatically clung onto his prescriptions, while completely overlooking his reasons (Werhane 1989, 1991).

Peter Kropotkin, in his important work *Mutual Aid: A Factor of Evolution* written in 1902, presented in rich and vivid detail an account of the cooperation and the innumerable examples of mutual aid and solidarity within species—and sometimes even across species—in order to prosper and survive. He concluded that the 'animals which acquire the habits of mutual aid are undoubtedly the *fittest*' and they 'attain the highest development of intelligence and bodily organisation' in their respective classes. To Kropotkin, Rousseau's optimistic notion of the 'noble savage' and Huxley's pessimistic conception of the 'gladiator's show' were both erroneous, far away from an accurate interpretation of the natural world. Human nature was for him a 'vague instinct', formed within the species during its long evolutionary history becoming the basis for the development of higher moral feelings (Kropotkin 1902). 'Virtue' and 'wickedness', as he pointed out, are biological, not human conceptions (Kropotkin 1902).

5.3 Human morality and economic theory

When Adam Smith wrote his *Wealth of Nations* in 1776, he believed that the interests of society and that of the individual were one and the same, and by creating a system that encourages each one to pursue their own rational self-interest, the best possible social outcomes could be achieved. In the 18th century political economy was not only concerned with *economics* but also with *ethics* and human *values*, but within two centuries, economics became an abstract 'science' disconnected from all moral considerations (Werhane 2006). Neoclassical economists made assumptions about human beings such that they took away all that was human from them. To make their abstract models work, they devised the *Homo economicus*, or the economic man, who is an amoral, self-interested creature, acting only so as to maximise its own gain, irrespective of the consequences of its actions on society. This vision is far away from the imaginings of Smith, who

felt that 'to restrain our selfish, and to indulge our benevolent affections, constitutes the perfection of human nature' (Smith 1759). In Smith's world, everyone must pursue their *self-interest*, as that would lead to socially beneficial outcomes; in the real world, everyone must become *selfish* because it makes for much better economics.

Economic institutions are those that organise the production, distribution and consumption of goods and services in a society, in our society the most important of these being markets, private property rights, wage labour, small and large firms, etc. Modern corporations behave very much like self-interested, wealth-maximising creatures, because as institutions they lack any form of 'morality' or compassion for others as exists in human beings. They are in every sense the perfect embodiment of *Homo economicus* (Patel 2009: 48). Individuals who are a part of such institutions must *play their roles* as expected from them, failing which they will be readily ejected and replaced. Moreover, in a society that is driven by the notion that markets are the best judge of value and the best means to happiness, and that amassing private wealth is the noblest of aims, it is not surprising that all human relationships and attitudes become subject to the logic of the marketplace. It is clear that our dominant institutions are wasteful, unjust, built for the wrong ends and built for the wrong creatures. Hence, in order to reform our institutions we will need not only to alter the purpose for which they are built but also to understand much better the 'nature' that is common to us all.

But even non-economic means to alleviate social ills have achieved limited results. At the same time it must be noted that the boundaries between non-economic and economic institutions in a capitalist world order are at best tenuous and at worst non-existent. The fault seems to lie mainly in the conception of the problem rather than poor implementation of the solution. For 200,000 years, humans have lived in 'non-state' societies and have organised themselves in autonomous communities to fulfil their human and material needs. These self-organised communities have emerged not from the minds of planners and statesmen that aim at creating the most efficient and governable environments, but from the intrinsic needs of survival and flourishing of the species. Organisations such as the UN and identified goals such as eradicating poverty and hunger (the Millennium Development Goals) are noble in intention, but they depend on states to fulfil these promises. Centralised and bureaucratic structures like the state, even in its most benevolent form, with its carefully planned schemes, suffer from a similar malady that infects economic theory: a highly schematic view of what makes human societies function, by ignoring essential local knowledge, practices and conditions (Scott 1998: 6). We must add that this view schematises human beings and their needs into abstract quantities for the sake of legibility and ease of execution and then goes about trying to fulfil them. This opens up an important question which needs to be urgently explored: what kind of arrangements would need to be made for solving socio-ethical problems, if we had a better understanding of our common nature, i.e. the so-called 'moral faculty'? This question will be explored in what follows.

5.4 Advances in the understanding of the 'moral faculty'

In recent times, biologists such as Marc Hauser, John Mikhail and others have aimed to demonstrate that human beings are endowed with a metaphorical 'moral organ' to explain what is thought to be a biological endowment, similar to our language competence. They have advanced a theory of 'universal moral grammar', which contains the principles and parameters of such an endowment, providing 'a toolkit for building possible moral systems'. The 'moral systems' that emerge are obviously dependent on environment, culture and education, certain parameters being selected and established during the early development of the individual (Hauser 2006a, b; Mikhail 2007).

Experiments undertaken by a group of interdisciplinary researchers with different social groups and cultures around the world, mainly using experimental games, have provided rich data and quite interesting results regarding human economic and social preferences. One such experiment, called the *Ultimatum game*, is a game played between two players, a 'proposer' and a 'responder', who do not get to see each other, and is played between them just once. They are presented with a sum of money (say €10) and the proposer must make an 'offer' to the responder (offering a part of the sum) which the latter can 'accept' or 'reject'. If the offer is accepted, the sum is divided as offered and accepted, whereas if rejected, both players get nothing. If the players were 'rational, self-maximising actors' the most predictable outcome would almost always be the minimum possible sum offered (say €1) and such an offer would always be accepted (as €1 is better than €0). But as the experimenters found out, 'the self-interested outcome is never attained and never even approximated'. In fact, the results varied greatly, depending on the social systems that exist in different societies, with the greatest offers being made in societies that provide greater rewards for cooperative behaviour (Gintis *et al.* 2003).

Another well-tested experiment, *The Public Goods game*, is played by multiple players and has multiple rounds. Every player is given a bunch of coins, or 'points', (say €10) and in every round, the players can choose to 'invest' some of their points in a 'common account' and the rest in their 'private account'. At the end of the round, the amount from the common account is announced and a set percentage (say 40%) is distributed equally among the players, irrespective of their contribution to that account. The amount in the private account stays with them. So for instance, if four players contribute their €10 into the common account, each will get €16 at the end of each round. But if say two players contribute €10 while the other two contribute nothing, the contributors will have €8 each at the end of the round, while the non-contributors will have 8 + 10 = €18. Hence, it would be collectively advantageous to contribute all one has to the common account, but individually, one would hope that others contribute all their points while contributing none themselves. If the self-interested actor hypothesis were valid, all players would refrain from contributing to the common account; instead it was found that most players

begin by contributing about half their sum and their contributions keep reducing as more and more rounds are played. The players would explain later that low contributions by the other players made them angry; hence the gradual deterioration of contributions to the common account. More interestingly, when the same game was played with revised rules allowing low contributors to be punished by other players (by paying a 'fee' themselves, players had an option of 'fining' others) to assure their cooperation in later rounds, cooperation did not deteriorate as it did earlier and in some cases, full cooperation was achieved (Gintis *et al.* 2006: 25-18).

The findings of the experiments provide a good amount of evidence to dispute the biological and economic model of the self-regarding actor and claim that behaviour can be better explained by what is called 'strong reciprocity', defined as 'a predisposition to cooperate with others, and to punish (at a personal cost, if necessary) those who violate the norms of cooperation, even when it is implausible to expect that these costs will be recovered at a later date'. It also asserts that human beings are neither self-regarding nor entirely altruistic; rather, they are 'conditional cooperators' who cooperate as long as others do so as well and 'altruistic punishers' who sanction unfair behaviour of others according to the prevalent norms of cooperation (Gintis *et al.* 2006: 6-8). Some findings from this study that might be of interest for our purposes are as follows:

- Human beings care not only about *outcomes* of economic interactions, but also about the *processes* by which those outcomes were attained. Which is to say, fairness and unfairness, justice and injustice, willingness and coercion, all play a part in the assessment of interactions (Gintis *et al.* 2006: 6)
- People care not only about the *outcomes* of an action, but also the *intentions* that lie behind them (Falk *et al.* 2008)
- In certain situations where individuals perceive external intervention as external *control*, they react by *reducing* their intrinsic motivation in that activity. In other words, people show greater motivation participating in activities that allow them greater control or self-determination. Conversely, when external intervention is perceived as being supportive and the individuals feel freer to act, intrinsic motivation increases. For instance studies conducted in Nepal about management strategies of irrigation systems found that Farmer Managed Systems achieved higher agricultural yields, distributed water more equitably and maintained the irrigation systems better as compared to systems managed by an external body (the government in this case). In many other cases studied, where fines and subsidies were introduced to encourage conservation, resources tended to deplete sooner, as the more effective community regulated systems of conservation broke down (Ostrom, cited in Gintis *et al.* 2006: 260-268)
- Human beings exhibit a considerable behavioural variation across cultures (as observed by large variations in the results of the Ultimatum Game, for example), a large portion of this variation due to prevalent economic patterns

and institutions (production, distribution). In other words, the greater the incentive to cooperate within the society (in the form of institutional arrangements), the greater is the level of cooperation and sharing that is displayed in the experimental games (Gintis *et al.* 2006: 27-28)

- People have a predisposition to contribute in a cooperative endeavour, provided others are willing to cooperate; providing material incentives usually goes against the spirit of cooperative behaviour. In other words, trust and mutual aid is more effective in ensuring motivation as compared to material incentives (especially if the incentives are provided by someone not trusted by the members) (Gintis *et al.* 2006: 28). A very good example of this point was seen in Haifa, where in six daycare centres a nominal fine was imposed on parents to deter them from arriving late to pick up their children. What was observed was that as a result of the fine, the average time of arriving late doubled, and surprisingly, even after the practice of fining was discontinued, the average time did not reduce. The moral obligation that drew parents to pick their children up sooner was replaced by a 'commodity', namely time, that the parents could 'buy', and this sense of obligation did not return, indicating that material incentives may sometimes be counterproductive in ensuring cooperative behaviour (Bowles 2008)

For almost all of human history, humans have lived in small groups in relatively isolated nomadic communities, and our 'moral faculty' has evolved during this time. It is very recently that there have been high concentrations within small urban centres and rapid integration of the world population due to technological advancements. It could be that this native disposition is ill-equipped to deal with the complexities of a modern, highly interconnected life, but it would be a rash conclusion, unless we can gain a much better insight into this 'native disposition', of which our understanding, if any, is crude at best. On the other hand, humans exhibit a remarkable proficiency in forming groups and associations across kinship lines for various reasons and purposes, occupational, ideological, regional, linguistic, cultural, religious, etc., with different levels of participation, commitment and loyalty. Quite many of our associations and loyalties that transcend parochial interests cannot simply be explained away as the fruits of the efforts of individuals and groups throughout history for a unified world, unless we acknowledge the role of the instinct of 'sympathy', however ill-defined, that enables us to feel one with others, which plays a substantial part in making any such efforts fruitful.

5.5 Some case studies

Not all our social relationships are mediated through the marketplace; in fact, in our day-to-day interactions, we are significantly communal and cooperative. Almost always, we unconsciously estimate the worth of characters and constantly assess

acts, both our own and of other people, without subjecting those acts through a conscious calculus of profit and loss. We intuitively understand that such a calculus is not only highly reprehensible when it comes to personal relationships, but it is also grossly ineffective when it comes to social welfare. Economic aid programmes, help in disaster-affected regions, humanitarian assistance and other such methods are non-market mechanisms, at least in popular perception, that aim at alleviating social ills and disadvantages. Large institutions such as the specialised agencies of the United Nations, insofar as they are independent, are institutions designed to further goals enshrined in the UN Charter. Even at a micro scale, sponsorship schemes and private donations are popular methods by which individuals contribute and support others, quite often people they have never met before. A lot of these institutions and methods bank on sympathy and solidaristic tendencies, but our task is to ask and enquire how these tendencies can be institutionalised to ensure socially beneficial outcomes. Some examples of such *institutionalised cooperation* follow in the next sections.

5.5.1 Participatory Planning[1]

The 73rd Constitutional Amendment in India aimed at institutionalising participatory democracy and decentralised planning in the rural areas, though its implementation around the country was marginal at best. One of the exceptions was Kerala, a state in India, which in 1996 initiated the People's Plan Campaign (PPC), a plan to apportion 35% of the state's development budget to local communities for planning and implementing their own schemes. This experiment is said to have 'radically improved the delivery of public services, brought about greater caste and ethnic equality, facilitated the entry of women into public life at a much greater pace and enhanced democratic practice' (Franke 2007). Quite a few creative and useful projects were initiated and implemented by the communities, such as collaborating with a team of local scientists to implement a biological mosquito control programme that is hailed to be one of the best internationally, social auditing and methods for tackling corruption and favouritism, creative ways of dealing with unemployment by creating a 'labour bank', a bridge to facilitate pedestrian and bicycle traffic that was being ignored by the state authorities earlier, and even a suicide prevention programme (Franke 2007).

One of the initiatives in Kerala, started around 2000–2001, was called the 'Mararikulam experiment', which consisted of 1,500 Neighbourhood Groups (NHGs) of 20–40 women each. The area had a population of about 272,000 people in about eight villages and two towns. The project was to transform the NHGs into worker owned and managed cooperatives and to produce goods by using local materials and supplying local markets. In order to generate capital to be able to create the cooperatives, the NHGs held weekly meetings and started what it called 'thrift collection', or a small amount of weekly or monthly contributions to be able to hand

1 This section is based on Franke 2005, 2007. Also see: Veron 2001; Bandyopadhyay 1997; Franke and Chasin 1998.

out loans for the members. The collections ultimately ended up creating enough capital to start up small businesses, which was provided as start-up capital by what became local cooperative banks. These banks took the micro-credit model of the Grameen Bank further by overcoming its quite serious limitations of being managed by an outside bureaucracy (Franke 2005).

With the help of some volunteer advisers, 16 NHGs were selected from the village assemblies, two per village, to become soap producing cooperatives. Soap production was a good choice for the overall project, as almost all the ingredients needed for the product are local (about 90% coconut oil), and the demand for soap is high as Kerala is the highest soap consuming state in India per capita. There was no need for advertising or ostentatious packaging; political consciousness substituted for corporate advertising, as education and participation informed the community and provided an assured market as well as mutual trust. Moreover, all raw material and markets being local, the money circulated within the local economy, and since the workers owned the cooperatives collectively, even modest profits as compared to private companies' profits translated into enhancing local wealth. In the second stage of the project, other goods such as notebooks, school bags, and umbrellas started being produced by local cooperatives, and as the third stage, food production and waste processing were planned.

The most important aspect of this experiment however was not only production or creating jobs: it was the sense of participation, cooperation and mutual aid. Women were empowered, poverty was reduced and the local ecology was protected and nurtured, not with state regulations or norms, but by the natural need of the communities to protect their resources and surroundings. Schemes like rainwater harvesting, waste recycling and fish breeding were implemented for this purpose.

5.5.2 Worker self-management[2]

After 2000–2001, around the time of Argentina's economic crisis, some workplaces began to be taken over by their employees and converted into worker cooperatives, during a time when thousands of enterprises were being shut down and millions of jobs were being lost. One of the largest factories that was taken over by the workers was a ceramic plant in the Patagonian province of Neuquén, called Zanon, which employs 470 workers. In 2001, Luis Zanon, the owner of Zanon, locked out the employees in response to a strike to protest against layoffs and unpaid wages. In October of the same year, the workers decided to take over the factory, camping outside the factory for months and finally deciding to start production with the bosses. The workers also fought for the legal recognition of worker-run cooperatives, called FASINPAT (Factory Without a Boss) cooperatives. It must be noted that these takeovers were for the most part due to necessity rather than some political ideology and the economic conditions that led to large-scale unemployment were

2 This section is based on: Marie Trigona, 'Fasinpat (Factory Without a Boss): An Argentine Experience in Self-management' (Spannos 2008: 155-168).

a major factor in compelling the employees to take such urgent steps. At the peak of the crisis, unemployment reached 20%, with 40% underemployed. A total of 53% of the population between 2001 and 2002 was living below the poverty line. Argentina has 'recuperated' about 180 factories under worker control, providing employment to about 10,000 Argentines (Spannos 2008: 157).

When the factory was run by the bosses, profit maximisation was the primary goal, resulting in low salaries, cost cutting in safety measures, keeping as few workers as possible, and so on. A striking illustration is the number of workplace accidents, which averaged at about 25–30 per month and one fatality on average per year. The workers were forced to maintain 'discipline' in the workplace, with different colour uniforms for different production lines, and interaction between them was prohibited. They were also restricted from freely chatting in the lunchroom or during break times. Even moving about in the factory and visiting the washroom was difficult. After the workers began managing their own affairs, they dismantled the hierarchical structure of management and organisation and introduced new methods to manage and operate the workplace, greatly improving the working conditions. The number of deaths due to accidents has fallen to zero, and the number of minor accidents has greatly reduced. Every worker is now awarded the same wage, with marginal differences, depending on experience and seniority. A total of 230 new workers were employed by the worker councils after the factory was taken over, many of them old workers that had been fired by the earlier bosses. The new organisation is based on a coordinator system, each production line forming a commission; every commission selects a coordinator and rotates regularly. All the coordinators together form an assembly of coordinators, informing and providing details about their respective sectors to the assembly and from other sectors to their commissions. Workers hold weekly assemblies, and there is a general assembly of all the workers once every month. The books are opened each month, the coordinator of that sector providing details about the accounts and expenditures of the company. The assemblies decide how the profits are to be used and other major decisions that affect the whole factory, including hiring new workers. The workers work with other professionals such as lawyers and accountants, but the professionals give their opinions only: the decisions are made collectively in the assemblies. The earlier owners manufactured entirely for export, but the new management produces mainly for local markets (Spannos 2008: 160).

The workers also attempt rotating tasks, dividing manual and mental work among the members approximately equally. They even created initiatives such as educational projects, a library in the Zanon factory, training programmes with universities and schools and even a women's commission to discuss and work on the challenges working women face even in a boss-less workplace. The workers try to constantly improve their workplace and environment, learning something new all the time rather than, as under the old system, worrying only about their salaries and position in the factory. The factory takes on community projects such as building homes for other working class families, student field trips, and donating ceramics for public purposes. It also organises events such as rock concerts, theatre productions, and collaboration with artists, activists and other workers.

Due to the integration with the community, Zanon has formed a broad solidarity network, and the community has even protected the rights of the workers against radical right-wing groups. Moreover, Zanon has begun collaborating with other worker-run enterprises, in a broad coalition called the National Movement of Recuperated Enterprises (MNER) of which 40 organisations are members, including hotels, printing works, food industries and others. Even internationally they have won support, inspiring others to do the same in their workplaces. A 2004 documentary by Naomi Klein called *The Take* was based on Zanon's takeover, making their struggle known all over the world. A worker summed up Zanon's success:

> Zanon represents a triumph for the working class and represents the possibility of organising society in another way: without bosses and the pressure of having to serve somebody that takes all the money and leaves the rest destitute (Spannos 2008: 166).

In Argentina itself, many more worker cooperatives have been created recently, and similar actions have been taken in countries such as the UK, US, Ireland, France, Poland and Canada (Klein 2009).

5.6 Insights from the 'moral faculty' and a potential role in system design for sustainability

The discipline of *Design for Sustainability* has enlarged its scope and field of action in the last two decades (e.g. Vezzoli and Manzini 2008): from *material and energy low impact selection* to *Life Cycle Design* (or *Eco-design*) *of products*, to *eco-efficient (Product-Service) System design*, and (system) *design for social equity and cohesion*, where the question of social equity and cohesion is directly addressed within the design process. This evolution has opened a debate on the role of design itself, a discipline that is already undergoing a redefinition of its (potential) role as a consequence of other socio-economic transitions, i.e. service orientation, interconnection, and globalisation–localisation (*glocalisation*).

One important role that designers could now begin to undertake is as *facilitators* of *institutions* that carry out economic functions and social interactions (UN-dedicated institutions, workplaces, councils, unions, etc.). This will require not only providing their skills in the *material* aspects of production, distribution and consumption (planning, articulation of objects and structures, and information design) but also providing insights into the *organisational* aspects (how decisions are made, how planning is undertaken, and how gains are redistributed). In order to be able do this, designers will require not only an understanding of how to design *efficient* and *ethical* organisations, but also how to design such organisations that are as coherent with our moral grammar that they result in being more

effective, e.g. by fostering cooperation and creativity. Evidence already indicates that cooperative institutions result in more socially and environmentally sustainable practices, and we already have a fair grasp of the building blocks that can be used to facilitate or design such institutions, which we briefly mention below. Some of these have been the norm in 'community governance' systems of the past and present (for instance the Farmer Managed Systems mentioned above); some others are hypotheses that could be tested:

- **Self-management**. Most firms and organisations today are organised hierarchically with a small group of people making decisions and the rest taking orders. Self-management enhances intrinsic motivation; it is the ability of all members of a group to make plans, set goals, manage resources, make decisions, carry out the agreed-upon tasks, elect representatives and most importantly, to determine the most appropriate form of management
- **Ownership**. Common ownership over resources, tools, workplaces and gains gives all participants a sense of common purpose. Asymmetrical ownership leads to asymmetric influence and uneven distribution of gains
- **Information/Knowledge**. Generally a self-managed group will have access to all the information relevant to the group and its activities, such as transactions and books. But access to such information must also be available to the community, to ensure transparency and accountability
- **Creative activity**. People enjoy work that is creative and fulfilling and usually avoid jobs that are monotonous and arduous. This will require doing the opposite of what usually happens today, which takes away creativity and control from the hands of the worker and reduces her/him into performing dull and monotonous tasks
- **Accessibility**. Accessibility implies providing open access not only to fruits of knowledge and technologies, but access to knowledge and technologies themselves. Monopoly over methods and secrecy creates potentially asymmetric power structures and unequal advantage to certain groups over others. The advantages of an 'intellectual commons' (Patel 2009: 154) are evident in the software world, and there is no reason, except resistance from vested interests, why they cannot be replicated in the 'real' world
- **Distribution of gains/remuneration**. The ideal formula has always been: 'from each according to his ability, to each according to his needs'. But different arrangements can be tried out depending on the type of organisation, type of work, external and internal constraints, etc. This decision must always be based on a consensus within the group
- **Defining needs**. Who will decide what to produce? How much to produce? In our present system, human needs are subordinate to the needs of private gain. This fails to benefit everyone equally and conceals and/or overlooks the

fallouts. Ideally, needs must be defined and articulated by the community, based on an assessment of productive capacities, resources available, willingness to work, possible fallouts, etc. Planning and budgeting must be participatory and not centralised

- **Leisure**. When work is organised to fulfil needs and not for maximising gains, a great deal of time will be available for all to pursue some of the most important pleasures that life has to offer

5.7 Conclusions

It is important to mention here that these recent developments are far from comprehensive, but there are important fragments that can form the basis for many interesting possibilities in other fields. This chapter has outlined a possible research area for designers, and several compelling questions have been framed. In this crucial period of our history, we may need to ask elementary questions to be able to receive profound answers. We may not yet know enough about ourselves, but we have a few clues and scraps of knowledge from where we can begin. All round the world, innumerable people already live in ways that enrich themselves as well as others, and it is up to us to learn from them what is most essential. Philosophers and moralists have expounded for centuries that benevolence, sympathy and cooperation are the only means by which we can secure the well-being of all; these ideals are not impossible to attain, they are very much a part of 'our common nature', and they have always been. Our task is to build institutions that foster these ideals and diminish tendencies that are destructive, and in an age when our destinies are intricately intertwined and our prospects grim, this is an urgent task indeed. The design community may have a crucial role to play, in relation to an approach oriented to stakeholder interaction design for socially and environmentally sustainable outcomes.

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Section 2

New Perspectives on Sustainable PSS in Low-Income and Emerging Contexts

6

PSS in waste: lessons from the Indian informal economy

Amrit Srinivasan
Department of Humanities and Social Sciences, IIT Delhi, India

6.1 Introduction

The environmental impact per capita in India, despite its recent high rate of growth, it is well recognised, is much lower than that of the industrialised nations. This is largely because of cultural observances and practices relating to waste recycling in particular (GOI 2007), historically presumed on specialised services provided by the most despised sections of society. In India, therefore, the informal sector in solid waste management provides a very important test case for PSS, the design innovation that seeks to address the diverse needs and satisfactions of all stakeholders concerned. Not only industry but also householders, traders, municipalities and the poor, marginalised waste worker must achieve 'satisfaction' if the PSS design focus spelt out by UNEP in 2002 is to be achieved from within social tradition itself.

In India, the adoption of sustainable practices in waste did not call forth the high personal, social and transaction costs they did in the West (Power and Mont 2010), precisely because of the mediation by the informal sector. The urban poor in India have been providing 'invisible' and cheap waste services to society at large for a long time, at huge *human* cost, of course. As a result, despite the vast numbers involved, Indian consumption habits do not add up to those of the rich, industrialised nations, today perceived as pre-eminent Polluters. The widely held view current in sustainable design thinking and practice that 'poverty leads to pollution'

is not true for India. The absence of large-scale technologies and tools in India for the treatment of waste is only part of the picture. In actuality, informal solid waste management (SWM) and all its associated activities—collecting, sorting, lifting/carting to storing, recycling, marketing and even manufacture—has made a huge historical contribution. It is the social discrimination faced by Indian waste workers that has led to a completely biased perception of SWM and under-assessment of this contribution. The long-standing indifference and apathy to SWM, even within the professional design community, testifies to the powerful social stigma that attaches to the handling of waste in Indian society.

The National Institute of Design (NID) was created in the 1960s, not within any university framework but consciously under the charge of the Ministry of Industry, to set the trend for design education as a servant to industrial development. The informal craft sector was certainly picked up for particular scrutiny, given the role of *khadi* (handspun, handwoven cloth) in the Indian freedom movement's history and the existence of a large number of institutions focused around village development. But isolation from the multidisciplinary context of a university education left the design curriculum theoretically bereft in the methodologies needed, to give support to the frequently voiced commitment to social and economic development.

By contrast, in industrialised countries, solutions to the design 'problem' of municipal solid waste (MSW) improved only when they were established as a top educational and political priority, based on the recognition by all involved, the ordinary citizen included, of the health and environmental hazards of improper handling of waste. This did not happen in India where the socio-cultural attitude to waste coupled with the easy availability of traditional services in waste militated against a formal, educational and political involvement. All recent efforts in recycling have consequently been largely uninformed by professional design experts, trained to take stock of local knowledge and action and to motivate citizens who are well aware of the ill-effects of poor waste practices but feel helpless to do anything about it. The difference in density, moisture content and size-distribution of waste material in India has of course involved the engineer and designer to train in the adaptation of industrial technologies, largely developed in the West, to local conditions. But their contribution has been least concerned with the socially significant sectors of waste recycling, involving the planned collection, segregation and storage strategies more important to PSS thinking.

Today, the informal economy's near total 'invisibility' in official records, and hence in the economic welfare policies put forward by the state, is slowly being recognised and attempts are being made to rectify the statistical gap in public documentation and research dealing with this vital sector of the Indian economy (Sengupta 2009). Within design methodology itself, PSS innovation is moving beyond product Life Cycle Assessment of environmental impacts to social and economic ones as well. This is in keeping with its ambitious aims—to transform entire cultures of human consumption, not just industrial production alone. Clearly, when dealing with municipal solid waste in India, a larger role is foreseen for sociology and economics in achieving PSS goals.

Today, when waste has 'become gold' worldwide, the design scenario in India is very different to what it was at the time of the setting up of NID. The best business minds are deeply concerned with enhancing waste's value while reducing its long-term environmental costs. As corporate solutions, these remain however largely technology and industry or product based. It is NGO and civil society involvement with MSW that has focused more on labour conditions of waste work on the one hand and how to bring about behavioural and attitudinal change in human consumption on the other. Neither however has any use for professional design and even less for PSS design, which could bring the two approaches together, through a willingness to deal with the informal economy in waste.

6.2 The waste pyramid

Quite clearly, PSS design goals of social equity cannot ignore the highly structured, pyramidal aspects of the informal waste service and trade sector already in existence in India. Though officially denied, the informal sector's involvement with waste is by no means parasitic or peripheral but presumes a long-standing partnership with the municipality in all activities from collection, segregation, lifting/carting to storing, recycling and trading in waste. Case studies testify to the comprehensive scope of this partnership and the informal sector's varied skills and services which have enabled diverse work arrangements—ranging from the lowliest of livelihoods to the most lucrative of businesses (Gill 2010; Chikermane, Deshpande and Narayan 2001; Snel 1999; Galloway 1993). Large-scale transportation and treatment of waste alone has remained exclusively in the municipality's purview.

An early study by Chintan, an NGO in Delhi, informs us that the average daily collection of waste by a rag picker is about 25–30 kg/day. About 125,000–130,000 kg of waste is collected and sold by rag pickers in only two zones of the Delhi Municipality. Annually, the contribution of the informal sector to the municipality is as much as 200–260 million rupees (Chintan 2003, 2007). And yet it has been rendered 'invisible', abandoned not only by official statistics and policy plans but by mainstream design practice and pedagogy as well.

At a time when rapid urbanisation and resource crunch has crippled municipal bodies everywhere in the discharge of their statutory functions, PSS design thinking has a major role to play in recognising the informal economy in waste as an important source of material and human capital. Under pressure from unplanned urban growth, official bodies, it is well known, are handling only about 30% of waste services (UNCHS 1994). In the National Capital Region of Delhi alone, municipal bodies are unable to clear all the waste that the city generates. A spokesperson for the NGO The Indian Pollution Control Association (IPCA), set up in 2001 by students and project staff shortly after being involved in the Campus Recycling Programme at the IIT Delhi, claimed in their mission statement that only 62% of waste generated in Delhi was being collected by the municipality. The rest of the waste

handling was being done by rag pickers who collect, sort and transport waste free of cost, as part of the informal trade in scrap, saving the government a large amount of money daily. A spokesperson from the Government of India, Ministry of Urban Employment and Poverty Alleviation at a *jan sunvai* (public hearing) organised by Chintan in Delhi in 2004 acknowledged that as much as 90% of employment in India today is in the informal sector with about 59% involved in waste alone.

The Indian scenario in waste services, and other like cases from the emerging world, seem to lie behind what the ILO and the World Bank have advocated more generally—an increased complementarity of the formal and the informal sectors, through ending discrimination and criminalisation of the latter (ILO 2001; World Bank 1999). And indeed, right after UNCED (United Nations Conference on Environment and Development) which took place in Rio de Janeiro in 1992, Agenda 21 programmes for minimising waste, for waste re-use and recycling, for ecologically sustainable waste disposal and treatment and for greater waste service coverage had begun looking not only at the environment but at informal community participation and livelihood issues as well.

Given this complex structure of interrelationship and exchange, it is important for PSS design interventions in waste to keep the interests of different components of the informal sector in mind. Today, for instance, privatisation threatens the livelihood needs of the waste-pickers the most, who constitute the lowest segment of the informal sector. Significantly, even PSS 'best practices' encouraging the involvement of urban residents in segregation and recycling end up hurting this section the most, because it usurps their monopoly over household waste.

Then again, official intolerance and citizen apathy and ignorance, however inadvertently, have combined against this segment in particular, already the most vulnerable to disease and police oppression. The informal waste sector's very lack of organisation keeps it permanently open to infiltration and association with marginalised, migrant communities who seek employment arenas marked by ease of entry into the lowest strata of the economy, irrespective of the social stigma attached. This makes them easy targets for state oppression.

The possibility for direct family involvement, further, makes waste picking attractive to the base of the pyramid, or the very poor, because it provides some income even to the women and children of the household. The next level in the pyramid, the waste-buyers who are itinerant, also include both men and women but they specialise in buying and selling different kinds of waste and their life conditions are consequently much better. Next in the hierarchy come the retailers, stockists and wholesalers, with an increasing degree of earnings from waste and a greater involvement in their work by the middle class.

The top of the pyramid, finally, made up of re-processors and registered dealers in waste, though often licensed and part of the formal sector, rarely own up to the responsibilities and regulations of the latter. Blatant disobedience to the various legislations covering the Shops and Establishments or the Factories Acts of 1948 is quite in evidence here (Anand 2001). There is a complete absence of institutional credit facilities. Small-scale or family-owned enterprises predominate in some

segments but women as also lower castes are universally absent as entrepreneurs, though they may work as hired labourers. Entry to the trade is highly restrictive and internal mobility from waste-picker or retailer to dealer or re-processor is totally absent.

The money to be made through informal waste handling services, though varying tremendously from level to level, keeps it a vibrant option for many, in spite of the prejudices associated with what continues to be seen as 'dirty work'. The lucrative possibilities at the higher end often attract people to this sector from regular salaried professions such as management, banking and even stockbroking. Indeed waste-handling or *kabari* in general is seen as a 'win–win' situation in PSS terms, providing satisfaction for everyone in the cycle: households get rid of their trash and pay lower prices for goods made from recycled material. Waste-pickers, buyers and retailers earn a living (from a few hundred to 20,000 rupees or more per month), in a segment that continues to remain open and has room for newcomers and migrants to the city. Factories pay less for re-processed materials, and the nation gains by not having to spend foreign exchange reserves on imported wood-pulp and plastic resins (Galloway 1993).

6.3 Social equity in PSS design for waste

To enhance awareness of PSS in the design community, research on MSW must incorporate all the structural elements of 'satisfaction' of major interest groups or 'stakeholders' in the field. There can, for instance, be no satisfaction for the poor waste pickers when the government provides solutions for their organisation and upliftment, such as the issuing of legal identity cards, social security and the like, without at the same time acknowledging 'recycling' officially in the municipal charter of activities. Equally, the waste solutions offered in collaboration with the technocrat and the corporate manager are incomplete if the satisfaction generated by the municipality does not include the informal economy operating on the ground.

The partnerships (*bhagidari*) initiatives being promoted today between the municipality and the corporate sector on the one hand and the unorganised sector on the other cannot be presumed upon a model of formal-informal alignments *in the abstract*. Nor can socially responsible PSS design, in the search for solutions, hope to wait until appropriate legal structures relating to wider community involvement with MSW are in place. Without exaggeration, there is great need to examine and observe what is actually happening on the ground in people's lives and living spaces in the field of MSW before intervening professionally. It is here that sociology and the methods of ethnography and participant observation in particular can inform PSS design pedagogy and practice to great advantage. The normative focus in design education has been so far fed by technology and management economics inputs—neither of which have yet found it possible to come up with a holistic solution to the problem of waste. At the methodological level, sociology with its

focus on: 1) concrete and everyday household and community practices; 2) the larger cultural discourse surrounding things or objects; and 3) the documentation of actual, not ideal, citizen attitudes, behaviours and practices, can help PSS design set socially responsible and equitable goals in its research solutions for waste. It can also enable a critical examination of the alignments already taking shape, between the informal and the formal sector—both corporate and municipal.

6.4 PSS and the privatisation issue

The plans for a greater 'privatisation' of MSW management in India so far only extend to the corporatisation of waste services, to the exclusion of the household and the informal sector. The flexibility, viability, comprehensive scope and self-sufficiency of the informal sector is not being allowed to contribute officially. The Municipal Corporation of Delhi's (MCD) handing over of the rights to waste and to waste-related functions to private contractors has in fact largely worked against the informal sector. The private sector ruthlessly protects its terrain. Waste collection by rag pickers within its boundaries now comes at a price, with a fee having to be paid to the contractor. Equally, the municipality's charter of activities continues to include only 'sweeping' of waste by municipal employees, 'collection' of waste in *dhalaos* or storage areas built by the authorities, 'transporting' of waste in municipal trucks and the 'land-filling' of waste in approved public sites. Nowhere is 'recycling' or 'trading' mentioned, which automatically excludes the rag picker and the *kabari-wallah*, ubiquitous on any urban street of India.

Equally, on the ground today, only large-scale transportation and treatment of waste remains in the exclusive purview of the municipality. And yet, the formal rules regulating MSW in India, Municipal Solid Waste (Managing and Handling) Rules (GOI 2000), by their very nature, presume a division of private from public space, unauthorised slum from official colony, *safai karamcharis* (municipal staff) from lumpen rag pickers, household residences from commercial establishments and the like. Such conceptual divisions do not reflect realities on the ground. In more ways than one, the official and the informal spaces are already merged. The *dhalao* encroaches on the street where rag pickers sort and segregate the waste; the slum becomes an informal *dhalao* when its living space is used as an unauthorised waste-collecting and sorting zone. The municipality worries about 'illegal' and hazardous recycling going on in urban areas but does not, quoting existing rules, allocate city space to the rag pickers who are otherwise substantially contributing to its public duties. For similar reasons, it *officially* collaborates in MSW only with the corporate, not social sector, which is seen as parasitic or peripheral to city governance. PSS design with its focus on satisfaction can re-orient official planning to take account of the arrangements, primarily in recycling, already existing between individual urban households and informal service providers, from *within* the social sector.

6.5 PSS and the political economy of waste recycling and re-use

PSS Design goals seeking to integrate formal and informal practices in MSW cannot hope to ignore recycling and re-use, for the quantum of satisfaction it can produce in the micro-social arena—the household and community—even while reaping macro, economic and environmental dividends. On the human capital plane, recycling has high potential for employment generation for the city's poor. For maximum effectiveness, however, all recycling programmes need to be presupposed on segregation and even reduction and treatment of waste at source, that is, the household. Ideally, not only should this improve the quantity and quality of resource recovery but it should make work conditions for the rag pickers less hazardous and less stigmatising, leading to a rise in their social and self-esteem. In reality, however, given deep-rooted cultural habits and prejudices in relation to the 'handling' of waste, segregation at source has not achieved much success in the Indian community and household. Equally, one can predict that the moment the resource value of waste is enhanced, it will certainly not accrue to the lowly waste-picker. Either the urban household or the private corporation will siphon off its benefits before the rag picker even gets to access it.

The existence traditionally of a separate, degraded section of Indian society 'specialising' in waste and waste services has led to a stigma being attached even to household members handling kitchen refuse. It is the domestic servant whether live-in or working part-time who is left to perform this task. At the public, street or municipal level, it is predominantly the Dalits (the erstwhile Untouchables of the Hindu social order who were considered polluting and dangerous to mix with, not only clinically but ritually, as well) who continue to perform waste activities. Indeed, the state policy during colonial rule to introduce municipal scavenging as a 'caste-based' quota created an Untouchable monopoly over the job (which now carried a salary) while removing their existing right to its commercial benefits through the sale of waste.

Even after independence, these official positions remained highly politicised along caste lines and fetched a great deal of money for the middleman responsible for distributing official benefits without any concern for improving Dalit living conditions or indeed their conditions of work. This inverse sense of monopoly over a degraded task also acted as a strong disincentive for the decentralisation of waste services. Segregation at source and the involvement of the informal sector in community recycling activities is today often violently opposed by the exploited Dalits who want to prevent 'outsiders', whether the urban middle class or the urban poor, from taking on work they see as their employment guarantee. Even within the municipality, waste services seen as official and secure are attracting higher caste people to the job, never mind the traditional stigma. This has also threatened the *safai karamcharis*. Indeed, the increase in market earnings possible now through

the illegal pilfering and sale of municipal waste has made the opposition to outside involvement often turn violent.

6.6 PSS promotion and cultural perceptions of waste

Many NGO or non-governmental initiatives in the field run awareness-raising programmes in order to break the vicious cycle between what are essentially two opposed and ranked cultural perceptions of waste in India: one largely shared by the urban middle class which sees waste as not their concern, and the other almost exclusively prevalent among stigmatised sections of the population, which sees it as their historical monopoly. The changing of deep-seated prejudices and habits in this regard is an effort located primarily at present in the non-governmental sector (Soumitri 2002; Prasad 1998). But there is room and need for a commitment on the part of the design community as well, which in India, for historical reasons, has for too long supported industrial solutions alone. An examination of the actual activities around which these cultural historical tensions surface among the various stakeholders in civil society is useful for concluding our understanding of PSS design potential in India.

6.6.1 Collection

Collection is lifting of waste from different collection points such as dustbins, households, community *dhalaos* (open bins) and open dumps. Officially littering is prohibited, but in India it has becomes the responsibility of the waste generator to ensure proper collection of garbage from the household, commercial enterprises, industries, and hotels for disposal. Everywhere, collection of waste from door-to-door is primarily done by the informal sector. Scavengers or waste pickers, as they are preferably called, fall at the bottom of the economic activity pyramid. Many of them whether men or women belong exclusively to the lower castes and marginalised categories of society. These people do even the cartage of waste to local community collection points and segregation. Sometimes the municipalities or Resident Welfare Associations (RWAs) provide hand driven carts or other small vehicles for this purpose.

Itinerant waste buyers (*kabari-wallahs* or *-wallas*) also aid in the collection and segregation of waste by buying from the household or other waste generators. They are fewer in number than the waste pickers, usually male and move around on bicycles. Contrary to popular belief waste pickers and buyers have specific beats, much like policemen. They establish 'territorial rights' over bins, dumping sites and beats. Squabbles over infringement of these 'rights' are not uncommon but entry continues to remain fairly open (Narayan and Chikarmane 2000). The

collection frequency for municipal solid waste in densely populated Indian cities is often every day or every other day, because of the hot climate combined with limited storage space (in homes or in neighbourhoods) and the high putrescible content of waste. Equally, average particle size of the solid waste in India tends to be significantly smaller than in industrialised countries, making many modern methods for resource recovery, which rely on size reduction as a preliminary step, often inappropriate. Given that informal services in collection are already available, there is no need for hi-tech alternatives in India with their high energy and raw material costs. The involvement of the private, corporate sector, though miniscule, is becoming more common in the activity of collection. But it is unfortunate that it does not choose the PSS way of organising the existing service sector better and instead sets up a parallel workforce.

6.6.2 Segregation

Municipal solid waste in India falls into certain broad categories in which the commonly separated items are listed below.

- **Glass and porcelain**. Bottles (both whole and broken), window and door glass, porcelain crockery, and glasses
- **Papers and paper products**. Newspapers, magazines, books, writing papers, paperboards and cardboard boxes
- **Plastic products**. Containers for oils, toiletry products and cosmetics; plastic bags; sheet plastic; pipes; toilet seats; and cement bags
- **Metals**. Iron and steel, aluminium, copper, and tin containers (whole and damaged)
- **Textiles**. Curtains, clothes and tapestries, and textile mill wastes
- **Rubber and leather items**. Tyres and shoes
- **Bones**. Dead animal carcasses, slaughterhouse waste, and hotel and restaurant wastes
- **Woods**. Broken furniture and garden waste
- **Other organic waste**. Kitchen wastes, vegetable wastes, and garden trimming wastes
- **Construction debris**. Brick and concrete rubble, iron and timbers (UNCHS 1994: 3-6)

Segregation into organic waste and recyclables is done primarily at four levels—at source, at communal bins, at transport vehicles and at dumping sites. And though it should ideally start from the household for a successful and effective waste management plan, at present it remains, for the reasons outlined above, an innovative and unacceptable idea for most Indians. The efficiency of door-to-door waste

collection consequently is not particularly good. Besides, the work conditions of scavengers/waste pickers who rummage for hours in the community garbage collection areas are appalling, posing great risk to their health. A certain amount of 'pilfering' of waste also occurs by municipal workers from official storage areas or transport vehicles, which is then sold illicitly to augment their low wages. It is over this area of privilege that the most violence occurs against the itinerant rag pickers, at the hands of the municipal staff and the local policemen. Given the huge loss in transport vehicle time and in working hours, this illicit activity entails a huge loss of revenue for the authorities, over and above the resource itself.

Itinerant buyers of the waste or *kabari-wallahs* also assist in the segregation of waste. The scraps they collect are usually of better quality and market value than that collected by waste pickers. The scrap is sold by weight to retail traders, usually having their premises in slum areas. None of these establishments comes under the organised sector. It is further sorted and graded as it moves progressively through various trade channels till it reaches the re-processor or the end user. Value addition takes place with each successive transaction.

6.6.3 Storage

Households in India rarely store waste because of cultural taboos and also because of the price different kinds of waste fetch in the market. The itinerant *kabari-wallahs* buy the waste, separate it and supply to the retailers and stockists. Many unauthorised colonies and 'slums' reflect the activity of unofficial segregation and storage of waste spatially. Scrap trade being completely unregulated, scrap stores operate from encroached space in slums but only very large establishments are licensed under the Shop and Establishment Act. However, no receipts are issued for cash transactions with scrap collectors and it is doubtful whether any tax is being paid. The scrap market is subject to seasonal price fluctuations and influenced by the dumping of scrap and import from industrialised countries. The larger traders very often purchase directly from industry, institutions and commercial establishments.

Technically, any valuable waste left or stored in the space provided by the municipality belongs to them and cannot be vandalised. The reality, however, is that unofficial and/or illicit recycling activity has already removed most of the commercially significant waste by this time. The rest is scavenged at great risk by the lowest rung of waste pickers at municipal collection centres and at landfill sites. For the most part, it is only biodegradable and 'value-less' waste (for the ordinary citizen) that finally finds its way out of the municipal storage area. Indeed, for these very reasons, the municipal authority does the entire transportation of waste from local bin to storage area and then onwards for treatment.

The responsibility for clearing waste not wanted by anyone else commercially invests the municipal sanitary worker with a major source of power over the local population. Dirty streets and uncleared bins become potent means of pressurising local governments, as well as the public, by an official stratum forced to live on the edge of respectable society but given political 'protection'. Since the supervisory

and higher staff are often from the educated, upper-caste middle class, municipalities are often at the mercy of their own workforce. Storage areas are not cleared on time and are often surrounded by dumped garbage because the facility does not take into account quantity of waste generated in the area, population density and ease of access.

6.7 Conclusions

The PSS relevant recycling of solid waste by the informal sector, this chapter has argued, is already going on in most Indian cities. However, the national and local government and the community are not deriving the full benefits of recycling and re-use that are available. Key reasons and conditions are listed below.

- There is a lack of incentives for households to separate recyclables at source, given that in cities in Asian emerging countries, charges for waste management services are very low. The informal economy is one of the reasons for this as well as the low community responsibility operating in India. The cultural factors hindering separation at source also prevent full recovery of recyclable waste and economic recycling
- There is reluctance of municipalities to work in partnership with the informal sector engaged in solid waste recycling (often the authorities consider that the activities of scavengers spread litter, create a nuisance of odour and interfere with their operations and therefore they believe the informal sector should be discouraged)
- There is inadequate support from local authorities or Resident Welfare Associations for scavengers and itinerant waste buyers for upgrading their working conditions. The historical discrimination faced by waste workers lends complexity to the promotion of larger public involvement in SWM
- Design education campaigns working closely with NGOs and municipalities or indeed even the public are non-existent or inadequate

These constraints and paradoxes prevent full realisation of PSS benefits and must therefore be taken into account in Design for Sustainability projects that address solid waste management in these contexts.

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7

Sustainable Product-Service Systems in the informal economy of poor urban contexts

India and the case of press workers in the clothes care system in Delhi

Parveen Pannu
Institute of Home Economics, University of Delhi, India

7.1 Urbanisation and rising poverty in India

Urbanisation is the most dominant social transformation of our times. Urban settlements are centres of non-agricultural production activity, which absorb the population rendered surplus in the rural areas. The 20th century witnessed a rapid growth in urban populations: an unprecedented exodus of rural population towards urban centres. The next few decades will continue to see an unprecedented scale of urban growth in the emerging world including the continents of Asia and Africa.

According to Sarin and Jain (2009) India is an increasingly urban country, with over half a billion people expected to live in towns and cities by 2020. India's urban population is also increasing at a faster rate than its total population. And like other emerging countries, India has largely been unprepared for this influx of population in urban areas. According to the report 'India: Urban Poverty Report 2009', with

over 575 million people, India will have 41% of its population living in cities and towns by 2030 from the present level of 286 million and 28%. There is need for more inclusive planning of cities and towns and to understand urban poverty as a phenomenon beyond the overflow of rural poverty and to evolve a national strategy for the urban poor. The pace of urbanisation in India is set to increase, and with it, urban poverty and urban slums, despite 62% of GDP now being generated in towns and cities. Aiyar (2009) points out that Delhi is one of the five states in India having an urban population of over 50%.

7.1.1 Micro-enterprises of the urban poor

Most urban poor work in micro-enterprises that provide self-employment for themselves and some family members. For the vast majority of the urban poor, informal activities are the only way to earn a living and survive. Micro-enterprises are businesses with five or fewer employees supporting households in emerging nations and are a critical part of their economies. The majority are simply self-employed and often struggling to get by, and will never grow their businesses into larger enterprises (Mead and Leidholm 1998).

The range of economic activities is vast in the informal sector in urban India, and providing ironing services constitutes an important micro-enterprise in the informal sector. It is a labour-intensive and service-oriented occupation: i.e. a service business that involves rendering an essential service to the customers.

Figure 7.1 **Press worker ironing clothes with a heavy laundry charcoal iron**
Source: author

There is great demand for ironing services, evidenced by the presence of press workers in almost every street in the city of Delhi. It is a traditional, caste-based family occupation in which men, women and children share responsibility.

Dhobis and press workers (commonly called *presswallas*) have long been an integral part of India's urban economy. To an ordinary resident, *dhobis* and press workers appear indispensable to urban living. One finds a 'press man' at the end of each suburban street in Delhi with his table and charcoal-heated iron (Sharma 1986). It is apparent that India's vast middle class likes to get its clothes ironed due to the enormous burden of household chores. Moreover, it can be said that the middle-income group requires a large number of clothes due to busy work schedules and weather conditions. Therefore, requiring an ironing service has become an essential part of the Indian cultural ethos.

The ironing business depends greatly on personal contact and goodwill. Majumdar and Lall (1992) report that overall it is notable and commendable that entrepreneurs in micro-enterprises, without the aid of professional education, have been able to carve out a niche for themselves in the competitive markets of metropolitan cities and that the market has its own self-correcting mechanism with the result that only the financially viable units eventually survive. If the units have faced a hostile environment and have survived, this only goes to indicate that these units can grow faster and perhaps do better in a more favourable environment. Some of the enterprising *dhobis* have set up modern laundries and dry cleaning shops where customers avail themselves of these facilities (NIUA 1991). These ironing establishments have originated with the entrepreneurs' own efforts and have been surviving on their own merits.

The ironing enterprise in the urban informal sector may also represent survival activities at the margins of society. With the advent of new, sophisticated household technologies such as washing machines, *dhobis*' traditional work is declining and the majority of the *dhobis* have taken up only ironing in urban areas thereby adapting themselves to change with the times (NIUA 1991).

Delhi, with its vast opportunities for a wide section of people to earn income, provides an ideal setting for studying the social and economic lives of the press workers and evaluating the micro-enterprise of ironing. This chapter draws attention to the role of press workers as entrepreneurs and the role of the products in the PSS such as mobile phones in the micro-enterprise of ironing in the informal sector. While there is much anecdotal evidence on the ways mobile use can improve the social and economic status of poor people, there is little systematic evidence on the benefits of mobiles for these groups. There is a need for better understanding, organisation and advocacy of the issues that confront the informal sector workers and the role of mobiles as ICTs, in their quest for higher income, improved working conditions, social security benefits and additional employment opportunities, leading to greater social and economic justice and development.

7.2 Profiling the press workers of Delhi

In such low-income contexts, PSS development presents a potential for generating win–win solutions that promote profit, environmental and social benefits (UNEP 2002). PSS strategies rely on existing technologies and socio-cultural contexts; this section therefore describes the conditions of the press worker himself in order to demonstrate where and how system Design for Sustainability may have a strategic role in strengthening such an enterprise.

This section is based on an empirical study of 200 families engaged in the micro-enterprise of ironing in different parts of Delhi. The data was collected through a survey, interviews, observations and discussions in 2009. The purpose of the study was to gain an insight into the press workers' economic activity history, work patterns, enterprise management, intra-household relationships including the role of women and children, and quality of life in running the micro-enterprise of ironing.

7.2.1 Profile of a press worker

Job summary

It is a (family) micro-enterprise that provides ironing services to the vast middle-income population in urban areas. In addition to the ironing of clothes, this includes collection of clothes from different houses, ironing and delivering the ironed clothes to the respective houses in exchange for money on already fixed rates. The type of work is manual, tedious and extremely uncomfortable in Delhi's hot summers, where temperatures reach 48º Celsius. There are thus problems of working in the open in the street.

Migration and residence

Most press workers have migrated to Delhi, especially from the northern states such as Uttar Pradesh, Haryana, Himachal Pradesh, and Rajasthan. The factors causing migration vary from family to family and are determined by the socio-economic system. The motivation is to seek better income and job opportunities and also to overcome the deprivation of their traditional social environments.

The reasons for migration of the press workers have been:

- Inadequate income and poverty at home (38.7%)
- National calamities, social ills such as communal violence (4.2%)
- Opportunities for employment in the city (28.2%)
- Acquaintances with primary migrants (19.8%)
- Fascination for the city (4.9%)
- Miscellaneous (4.2%)

Twenty-nine per cent of all the families have resided in Delhi since birth; that is, they were born and brought up in Delhi. The remaining, about 71% of families, were migrants to Delhi for durations of less than 1 year to more than 15 years.

Time devoted to work

Press workers were devoting 8–10 hours (the whole family together) for ironing of clothes every day.

Equipment

Two types of iron were being used: laundry charcoal press and the industrial electric iron (900–1,200 Watts). The charcoal iron weighs about 6 kilograms and the industrial electric iron about 7–8 kilograms. The heavy weight of the charcoal iron makes the work extremely fatiguing. There is also a need to impart more knowledge about the fabric on which they are applied.

Type of dwelling and availability of basic amenities

The sample families were residing in dwelling units such as *jhuggis* (thatched kutchha huts), 66%; flats for economically disadvantaged groups, 9%; one-room rented accommodation, 10%; and accommodation given free by the landlord, 21%. A large percentage of the families did not have basic amenities such as drinking water, lighting, proper housing and private lavatories, and the vast majority had to use open space for defecation.

Location of the business

The business is located mainly in the residential areas and the location is of strategic importance since door-to-door service is the very essence of this profession.

Caste

It was found that all the press-workers were *dhobis* by caste.[1] In modern India, caste discrimination has reduced in recent decades due to government initiatives such as the quota system, free education for the underprivileged and other social reforms. It

1 The caste system in India is complex and has a long history dating back to the ancient past. It is a composite structure of different social classes in the Hindu religion. There are four main castes: *Brahman* (teachers, scholars, priests), *Kshatriya* (warriors), *Vaishya* (agriculturists and traders) and *Shudra* (service providers and artisans), as well as the *Dalits* ('untouchables'). There are hundreds of sub-castes for each of these. *Dhobis* belong to the upper sub-castes among *Dalits*. The *Dalits* or 'untouchables' are the lowest caste. They have the lowest social status and work in unhealthy, unpleasant or polluting jobs. They have been subjected to extreme discrimination, segregation and poverty.

has also been outlawed in the constitution. Caste barriers have mostly broken down in large cities, though they persist in rural areas where 72% of the population lives.

Figure 7.2 **Press workers' operating environments**

Source: author

Composition of the family, education and training

In the 200 sample households (families) engaged in the micro-enterprise of ironing, there were 33% adults, 47% adolescents and 20% children, altogether 52% males and 48% females. A total of 82% were nuclear families, 15% extended families (comprising more than one married couple or a nuclear family plus other adult relatives of either husband or wife), and 3% sub-nuclear families (comprising households that do not include a married couple: i.e., households with a widow, widower, divorced man or woman; one consisting of a group of unmarried siblings; or an assortment of men related by kith and kin which includes relatives, friends and co-villagers). The majority of the family members were found to be illiterate, and there were more illiterate women than men. They were undertaking 'on-the-job' training since it is a traditional caste-based activity.

Responsibilities of women and children

Women workers have triple responsibilities: looking after the household (as a wife and a homemaker), the children (as a mother) and as a press worker in the ironing unit. Nearly 60% of the women involved in ironing, despite the arduous physical work, had to do their household work on their own without any assistance from other family members. Four out of ten even had to do shopping for their day-to-day needs by themselves.

All these factors clearly reflect on the poor quality of life they and their families lead. Women workers in the family enterprise cannot account for their monetary contribution individually as two or more family members work together and the amount of labour they put in often varies.

Though the ironing enterprise is a family profession, the neglect of infants and young children was found to be less as all the family members were working together.

Secondary occupations

It was seen that along with ironing, the main occupation of the family members, some of the family members were also involved in secondary occupations which could be either related or totally unrelated to ironing. Most families' (70.5%) major occupation was only ironing. In the remaining number of families, about 20% of households were involved in related business activities such as starching. It was also found that such activities were undertaken by menfolk, while the women members were doing ironing at the enterprise level. Eight per cent were found to be involved in washing clothes, mostly performed by women members of the sample families.

7.2.2 Activities in the ironing enterprise

The major activities undertaken during the beginning and the established stages of the ironing enterprise are listed below.

Phases and sub-phases in the beginning stage of the ironing enterprise:

- Resources for investment
- Selection of premises
- Market considerations
  - Market size
  - Market potential
  - Pricing of services
- Maintenance of the market
  - Adequate supply of services
  - Good quality of services
  - Dealing with competitors

Phases and sub-phases in the established stage of the ironing enterprise:

- Ironing of clothes
- Collection and delivery of clothes
- Buying coal, kerosene oil, match box, etc. for charcoal iron
- Maintenance of electric press
- Maintenance of relationship with customers, relatives, union members

Records and initial funds

It was realised that the majority were keeping only mental records and awareness about bank facilities was limited. It was also found that the initial funds for the business had been raised through their own funds.

The finance cycle

The finance cycle in the ironing enterprise is understood as a step-by-step process that begins with the entrepreneur in the ironing unit who conceives the business idea and invests in various resources. A pool of funds is generated with the family's own as well as borrowed funds to create assets and bear expenses. The actual sale of their service of providing ironed clothes to their customers earns them profit.

The finance cycle thus entails the following:

- The entrepreneur—the press workers in the ironing unit
- His/her business idea—the ironing enterprise
- Investments—the selection of space and location, iron, ironing table, etc.
- Business pool of funds
- Borrowed funds
- Assets
- Expenses
- Sales of service
- Profits

7.2.3 Availability of goods and conveyance

It was found that 87% of the families owned a transistor/radio, 42% a black-and-white television, 40% possessed a fan (table or ceiling type), 37% a pressure cooker, though not all were using it as a pressure cooker but simply as a pan, 7% possessed a room cooler and 3.5% even owned a colour television. These findings indicate that the business is viable.

A very large majority, i.e., 93% of the sample households, owned a bicycle and used it as their personal mode of conveyance; 1% of the households possessed a two-wheeler scooter; 0.5% of households had a three-wheeler scooter for commercial purposes; and 5.5% of the households did not own a bicycle and therefore had no conveyance.

A total of 67.5% of households were found to be phone 'user' households (27 households owned two phones, i.e. more than one phone) and 32.5% were 'non-user' households (households not possessing a mobile phone).

7.2.4 The ironing enterprise and its environments

The ironing enterprise consists of various subsystems: the household unit consisting of workers, the self-employment unit of ironing representing the work of providing ironing services, and the clientele unit representing the demand for their work at the customers' end.

The self-employment sector is a useful concept for the analysis of the process by which employment is created by individuals and the institutional and policy environment that conditions the process. The position of the ironing enterprise is shaped by the larger environments: the physical, policy and the socio-cultural environments. These environments affect the present strategy and the future environment for continuity of the ironing enterprise system.

- **Physical environment**. Consisting of climate, season, temperature and infrastructure
- **Policy/institutional environment**. Consisting of government rules and regulations, policies, legal and political framework, research and extension, support services
- **Socio-cultural environment**. Consisting of caste, community, religion, culture, values and tradition

7.2.5 Challenges faced and aspirations of the press workers

The challenges faced by the press workers reveal their micro-enterprise to be under constant pressure:

- Scorching heat especially in the months of June and July was extremely difficult to bear while ironing
- Lack of facilities at place of work
- Unhealthy competition with fellow press workers
- Lack of customers (in a few cases)
- Vending ironing services in the street being illegal, it caused them much harassment and to escape it they often resorted to bribes

The insight into the aspirations and the expectations of press workers and their families showed that they have high aspirations for themselves and their children.

- The majority, i.e., 72.5% of the families, reported an increase in their economic status in the city of Delhi and 63% of the sample families perceived a change towards better living conditions, i.e. better access to essential basic services of water, housing and food
- Enquiries regarding the preferred method of livelihood revealed that 54.5% wanted to continue the self-employed business of ironing and 22% preferred a permanent job in government service in the formal sector. Another 16% showed their preference for a business such as dry-cleaning

Future aspirations for their children

They were considering better opportunities of employment for their children. On being asked about aspirations for the future prospects for the method of livelihood for their children, it was found that:

- The majority of them, 42.5%, wanted them to continue the ironing enterprise which is the traditional form of income earning by the sample families. They felt it offered enough scope for development
- A very large percentage of families, i.e. 32 %, wanted a job in the formal sector, a stable and secured government job. For this, they were giving education to their children as all of them were found to be attending school
- 10% wanted an ironing-related business such as a dry-cleaning business
- 4.5% wanted to shift to some other skilled job
- 11% expressed no opinion

7.3 Sustainability of this unique Product-Service System

The enterprise is keeping the three Product-Service System axes alive. These are the Planet (the environment component), Profit (the economic component) and People (the social component).

The enterprise is a family, caste and profit-oriented service owing to the various factors mentioned below:

- Low establishing and operational costs
- Low maintenance cost for tools (press, charcoal, electric fitting, ironing table, bicycle, etc.), responsibility for products (the ironed clothes), responsibility for materials and work in progress and responsibility for the work of other relatives/family members for the enterprise
- Sometimes a bicycle is used for delivering ironed clothes
- Value pricing for ironing clothes for customers = Rs2.00–5.00 per garment (€0.035–0.89)/other household clothes
- Annual monthly income of Rs.6,435[2]

The sustainability aspects of the enterprise are listed below.

2 About €114 at the Euro-Rupee exchange rate on 17 May 2010.

No waste in the enterprise

- The irons are sturdy, durable and the press workers use their irons in the most efficient manner (for example, while hot, it is used for cottons and when warm, synthetic fabrics are ironed). There is no wastage of fuels in the work of ironing of clothes and press workers are sensitive towards waste management
- It is an ecologically efficient system of providing the service as no major transport is required to deliver the clothes; this is due to the fact that most press workers operate within a single neighbourhood or cater to a local area very near to their work operation. Therefore there is no usage of petrol, and they either walk or cycle to collect and deliver the ironed clothes. The service structure is designed in a convenient manner both at the delivery and receiving end. Thus there is no transport cost incurred during the service delivery
- Publicity is accomplished by word of mouth: no paper pamphlets are used for publicity and advertisements

Satisfaction-based service customer relationship

The enterprises are service oriented but form an integrated whole with the product and consumer satisfaction—freshly ironed clothes whenever needed at very reasonable rates from a familiar, well-known, trustworthy press worker in one's locality.

- A press worker serves customers loyally and has customers of many years
- He/she has gained their trust and achieved high customer satisfaction
- This is mainly due to an error-free, rationalised pricing and timely delivery system
- He or she shows presence of mind, orderliness and a friendly and clean appearance with pleasant and respectful conduct towards the customers
- The enterprises now use mobiles phones to contact their old and new customers to maintain the desired customer volumes as well as good customer relationships

Optimisation of resources and value via mobile phones

Mobiles give the enterprises an appropriate network structure, i.e. enable them to concentrate on a very small area but with manageable volumes and transactions thereby yielding reasonable profits to be able to maintain a sustainable business.

Press workers are increasingly adopting mobile phones for work-related purposes; social purposes; entertainment, playing games; as an information device/news/radio; for contacting the doctor, tuition teacher, nurse, etc.; to participate

in radio and television contests; and even for camera usage. The study findings showed that the predominant use of the mobile was for contacting family and friends, with work-related reasons far less important. Press workers reported owning the mobile phone was of great advantage as having the contact numbers of important and useful persons in their colony of residence or work, such as a doctor, nurse, tutor teacher, or constable, proved to be useful especially in emergencies.

The service is designed in a manner where management and operating of the structure is methodically planned, as it ensures wrinkle-free and smoothly ironed clothes at convenient timings, efficient and punctual service, and capability to handle emergency situations and special occasions such as weddings or trips out of town requiring a large number of clothes to be ironed by a skilled, informally trained but experienced, press worker.

Enterprise as representing Indian culture and people

Providing services for ironing clothes against payment is a traditional micro-enterprise.

- The service popularises the use of cotton clothes, a fabric most suitable for Indian weather conditions as well as mass-produced cheaply in India
- Therefore, requirement of the ironing service has become an essential part of the Indian cultural ethos
- As a PSS it provides sustainability to poor migrant families in the vast informal sector in India. It provides opportunities to a large number of illiterate and low skilled families to earn income and provide for their families with honest means
- It provides a setting for caring and cordial relations among the family members as all the family members work together
- It provides opportunities for leadership qualities as all the press workers are part of a union
- Press workers develop supportive relationships with their clients who may be highly educated professionals, well-to-do business families, and so on

7.4 Conclusions and future PSS intervention

It is evident that press workers form an exemplary case of Sustainable PSS. However it would be beneficial to further advance the ironing enterprise's core operation and structure via PSS thinking and Sustainable PSS design. PSS intervention in its theoretical sense can also aid in incorporation of this case and many such

examples into formal education set-ups. Therefore possible future interventions can be proposed in the following areas:

- The two types of iron could be modified into upgraded, eco-efficient, low-cost, low-weight and fuel-efficient irons
- The design component for clothes storage and organisation has to be taken care of
- The government needs to protect the workers from harassment in the streets and acknowledge them as part of the informal sector
- There is need to understand urban poverty as a phenomenon beyond the overflow of rural poverty and to evolve a national strategy for the urban poor and for more inclusive planning of cities and towns
- It is vital to address the digital divide, the rural–urban divide and the resultant migration and urban poverty issues, as mobile phones are impacting the social and economic lives of the press workers and the returns that they derive from their micro-enterprise

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8

Sustainability at work, sustainability at play

The consequences of an urban horticulture project involving underprivileged children in India

Jyothsna Belliappa, Alison Byrnes and Prayas Abhinav
Srishti School of Art, Design and Technology, India

8.1 Introduction

The City Spinning project, an experiment in urban horticulture and creating community networks that occurred in two Indian cities, is an example of a low cost, resource-light project that delinks consumption from ownership—a basic criteria for effective sustainable PSS. Srinivasan and Varadarajan (2003) argue for models of PSS in emerging economies such as those of India, China, and Brazil that draw on the wealth of their traditional informal service relationships instead of uncritically drawing from modern industrial manufacturing models. While City Spinning was not based on conventional informal sector service relationships (such as those between middle class households and street hawkers for instance), it does suggest that non-monetised, informal models of exchange can help urban communities, whether rich or poor, move towards self-sufficiency and sustainability in basic needs (food). The project thus serves as a case study of a sustainable PSS in that it intersects with issues of food security, employment opportunities and social

cohesion. Examining this case study we argue for a more playful, artistic approach to PSS design which takes into account human capabilities and for encouraging marginalised groups to take responsibility in sharing and husbanding resources. Evaluating the consequences of the project in terms of Martha Nussbaum's capabilities approach, we attempt to demonstrate that cross-pollinating the capabilities approach that emerged from development economics and political philosophy and the sustainable PSS approach in design could be theoretically rewarding.

The City Spinning project (so called because it suggests a way in which networks of mutually beneficial relationships can organically spin-out between disparate communities within a metropolitan city) needs to be understood in terms of the recent socio-economic history of India. During the movement for independence in the early part of the 20th century, leaders proposed divergent economic models for the (future) nation. The first model draws inspiration from Gandhian philosophy, which championed small-scale, low cost technology, strengthening of local economies and self-sufficiency at the village level, while minimising consumption and expenditure. This model was largely antithetical to large-scale industrialisation, consumption and dependence on imports (although it should be noted that Gandhi was not completely opposed to all forms of industry or machinery as is sometimes suggested—see his *Hind Swaraj* for more details [Gandhi 1910]).

The second model, often attributed to Nehru, favoured the development of heavy industries alongside a largely socialist economy where the state controlled important sectors of the economy. This socialist approach prevailed for over three decades following independence—the state established and managed large public sector industries and controlled private enterprise through a network of licensing schemes and import restrictions. However, in the early 1990s with the enactment of sweeping neo-liberal reforms where many of the above restrictions were lifted, the state withdrew from several key sectors and impetus was given to private enterprise. What was most evident however was a change in attitudes to consumption. As Pavan Varma (1998) argues, Gandhian austerity and Nehruvian socialism gave way to an ideology where high levels of consumption were seen to be beneficial to the nation as it fuelled economic growth. Since then, the Indian economy has flourished and become an important market alongside other growing economies such as China and Brazil. The growing, upwardly mobile Indian middle class often takes cues from the consumption habits of the so-called 'developed' world (nations with well-established, industrialised, capitalistic economies), whose lifestyles they have increasingly accessed via imported media and foreign-based franchises.

According to mainstream economic views, which tend to favour corporate and shareholder interests, the ability to consume became an aspiration to strive for and the inability to do so an indication of poverty or 'under-development'. Consequently, it is unsurprising that emerging economies strive to achieve higher levels of consumption comparable to more 'developed' economies with the ironic consequence that they are emulating a model of growth and development that is increasingly being accepted as environmentally unsustainable and socially and economically inegalitarian. Currently, cities such as Bangalore, Delhi, and Shanghai are engaged

in rapidly improving infrastructure, services, transportation and telecommunication in a bid to 'catch up' but in doing so are likely to race towards a future that is environmentally unstable and socially polarised.

Against this background, and conceived as a series of experiments in community building, horticulture, and regeneration of 'wasted spaces', City Spinning was undertaken as a public art project across two Indian cities, Bangalore and Delhi, in 2008-2009. In this chapter, we focus mostly on 'Pett Puja' (Hindi for filling one's stomach), the core experiment of the City Spinning project which involved a product initially designed by Prayas Abhinav, one of the authors of this chapter. This product, a bamboo canopy, was used by unhoused 'street' children for play, recreation and growing food and by adults for hosting performances and as a teashop. While the end product was cooked food made from the vegetables grown by the children, the community bonding and sense of empowerment that stakeholders experienced were the most important objectives in the cycle of creation and service. Seen as a PSS initiative, City Spinning facilitated a process, integrating a product and a service, though the system interestingly benefits both the provider and the recipient without monetary profit. Moreover the project had multiple social, ecological, economic and political consequences which we examine through the lens of Martha Nussbaum's (2007) capabilities approach. We argue that supporting and cultivating the capabilities of individuals and groups empowers them to take a more agential position in social and economic transactions. Before discussing the consequences of the project therefore, we will first briefly outline the essential principles of Nussbaum's capabilities approach.

8.2 Understanding human needs through the capabilities approach

The capabilities approach was championed by Amartya Sen and Martha Nussbaum (1993) as an alternative to dominant approaches to understanding well-being that focus on GDP and household income as indicators of development. Sen argues against looking at resources, income, or utility derived from commodities (products) as a measure of human development, contending that more meaningful measures could be found in the beings and doings of individuals within a given population. For instance, such measures could include health, education, freedom of mobility, political participation, freedom from violence and freedom from hunger. The capabilities approach, also known as the human development approach, has become popular among development activists because it brings in the issue of distributive justice (allocation of resources among people according to needs and situational factors, i.e. the socio-ethical sustainability dimension) and highlights the significance of non-monetary aspects of well-being. It conceives of individuals as agential beings who can participate in creating their own futures

with appropriate support (Nussbaum 2007). This movement away from product ownership towards the satisfaction of human needs by empowering social actors is also evident in contemporary PSS thinking (Manzini 2006, 2010; Narayanan 2010; Ceschin, Vezzoli and Zingale 2010).

Sen avoids defining a list of capabilities, arguing that his approach is a framework within which definitions of capabilities can be made, depending on context (see Sen and Nussbaum 1993). In contrast, Nussbaum (2007) has developed a well-defined set of capabilities that, she argues, could be the basis for developing a theory of justice and constitutional principles for ensuring a just society. These include the right to life; health and bodily integrity; senses and imagination; emotions; play; practical reason or the ability to conceive of good and to reflect on a plan of one's life; control over one's political and material environment and affiliation—including the freedom to assemble, freedom of speech and freedom to interact while showing concern for and supporting others—and the right to be treated with dignity and without discrimination. Nussbaum uses her theory to view narratives of struggle and success among marginalised communities, such as underprivileged women in India. Her work could be criticised as too prescriptive and universalist—arguments that she refutes by claiming that her list is merely suggestive and that individual nations can incorporate the capabilities into their constitutions according to their socio-cultural contexts and histories (Nussbaum 2007).

In the next two sections of this chapter we investigate City Spinning from the point of view of the capabilities it supports. The framework of the capabilities approach here intersects with the socio-ethical (people) sustainability dimension (Manzini 2006), in its attempt to not only facilitate urban poor children's ability to meet their own nutritional needs, but also to achieve some measure of social equity, as the same marginalised group found itself in a position to interact with various members of the community and later offer them something (soup).

8.3 City Spinning

City Spinning began with the Pett Puja project. 'Pett Puja' (which literally means 'worship of the stomach' in Hindi although metaphorically it is used to suggest filling one's stomach) was conceived as a means to integrate a marginalised and somewhat stigmatised community of 'street children' within the broader urban landscape of Delhi. It was set up by Abhinav while he was a post-graduate student at the Srishti School of Art, Design and Technology as a documented experiment in artistic intervention within a community (a diploma requirement). However it began to grow much beyond its initial goals. It also inspired a number of spin-off experiments in Bangalore and Delhi. The inspiration for Pett Puja came from Abhinav's own sense of isolation within the city, which prompted him to consider ways in which to encourage different urban communities to interact. Via Pett Puja, he taught the children to grow their own vegetables and encouraged them to share

their produce with the rest of the community. Spinach and other vegetables were grown in baskets which hung from a tall bamboo canopy (see Figure 8.1), which was placed in the parking lot of the busy Jama Masijid area of Delhi from 12 to 21 December 2008. Once they had enough spinach the children threw a 'soup party' for neighbouring shop owners and passers-by, thus reaching out to the community and making friends both for themselves and the hanging kitchen garden they were tending. The inspiration behind such neighbourhood parties, enabling sharing of food and community cooking, was the Sikh concept of the *langar* (community kitchen), which reinforces community bonds while also creating food security for vulnerable individuals and groups. Pett Puja thus draws from models embedded in local cultural heritage (rather than reproducing a model from very divergent cultural contexts within a localised setting), a key factor for the success of PSS in emerging economies (Srinivasan and Varadarajan 2003; Penin and Vezzoli 2004).

Figure 8.1 **The 'Pett Puja' structure**

Source: authors

Additional benefits that were not envisaged in Abhinav's initial project proposal accrued. Children from nearby schools were intrigued by the canopy and began to tend the plants as well. Thus not only did the garden acquire multiple 'parents' but it also became a play area shared by children from middle and lower middle class homes and children from the streets, two groups who did not normally interact with each other. A tea stall was set up under the canopy, which gained more clientele from its intriguing location and provided the owner, an under-employed young man, with much needed income. The stall owner perceived that it was in his interest to take care of the garden and the canopy and support the children in their enterprise. Other street vendors began to intermittently set up camp under the canopy. It also became a performance space for local artists, which increased the clientele at the teashop and created access to artistic experiences that are usually denied to unhoused communities who live in the public space. Thus the project augmented the livelihoods of several adult participants. However its real value was

for children, as the canopy became a safe space in an otherwise somewhat hostile urban environment.

Being a diploma project, Pett Puja had a limited shelf-life but could easily be reproduced in different urban settings. It inspired several spin-offs: an exchange mela (festival) was held in Bangalore where children could exchange stories for food and other objects. Their stories were recorded and are currently being compiled for educational and artistic purposes. An international competition took place in which artists entered designs for similar structures which would enable temporary and mobile cultural spaces to exist in Bangalore. Street children in Delhi participated in a mapping project where they mapped their locality in terms of the resources relevant to them, e.g. trees for shelter, play and fruit that they accessed in times of need. The resources that the city afforded from an earlier history of more integrated and supportive social structures were brought back into focus. A disused construction site in Bangalore was regenerated as a play area facilitating children from diverse socio-economic backgrounds to play and converse together.

8.4 Social and ecological consequences of the project

All children need safe spaces to play, socialise and develop competences associated with citizenship such as responsibility, collaboration and self-expression. In most Indian cities children's play areas are usually restricted to playgrounds and parks that have well-defined boundaries and fences. The practice of playing on the lane outside one's home is decreasing due to the unpredictability of traffic and fear of road accidents. Parks are usually constructed by the city municipality with little or no consultation with children. Moreover, while legally defined as 'public space' these are accessible only to middle class or upper class children who usually enter them under the supervision of parents, nannies and older siblings. Seldom are parks and playgrounds open to street children.

By creating space for unsupervised and unstructured recreation, for creativity and for witnessing and participating in artistic performances, Pett Puja supported the children's capabilities for play, for expressing emotions, for engaging the senses and imagination and for affiliation (see Nussbaum's list in Section 8.2). It created a much needed space for street children to play albeit for a limited amount of time. While the project did not necessarily meet all their social and recreational needs, it did create a sense of belonging not only in the canopy itself but in the area underneath, making this small pocket of the city a little more familiar and hospitable to the children. Exploring ways in which PSS adoption could be made more attractive, Ceschin, Vezzoli and Zingale (2010) argue for creating opportunities for recreation, socialisation and strengthening social bonds through PSS design. The Pett Puja project did just that but it also had an additional consequence, that of empowering its young participants.

The project thus encouraged a marginalised and somewhat alienated group, often associated with begging, juvenile crime and delinquency on the one hand and exploitation on the other, to demonstrate sustainable and socially beneficial ways of being. Instead of being positioned as 'recipients' of state welfare activities or middle class philanthropy, these vulnerable members of the urban poor became agents of change within their community. Their resources and abilities came to be recognised as in the 'tree-mapping' exercise. This enabled a re-configuration of the city and its environmental resources as well as its relevance to underprivileged children. It also strengthened their sense of self-worth as their knowledge and understanding of the city were valued.

By encouraging the children to share their produce with the community, Pett Puja reduced the distance between the urban poor and the middle class in tangible ways, encouraging the two communities to come together in a more equal form of exchange than they were otherwise accustomed to (interaction between the two communities is otherwise mainly through employment of the urban poor in the unorganised sector). Moreover it facilitated interactions between middle class and poor children through play and the shared ownership of the garden. It is probable that unhoused poor children were able to share skills and resources which were unfamiliar to the more protected middle class children, enabling a re-working of hierarchies embedded in class, income, lifestyles and (formal) education.

The project also facilitated mutually beneficial relationships between adults and children, enabling the latter to transcend their positions as objects of the former's care and compassion (or annoyance) to empowered subjects capable of meaningful interventions in the public space. It has been argued that the categories of adult and child are contested and fluid and that the knowledge, understanding and resources available to children are not always accessible to adults (Valentine 1997). Valentine (1997) argues that children are as capable of adult behaviours (demonstrating rationality, self-awareness and maturity) as adults are capable of 'childish' behaviours. By recognising the knowledge, resources and perspectives of children, the project enabled a reconfiguration of the categories of adult and child.

City Spinning was probably more successful in socialising young citizens to adopt ecologically beneficial behaviours (food security and social cohesion) than mainstream educational curricula on environmental science. Indian school curricula usually alert students to environmental problems such as global warming, water scarcity, pollution and the global energy crisis through a model that 'informs, educates and warns' in order to change behaviours. However, such methods are unlikely to be effective in the long run in comparison to demonstrating ecologically sound ways to enhance personal satisfaction and social bonds, such as occurred when socio-economically diverse groups came together to tend the garden and share its end-result. Without deliberately setting out to do so, the project engaged the children in behaviours that are altruistic and environmentally sustainable.

In ecological terms the project reduced the distance between production and consumption by producing food within urban spaces. Food security, a major priority for urban poor communities, was enhanced and children involved in the project

were able to supplement their diet while saving valuable income (otherwise spent on food) which could be spent on other necessities. Although it did not address basic nutrition it provided them with vital supplementary nutrition, the vegetables grown organically, without using fertilisers or harmful pesticides.

The project also enabled creative re-use of under-utilised and somewhat unaesthetic spaces such as parking lots and abandoned construction sites, demonstrating that meaningful use can be made of existing urban spaces without expensive, unsustainable and resource intensive new construction. It provided an illustrative example of how community interactions can be facilitated in a low cost manner without constructing clubhouses and recreational centres. Street soup parties could enable sharing food, skills and local knowledge, a 'core task of design for sustainability' as John Thackara (2010: 31) argues, thus enabling the co-existence of two economies, the commercial economy of the teashop and the non-commercial economy of neighbourhood food exchange.

Ezio Manzini argues for sustainable solutions that '*propose different ways of being and doing from those currently dominant, lighter in environmental terms and more favourable towards new forms of socialisation*' (2010: 14) (emphasis in original). The canopy used in the Pett Puja project, a low-cost, temporary structure made from local resources (bamboo and hemp rope) and designed by indigenous expertise, is easily constructed and dismantled. Assembling or transporting it requires little labour or engineering skill. In its simplicity it exemplifies environmentally sustainable technology but is of little value in itself. However, the social and cultural meanings associated with its conceptualisation as a centre for community horticulture, play and performance generates intangible value in its vicinity. It enables a re-conceptualisation of relationships within and between communities and reclamation of the public space for individual use and social interaction. The forging of personal relationships between socially distant groups via connections of camaraderie, (non-commercial) exchange and artistic performance strengthens the urban community. The individual citizen becomes re-socialised to experience a sense of belonging in the public space because it bears a mark of her labour and recreates associations of pleasure, friendship and fun with what could otherwise be perceived as a somewhat alienating, mundane and possibly ugly environment. The public space becomes personalised, and therefore less threatening.

The project challenged many dichotomies on which contemporary social life is built: the dichotomies between work and play, commercial and non-commercial, and artistic and utilitarian. It enabled an interrogation of several taken-for-granted assumptions associated with urban life: the notion that one must have work and money to access food, the belief that public spaces are unsafe for children, and the injunction against 'talking to strangers'. It reconfigured the public space as a space for citizens of all age groups to interact with each other and create meaningful relationships of social, economic and cultural exchange. It created experiences of surprise, pleasure and camaraderie in the utilitarian space of a parking lot or construction site via a creative and proactive re-use of the spaces.

8.5 Focusing on human needs and capabilities in design

City Spinning supported some of the basic capabilities that Nussbaum (2007) outlines: bodily health, play and the affiliation with other human beings. However it also enabled the development of other capabilities such as health, control over the environment, affiliation, and emotional well-being. By participating in this project, unhoused children could potentially conceive of their lives and their futures in broader ways, understand the value of what they can offer their communities, and enhance their sense of dignity and self-worth. While not necessarily addressing all of the more conventional needs associated with children such as basic (rather than supplementary) nutrition, clean drinking water, adequate health care and (formal) education, the project made a significant impact on their capabilities and their ability to conceive of themselves as agential beings.

Echoing Nussbaum's (2007) capabilities approach, Mary Clark (1994) addresses the issue of sustainability within the framework of 'human needs'. Clark (1994) stresses the importance of humans sharing a worldview with others in order to feel secure. So imperative is group belonging that when the shared identity comes under threat, a strong response of fear or even violence can be the result. Along with group belonging, personal autonomy is also an essential human need to be met. Thus, individual freedom and group conformity work in tandem, not against each other, to form the basis of a stable society (Clark 1994: 181). Within the framework of sustainability, Clark argues that without the satisfaction of these conditions, humans fall back on the 'maladaptive social behaviours that lead to environmental destruction' (Clark 1994: 182).

Maladaptive social behaviours are often traced back to conflict over resources. Clark (1994) suggests that the individualism of contemporary neo-liberal society increasingly evident in the emerging economies of the South is manifestation of this conflict. With individualisation comes forceful competition for resources. Among street children this competition could take the form of petty theft or other anti-social behaviours. As individuals become alienated from the community their major aim is to gain access to scarce resources. By not identifying 'others' as the same as oneself, that is, sharing a community bond with them, individuals can much more easily transgress social norms for the sake of resource reallocation. In contrast, identifying with the other leads individuals to act in a more altruistic way.

Pett Puja harnessed this innate tendency to do something for the sake of sharing an experience with another human being. Children involved with the project first experienced the bond of interaction with Prayas who got to know them and gave them the canopy. They then further developed their own micro-community by working on the garden, producing food, making the soup, and distributing it. The children from the middle class neighbourhood nearby observed the high-functioning community centred round the plant-growing structure and integrated themselves to it, because a meaningful bond between people (whether based on

constructive or destructive agendas) attracts others. Thence did the tea-seller and performers insert themselves into the community as well.

As Nussbaum and Clark have suggested the importance of focusing on human capabilities and needs from a development perspective, so have these values been articulated from a design perspective. Richard Buchanan argues passionately for design that 'supports and strengthens the dignity of human beings as they act out their lives in varied social economic, political and cultural circumstances' (2000). He suggests that design should be human-centred, rather than user-centred: the subtle difference between the two concepts lies in the valuing of human lives rather than merely tailoring a design to fulfil the needs of the end-user. Viewed from this perspective, the Pett Puja canopy can be said to be an example of human-centred design as it went much beyond providing children with a recreational space by making a noticeable difference to their quality of life (and to the lives of communities who lived/worked in its vicinity), albeit for a limited amount of time. Ilse Oosterlaken (2009) makes a similar argument to Buchanan suggesting that a capabilities-centred approach is essential when designing for the developing world. Oosterlaken argues for a participative approach to design that takes into account human needs, capabilities and contexts in all their diversity and the varied aspects of well-being. In this chapter we attempt to demonstrate how the capabilities approach could enhance design practice. While in this case we have suggested how it could be used to evaluate a design retrospectively, it can also be used as a guideline for the entire design process. Designers can begin the design process with questions about how their design might support human capabilities and might return to this question from time to time throughout the design process. Doing this should nevertheless not constrain the design process—it is best to remember that design often has outcomes and consequences not originally envisaged by the designers.

8.6 Conclusion: lessons for PSS design

The question arises, what lessons does the City Spinning project offer for PSS design? In order to answer this question it is first worth asking whether the project may be called a success. Given the short time period and lack of funding for the project, many of the consequences could arguably have had a short-term impact. The street children could have lost interest in horticulture and gone back to begging for or even stealing food, the middle class children would most likely have returned to their sheltered neighbourhoods, and the teashop owner and other street vendors are probably continuing to make an unstable living under constant threat of harassment from petty criminals and the police. However the success of the experiment and the enthusiastic participation it generated indicate that if it is recreated as a long-term initiative it has potential to be relatively successful.

When it is renewed the major challenge would be to find seed funding. Abhinav believes that the best source of funding would be via a microfinance loan to a

consortium of street vendors or a not-for-profit body that represents the children. Once the loan is paid the project could be self-sustaining. Another challenge might possibly be from local government officials who tend to view street vendors with suspicion; they would need to be convinced to make space available for the project and to avoid interference. Official recognition and funding come with their own contradictions, namely the possibility of becoming structured, bureaucratic and inflexible. Efforts will need to be made to maintain the project's organic, intuitive and poetic nature.

Within the short length of time for which it ran, the project proved to be effective in creating spaces for recreation, collaboration and livelihood generation but its long-term impact cannot be assessed over such a short span of time. Moreover, its success owed something to Abhinav's enthusiasm and ability to bond with the children in the initial stage. The project could not be free from the influences of his personality. Therefore, it would be necessary to carry out the project under a variety of initiators before one can assess the effectiveness of the project as model independent of the initiator. These conditions aside, there are still some useful lessons within the project for PSS design.

The success of City Spinning as a sustainability project may be attributed to several factors. A small-scale, low-cost initiative that used existing resources, it was locally managed and available to anyone who felt a sense of ownership in it. Thus it conformed to three of the four characteristics that Manzini (2010) identifies as essential to contemporary sustainability initiatives: small, open, local and connected. Due to constraints of time and resources Abhinav was unable to realise his aim of creating a network of Pett Puja canopies across the city that could barter food, commodities and other skills; therefore the characteristic of connectedness was not fully realised although the project did create connections between disparate communities and groups.

The playful, poetic and intuitive character of the project is its strength. Instead of using the usual methods of sustainability initiatives which attempt to create buy-in by inducing fear about the future through facts and figures, or by creating guilt around consumption, it sought to change behaviours through means which come easily and effortlessly to the children: play, social interaction, story-telling and physical activity. This sensitivity to the needs of its young participants was an essential factor in its success.

Possibly the most important lesson from this experiment is how a PSS project can be effective even when it does not rigidly follow conventional design processes. Abhinav's organic, intuitive and loosely structured approach enabled the project to acquire a life of its own beyond his original agenda. It enabled relationships to grow organically, without premeditation or expectation of final results. Stakeholders envisioned and realised possibilities in the canopy that the designer himself had not imagined. This egalitarian approach quickly instilled a sense of ownership in the space among stakeholders and users across class, age and lifestyle as they participated (intuitively rather than deliberately) in the design process. While the product remained more or less the same as what was originally conceived, the

multiple services offered changed over time and the system developed organically. To some extent this was possible because there was no funder, NGO or government body behind the design, influencing its agenda. Thus another lesson for PSS design in this experiment is to enable the agendas of end-users to influence the outcome rather than valuing only those of the funding body initiating the design. Top-down methods wherein officials decree what is for the greater good (as an abstraction) do not encourage individuals to act when they are not supervised. Therefore it is important to have faith; as Samuel Hess (1998: 291) argues, 'a certain level of public good can be provided without government intervention'.

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Section 3

New Ways to Leverage Social Innovation for Sustainability

9

Design for Chinese social innovation

Pilot PSS design experiences for sustainable lifestyles*

Miaosen Gong
School of Design, Jiangnan University, China

9.1 Chinese social innovations for a sustainable and harmonious society

In China, a new movement has been launched by the central government, the Harmonious Society, which came into being after a significant decision to shift from economic development to sustainable development. Confronting pressing problems (environmental as well as social) while developing visions of society (a harmonious society), it is an appropriate moment to promote the design research and action agenda for sustainability in China. Social innovation towards a sustainable

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lifestyle is one of the keys that can open the door to a sustainable and harmonious society, indicated by both top-down and bottom-up initiatives. One milestone was the 'International Conference on Social Innovation', the first-ever international social innovation conference, organised by the British Council (2007), the Young Foundation and China Center for Comparative Politics and Economics (CCCPE) on 16–17 October 2006, in Beijing. Subsequent to this conference, social innovation has been widely promoted by government and institutions.

Moreover, bottom-up initiatives are also emerging in China. A cluster of promising cases in grassroots social innovations has been collected and studied as creative communities (Meroni 2007) in the CCSL (2007) project, such as *community-supported agriculture, carpooling, purchasing groups, co-housing, mutual elderly services, mutual neighbourhoods, time banks,* and a *rediscovery of bicycle transport*. These types of cases are emerging and diffused in the urban everyday life of many different regions. Meanwhile, social innovations such as *Car Sharing, PinKe, Group Purchase, and Community-Supported Agriculture* are being promoted in China. These promising cases anticipate sustainable lifestyles and implicate further initiatives that emerge spontaneously in everyday life.

Taking PINCHE (Chinese Carpooling) as an example, this is a service system that generates a convergence between people with cars and those without, in the regular routine of going to work. It generates a common value between the service participants to enhance the quality of mobility and to reduce costs. As a result, the system decreases the ecological footprint of transportation and increases social participation. It was found when comparing the promising cases found in China (CCSL 2007) and Europe (EMUDE 2006) that many have the same service ideas but have different contexts. For example, the PINCHE users in China are mainly influenced by economic factors and less by environmental concerns. Nevertheless, the cases could be seen as anticipating a Chinese sustainable lifestyle (Gong *et al.* 2008). Therefore promoting the more promising cases and their initiatives could be a true step forward towards a Chinese sustainable society.

9.2 Design exercises on grassroots social innovation

To better understand how design can promote grassroots social innovation, in particular collaborative services, a series of action research projects have been organised in the last few years as collaboration between the School of Design at Jiangnan University and the Design Department at Politecnico di Milano. The collaboration is in the form of design workshops, where a number of Chinese students work with a mixed group of professors and researchers from both universities and other partners. They focus on specific topics, and project teams develop new proposals for specific service systems towards the Chinese sustainable lifestyle. Through these pilot design exercises, the research aims to explore the role of designers, particularly PSS design, in promotion of social innovation and how it works.

9.2.1 Chita08: Collaborative services and mobile communication

The CHITA08 project was a teaching and research collaboration between the two design universities in Italy and China. The focus was on how to promote social innovation and the initiatives of sustainable lifestyles with a PSS-design-based approach, and how they can be empowered by mobile communication. It was a pilot experiment on the subject of design for social innovations in the context of China, as compared to European experiences. A workshop was organised as the main part of the project in Jiangnan University, with 27 students and nine multicultural and multidisciplinary instructors.

In the beginning, each group of students was asked to do field research and to define the project questions in their local context. They then generated PSS ideas based on the field research findings and lastly developed concepts and solutions using PSS design tools: storyboards, system maps and video simulations. Finally, six PSS design proposals about food networks, mobility, healthcare, stories connecting places, migrant workers and outdoor sports based on the local context in Wuxi were developed. These PSS design exercises focused on concept design—offerings and interaction more than systems and solutions. The result of the workshop thus presented more the *front stage* scenarios of services than the *back stage* scenarios of Chinese sustainable lifestyles.

Figure 9.1 **Idea generation of design scenarios**

Source: Chita08

9.2.2 Desis09-JU: Social innovation and community services

DESIS 09 was a collaboration between Politecnico di Milano (Polimi) and the founding members of DESIS-China. It was a didactical and research-based project concerning design-oriented phenomena, observation and exploration of design for Chinese social innovations. At the School of Design at Jiangnan University, 28 students joined the project in seven groups.

During the workshop, they identified seven social phenomena cases in Wuxi including junk collectors, elderly stockholders, idle fishermen during the fishing ban, volunteer blood donors, a vegetarianism campaign, newsstand vendors, and dancers in the city square. Through field research they collected data on their target 'users', and after the data analysis, design concepts were generated. In addition, several short-term exercises were organised: a user game workshop, a balloon workshop, and a performance tools workshop to further develop design concepts. In the end, the participants created a vivid picture of various grassroots living in Wuxi and possible design interventions.

Figure 9.2 **Card playing with users**

Source: Xian Zhang

9.2.3 DESIS10@Wuxi: Ecological agriculture and healthy food

DESIS10@Wuxi was another collaborative project between Jiangnan University and Politecnico di Milano. It was a PSS design workshop for social innovation on the specific topic of food networks, in particular, urban agriculture and Community-Supported Agriculture (CSA) for the local context of Wuxi. One aspect of the project explored was new possibilities for food solutions: services and systems aiming to radically change the mainstream food industries and consumption patterns

that have been widely recognised as unsustainable. The project also investigated a new dynamic relationship between rural and urban areas by various systematic design approaches. Twenty-eight senior and graduate students participated in this workshop, led by a multicultural team of six lecturers from several universities. In the end, five design proposals were developed based on the local context and cases: Next-Door Veges, Happy Planting, Grow, Co-planting and Feeducation. The proposals present different emerging local scenarios on agriculture and food.

Figure 9.3 **Field research at an ecological farm**

Source: author

9.3 Design scenarios of Chinese sustainable lifestyles

As a direct outcome of the design workshops described above, a group of design scenarios, concepts and proposals were generated and developed. They are examples of new possibilities for a sustainable future. As design exercises, most of these proposals are still in the process of being designed and have not yet been implemented. Some of them could be considered naïve and perhaps easy to dismiss as too difficult to implement. However, they are not utterly utopian, as all the proposals are based on the local context, oriented and anchored by field research and problem definition.

These experimental concepts provide fresh ideas, promising visions and interesting proposals for new business models and exercises on sustainable lifestyles in China. They explored design interventions in social innovation from different perspectives: enabling technologies and how mobile communication can facilitate collaborative services; communities at the margins of society and how we can improve

their quality of life through community services in a sustainable way; and ecological agriculture and rebuilding the relationship between urban and rural areas. They express rich visions and scenarios about new possibilities for Chinese sustainable lifestyles in different aspects of everyday life, such as re-managing mobility services (Taxi Pooling), sharing personal travelling experiences (Footprints), facilitating the social cohesion of migrants (Pride House), enabling elective communities (Mom's Talk), building food networks (Finding the Fresh, Co-planting and Feeducation), enabling community agriculture (Next-Door Veges, Grow, Planting Together) and recovering social infrastructure (Yesterday Once More). As a whole, they are collaborative and participative services that can be developed further and promoted as social innovations. With these design processes and results, the research projects suggest preliminary discussion in the following paragraphs.

9.3.1 Design in local contexts

The results of the workshops show the connection between the PSS design action and the systemic context of clearly identified problems. Grassroots social innovation evolves through bottom-up initiatives and experiments that start with top-down interventions. In other words, it is generated in concrete places, creative places (Franqueira 2009), by collaborative communities of creative people (Meroni 2007). This is why field research and other tools that support generation of tacit knowledge are fundamental steps within the PSS design process and, most of all, during the creative and problem setting phase. In the aforementioned design exercises, the teamwork begins from field research and ethnographic research in order to identify the real problems and opportunities instead of relying on mere hypotheses. Therefore, in most of these proposals the PSS ideas are strongly adapted to the local context. For example, 'Yesterday Once More', a digital platform where people who have experiences from a certain place can keep the memory of that place and share its stories with a mobile-specific local service, is based on the large-scale urbanisation pattern in contemporary China, which destroys the social infrastructure of urban communities. 'Co-planting' is directed toward the problem of local Community Supported Agriculture, where participants find it difficult to perform the required activities regularly and can therefore rely on co-leasees and partners to tend the plants. At the same time a corresponding challenge for design intervention is the accessibility of the local context, which is often beyond where general design processes and methods can reach.

9.3.2 Design for specific targets

In these design processes, who the users of the service are was strongly discussed, and the results show that the target group of the scenarios is often very specific. The sense of 'specific' here is something other than demographic groups or marketing segments, as these solutions cannot be understood in any generalised population sense. For example, pregnant women who wish to protect themselves from

strangers will find it problematic to participate in 'Mom's Talk', which aims to facilitate the connection between pregnant women, new mothers and doctors. Most likely these services are not intended for a wider public but rather a given group that expresses a more collaborative personality and fits the subjective conditions. Therefore, the designer must carefully identify the target group, which is a selection to be discovered rather than a choice to be made. These promising ideas and proposals are mainly set in specific contexts and groups from the outset, since large contexts are not their ideal setting. Designers must search for and define the pioneers of social innovation. For various reasons, these pioneers have enough motivation and knowledge to experiment with a new way of living and doing. Once the collaborative services start to work and become rooted in these specific groups' routines, they are in a better position to be promoted and diffused further in a larger scale.

9.3.3 Design as co-creation

In complex interactions, accounting also for the spontaneity of collaborative services, the design process in co-creating services takes place between designers, final users and stakeholders (Cottam and Leadbeater 2004). In workshops, the assumed final users are not only involved at the beginning of the design process and in field research for defining the problem, but also in idea generation and solution developing. For example, in the Finding the Fresh or Next-Door Veges proposals, besides field research where the designers visited farms and interviewed a number of farmers, the latter are also involved in the whole design process. The dialogue and interaction between the designers and the farmers catalyse the design process and create innovative results. They thus put themselves into a co-creative process. In this process, 'traditional' designers are not only in the position to design; they also have to learn to collaborate with the different actors in the system: to have the patience to communicate with them and to understand their voices. On the other hand, the other actors in the system are also 'amateur' designers; it is necessary to encourage and empower them to be involved in the design process with the best possible design atmosphere and tools. As a result, this co-creative process significantly changes the experience, knowledge and methods of the design profession, because it makes the design process much more complex than the traditional process. In traditional design, interdisciplinary collaboration has often meant working with marketing and/or engineering professionals while the users remain the users. The co-creative process differs in that it is not only interdisciplinary, but it involves a variety of actors, including the users, in the creation process.

9.3.4 Design to rebuild trust

Collaborative relationships require a relatively high degree of mutual trust and a relational quality. This has become a key challenge of service system design in these exercises, as the mutual trust between people has been deteriorating in the last few

decades due to rapid urbanisation and individualisation in our society. Given this low level of trust, rebuilding and increasing the mutual trust and relational quality between actors is one important principle of PSS design. On the one hand, PSS design could begin from existing initiatives instead of developing completely new ones, so that there is already mutual trust existent. On the other hand, the system must be able to support rebuilding of trust. For example, in Planting Together, the actors are from the same community so they know each other on some level. In Next-Door Veges, there is no certification of organic food by micro-farmers. We can, however, trust that this form of agri-production is healthy enough because of its micro scale, especially when compared to the supermarket chain where the production process is distanced and invisible.

9.3.5 Design for new business models

The business model is an important part of PSS design projects, providing the business viewpoint to the service idea and concepts. However, in design for collaborative services, we need to have a new type of business model. It can be found that these service ideas are oriented for social more than economic benefit since the defined problems or initiatives in the projects are usually ignored by traditional business sectors. In addition the systems of these services are often non- or only partly business-oriented, such as social enterprises. They involve governments, public service sectors and NGOs/CSOs besides industrial partners. From an economic viewpoint, they often cannot make a profit in the short term but this does not preclude them from making profits in the future, necessitating a new business model. For example, the Pride House solution, a mobile digital platform where migrant workers can share and exchange experiences and skills, can strengthen the social cohesion among migrant workers and local communities and build their confidence in urban life. Its stakeholders include local government, the association of migrant workers, the local community, the technology developer and the mobile telecom who could be motivated to become involved in a new business channel.

9.4 Conclusions

The exercises and research reported in this chapter are not intended to give a map or overview of PSS design for social innovation and sustainability, nor to present solid conclusions on specific issues. Instead, the chapter offers new information on pilot exploration in this topic at a specific design university, the School of Design, Jiangnan University, which is one of the oldest, largest and top design schools in China. Given that, social innovation and design for it are very new issues both in general academia and in the field of design, whose exploration and experiences could inspire further fruitful discussion and research. Nevertheless, some tentative findings may be defined. First, by introducing PSS design approaches, social

innovation has become a new design issue in a traditional design school system where professors and students start to recognise the new paradigm of design and design education; second, design intervention must be strongly based on the local context of China, which differs from Europe and other regions, especially in cultural, social and political dimensions (with less emphasis on the technological dimension which is more similar). The context of civil society in China is relatively weak generally speaking; rebuilding trust is a key issue of enabling solutions. All of these conditions mean new challenges and opportunities for design. They are specific subjects that could be investigated in further research. Furthermore, it is evident that design schools can play important roles in promoting social innovation for sustainability as agencies. Not only are design schools the place to train the next generation of future young design experts, but they are also active agents for sustainable change. In this research, this viewpoint was largely confirmed.

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10

Design and social innovation

Design practice and methods based on networks and communities

Tie Ji, Qiuyue Yang and Wei Wang
School of Design, Hunan University, China

10.1 Introduction

China, the world's most rapidly developing country in the past 30 years, is experiencing a severe economic and cultural development imbalance. On the surface, economic strategies focusing on regional-centred, radiating expansion have shown significant improvements in some areas such as basic infrastructure, GDP, real estate, urbanisation, and fashion products. However there has been very little growth in general welfare, social values, spiritual belief, and culture. Rapid urbanisation has destroyed many regional cultural and traditional communities. Both in rural and urban communities, many issues and contradictions, which arise from both dramatic changes in the relationship between people and the land as well as the reconstruction of old cities, renovation of dilapidated buildings and new city building and urbanisation, are accumulating, often to be solved by grassroots communities. Social unrest caused by the changes at the macro-economic level

has posed new problems regarding how to integrate 'atomised' individuals[1] and 'fragmented' societies as the 'Work unit' system and 'street residence' system[2] are rendered useless. As a result of these social issues, pointing to either the need for governance or civil society awareness, many Chinese scholars have begun to focus on a framework to enable analysis of the state-society. 'Community conflicts' have also become a focus.

The field of design has also experienced many challenges in the past ten years. It has shifted its focus from product design to immaterial design such as service design, information design, business model design, and system design (Sanders 2006; Burns, Cottam, Vanstone and Winhall 2006; Sanders and Stappers 2008; Mager 2009; Manzini 2009b). Design uses new technologies to stimulate people's imagination and satisfy their desires; on the other hand, people's social attributes are reconstructed under the impact of these products, which can lead to many new social and environmental problems. In this process, designers as important conceivers and practitioners need to reflect upon their role, from the perspective of anthropology and sociology, and on the question of how to balance between the 'material needs of individuals' and the 'commonwealth of society'.

User-centred research methods used in the field of design often focus on the needs of individuals, especially as consumer groups. However in reality, the state of being a consumer is only temporary: most often people are within other social contexts. The aim of this chapter is to show how people can be understood *in* their communities and how a real-life project explored design methods centred on 'community' and 'people in their community'. How can design methods be used to create greater social value? What kinds of problems between people and society can designers actually solve? How can designers with different backgrounds work together efficiently?

10.2 Design objectives and methods

Key issues relevant to traditional rural communities as compared to modern urban communities differ significantly according to the literature. These issues and their related practices are discussed in the following sections.

1 'Atomised' originated from a sociological theory, atomism, in which the individual is appointed as the basic unit of analysis for all implications of social life. 'Atomised individuals' here refers to the Chinese population, who are trending towards being self-interested, equal and rational social atoms that together form an aggregate society of self-interested individuals.

2 The 'Work unit' system and 'street residence' system were the basic-level governance systems in Chinese city management. With the establishment of a market economy, the traditional unit system has been profoundly affected and a community system has taken the place of the above two.

10.2.1 Objectives of traditional and urban communities

Traditional communities have an existing strong sense of identity thanks to physical proximity, kinship, ethnic, linguistic or religious identities and local culture. Practices in traditional communities mainly aim to achieve the following objectives (Liu 2008):

- Preservation and maintenance of the original social capital, which is threatened by a decreasing population
- Promotion of the diversification of rural industries to stimulate local economic development as the income from agriculture declines
- Transformation of public spaces and infrastructures to prevent decline and strengthen the sense of community though joint participation of local residents
- Encouraging social practices from a sustainable perspective to promote traditional cultural heritage and the rational use[3] of the environment and natural resources

Community building methods introduced by the Japanese scholar Kiyoshi Miyazaki have inspired numerous related innovations in Southeast Asian countries and China's Taiwan region and have had a broad social impact (Suzuki and Miyazaki 2008). These practices are grounded in original community identity and local knowledge.

In contrast the primary social needs of urban communities differ substantially. Urban communities are characterised by heterogeneous population structures, high mobility, diversity and openness, resulting in social relations that are not as strong as those in traditional communities. Concern with the development or diversity of the economy also differs due to the spatial differentiation of urban functional structures. Moreover, as urban communities exist within a broader system of connections compared with traditional groups, they should be examined from the perspective of the entire city, as opposed to a limited, narrow physical perspective that fails to acknowledge the links to the external environment. Social practices in urban communities mainly focus on the following objectives (Liu 2008; Landry 2000; Bolz *et al.* 2005):

- Resolving the problems of inadequate community spatial planning and public facilities caused by rapid urbanisation
- Alleviating the problem of urban community space classification and taking actions on social equity to avoid community confrontation

3 Several cases have been reported in China where locales with significant environmental and cultural resources have sought economic development through tourism but ended up with pollution and ecological damage. Against this background we propose 'rational use of the environment and natural resources' as a key objective.

- Establishment of an urban community identity to cope with the negative effects brought by the global tendency towards individualism
- Improving community services and enhancing quality of life
- Exploring urban sustainable lifestyles and addressing global climate and environmental challenges
- Creating city brands by establishing distinctive communities, so as to enhance the ability to attract capital and talents in the era of a knowledge and experience economy

Typical methods and examples of urban community social practice include community revitalisation experiences from the city of Barcelona; sustainable lifestyle scenarios constructed by Manzini and other scholars; community building through service design methods by design agencies and actors such as Dott, IDEO and live|work; and cities' future thinking in 'Cities of the Future' by PricewaterhouseCoopers and 'creative cities' by Charles Landry (Manzini and Jegou 2003; Jegou and Manzini 2008; Bolz *et al.* 2005; Landry 2000).

In the transformation process from traditional to urban communities, local differentiation gradually disappears. The dominant knowledge changes from local knowledge to global knowledge. Meanwhile, the linking factors of geography, kinship, ethnicity and local culture weaken, and instead factors such as professional education, status, career and hobbies play an increasingly important role as social bonds. The urban community of the future will be characterised by diversity and individualism (Landry 2000; Florida 2002) and emerging communities of interest are defined by weak ties and contingent commitments. A community of diversity and individualism challenges the traditional ways of building identity, which emphasise geographical links and participation. However, the spread of global network infrastructures provides tools for information sharing and social networks and creates new possibilities to re-connect atomised individuals. **Virtual communities** and **mobile communities** can become bona fide spaces that can unite creative citizens in future.

10.2.2 Design networks and social innovation

According to Pierre Bourdieu's social praxeology, Michel Foucault's power theory, and Clifford Geertz's local knowledge research, design can be thought of as actions of social practice or creation, which need the existence of a structure (i.e. power) to implement. 'Design' in this era has been pushed to the forefront of social and public discourse and some design elites keen to participate in the discussion of certain public issues may become public intellectuals. At the same time, popular concepts such as 'Created in China', 'the national innovation system' and 'low-carbon design' often reflect the strategic thinking of governments, and designers actually play a somewhat random role in the process of community transformation. In

the complex relationship among community institutions, designers are merely a grassroots force and mainly involved with 'servicising'. In other words, on the one hand, designers often participate as 'outsiders'. In the confrontation between various kinds of unbalanced *power* and *capital*, designers cannot usually organise the structured form necessary for participation. On the other hand, how can designers acquire the *local knowledge* needed and creatively promote social innovation from a native's point of view? We believe it would be more effective to construct a **multidisciplinary design network** by which designers can participate in social practices in communities.

In reviewing existing community practices, we find that designers are accustomed to understanding and solving problems within their own disciplines. Solutions thereby tend to be limited to one's special discipline, such as architecture, planning, industrial design, information design or visual design. At the same time, their design activities are often separated and there are few approaches for them to work collaboratively. Nevertheless, a community is a complex system in which all problems and needs are interconnected, and it is almost impossible for one discipline to cope with all community issues. Meanwhile, emerging disciplines or practices such as Transformation Design and Strategic Design all place emphasis on systemic thinking and collaborating between disciplines (Burns, Cottam, Vanstone and Winhall 2006; Meroni 2008). Moreover the 'information age' or 'network society' (Castells 2000) demonstrates the importance of organisational networks: the network-based 'virtual intelligence community' of the future. In the process of community-based design practices and social innovations, *construction of knowledge platforms* and *organisation design* may therefore be a viable approach for designers' participation. This also calls for a re-examination of fundamental working methods.

Emphasis on *local knowledge* helps address the problem of designers' roles in these practices; construction of *knowledge platforms* helps to answer the question on how to obtain local knowledge; and *organisation design* offers a way to involve different stakeholders and multidisciplinary partners. Design in this sense will use a more tensional structural form[4] and the power of social identity (through innovation networks, design networks, social networks, etc.) to participate in community social innovation, enabling web-based and sustainable harmonious community building.

4 Tension in physics means force resistance to passive stretch. It helps maintain the state. Here 'tensional structural form' refers to design that has the resistance to passive powers in community innovation through these networks, which helps ensure the innovation outcomes are more sustainable.

10.3 Case study: Social innovation practice in a traditional community

The Autonomous County of Tongdao Dong Nationality lies on the boundaries of three provinces, Hunan, Guangxi, and Guizhou. The population of Tongdao is about 2,250,000. The Dong minority makes up about 78.4% of the population. Besides its well-preserved ecological environment and local culture, Tongdao is also well known as the 'Holy Land of the Dong culture'. Although Tongdao is rich in natural resources, with forest coverage of up to 74% and up to 170,000 cubic metres of merchantable timber produced annually, it is still a poverty-stricken county in the country. In 2008, the per capita income of farmers was 1,756 Yuan.

In this project, called 'New Channel Design & Social Innovation', we wished to take advantage of having several disciplines and, through reasonable town planning, eco-tourism development, information and logistics network construction, integration of product and service systems, and protection of non-material cultural heritage, to establish an International Innovation Design Union and web-based information platform, promoting the cultural self-awareness of local residents as well as industrial innovation.

In order to approach the issues Tongdao faced, a workshop was co-organised by NRC (Nokia Research Center, Beijing[5]) and the School of Design, Hunan University (HNU[6]), who provided relevant design and support in the 20-day field surveys, focusing on the lives of local villagers. The entire team was split into five groups: social research, environmental and industrial design, interactive, video and visual design. The study methods included contextual inquiry, a brief questionnaire, participatory observation, participatory rural rapid appraisal, and social impact analysis. More than 25 families coming from four villages in the Autonomous County of Tongdao joined our project. Twenty-eight local people, both male and female and a diversity of ages, participated in our formal interviews.

10.3.1 Keywords

The following terms were crucial concepts in the project and are therefore elaborated in this section.

5 A team of 16 senior research staff members, including information experts from France, the UK, the United States and Finland.

6 The HNU team, with up to 50 members, was made up of professors, doctors, and graduate students from industrial design, architecture, landscape, city planning, environmental protection, information, and video art.

Local

Local people come first. The diversity of culture is as important as the diversity of nature. It contributes to the harmonious development of the whole society and ecosystem. We should also pay attention to personalised needs and individual experiences in different cultural contexts as well as adaptive faculties and the transitioning status of culture rooted in different cultural groups. We should, with local people, find their own way of living which meets their needs.

Connected

Connecting the economically marginalised areas to global networks. At present, under the influence of global networks, fundamental changes have taken place in cultural communication, lifestyles, production modes and consumption behaviours. Economically marginalised areas have however missed the opportunities of development brought by the industrial age. How can they take advantage of the cultural and natural resources that are left in order to merge into a global commercial and social network at minimal cost? How can they develop eco-tourism, organic agriculture, and forestry processing? How can they establish web-based transactions and communication platforms and increase employment opportunities?

Sustainable

Achieving sustainable communities through localised Product-Service System design. The scope of sustainability has extended from environmental protection and resource conservation to sustainable design of lifestyle and consumption patterns, from environmentally friendly product design to community service and innovation.

10.3.2 Social needs

The Young Foundation defines social innovation as 'new ideas that work to meet pressing unmet needs and improve people's lives' (Mulgan 2006). Describing the contents of social needs is the starting point of rural social innovation. Pol and Ville (2009) argue that social innovation should benefit the majority, a statement that became one of our main standards to filter social needs. We summarised these social needs in two categories.

10.3.2.1 Lifestyles and ways of living

The ancient village is the original carrier of the traditional way of life. It also represents Tongdao's most important cultural heritage and visual characteristics. When the traditional peasant economy cannot achieve its development needs, much change is needed. The changing relationship between people and the land leads to

the sale of resources, commercial and tourism development, migrant workers and other new economic forms. Peasants that have saved up for years end up replacing the ancient houses with new buildings decorated with tiles. How can the ancient village landscapes be protected while the villagers' need to rebuild is also met? How can traditional culture and crafts be used to improve the quality of home life? Peasants are not able to solve these problems alone. It is our duty to actively work together with the local people to co-explore the solutions.

- Landscape: protect as well as develop landscape and architecture
- Furniture: enhance with local products and traditions
- Culture and nature as business resources for local benefit

10.3.2.2 Ways of connecting

A large number of young adults move out as migrant workers and leave the children, women and elderly people to become the major members of the village. At the same time, they are offered a large number of new communication methods, but can the services promised in the overwhelming number of ads actually help them maintain communication? New social network services may shift these young adults towards notions of productivity and new lifestyles. In this process, building education, social learning, and communication platforms needs the support of indigenous knowledge and communication systems. Therefore, the study of local communities, existing communication methods between individuals, and ways to build a virtual community was another important goal of our project.

- Families: how to maintain family connections when some of them work far away or move to the city
- Economy: how to connect the rural areas with global networks to gain development opportunities
- Culture: how to use local traditions to preserve a harmonious cultural ecology

10.3.3 Knowledge platforms and organisation design

As stated previously, the construction of 'knowledge platforms' and 'organisation design' is prioritised over actual design outputs when designing for communities and social innovation.

The **knowledge platform** consists of two main parts: first local context and knowledge; and second the background knowledge of the multidisciplinary team. Local knowledge includes various forms of local capital or assets, three major types being cultural, natural and behavioural resources. Local knowledge is obtained through interviews with local government, residents and other organisations, field observations, books and stories. Teams of diverse backgrounds provide diverse

observation and interpretation perspectives, which create conditions conducive to systemic social innovation. Key to cooperation in a multidisciplinary team is to maintain openness and mutual exchange by approaches such as reporting and panel discussion. Building the knowledge platform is a process of gaining **design power**. It also serves as a foundation for attracting other stakeholders and ensuring multidisciplinary cooperation.

When it comes to **organisational design**, we must ask one question: who are the social innovation actors?

Robin Murray pointed out that the new social economy would appear in four sub-economies—the state, the market, the grant economy and the household—and more social innovations would straddle the boundaries between sectors and disciplines (Murray 2009). Moreover Ezio Manzini described social innovation as 'a process of change where new ideas emerge from a variety of actors directly involved in the problems to be solved: final users, grassroots technicians and entrepreneurs, local institutions and civil society organisations' (Manzini 2009b). According to these ideas, we summarised the actors in rural social innovation as the government (state), NGOs (the grant economy), companies (the market), and local residents and other grassroots institutions (the household). According to the understanding of these roles, we built a joint innovation organisation for this project.

Figure 10.1 **Partners in the 'New Channel Design & Social Innovation' project**

Source: authors

10.3.4 Design contents

Kretzmann and McKnight (1997) argue that only asset-based community development can help us escape from a needs-driven dead-end. Boyle, Slay and Stephens (2010) also emphasise the importance of building on people's existing capabilities. Design opportunities hide in the integration of assets and social needs. Their discovery depends on the interpretation of the local context and knowledge by the design team.

Table 10.1 **Design opportunities**

Source: authors

Design opportunities			
Intellectual + social capital Cultural capital Natural capital Behavioural capital …	Advantages ⇩ Community assets	Disadvantages ⇩ Social needs	Economic revitalisation Retention of social capital Infrastructure transformation Cultural heritage …

In 'New Channel Social Innovation' practice, we aimed to combine planning and architecture design, industrial design and information service design in forming a collaborative approach to participating in social innovation. The sociology research team carried out studies on population structure, production patterns, consumption patterns, social associations and other organisations, all of which would be used as reference knowledge for other teams when designing. The environmental and industrial design team handled the social needs classified as 'Lifestyles and ways of living'. The interactive design and communication design team aimed at solving problems associated with 'Ways of connecting'. All these teams were not completely independent of each other; they collaborated on some overlapping design contents. Through this process, the project yielded fruitful design results, some of which are described in the following sections.

Figure 10.2 **Participatory innovation**

Source: authors

Planning and architecture

Architectural styles in Tongdao are distinctive. Zhihua Chen (2008), professor at the School of Architecture, Tsinghua University, writes that '[s]ettlement is an organic system, whose historical and cultural significance and function is much higher than the total of all of its buildings. Local architecture conservation should protect the village or the town as a whole'. While public architecture in Tongdao is already under protection of the law, what was more worrying were the local residences: from 2006 to 2009, we witnessed the destruction process of local landscapes. This led us to conclude that the villagers do not recognise the value of their landscapes; they have saved up for years to change their wooden houses into cement cubes decorated with white tiles, which, in our view, are not aesthetically beautiful and do not suit the environment. What made the problem challenging was the contradiction between the villagers' will and choice and our objectives to preserve the overall landscape. Moreover most Dong villages in the area are located along the Pingtan River. We found increasing signs of contamination, as more and more solid trash and sewage is directly dumped into the river.

In New Channel Social Innovation Practice, we aimed to tackle these problems from different angles. The environmental and industrial group surveyed the current status of local villages, landscape and resources, and drafted Ancient Village Protection Guidelines and Pollution Control Guidelines, which were presented to the local government as a policy-making reference. The Guidelines included identification of ancient architecture, restoration and transformation methods, material and style requirements on newly constructed buildings, issues related to protection and tourism development, the rights and responsibilities of relevant stakeholders, and approaches to enhance public awareness of and residents' respect for local architecture. The Pollution Control Guidelines, which take Gaotuan Village as an example, discussed methods to deal with daily garbage, wastewater, and ways to reduce agricultural pollution, as well as viable models of Ecological Agriculture. A brief sanitation regulation is also suggested in the report.

From the construction point of view, in order to help villagers find a reasonable balance between new housing building and the protection of ancient villages, we designed new folk housing prototypes that meet the needs of local residents and are compatible with the existing landscapes. Based on the traditional forms, the new folk housing prototypes are improved to be more functional and comfortable, especially in terms of ventilation; protection against rain, fire and noise; strengthening of weak structures; and reconsidering some functional layouts for health reasons. These advantages aim to encourage local people to choose the recommended housing-style willingly, so as to achieve the goal of protecting landscapes indirectly.

Another important incentive to stimulate the villagers to take conscious action is direct benefit from landscape protection. Therefore, we also developed local tourism planning for the village of Hengling to promote cultural resource utilisation. This is also in line with the local government's future economic development plan, to promote the local economy by tourism. We selected the appropriate sites after a survey in the village and planned service areas, distribution areas, and tourist routes accordingly.

Figure 10.3 **Traditional public architecture, local residential housing, new folk housing prototype**

Source: authors

Industrial design

Our survey found that Tongdao has vast, high quality forest resources, but many forest products are sold at a low price with only primary processing and low added value. Tongdao also has excellent woodworking skills, as evidenced by local public buildings and furniture. Nevertheless as local demand drops and incomes become unpredictable, skilful carpenters tend to go elsewhere, seeking better opportunities. In the long run this means a loss of traditional skills.

We also found there is huge potential for a local furniture market. However from among the current mix of existing furniture consumption patterns involving local furniture, imported furniture from big cities, and homemade furniture, it is a challenge for residents to find a balance between price, quality, function and aesthetics. In addition the local government sets multiple strategies to reduce local poverty, such as supporting local business, job training, and subsidising the peasants to drive market demand. All these efforts are nonetheless independent and discrete and have not yet formed an effective force.

By analysing these service ecologies, it is possible to reveal opportunities for new actors to join the ecology and new relationships among the actors. Ultimately, sustainable service ecologies depend on a balance where the actors involved exchange value in ways that is mutually beneficial over time (Live|work 2008). Facing the problems and opportunities described above, we designed a new local furnishing product-service system. The new PSS redesigns the relationship among local residents, local carpenters, government, forestry, furniture manufacturers, and other stakeholders. The system map (Figure 10.4) is used as a visual description of the service technical organisation: the different actors involved, their mutual links and the flows of materials, energy, information and money through the system (Morelli and Tollestrup 2007).

In this new system, the government helps local small factories purchase wood-processing equipment to improve their product mix. The small factories buy local forest timber and process it into planks of various specifications, which can be directly used for building houses and making furniture. The local carpenters will be organised into local associations. Local residents purchase the standardised

planks and contact the local carpentry association for assembly and customisation services. There are three particularly innovative or novel qualities in this PSS: first, design institutions are included, who take part in government projects aimed at rural areas; second, local carpenters create design solutions with the help of some special training; and third, cooperation with local design schools is planned. As an example of furnishing design innovation, we have sought to match interior design concepts for furniture and decoration with the folk housing prototype described above according to guidelines of low cost and high quality.

The new PSS makes up for the defects of the original three furniture trading models. It meets the Triple Bottom Line, which is considered the best way to promote sustainable practice in business (*Economist* 2010).

- **Economic**. The local residents can enjoy furniture that in low is price, high in quality, functional in usage, and good looking in aesthetics. The operation of the service unites the efforts of government in poverty alleviation and economic development to form a virtuous cycle of investment and income. It stimulates the prosperity of local furniture-related companies and forestry by consumption pull and ensures the new furnishing is consistent with the original cultural tradition
- **Environmental**. This service could greatly reduce the transportation needs, as less wood will be sold to other provinces
- **Social**. Carpenters' associations are organised in this service as a key part to provide the furnishing service collaboratively, which stops the loss of wood craftsmanship by enhancing carpenters' livelihood capabilities and guaranteeing the continuity of local building and carpentry techniques

In fact, this kind of PSS model enabled by local associations is also suitable for local handmade textile and livestock breeding industries.

Figure 10.4 **Local furnishing service design**

Source: authors

Products and visual design

Design for local residents

Local women mainly have a low level of education and they have no source of income other than farming. Most of them master a variety of handicraft skills such as fabric making, cloth ornament making, and Dong brocade. We also found there are only a few souvenirs for tourists, most of which are imported from China's coastal areas where they are mass produced and not distinctive. We therefore designed home textile and decoration products derived from the local fabric Dongjin. Local women could make these products in their free time and earn extra income by selling these products to tourists.

In addition, we observed a number of delicious and unique local products, such as Dong Wang wine, red bayberry wine and snacks. We made some commercial designs for these local specialities, including wine bottles, packaging, and posters.

Design for outsiders

This series included three themes. The first was visualisations of local architecture, which aimed to present the most valuable cultural heritage and the local landscape to outsiders. The second was Dongjin (the traditional local fabric), which we studied and aimed to modernise, and the third theme used graphic design to make manifest local textures and communicate local features.

Information service design

Cell phones have been quite popular in rural areas and have become an important tool for communication and entertainment. We made in-depth studies on rural information needs and found opportunities worthy of further design. For example, we studied the patterns and habits of villagers in finding work opportunities and designed a phone-based job hunting service. Moreover, as in most rural areas, a large number of young adults work in big cities and leave behind many children and elderly people. Family members are thus separated and do not meet each other for long durations: the phone becomes their main tool to keep in touch. Calls are made infrequently for cost reasons, once a week or even once a month. Migrant workers living in faraway cities want to hear more news on changes in their hometown, but the information that the phone can bring is limited. Most young migrant workers have experience with using the internet: they can talk on QQ, browse the web, and are sophisticated forum users. However, children and elderly people in rural areas have few chances to access a computer and their ability to operate one is relatively low. They cannot handle complex registration processes nor use the online video chatting functions on QQ or Skype.[7] Though computers and the internet are not common, residents can access the web in the Local Cultural Centre of each village.

7 Online software services that connect registered users via audio and/or video.

Taking careful consideration of these characteristics, we designed a local web tool to be as simple as possible. Through the site, migrant workers can catch up on news from their hometown and children and the elderly can use the video chatting function easily after a simple training process.

10.3.5 Communication

The design of videos was an important part of the communication team's work, using Participatory Video as one of the methods. We played the unedited video clips to the villagers, who then recommended contents they thought worth shooting and actively helped us to find people, customs and special ceremonies worth recording. This helped the villagers to rediscover their most precious traditions, customs, skills and architecture, which served to enhance their local cultural pride and community cohesion. The resulting video and music productions recorded the local immaterial culture in a digital way and will serve as media to connect and communicate with the outside world, using these excellent cultural traditions to attract more social resources and help ensure the problems are recognised and solved.

10.4 Conclusions

Designers who only attempt to carry out 'design services' will not acquire substantial structural power in community transformation practice. Therefore, **construction of a knowledge platform** and **organisation design** may be more viable design aims. In our practices described in this chapter, we have identified the needs of social innovation in a particular region through a participatory approach. By taking the natives' point of view, we have aimed to build a local knowledge platform that meets the local demands and establish organisational networks consisting of the local government, external business, local residents and a cross-disciplinary design team. Through these means, we have transformed the conventional participatory, user-centred design approach, in which designers often serve in an uncertain[8] and individual, business-oriented way, into a new method that integrates design resources as the power of a network and promotes social innovations that meet common social needs (Community-Centred Design).

Design based on networks and communities may become a new paradigm of social innovation. Knowledge platforms, organisation design, social learning and other aspects are all dependent on the building of network platforms and cross-disciplinary collaborative design in the process of social innovation. Networks and virtual communities will drive design's participation in community social innovation in a more tensional structural form and with more social identity power

8 That is, the influence of the design outcomes is uncertain, as they are designed without involving enough actors. They may be unsustainable.

(innovation networks, design networks, social networks, etc.), making a web-based and sustainable, harmonious community possible.

Figure 10.5 **Social innovation platform**

Source: authors

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11

Catalysing social resources for sustainable changes

Social innovation and community-centred design

Ezio Manzini
DESIS Network Coordinator

Anna Meroni
Politecnico di Milano, Department of Design, Italy

11.1 Social innovation

Social innovation is a form of innovation driven by social demands rather than by the market and/or autonomous techno-scientific research, and generated more by the actors involved than by professional researchers. Given this very rough initial definition, we can easily observe that social innovation has always been and will continue to be a normal component of every possible society. Nevertheless, though social innovation has always existed, there are two good reasons to focus on it today. The first is that social innovation initiatives are multiplying and will become even more common in the near future, in answer to the growing challenges of sustainability. The second is that, as contemporary societies change, the nature of social innovation itself is also changing, opening new and until now unthinkable possibilities.

An attentive observation of the past indicates that social innovation flourishes and evolves when two contemporary conditions are present: when society is facing

difficult problems and when new, widely used technologies open new and only partially explored possibilities. Both these conditions are particularly evident today (Mulgan 2006).

In fact, as far as the *quantity and dimension of problems to be faced* is concerned, the present economic crisis alone would be more than sufficient to lead us to forecast a larger future role for social innovation (Murray 2009). However, as well as this, other deep and growing problems can be considered as social innovation triggers: the living conditions of hundreds of millions of people (those moving—and being moved—from villages to urban contexts) force them to invent new ways of living and producing. At the same time, as the limits of the planet become clearer, people are beginning to perceive them in a different way (both in economic and health related terms) and ask for new, less resource-intensive systems. The list of 'big problems' and associated motivations for social innovation could continue (Vezzoli and Manzini 2008; Kling and Schulz 2009).

At the same time it is clear that the second condition, the *quantity and quality of widely used technologies*, is more than satisfied too (Castells 1996; Benkler 2006). Over recent decades our societies have been impacted worldwide by several waves of technological innovation: from distributed computing, to the internet, to mobile phones. Although these technologies have very quickly become normal (for instance, no one today would say that the use of mobile phones is per se a technologically advanced solution), they still present potentialities that users experiment with in their everyday lives and transform into new, viable solutions based on the unprecedented forms of organisation, business models and economy that the new networks make possible (Bauwens 2006; Tapscott and Williams, 2007; Leadbeater 2008).

Given that these two conditions are satisfied, we can reasonably predict that new solutions to old and new problems will appear in contemporary society (Mulgan 2006; Green 2009).

11.1.1 Mapping social innovation

A very concise definition of social innovation is: 'a new idea that works in meeting social goals' (Mulgan 2006). A more articulate one could be the following: social innovation is a process of change emerging from the creative re-combination of existing assets (from social capital to historical heritage, from traditional craftsmanship to accessible advanced technology), which aims to achieve socially recognised goals in a new way. Such a definition suggests that a very wide range of events can be considered social innovation. We would do well to draw up a well-defined map of their different typologies but this task is far beyond the limits of this chapter. Here we will limit ourselves to indicating some possible polarities, on the basis of which a first draft could be outlined.

A first, simple, polarity is between *incremental* vs. *radical* innovation. Here the adjectives *incremental* and *radical* are used as in the field of technological innovation: they refer to changes that lie within the range of existing ways of thinking and

doing (incremental innovation) or outside them (radical innovation). In our case, given the intention to promote sustainable changes, the innovation that we are going to consider must by definition be radical (Vezzoli and Manzini 2008). That is, the goal itself and the way to achieve it must be different from the mainstream ones.

A second polarity is *top-down* vs. *bottom-up*. This relates to where the change starts and, therefore, who its original drivers are. If they are experts, decision-makers or political activists, the innovation will be largely top-down. If they are (mainly) the people and communities directly involved, then it will be (mainly) bottom-up. In this paper we will mainly consider bottom-up innovations conceived, implemented and managed by the people involved or, more precisely, by groups of active and collaborative people who we will refer to here as new forms of communities (Bernard 1973; Benkler 2006). We will therefore refer to these bottom-up innovations as *community-based innovations*. In fact, as people's attitudes and capabilities change with the increasing diffusion of creativity, entrepreneurship and design approach (Ray and Anderson 2000; Landry 2000; Meroni 2007) and considering how internet-based organisation could support them (Wellman, Haase, Witte, and Hampton 2001; Mulgan, Steinberg, and Salem 2005; Leadbeater 2008), these *community-based innovations* offer the highest potential as effective and diffuse drivers of sustainable changes.

11.1.2 Social problems and sustainable changes

A third polarity is *social problems* vs. *sustainable changes*. This derives from two different, possible meanings for the adjective 'social'. Until now, 'social' has often been used to signify urgent, acute problems generated by extreme poverty, particular diseases, fragile social groups, and so on (e.g. the need for fresh water in a shanty town; medical care in an isolated village; or working opportunities for marginalised young people). In these cases, what motivates innovation is the need for *urgent* solutions. To reach them all forms of innovation are possible and welcome: technological and social, incremental and radical, top-down and bottom-up. Frequently, the design process that triggers and supports these innovations is called *social design*: a design activity that is not motivated by market demands but by this kind of socially recognised problem (Margolin 2003; Brown and Wyatt 2010). However, the adjective 'social' can also be used with a different meaning: to describe the changes in society that are needed in order to move towards sustainability. These *sustainable changes* depend on major trends that are impacting society as a whole: demographic evolution, urbanisation, increasing connectivity and, more in general, the transition towards a sustainable society (food networks and new city/countryside relationships; co-housing and collaborative services; alternative mobility and sharing and pooling of cars and bikes; and so on). In these cases what motivates innovations is both the search for solutions to short- and long-term problems and the hope of discovering emerging opportunities. This means that different actors can drive this kind of social innovation: local, national or international public entities, foundations and non-profit organisations, but also different kinds of innovative

businesses; poor and marginalised people but also the new middle class in emerging countries. The design processes operating in this field are defined as *design for sustainable change*: a design activity (mostly) triggered by concerns for social and economic sustainability and, therefore, oriented towards solutions and business ideas capable of enhancing radical changes in the mainstream models of living and producing (Manzini and Jégou 2003).

We should also add that although these two fields of innovation have been discussed in different arenas and with different motivations, in recent times they have tended to converge. In fact, on one side, it appears clearer and clearer that the majority of social problems can be solved only in the framework of larger sustainable changes. Vice versa, when confronted with the crisis and the need to move towards sustainable ways of living, the growing middle classes can be found looking to the inventions of the poorest social groups and to the traditions of those still living in a phase of pre-modernisation.

In discussing the potentialities of social innovation for sustainability, this chapter mainly focuses on *sustainable changes*; in particular we shall concentrate on a specific kind of social innovation: community-based innovations that generate sustainable changes.

11.1.3 Community-based innovation

For a more practical introduction to community-based innovation, we can refer to a variety of real life initiatives in our contemporary world. We can look for example at 'zero-mile food', where not only a new way of eating but also a new relationship between production and consumption and between the city and the countryside are established, or collaborative services where elderly people organise themselves to exchange mutual help and, at the same time, promote a new idea of welfare. Further examples are neighbourhood gardens set up and managed by citizens who in this way improve the quality of the city and its social fabric, or groups of families who decide to share some services to reduce the economic and environmental costs, but also to create new forms of neighbourhood.

Once we start to observe society and look for this kind of initiative, a variety of other interesting cases appears: new forms of social interchange and mutual help (such as local exchange trading systems and time banks); systems of mobility that present alternatives to the use of individual cars (from car sharing and car pooling to the rediscovery of the possibilities offered by bicycles); the development of productive activities based on local resources and skills which are linked into wider global networks (as is the case of certain products typical of a specific place, or the fair and direct trade networks between producers and consumers established around the globe). The list could continue, touching on every area of daily life and emerging all over the world (to read more about them, see the Sustainable Everyday Project[1]).

1 www.sustainable-everyday.net

Looking at such cases of social innovation we can observe that they challenge traditional ways of doing things and introduce new, different and more sustainable behaviour. Of course, each one should be analysed in detail (to assess their effective environmental and social sustainability more accurately). However, at a first glance we can recognise their coherence with some of the fundamental guidelines for sustainability.

First of all, many of them have an unprecedented capacity to bring individual interests into line with social and environmental ones (for example one side effect is that they reinforce the social fabric) and they generate new and more sustainable ideas of well-being, a well-being where greater value is given to the quality of the social and physical context, to a caring attitude, to a slower pace in life, to collaborative actions, to new forms of community and to new ideas of locality (Manzini and Jégou 2003). Furthermore, achieving this well-being appears to be coherent with major guidelines for environmental sustainability, such as: positive attitudes towards sharing spaces and goods; a preference for organic, regional and seasonal food; a tendency toward the regeneration of local networks; and finally, and most importantly, coherence with an economic model that could be less transport intensive and more capable of integrating renewable energies and eco-efficient systems (Vezzoli and Manzini 2008).

Precisely because these cases suggest solutions that merge personal interests with social and environmental ones, they should be considered as *promising cases*: initiatives where, in different ways and for different reasons, people have been able to steer their expectations and their individual behaviour towards more sustainable ways of living and producing.

11.1.4 Creative communities

Behind each of these promising cases of social innovation there are groups of people who have been able to imagine, develop and manage them. A first glance shows that they have some fundamental traits in common: they are all groups of people who cooperatively invent, enhance and manage innovative solutions for new ways of living. And they do so recombining what already exists, without waiting for a general change in the system (in the economy, in the institutions, in the large infrastructures). For this reason, these groups of people can be defined as *creative communities*: people who cooperatively invent, enhance and manage innovative solutions for new ways of living (Meroni 2007).

A second characteristic common to these promising cases is that they have grown out of problems posed by contemporary everyday life such as: how can we overcome the isolation that an exasperated individualism has brought and brings in its wake? How can we organise daily functions if the family and neighbourhood no longer provide the support they traditionally offered? How can we respond to the demand for natural food and healthy living conditions when living in a global metropolis? How can we support local production without being trampled on by the power of the mighty apparatus of global trade?

Creative communities generate solutions able to answer all these questions: questions that are as day-to-day as they are radical; questions to which the dominant production and consumption system, in spite of its overwhelming offer of products and services, is unable to give an answer and, above all, is unable to give an adequate answer from the point of view of sustainability. In conclusion, we can state that creative communities apply their creativity to break with given mainstream models of thinking and doing and in doing so, consciously or unconsciously, they generate the local discontinuities we mentioned before.

A third common denominator is that creative communities result from an original combination of *demands* and *opportunities* where the demands, as we have seen, are always posed by problems of contemporary everyday life and the opportunities arise from different combinations of two basic elements: the existence (or at least the memory) of *traditions* and the possibility of using (in an appropriate way) an existing *set of technologies* (in the form of *products*, *services* and *infrastructure*s).

In relation to the last point, a convergence between creative communities and social networks (and other forms of internet-based organisations) can be observed. Even though they emerge in different contexts, driven by different motivations, creative communities and social networks present interesting similarities: they both more commonly originate from user needs rather than in specialised laboratories and in both cases service deliverer and user roles blur, generating the profiles of new social actors who are both producers and consumers at the same time. Finally, and most importantly, a certain complementariness can be observed: social networks find in creative community initiatives the possibility to link themselves to the concrete reality of everyday life, while on the other hand, creative communities can find in their social network the enabling tools they need to move towards more effective, lasting, replicable organisations (Granovetter 1983; Baek 2010). On this basis, it can be stated that the convergence between *community-based innovations* (of creative communities) and *internet-based innovations* (of social networks) is an ongoing trend: a powerful trend with the potentiality to strongly support existing social innovations and, at the same time, generate new and until now unforeseeable ones (Rheingold 1993, 2002).

At the end of this short overview of the features of creative communities we can attempt a definition of community-based innovation (against the background of other forms of social innovation):

> **community-based innovation** is the result of a co-design process between a variety of actors (final users, grassroots technicians and entrepreneurs, local institutions and civil society organisations) seeking to find a shared solution for a common issue.

11.1.5 Collaborative organisations

Creative communities are living entities that evolve over time. A closer observation shows that the promising cases they generate can be seen as organisations at different stages of development. In fact, when they consolidate into mature

organisations, creative communities become a new kind of organisation: *collaborative organisations* that, in practical terms, can operate as social services, responsible enterprises or users' associations (Jégou and Manzini 2008).

Collaborative services are social services where final users are actively involved and assume the role of service co-designer and co-producers. Some examples are: houses where elderly people of different ages live in a resource-sharing community suited to their diverse needs and lifestyles; services that facilitate house sharing between elderly and young people, where students find cheap, family-style accommodation, while giving lonely but independent elderly people help, companionship and financial support; and self-organised nurseries for small groups of infants, making best use of such existing resources as parents' capabilities (social resource) and houses (physical resource).

Collaborative enterprises are entrepreneurial production and service initiatives that enhance new models of locally based activities by encouraging direct relationships with users and consumers who, in this case too, become co-producers. Examples are: farms that help clients to experience the value of biodiversity in the food chain; local enterprises that teach people how to re-use old and used materials; shops where people exchange used sporting goods; and housing companies that renovate houses for more communal ways of living.

Collaborative associations are groups of people who collaboratively solve problems or open new possibilities (and who, again, become co-producers of the results). Some examples of this category are: groups of residents who transform an abandoned plot into a shared neighbourhood garden; groups of people who love cooking and who use their skills to cook for a larger group, dining together in one of the members' houses; groups of people who exchange mutual help in terms of time and skills; and groups of elderly people and teachers who organise vegetable gardens for children in elementary schools.

11.1.6 Bottom-up, top-down, peer-to-peer interactions

Creative communities and collaborative organisations have always been described as *bottom-up* initiatives: actions 'from the bottom' that give rise to promising cases of social innovations. However, a closer observation of their evolution from initial idea towards more mature forms of organisation indicates that their possibility of long-term existence, and often even of their start-up, depends on complex mechanisms and that the initiative taken directly by the people concerned (bottom-up interaction) is often supported by information exchanges with other similar organisations (peer-to-peer interaction) and by different kinds of intervention from institutions, civic organisations or companies (top-down interaction).

For instance, a micro-nursery exists thanks to the active participation of the mothers and fathers involved. However, it may have been started looking to the experiences of other groups (and eventually interacting with some of them) and it may be backed up by specific top-down initiatives and enabling tools, e.g. a guidebook indicating, step by step, the procedure to be followed in starting up and

managing it; local authority support in assessment (to guarantee its conformity to established standards); or the support of a centralised service (in case of educational or medical problems that cannot be solved within the nursery itself). These examples, like many other similar ones, tell us that *creative communities and collaborative services should be considered as bottom-up initiatives not because everything happens at the grassroots level but because the precondition for their existence is the active involvement of people directly interested.*

Consequently their starting up, their daily life and their possible improvement usually emerge out of a complex interplay between bottom-up, top-down and peer-to-peer interactions (which differ from case to case). It is exactly on this basis that we can assume that even if the creativity and collaborative actions that are the necessary building materials of every creative community and collaborative organisation cannot be planned, something can be done to make their existence more probable and their diffusion potentialities higher.

11.2 Community-centred design

Creative communities and the collaborative organisations they may generate are important for us not only because they are sociologically interesting (although they do reflect a significant aspect of contemporary societies) or because they can generate potentially profitable niche markets for new businesses (even though this opportunity too could and should be explored) (Drayton and Budinich 2010; Thomson and MacMillan 2010). They are important because they are 'prototypes' of sustainable ways of living that can be implemented as viable solutions to urgent contemporary problems. And therefore they have the possibility to spread and to support sustainable lifestyles for a large number of people.

In this section we will discuss how this can happen: that is, how creative communities and collaborative organisations can be *scaled up* with the support of design actions focused on them, meaning Community-Centred Design, and second what role contemporary designers can play in this context.

11.2.1 Unofficial designers in everyday life contexts

Creative communities are expert communities: they master the activities they carry out. They have invented, designed, tested, prototyped and assessed these activities, so that no one is likely to be more expert than they themselves. They are moved by strong commitment and motivation, driven by clear values and robust ideologies. They represent producer and user issues because they have experienced both. They are like ecosystems that have found a proper habitat, a niche in which to live or even to prosper.

As designers, there is a lot to learn from what they do. The communities are not replicable in their very essence, but a deep knowledge of them is worth acquiring,

whether we aim to work for and with them or if we want to learn from them. We propose referring to the design focused on them as Community-Centred Design (Meroni 2008b), where understanding values and behaviours and collaborating with the most active social communities in conceiving and developing solutions (Ogilvy 2002; Jégou and Manzini 2008) is the distinctive work of the designer. Community-Centred Design also refers to an approach that upgrades the consolidated methods and tools of User-Centred Design to the complexity of the community, in order to understand its behaviours, needs and network of relationships.

Community-Centred Design requires two kinds of competence: one related to the capacity to gain knowledge about the community and the habitat where it lives; and the other related to the capability of creatively collaborating with non-designers. The former results in field immersion, so as to pursue a direct experience of the contexts and develop empathy with the community. The latter requires applying designer creativity in a slightly different way.

The purpose of diving deep into a creative community is to gain insight, to understand behaviours and the crucial network of values and relations that influence the structure of the community, so as to orient any subsequent design actions to make these values emerge or become more tangible. This way of looking at communities has much to do with what Buchanan (2001) defined as Human-Centred Design, meaning respect for the quality of the human culture and dignity that can be expressed through products, services and solutions. Moreover, immersion allows designers to gain insights into innovative behaviour, opportunities and unexpressed needs that can bring about truly radical innovation. Finally, immersion is the most effective way to develop an empathic relation with the people: empathic design is an approach where designers move into real contexts, so that projects benefit from the emotions of both users and designers (Leonard and Rayport 1997).

In our direct experience with Community-Centred Design, empathy is not only a welcome condition that can enrich the project, but it is the only possible precondition to deeply understand a creative community and to learn something about how to activate people, to spur them to take action and collaborate in doing things.

This leads us to discuss the second kind of competence we mentioned: if the purpose of designer intervention is to generate a creative outcome, the relationship with the community is likely to be different from a regular professional–client relationship. Actually, creative communities already have unofficial, but de facto, designers in their midst who must be considered by the professional designer. Consequently, the design intervention may evolve in two main ways:

- A collaboration *with* the community to improve or solve problems occurring in their activity. This requires the designer to be able to manage collaborative processes and transdisciplinary skills, to step back from the role of 'design creator' and find the right attitude for interacting with someone not professionally skilled as a designer but actually practising design thinking as well as or even better than experts (Leadbeater 2008; von Hippel 2004). The

relationship develops as a highly cooperative experience primarily oriented towards bringing out the creativity of the community. It requires the designer to promote participation and sharing of values and vision. It can lead to incremental or even radical innovations in the activity of the community

- A contribution *for* the community aiming to apply specific professional skills to various issues. This is likely to happen as support for explicit problems, but in our experience, it does not influence the core of the community's activity, because the community is both able and willing to design the system it wants by itself. Another way of designing *for* a community is to aim at 'replicating' or 'scaling up' the most promising activities (Jégou and Manzini 2008). This is the case when the designer looks at the system and with considerable insight 'designs' a new solution that interprets and reproduces the original one, making it more practicable for a larger target. Even radical innovations can result from this 'interpretation', but the crucial issue here becomes the engagement of the potential future 'creative communities'

In the next part of the chapter we will discuss these two options and will question the original idea of *enabling platform* to kick off new initiatives.

11.2.2 For, with, by themselves

Paraphrasing Tim Brown, we can recap these different ways of designing as a shift from *designing for* to *designing with* and finally to letting communities *design by themselves* (Brown 2009).

To move further in this direction we have to make a clear distinction: there is a big difference between an already existent community asking for some design intervention and a future potential community yet to be built around an idea and an activity. Actually, the creative community 'heroes' who act as designers bring the power of the vision and the motivation to the group. They cannot be replicated and if they are non-existent they must somehow be 'substituted' in order for a new initiative to start. Is this a possible role for the contemporary designer?

Let us take a step backward.

Generating a new idea, creatively adapting and managing an existing one, or even simply participating in an ongoing venture calls for a huge commitment in terms of time and personal dedication. Although this almost heroic aspect is one of the most fascinating characteristics of these initiatives, it is also an objective limit to their long-term existence and to the possibility of their being replicated and adopted by many. So this appears to be the major limit to the diffusion of collaborative organisations: the limited number of people capable and willing to cross the threshold of commitment required to become one of their promoters or even just one of their active participants. In fact, it has been verified that these initiatives appear very attractive to many people, but in practice for the majority, they simply require too much attention and time: i.e. they call for too large an investment of the very resources that today are, or are perceived to be, the scarcest ones.

While the heroes of the communities are not expected to be designers, professional designers (and especially service, strategic and PSS designers) are supposed to be able to build scenarios for and with communities, which is an activity implying a very deep integration into groups and contexts. This means helping collaborative design practices to happen, fostering conversations around systemic changes exemplified at the level of everyday experiences, and materialising big shifts in tangible lifestyles and business opportunities (Meroni and Sangiorgi 2011). In order for these scenarios to have some chance of finding the right humus to flourish as future solutions (Ogilvy 2002; Brown 2009), they must grow upon a very good understanding of the given ecosystem, as previously discussed.

This acknowledged, the strategic role of designers lies alongside the more established one of ideating specific product-service system elements that can become components of more complex solutions and that can also be conceived for use by amateurs or 'ordinary people' to design and set up their own solution. We are speaking of communication and production tools, digital platforms, transformable objects and spaces, and logistic and information services: a variety of artefacts and semi-finished components that can significantly impact on the do-it-yourself capacity of society.

Nevertheless, these designer competences are unlikely to be enough if we aim to start up a new activity and a new community, especially if we aim to do so in a broad segment of the society where people are not willing to become 'heroes' of such new endeavours as those of social innovation communities. In other words, challenging scenarios and smart components will remain useless in the absence of creative and motivated users.

The action research projects we are currently running in various contexts (among others, an ambitious one in the metropolitan area of Milan, aiming to create a local food system) are teaching us an important lesson: only through the personal, committed involvement of the project designer does social innovation truly seem to take off. This means an engagement that goes far beyond professional consultancy and enters the sphere of group motivation and values. In other words, to start up a new community the designer must substitute the hero. In doing so, the difference between designing *for* and *with* the community becomes blurred, while the issue of designing an 'exit strategy' emerges. This actually becomes a question of strategic design because the emphasis falls on finding and combining the right stakeholders and enabling them to carry on the activity (Meroni 2008b).

As a first conclusion we would like to affirm that, if the purpose of the design activity is to spread or start up social innovation in a broad spectrum of the society, the *enabling platform* must include a designer able to:

- Focus the idea and gather the potential stakeholders
- Select components that will enable the community to manage the activity and innovate by themselves

- Motivate and spur participants to mutual support and collaboration so as to create a good relational environment
- Implement an effective exit strategy so the group does not collapse

In other words, we propose that the designer acts as a 'temporary hero', supporting the start-up and development of a new collaborative community.

Figure 11.1 **This image depicts the pieces of evidence from an action research project involving a large community, designing and implementing a scenario for a local food chain system for the city of Milan. Titled 'Nutrire Milano' ('Feeding Milano') it is a large-scale programme developing a network of services to put peri-urban farmers and citizens into direct contact, through various offerings. The figure shows a metaphorical image of the scenario and several situations involving co-design interaction with different stakeholders**

Source: Politecnico di Milano

11.2.3 Networks and synergies

Replicating a good initiative or starting up a new one is not the only possible strategy to encourage social innovation. By their very nature, in fact, these initiatives tend to be economically and technically fragile and unstable, so to enable them to flourish we must find a way of making them stronger.

Synergising, meaning connecting them in order to share resources and energy, is an action of coordination that can bring measurable benefits to activities that operate at a local scale. It entails designing a common 'framework', a large-scale programme encompassing several specific initiatives that share a similar vision for the development of the region and apply similar principles. We can see this framework as a scenario.

These large-scale programmes (such as urban regeneration projects, regional food networks, community-based developments, and active welfare schemes) are very diverse and context-specific. Nevertheless, they present a similar architecture: a multiplicity of self-standing *local projects* are promoted and coordinated by a clear *framework project* able to give them a vision (to indicate the direction), a strategy (to implement the vision) and a set of specific supporting activities (to systemise the local projects, to empower them and to communicate the overall project). The results of this approach are large-scale programmes that are, at the same time, focalised (thanks to their framework projects), flexible and adaptable (due to their nature as small self-standing projects) (Meroni 2008a; Meroni, Simeone and Trapani 2009).

The creation of synergies among different initiatives (already existent ones or new ones) can successfully lead them to last and flourish for two reasons.

The social and relational basis for a network of creative communities and enterprises is likely to be the need to enhance the actors' perception of a coherent community where everyone (the local 'changemakers'; Drayton and Budinich 2010) contributes to collective success. This is facilitated when a shared vision confers the network with a sense of identity, claims values, creates trust and orients motivations, actions and strategies (Van Alstyne 1997). This is actually what a framework scenario can do.

The functional basis for a network is the need to share or complement the various assets and operations of the different initiatives, so as to save money and time. Therefore, the synergies we have been talking about so far may be of three main kinds:

- **Synergies between analogous activities**. Economies of scale and scope of similar solutions that can benefit from sharing operations and infrastructure, and creating critical mass
- **Synergies between complementary activities**. Economies of scale and scope between different solutions which, though delivering different products and services, have many common elements since the outputs of one activity become the inputs for another

- **Synergies between compatible activities**. Economies of scale and scope between solutions which, when combined, can generate mutual virtuous savings and reinforcement

In conclusion, establishing synergies seems to be an effective way to set up networks of initiatives based in the same place, sharing a vision of the future and organised as collaborative activities.

Is the contemporary designer skilled to master this kind of work?

We believe that certain programmes in the current panorama of design schools are actually proposing a research and training path that can certainly develop these skills and particularly the abilities to:

- Build scenarios and framework projects that can help a number of stakeholders and initiatives to find a common horizon and work more efficiently
- Design collaboratively with different subjects, matching competences and interests in view of a common benefit
- Have a holistic approach that enables them to manage product-service systems
- Apply design thinking and strategic thinking, in order to produce ideas with overall sustainability potential: social, economic, technical and environmental

11.2.4 Perspectives and roles for the contemporary designer

We have learnt so far that it is time to adopt new perspectives in design education and practice.

We hear from several scholars that designers today must be able to create conditions for people to use their own creativity to innovate; to do so, professional designers must be able to recognise and understand the context in which innovations are born and develop tools and methodologies to support these situations (IDEO 2009). They must use their expert design skills and sensitivity to empower the other actors to be, themselves, good designers (Thackara 2005; Murray, Caulier-Grice, and Mulgan 2008). We can recap the entire argument by saying: 'it's time to *support people in doing things* and to *do things with people*' (Meroni and Trapani 2010). The two actions are connected and largely overlapping; both imply a co-designing capacity that must be put into practice with professional skills and tools. Both require stimulating a positive attitude in people, systematically building competence and encouraging proactivity. Most of all, both require that design thinking becomes embedded in people's behaviour as a natural part of the context of everyday actions.

A variety of initiatives in the design world seem to have precisely the purpose of familiarising non-designers with design thinking, while helping designers to support people in doing things and do things with people. In particular, a number of

English-language manuals and toolkits have been designed by prestigious design consultancies to support bottom-up innovation and then offered to the public at large as creative commons via websites.[2] Ultimately, these materials are organised combinations of problem setting and solving design tools, targeting local organisations or, more directly, communities who are aiming to implement new activities. In addition to this typology of material, specific activity *toolkits*, *getting-started tips* and step-by-step *instructables* are commonly available through the internet for free use and open-source.[3]

While this material is mainly thought up to transmit a 'method' of work (a *design thinking* approach), the generation of the idea and the combination of a proper product-service system to put it in place are left to the skills of the (professional or amateur) 'designer' and to the diversity of local assets. We believe this expert capacity (the *design knowledge*) could be brought to the community by trained designers, who would become *agents of social innovation* in society (Manzini 2009b). Their role would not be only that of facilitating a process, but rather of conjuring a vision and helping it to materialise in specific solutions, motivating people to join or even lead the community. They would be the 'temporary heroes' of the community and this is the very core of what we call Community-Centred Design. It implies a designer centric vision where the emphasis is not on her/his professional profile, but on the capacity of mastering design thinking and knowledge with unique sensibility for the human and relational values of the community.

As discussed in this chapter, this changed role of designers does not outline a new discipline but rather combines the skills of service, strategic and product-service system design into a transversal approach that is being proposed today in an increasing number of design programmes all over the world.

11.3 An open, distributed design agency

Having said this, it appears that social innovations are *design-led processes* with a particular characteristic: those who 'design' are very diverse social actors who, consciously or not, adopt ways of thinking and competences that are in all respects forms of 'design thinking' and 'design knowledge' (Bruns, Cottam, Vanstone, and Winhall 2006).

2 Just to provide a few examples, we can mention IDEO, which published the 'HCD Human Centered Design: Toolkit' in 2009; Engine Service Design, which issued the 'Design for Service: for both service and manufacturing businesses', and the D-School of the Hasso Plattner Institute of Design at Stanford, which released the 'D-School Bootcamp Bootleg', both in 2010.

3 www.instructables.com, www.makingpolicypublic.net, www.wallacecenter.org/our-work/Resource-Library/wallace-publications/handbooks/Farmer11-1_Sc.pdf/view.

The notion of *design for social innovation* we refer to here is therefore quite large. In practice, it is an 'umbrella concept' that includes '*whatever design can do to trigger and support social innovation*' (Manzini 2009a). Similarly, we can say that designers for social innovation are whoever is actively involved in conceiving and developing social innovations: the *design experts*, who have been trained as designers, but also all those who, consciously or not, adopt a design approach and use design competences.

In practical terms, what design experts do to trigger and support social innovation can be articulated in four lines of work:

- To feed the social conversations with *scenarios* and *proposals,* doing so at different scales: from the smallest (considering specific local problems) to the largest (aiming at building shared visions of the future)
- To empower existing cases of social innovation by working with creative communities and, thanks to dedicated tools and *specifically conceived products and services*, help them to last in time and to become more effective, accessible and pleasurable
- To act as *agents of social innovation* ('temporary hero') replicating good ideas and starting up new ones, initiating new communities and using design thinking and knowledge
- To promote large systemic changes, synergising a variety of local initiatives, thanks to the development of specifically conceived *framework strategies*

These four lines of work entail very practical activities and require specific design knowledge developed through research and training. Thanks to students' enthusiasm and teachers' experience, design schools are—or at least, they could be—active laboratories where complex problems are tackled, new visions generated, and new tools defined and tested, but unfortunately, until now this potential has been under-valued (or even not valued at all). However, if an appropriate framework and a supporting platform were given, these potential resources could be catalysed and results shared and communicated. In other words, all these schools, or part of them, could become design laboratories which openly and freely produce meaningful contributions. In turn, by connecting these design labs, it would be possible to create a large distributed design agency: an open design agency where social innovation projects could be started and supported locally and experience could be shared and discussed at local, regional and global level. The DESIS Network has been launched internationally in just this spirit, and with this aim.

DESIS stands for *Design for Social Innovation and Sustainability*. It is a network of *design labs* based in design schools (or in other design-oriented universities) promoting social innovation towards sustainability.[4] These *DESIS Labs* are teams of professors, researchers and students who orient their didactic and research activi-

4 www.desis-network.org.

ties in order to start and/or facilitate social innovation processes. Each lab develops projects and research on a local scale but at the same time functions as a node of a wider network of similar labs, the *DESIS Network*, which enables them to exchange experiences and collaboratively develop larger design and research programmes.

The DESIS Network, therefore, operates as a highly innovative design agency: an open agency, where complex, socially relevant topics can be tackled, scenarios built and solutions found and offered as contributions to the social conversation. It is a distributed agency, where many design teams work in parallel, mutually connected and sensitive to cultural, social and economic diversity.

In conclusion, the DESIS Network itself can be seen as an example of social innovation: an original, highly distributed organisation where the existing (but previously under-valued) social resource of students' enthusiasm and teachers' experience is catalysed—where scenarios and solutions, conceptual frameworks and practical tools are generated and offered as an open contribution to the transition towards sustainability.

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Section 4

New Ways to Design for Moderation

12

A brief introduction to the Sufficiency Economy Philosophy

Sompit Moi Fusakul
Faculty of Architecture, King Mongkut's Institute of Technology Ladkrabang, Thailand

12.1 The origins of the Sufficiency Economy Philosophy

The Sufficiency Economy Philosophy (SEP) is the philosophy bestowed by **His Majesty King Bhumibol Adulyadej** of Thailand. Among many achievements in 65 years to ensure the welfare of his people, the *Sufficiency Economy* and its Philosophy is one of His Majesty's contributions to human development, poverty reduction and conserving the environment in the country.[1]

The SEP was first introduced to the nation on 18 July 1974, in a royal speech to graduates of Kasetsart University:

> Economic development must be done step by step. It should begin with the strengthening of our economic foundation, by assuring that the majority of our population has enough to live on… Once reasonable progress has been achieved, we should then embark on the next steps, by pursuing more advanced levels of economic development. Here, if one focuses only on rapid economic expansion without making sure that such

1 See also Part 1, Section 3.5.2.

> [a] plan is appropriate for our people and the condition of our country, it will inevitably result in various imbalances and eventually end up as failure or crisis as found in other countries…

Since this seminal speech the philosophy has been providing guidance on living for all parts of society, including guidelines on appropriate business conduct. Especially since the Asian financial crisis of 1997, the SEP has been re-emphasised as a solution to globalisation and rapid changes. In 1997, the King reiterated and expanded on the SEP; soon after, the National Economic and Social Development Board (NESDB) published an unofficial translation of the Thai working definition approved by His Majesty (Sathirathai and Piboolsravut 2004: 9):

> 'Sufficiency Economy' is a philosophy that stresses the middle path as an overriding principle for appropriate conduct by the populace at all levels… 'Sufficiency' means moderation, reasonableness, and the need of [a] self-immunity mechanism for sufficient protection from impact arising from internal and external changes. To achieve this, an application of knowledge with due consideration and prudence is essential… At the same time, it is essential to strengthen the moral fibre of the nation, so that everyone, particularly public officials, academics, businessmen at all levels, adheres first and foremost to the principle of honesty and integrity.

In essence, the SEP is a holistic concept of moderation in consumption and production, acknowledging the interdependency among people and between humans and nature. It emphasises economic growth, sustainability, human rights and security, equity and political participation. By prioritising human development the SEP accords with the UN's agenda to empower all people with choices so they may live healthy, knowledgeable and creative lives. On 26 May 2006, UN Secretary-General Kofi Annan presented the first ever *Human Development Lifetime Achievement Award* to H.M. King Bhumibol Adulyadej in recognition of His Majesty's contributions to human development. Annan lauded the SEP as being 'of great relevance to communities everywhere during these times of rapid globalization. The philosophy's "middle path" approach strongly reinforces the United Nations' own advocacy of a people-centred and sustainable path towards human development' (UN 2006).

12.2 The essence of the SEP

In 2001 a working group was convened to work further on SEP interpretation and elaboration in order to make it communicable and actionable for the general public. This group comprised the NESDB, the Crown Property Bureau (CPB) and the newly set up Sufficiency Economy Working Group (SEWG), who aimed to develop an economic framework based on the SEP.

Based on the official definition of the Philosophy described above, the SEWG conducted the work via a deductive process, 'parsing' the definition into syntactically

and semantically analysed components. Among the working group's conclusions (Piboolsravut 2009) are the following:

12.2.1 Form and function

- As an agenda, the Sufficiency Economy delivers the middle path as the 'economic life guiding principle', i.e. a secularised normative prescription and not a religious statement of faith
- In implementation, the Sufficiency Economy is scalable, with 'universal domain applicability': individual, household, community, project, business, management, institution, polity, society, nation state, region, humanity, and biosphere
- As the foundation for an economic framework, the Sufficiency Economy is complete, governing everything from motivation (utility, drives, etc.), to criteria (goals, objectives, etc.), to behaviour (production, consumption, investment, etc.), to system (collectivity, connectivity, etc.), and can be said to, at least implicitly, address all issues within a dynamic setting

12.2.2 Relevant contexts

- The Sufficiency Economy has been in effect for quite some time and was not initiated as a result of the Asian Crisis. In the present course of development, in the post-crisis environment, it has been re-emphasised as the solution to globalisation and rapid changes
- As a future course of development, the middle path remains critical, particularly now with the current process of pursuing economic and social development to keep pace with globalisation. As a promise of the future, the Sufficiency Economy ensures balance and readiness to cope with rapid and extensive changes with respect to materials, society, environment, and culture

12.2.3 Regarding the working definition

- 'Sufficiency' entails three components:
  - **Moderation**, i.e. what is 'enough', in the sense of not too little and not too much, between self-reliance and frugality
  - **Reasonableness**, i.e. evaluating the reasons for any action and understanding its full consequences
  - A system requirement for **self-immunity**, i.e. able to cope with shocks from internal and external changes

- Two underlying conditions are necessary to achieve 'Sufficiency':
  - **Knowledge**, i.e. wisdom, accumulating information with the insight to understand its meaning with care and prudence
  - **Morality**, i.e. people are to possess honesty and integrity, while conducting their lives with perseverance, harmlessness and generosity

Figure 12.1 illustrates the framework of the Sufficiency Economy. Three interlocking circles embody the three components, Reasonableness, Moderation and Self-immunity, symbolising their interconnection and interdependence. To achieve an appropriate level of the three components, one must apply appropriate *knowledge* and enforce *morality* directed towards principles that promote *security* in life and living *harmoniously* with nature and society. The SEP thereby helps strengthen both individuals' and communities' capability to maintain balance and secure readiness to cope with immediate changes and immune themselves when encountering unexpected shocks: material, society, environment, culture, technology and other types of impact.

Figure 12.1 **Framework of Sufficiency Economy Philosophy**

Source: author

12.3 Implementing the Sufficiency Economy Philosophy

Among the numerous efforts to implement and interpret the Philosophy are the valuable longitudinal experiments conducted by the King at Chitralada Villa in the *Royal Chitralada Agricultural Projects*, where knowledge collection and integration has given rise to the emergence of *New Theory Agriculture* and the establishment of the *Royal Development Learning Centres* (RDSC).

For more than half a century, the Royal Chitralada Agricultural Projects have been continuously implementing a diverse range of agricultural activities for experimentation and demonstration purposes. Starting from a small fish pond, the Projects have expanded to more diverse areas including rice fields, vegetable beds, groves, livestock enclosures, rice mills, dairy factories, small-scale industries, forestry, plant research, and bio-diesel.

Figure 12.2 **Sustainable cycle at Chitralada Villa**

Source: author

Over these decades of experiments, knowledge on integrated agriculture has been cultivated and distributed to farmers and local communities. Chitralada Villa as the initial experimental grounds has turned into a huge 'classroom', providing exemplary lessons for sustainable agricultural technology and self-supporting lifestyles. Anyone interested in the projects, including foreigners, can be admitted to

this 'classroom' for a day visit. These visits enable visitors to adopt, duplicate or adapt the relevant knowledge for implementation in their own contexts for the betterment of lives and enterprises. The projects not only aim to present comprehensible models for optimal utilisation of agricultural resources but also to appreciate the value of natural resources in order to use them economically, sustainably and sufficiently.

In particular, most projects are interrelated and self-supporting as one project leads to other related projects while by-products from one project can be utilised in others. This interrelation demonstrates how integrated agriculture systems can have the most effective and sustainable cycles (see Figure 12.2). The Projects make evident that individuals can be sufficient regarding basic needs while being sustainable regarding the biosphere.

12.3.1 Empowering individuals

As the majority of Thai people are farmers, who are poor and have limited access to basic daily needs, guidelines have been developed for an integrated agriculture system commonly known as *New Theory Agriculture*. The Theory was designed to strengthen rural households in respect to their daily living and working conducts, enabling more socially and economically self-reliant lifestyles that coexist harmoniously within their geographical and social circumstances. According to the NESDB (Piboolsravut 2000: 5), New Theory Agriculture has three stages: sufficiency at the household level, the community level, and the national level.

The **first stage** is to create sufficiency at the household level by ensuring the most basic life necessities, through providing guidelines for effective land management for housing, ample clean water, nutritious food resources and access to well-being through locally grown herbs. Application of appropriate and sustainable farming technologies must be carefully chosen, e.g. making use of interrelationships for insect and weed control; Effective Microorganism technology for fertiliser; seasonal crop rotation, and holistic agro-systems.

The **second stage** is to create sufficiency at the community level based on cooperative activities and sharing resource excess, leading to a more self-reliant community while strengthening its members by reducing living costs and generating revenue. Activities such as coops, savings groups, community enterprises, and healthcare centres help create a social safety net while achieving economies of scale as well as economies of scope.

The **third stage** is to create sufficiency at the national level. The most advanced of all three stages is achieved when communities reach out to outside sources and expand their activities across different levels of organisations (e.g. raising funds to establish a community rice mill or bank). At this stage, institutions (including private firms and governments) join hands in collaborative ways, initiating social responsibility to reach out to communities while facilitating trust among actors through institutional arrangements.

Figure 12.3 **Housewives set up a weaving business, producing fabric for national and international markets**

Source: author

12.3.2 Empowering communities

The second and third stages of New Theory Agriculture provided the basis for community empowerment programmes in Thailand. However, *New Theory Agriculture* is merely one example of a guideline that is suitable for farmers. Communities of various professions wishing to apply the SEP can develop their own guidelines or plans. The NESDB introduced *Five Stages of preparing the Community Development Plan (CDP)*, which aimed to strengthen people's participation and to build capacity for community management for community members who are already sufficient at household level. The stages provide guidelines for members to be able to collaboratively understand and analyse the community's current situation, form a shared vision and related work plan, and learn about appropriate solutions from others (Piboolsravut 2000: 6). The guiding vision can range from reducing expenditure on food by producing more crops or vegetables within the village that can lead to more self-reliance, to setting up a savings fund within the village for members to borrow from in times of need. The five stages increase learning processes among community members while governmental bodies act as coordinators or facilitators that help the communities in planning and implementing their plans. In three fiscal years (i.e. 2003/04–2005/06), over 3,000 communities prepared CDPs, with the NESDB as the main coordinating agency.

12.3.3 Empowering business sectors

The SEP was expanded gradually from the context of conducting life to conducting business, as private firms and organisations should implement the SEP in practice to encourage corporate pursuance of sustainable profits. Enterprises are urged to conduct business with ethics, honesty and integrity; to be socially responsible and concerned about the environment at every step; to be mindful in the balance of profit-sharing among all stakeholders such as consumers, employees, business partners, and shareholders; to maintain good corporate governance; and to be prudent with risk management (Sufficiency Economy Movement Sub-committee 2007: 1).

Numerous companies that survived the 1997 Asian Crisis are living proof of how SEP conducts help enhance resilience and self-immunity and have shielded them from global economic impacts (UNDP 2007: 70). These businesses include Chumphon Cabana Resort, Siam Cement Group, PTT, Toshiba Thailand, Pranda Jewelry, and Bangchak Petroleum, First Prize Winner of the Sufficiency Economy Contest in 2010.

In March 2010, the Sasin Graduate Institute of Business Administration of Chulalongkorn University published a document entitled *Corporate Sustainability Under Sufficiency Economy Philosophy*. This book interpreted, developed, and framed the SEP with respect to business and management, based on the broad theme of Corporate Sustainability, using case studies on the companies Bathroom Design, Chumphon Cabana, Nithi Foods, Nopadol Panich and Phiboonchai Mae Pranom to analyse the relevance of the SEP to the corporate sector and how the operations of Thai enterprises in a variety of industries adopt and reflect the principles of Corporate Sustainability (SGIBA 2010: 14-22). The document also proposed the use of other terms for the SEP that both contained the original connotations and were more familiar to the business community: *Reasonableness* in the SEP was thus used in parallel with Corporate Governance; *Moderation* in parallel with Sustainability; and *Self-immunity* in parallel with Risk Management.

12.4 Sufficiency Economy for all

According to the book *Sufficiency Economy Implications and Applications*, the SEP can be applied by people at all levels (i.e. household, community and nation) and from any 'group' (Sufficiency Economy Movement Sub-committee 2007: 12-31). These groups were classified as Farmer, Businessman, Politician, Government Officer and Educator. With regard to education, the book advised that a teacher or lecturer should be a role model for students by living a life based on the Sufficiency Economy, so that they can teach by example and be able to guide students to a better understanding of the Sufficiency Economy through classroom curricula and student activities (Sufficiency Economy Movement Sub-committee 2007: 29-30).

With ample examples showing successful implementation of the Sufficiency Economy Philosophy, the people of Thailand are increasingly embracing the concept and its significance. Design for a Sufficiency Economy Philosophy thus presents an important facet in the range of System Design for Sustainability and sustainable PSS design strategies.

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13

The principle of self-reliance in design for a sufficiency economy

Praoranuj Siridej
Faculty of Architecture, King Mongkut's Institute of Technology Ladkrabang, Thailand

13.1 The need for self-reliance

The severity of the 1997 Asian economic crisis was beyond anyone's imagination and experience. In Thailand it led to wider socio-economic gaps, an unfair distribution of capital, income and growth that resulted in the deterioration of natural resources and the environment and even, according to many, a decline in moral and cultural values. The Thai people and their communities suffered greatly. Those impacted the most were the ones who had nothing to fall back on—the unemployed, the poor, small businesses and marginal farmers (Tinsulanonda 2001). The concept of the *Sufficiency Economy Philosophy* (SEP) attracted attention once again during the 1997 crisis, as an economic principle to maintain stability and to recover quickly (UNESCAP 2006).

This Philosophy thereby questions the sole focus on economic growth and suggests an alternative, human-centred development approach enabling individuals to achieve *self-reliance* and an appropriate balance in their endeavours (APO 2008).

This approach requires a pause and rethinking—a return to local wisdom and appropriate technology usage to solve problems according to the particular need and local conditions and context. *Self-reliance* in the SEP refers to the ability to assess strengths and weaknesses with wisdom and knowledge and to foster appropriate tools to immunise the individual, society and country against internal and external changes.

This nevertheless does not mean a complete self-sufficient isolation from others as in 'autarky' where a country or unit relies upon itself and its people to produce all its needs with no dependence on others. Rather, villages and districts should have relative self-sufficiency and goods produced in surplus may be sold in the same region. Some have referred to the SEP as a 'Gandhian Economy', where the economy is traditionally based on the family and on small-scale enterprises. This would have been practical in India during the middle of the 20th century due to limited technology. However this practice would be inappropriate in the open world of today where there are modern needs and modern technology (Krongkaew 2003). The SEP therefore acknowledges the inevitable process of increasing global interdependence as well as the dependence of people on their natural environment through modest consumption (Sathirathai and Piboolsravut 2004). By practising the three principles (Moderation, Reasonableness and Self-immunity) with the two underlying conditions (Knowledge and Morality) of the SEP, people are able to live securely in harmony in a sustainable society and environment—with self-reliance.

The SEP recommends a secure balance in the following five aspects to achieve the principle of *self-reliance* (UNESCAP 2006).

- **State of mind**. One should be strong, self-reliant, compassionate and flexible. One should possess a good conscience and place public interest as a higher priority than one's own
- **Social affairs**. People should help one another, strengthen the community, maintain unity and develop a learning process that stems from a stable foundation
- **Natural resource and environmental management**. The country's resources need to be used efficiently and carefully to create sustainable benefits and to develop the nation's stability progressively
- **Technology**. Technological development should be used appropriately while encouraging new developments to come from the villagers' local wisdom
- **Economic affairs**. One needs to increase earnings, reduce expenses, and pursue a decent life

13.2 Applications of self-reliance

13.2.1 Self-reliance in agriculture and community development: the New Theory

In order to facilitate the individual to become self-reliant, particularly Thai farmers in the countryside with low incomes and limited access to basic daily needs, a new, sustainable system of agriculture has been developed, commonly known in Thailand as *New Theory Agriculture*. Many farmers in Thailand normally plant monocrops or cash crops that are profitable at the time, aiming to make a profit. However, these crops are highly dependent on market prices, thus increasing the farmers' vulnerability to external price shocks. Oversupply of the product reduces the price greatly, thus forcing these farmers to borrow money for reinvestment and in the worst case borrow money to buy their own food because they cannot eat their cash crops. Moreover, the heavy use of chemical fertilisers and pesticides to increase production tends to damage the environment. This type of practice is unsustainable in the long run. According to the New Theory, a family should change from mono-crop or cash-crop farming to integrated farming. With this practice, farmers, both individuals and families, would become more self-reliant, '*have enough to live and to eat*' through holistic management of their land, while living harmoniously with nature and within society. The following paragraphs explain how the New Theory Agriculture helps Thai farmers to become self-reliant at different levels.

Self-reliance at the level of the individual and family

At the family level the goal is to build a foundation where people are at least self-reliant in terms of food, after which they are expected to earn enough income from selling surplus crops and products beyond the necessary consumption of the household without taking advantage of others. This will provide basic self-immunity for farmers.

The New Theory is basically aimed at an average household size in Thailand which owns 10-15 rai (2.4 hectares), but it can also be applied to larger areas. Typically the land is divided into the proportions of 30:30:30:10 (i.e. 30% for rice cultivation; 30% for water, e.g. by digging a fish pond or water reservoir; 30% for integrated farming and garden crops, i.e. fruit, vegetables and livestock; and the remaining 10% for residential housing and other uses). As rice is a staple in the Thai household, the New Theory estimates that with such a proportion of rice cultivation, the family is guaranteed a whole year's supply of rice, thus ensuring food security and avoiding having to buy rice later at an unreasonably high price (Piboolsravut 2000: 3).

Self-reliance for communities

Community self-reliance is strengthened by individuals and families who are already self-reliant but strive for a higher level of development; the next level is

to enable neighbours within communities to come together as groups or cooperatives to pool their resources. Community members can thereby reduce their dependency on external parties, while increasing their bargaining power in the acquisition of assets and the sale of their products. Transportation and marketing costs can also be reduced through economies of scale. Production planning can be done for the community for common benefits. Community self-reliance can be demonstrated in several ways such as community enterprise or coop-based production; replacement of imported production materials with local ones; use of local experts instead of external experts; use of local wisdom to create income-generating activities instead of adopting new and unfamiliar techniques; community savings groups; reliance on local sources of funds instead of external borrowing; community self-management instead of reliance on external support; hands-on and take-charge actions instead of waiting for government assistance, as well as more emphasis on building social capital along with economic capital. These help improve living conditions and strengthen the community and their self-reliance. However, to progress to national level there must be some gradual development beyond sufficiency such as exchange and cooperation between districts, provinces and countries.

The villages of Ban Moung Wan and Koak Chareon (NESDB 2005) are good examples of how the concept of self-reliance can be applied at community level. These two communities have engaged in savings schemes and successfully reduced expenses and debt while increasing their savings. They started a micro-saving scheme with ten participants, where each member was required to save a small amount of money every week. Gradually, the number of group members reached 667 with a savings account of 7.5 million Baht. Villagers now prefer to borrow from the community savings account rather than obtain loans from an outside bank, thus creating benefits for the communities. The profit from lending is divided into two parts: one is returned to the members and the other is used for community activities. This practice illustrates the immunity aspect of the SEP, whereby people help guard themselves against external shocks, implying a foundation of self-reliance. Other examples of successful community activities that Ban Moung Wan and Koak Chareon have operated include a community shop, rice mill and car service. Part of the profits from these projects is invested in the community welfare fund, which will be used for community activities and for welfare for orphans, the poor and neglected elders.

13.2.2 Self-reliance in business sectors

The Sufficiency Economy principles are gradually being implemented in the conduct of business at all levels. Examples of enterprises that have benefited from successfully applying the SEP include the Chumphon Cabana Resort and the Siam Cement Group, Bangchak Petroleum plc, True Corporation, and SE-Education. The case of the *Chumphon Cabana Resort* is described below.

The Chumphon Cabana Resort & Diving Centre

Chumphon Cabana was established in 1982, on Thung Wua Laen Beach, Thailand. The resort decided to borrow from a bank to expand their business and build three new hotel buildings. Unfortunately the resort suffered financial difficulties during the Asian financial crisis like many other businesses. In a desperate attempt to secure the business, the owner adopted the Sufficiency Economy approach as a guideline for managing and planning within his resort. By following the SEP principle of *self-reliance*, the owner began to plant local rice, vegetables, flowers and fruit within the resort area for its own consumption: meals for guests and employees. With environmental concern in mind, the owner experimented with making organic fertiliser from hotel waste and other materials to improve the sandy land, eliminating the cost of chemicals. Later, a rice mill was installed and the husk was used in making the fertiliser and in feeding animals.

Once the resort's land was not enough to supply all its needs, the owner sought cooperation from employees and people in the village who were mostly farmers to supply the shortage and helped train them to make fertiliser and other organic farming practices. The workers have therefore been able to continue their main career while providing services during their free time to increase their income; gradually the idea of SEP was accepted community-wide.

Local production expanded beyond food to include various cleaning materials made with local resources, knowledge and technology. As production increased, these products were also supplied to other resorts in the area. The resort benefited from low production costs and reliable supplies. Surrounding farmers could secure this market, as well as good prices as there were no middlemen. The resort earned a good reputation from its successful operations, and many groups such as other resort owners, farmers, NGOs and government officials wanted to learn from this success. As a result, 'Plearn' (Play + Learn), a learning centre open to all, was established with the support of the *Agriculture Foundation* and the *Sufficiency Economy Institution*. Visitors come to observe the resort, which also gives employees a sense of achievement.

Several other projects have been initiated by the owner of the resort that show his concern towards others, their economy and the environment. The *'Pathiu rice returns home' Campaign* attempts to preserve and promote the Yellow Pathiu rice grain grown organically. Yellow Pathiu rice has been one of the most popular rice grains in Thailand, originating in Chumphon. However, its use has declined to near extinction in Thailand, as most farmers in the area now grow mono-crops. In the project *'People live, forest alive'*, participants learn how people can benefit from and live harmoniously with nature. Finally *'The great ocean' Project* focuses on the sport of diving. Chumphon Cabana's diving lessons also emphasise looking after water resources and teaching rules on how to behave in and on water.

Chumphon Cabana is thus one excellent example of a medium-sized business applying the SEP. It has shown how development can be step-by-step, starting with

a firm foundation of being self-reliant as individuals and then gradually moving up to community level and national level.

13.2.3 Self-reliance at the national level

At the national level government administrative and community leaders play an important role in developing the country. The Government of Thailand has thus far applied the SEP in designing policies (UNDP 2007), especially those that help alleviate poverty and encourage communities to be strong and self-reliant. An example of self-reliance at national level is described in the following section.

Doi Tung Development Project

The Doi Tung Development Project (DTDP) is a renowned project managed by the *Mae Fah Luang Foundation* (MFLF), a not-for-profit development foundation that aims to improve the quality of life of Thailand's ethnic minorities and to provide them with sustainable and licit livelihoods.[1] The model for development known as Sustainable Alternative Livelihood Development (SALD), a people-centric approach, was developed from this work. In SALD, the focus is on three pillars: health, livelihood development and education.

The remote mountain areas of Doi Tung in northern Thailand are inhabited by ethnic minorities, approximately 11,000 people in 29 villages, many of whom earned a living from opium cultivation, slash-and-burn agriculture, and trafficking in humans and arms. Progressing through a 30-year plan with the long-term goal of community ownership, the DTDP tackled health by bringing volunteer doctors to the region. Livelihood creation took the form of a quick response in reforestation jobs, turning opium farmers and agricultural subsistence workers into forestry workers. This immediate wage-paying activity had a beneficial short-term impact which helped to earn the trust of the local community (Diskul 2010). Education will lay the foundation for long-term development and will lead to the sustainable elimination of poverty.

Sixteen years later, reforestation has been successful, greatly improving the environment. Opium cultivation has been eradicated and replaced by coffee and macadamia crop cultivations. One key success factor of the SALD model to improve the quality and productivity of the work is to instil a sense of ownership among local communities. The DTDP allowed local people to rent coffee trees for half a baht (approximately US$0.01) per tree per year. The farmers and their families took pride in caring for the plants because the more quality coffee they produced, the more they could earn. In addition, in order to minimise risk from solely relying on one enterprise, other business units were set up including tissue culture, horticulture and factories producing mulberry paper, ceramics, carpets and woven cloth.

1 See www.doitung.org.

Since 2001, the DTDP has been financially self-sustaining. By 2017 the Mae Fah Luang Foundation will transfer the businesses back to the local communities when their economic viability has been demonstrated and when the local population has the capacity to manage them on their own.

13.3 Conclusions

In order to build a firm foundation for sustainable development, it is important to encourage and empower people to create their own objectives and develop the skills, knowledge and resources they need to become more self-reliant. This is because those individuals, communities, businesses and nations who are able to earn their living and support themselves with adequate means based on their own knowledge and moral strength are capable of meaningfully contributing towards higher levels of development and better able to face a certain degree of uncertainty without relying too much on others.

The examples in this chapter show that being self-reliant in the SEP does not mean complete isolation from others; rather individuals, communities and businesses rely very much on interactions among various stakeholders. Sufficiency Economy designers must be able to assess the strengths and weaknesses of the users (an individual, a community, an enterprise or a nation) and analyse how they conduct their lives and their businesses. Then, taking into consideration their particular need, the local conditions and the context, designers must be able to formulate a suitable Product-Service System design strategy that promotes self-reliant practice for the long-term well-being of both humanity and the planet.

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14

MATTEROLOGY

A Chinese method for sustainable design thinking*

Liu Guanzhong and Liu Xin
Academy of Arts & Design, Tsinghua University, China

14.1 Introduction

Today's Chinese society differs completely from the Western industrial society into which industrial design primarily emerged at its birth. History and our contemporary era do not allow us to repeat the Western developmental path, and we must learn from the experiences and lessons in the process of Western development. We stand on the shoulders of the giants of human civilisation and should look much further than the giant. Therefore, we must combine the essence of the long-standing Chinese civilisation with Chinese wisdom, in order to seek our own ways towards sustainable development.

Wen Jiabao, Premier of China, proposed to 'attach great importance to industrial design', the first time that Chinese leaders confirmed the importance of design in economic development which also indicates that the research and practice of Design for Sustainability deserves widespread recognition and

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attention. How to construct a design theory for sustainability in the context of today's China and effectively guide design innovation is a major topic of design research. This means that design should satisfy human sustainable development as its guiding ideology; should create a reasonable and healthy mode of life for people and a living environment in harmony with nature as its goal; should make full use of high technology as its means to regulate the alienation of market mechanisms; and should at the same time protect human cultural heritage, benefit the majority of people, and create more rich and colourful lifestyles. This situation offers the opportunity and social basis on which to develop a new 'design science', MATTEROLOGY, which pushes the ontology, epistemology and methodology of industrial design to evolve, to go beyond its conventional meanings. It also makes it possible for us to take industrial design into a national policy of sustainable development, construct a harmonious society, and create our own new culture of a knowledge-based economy.

14.2 The significance of industrial design in contemporary society

The survival and development of humanity not only entails the basic necessities of life, but also relates to sweat on the forehead; calluses on the hands; contact, communication and understanding between each other; interaction and symbiosis with nature; emotion (fun, pleasure etc.) and sentiment generated from the rhythm of organised behaviour and a unified ideological harmony when people work together and cooperate to create artefacts; and the respect for nature and all existing things. Any social progress is first represented by the progress of morality, social customs and the political system, which is attributed to scientific development and cultural progress. This is a reflection of the reality of social development in current China as well as the reality facing industrial design.

First, we must understand that any artificial thing usually starts from three levels: the object layer, the organisation layer and the concept layer (Figure 14.1). The same object thus results in completely different conclusions or interpretations because of different observers' standpoints, perspectives, thinking levels, etc., or due to different motives, processes, concepts, methods, techniques, tools, effects and so on. Language contains these layers: as a symbolic and unique system of communication, Chinese characters have both 'pictographic' and 'semasiography' features, which integrate subjective imagination and meanings into the texts. And according to Chinese traditional thought every thing in the world should be treated holistically and comprehensively.

Figure 14.1 **Design's relationships and mechanism**
Source: authors

Concepts are constantly evolving as social backgrounds and social relationships change. 'Industrial design' simply originated in the process from the 'handicraft economy' to the 'industrial economy'. Industrial design as originated in Germany resulted from the changed social system on the economic basis of large-scale production and division of labour due to the Industrial Revolution. The establishment of the Deutsche Werkbund with the support of the government symbolised 'industrialisation' in organising the German economic mechanism. Modern Design, the newly emerging phenomenon from the Industrial Revolution, was a kind of 'productive relationship' which was expedited to solve the problem that the small-scale productive mode could not be adapted to the large-scale mode. Design is a way of working that is instructed by lateral thinking, conducted with a method of integral systemisation, and reflected in the unification of a series of processes such as creation, plan, procedure, and outcomes. Its radical purpose is to coordinate conflicts between various types of labour, various professionals, and various interest groups in the production chain. This is precisely the goal and essence of industrial design. However, industrial design is easily interpreted narrowly as the 'design of industrial products' because its early work involved mainly products. In addition, there have been a large number of new products since the industrial revolution that have an entirely different appearance compared with handicrafts. Therefore, it is also not uncommon that industrial design can be superficially misunderstood as beautification of product appearance. This has weakened or impeded an appropriate understanding of the essence of industrial design: 'the ideas and methods of design activities in the industrial era'.

Therefore, the essence of contemporary Design for Sustainability should be the reconstruction of the structure of the knowledge and industrial chain, the integration of resources, and the innovation of industrial mechanisms, in order to guide the demand for healthy, reasonable and sustainable survival and development of human society (see also Guanzhong 2009a, b).

14.2.1 *Yuan* (origin) and *Ben* (primacy) of design

The abstract meanings of things can be similar:

- Washboard, washing machine, self-laundry station
- Abacus, computer, computing centre
- Broom, vacuum cleaner, cleaning service
- House, building, district, city

These things have a common 'purpose': either for clean clothes or for calculation, for eliminating dust or for living. This is the invariable *content* of design, i.e. *Yuan* and *Ben*. Design is always innovative and always visibly demonstrates change, but we should not forget its eternal core: creative social activities for the future and with purpose for human beings.

Design is thus the entire social process of purposeful activities, during which people always try to adapt and transform nature for survival, create and use tools, and make dreams a reality in practice. People also try to transform themselves simultaneously in the process of transforming nature and create a human society in harmony with nature. Design is therefore a kind of creation behaviour, which creates a somewhat more 'reasonable lifestyle'. This formulation may seem abstract: not as concrete as what technical experts expect, such as product designs or form design. Once a design has been constrained to an object, creativity has been fettered by the concept of the object.

Industrial design is the thought and revision of industrial civilisation based on human culture and the sublimation from designing 'objects' to designing 'matters'. Therefore, industrial design may 'plan matters', a brand-new design of the social system: this may be the concept, plan and development of a lifestyle such as the activities related to work, studying, diet, entertainment, leisure, and communication.

14.3 Shift from designing 'objects' to designing 'matters'

The natural system is dynamic and vibrant because everything within this system is constantly changing in a process of adapting (the external factor) and adjusting its own features (the internal factor) to be able to multiply. We call it 'survival of

the fittest', 'each in its proper place'. Anything in nature could not exist if isolated from the external environment and other species in the food chain. The existence of nature and all things on earth form the structure of the overall system. Each individual 'object' within this system has an external factor and countless relations with others. This truth is the beginning and foundation of research in any discipline.

The most important feature of humans distinguished from other creatures is our ability to transform nature and create a second nature with artificial things, namely humanity's social system. However, each invention, development and progress at any particular time in the history of material civilisation has been influenced by the whole background of human society at that time. Although humanity's material civilisation may derive from different ethnicities, different regions, different climates and different times, it still follows the laws of 'survival of the fittest', 'each in its proper place'. The inventions and creations of humans cannot violate this law, which includes the axiom that we always talk about 'learning from nature' (Figure 14.2).

Figure 14.2 **The human social system**

Source: authors

Design's agenda is to 'create a more reasonable mode of life' for humans, and its most prominent feature is to constantly 'innovate'. The 'new' is not to fussily add high-tech, to superfluously beautify and decorate. The sustainable development of human society, the earth's limited resources, and constraints on any ideal of infinite expansion of 'individuality', all force us to understand profoundly that the evaluation criteria must be *appropriateness* and *moderation*: in other words, 'enough is enough', as in ancient Chinese philosophy. 'Creating' new things on this evaluation platform means that we will learn to find, analyse, judge, solve problems and evaluate the solutions from the entire life cycle of 'artificial things', the essence of a systematic industrial design method.

14.4 Design MATTEROLOGY in a knowledge economy

14.4.1 Design MATTEROLOGY

Design MATTEROLOGY aims to establish the target system of design through exploring the 'external factors' of limited things, then choosing and reorganising the 'internal factors' of new things to achieve the new goal of design innovation (Figure 14.3).

Figure 14.3 **MATTEROLOGY and the target system**

Source: authors

Design MATTEROLOGY is centred on 'problems': relations or conflicts produced when elements of design are interwoven. The way to investigate problems is often to build a pattern of problem solution. If the research on the *external factors* that constrain the target system of design is not clear, however, design will lose its direction. Such blind 'trial-and-error' is inefficient. Therefore, design needs to develop its own methodology to explore the external factors and make the design goal clear.

'Matters' refer specifically to behavioural interaction or informational communication between people or between people and objects in a particular time and space. *Meaning* is generated from human consciousness in the process; therefore objects result in a 'change' of states and properties. The 'matters' involve people, objects, the background and the relations among the three factors (via behavioural interaction and informational communication) and reflect the context of time and space. People's underlying motives, purposes, emotions and values can be identified through matters. Therefore, matters are a more complex system; there is a dynamic reflection of 'dominant relations' and 'hidden logic' among people, objects and the environment. Matters can be regarded as a 'relationship field', from which the clue to the rationale for the existence of objects can be detected.

'Matter' is the sum of external factors that shape, limit and constrain 'objects'. The first step is to explore the needs of different people (or the same person) under different conditions, environments, times and so on, to establish the aims of design by observing the state of use and the process of use. The second step is to choose the principle of creating 'objects', materials, techniques, equipment, forms, colour and so on, the internal factors. 'Being practical', i.e. the first step, concerns finding and defining the problem, while 'seeking the truth', the second step, entails solving the problem. Then, the solution is taken back to 'matters' to test whether it conforms to the specific purpose, whether it conforms to behavioural habits, emotional needs and cognition patterns, or whether it conforms to the environment and values. MATTEROLOGY thus comprises all these thinking methods and illustrates that design does not mean creating something new. Paradoxically, it means being reasonable and rhythmic.

MATTEROLOGY research may be roughly divided into two levels: micro- and macro-research. Micro-research aims to grasp the relationship between various elements in the concrete situation, to understand how people perceive the external world, how people interact with the external world, and how people are affected by the external world: to find problems and to provide the basis for the detailed design. Macro-research explores the form of life. People and microscopic matters, which have been organised together by structure, form a macroscopic 'lifestyle'. Such research sheds some light on how people live, what is acceptable, and what their hopes and dreams are. In this sense, what design creates is actually people's mode of life. MATTEROLOGY is also characterised by the aspiration to explore new knowledge and develop innovative directions and even reorganise structures of knowledge, reorganise the *system* of resources and knowledge, and satisfy the potential needs of human development. Therefore, the way the mode of technology guides people's demands in the traditional industrial society would be reversed

such that the people's ideal demands guide the direction of scientific and technological development.

MATTEROLOGY, i.e. a 'methodology of artificial things', regards design as a scientific, complete system, which has revolutionary implications in this crucial era. Emerging economies, especially, are expected to focus their attention not only on raw materials and new technology, but to seek sustainable economic development, transforming ideas, seeking growth points and a more effective and innovative system and structure of knowledge.

14.4.2 Design MATTEROLOGY's core idea and methodology

Design MATTEROLOGY is defined as combining traditional Chinese thoughts with modern design ideas and is devoted to design solutions to current Chinese problems. It not only reflects the essence and connotation of sustainable design and sustainable PSS design, but also is acceptable to Chinese culture. Exploring this process, which is specified by factors beyond 'matters', involves localisation of the 'target system', of 'doing things', which is also the basis of **internal factors** such as evaluation, choice, integration principle, materials, technology, structure, organisation, and style, as well as leading the innovative driving force of those internal factors and creating 'new' species, 'service systems' or Product-Service Systems. Understanding **external factors** that solve problems entails the correction or 'revolution' of existing human productions or a service's 'target system'. The evaluation criteria for design MATTEROLOGY is derived from ancient Chinese philosophy: 'using but not possessing' and 'enough is satisfaction', where *appropriate*, *moderate* and *suitable* are sought characteristics, rather than the infinite pursuit of materials and optimal solutions.

14.4.3 Case studies

Two selected projects involving the authors are described in this section for reference. The introduction focuses on the process and methods based on design MATTEROLOGY, rather than only reporting the design findings.

Chopsticks Project and COOK-BAR

The Chopsticks Project is a cross-cultural research project[1] that aims at understanding consumers' daily habits and behaviours in different cultures in food preparation and consumption at home. Therefore, the 'matter' of 'Man–aim–environment'

1 The project was co-sponsored by the Hong Kong Polytechnic University and Hong Kong Design Center, the Beijing area led by Professor Liu Guanzhong, the Academy of Arts & Design, Tsinghua University. The final results of the project were published during Business of Design Week in Hong Kong, 2004. See Lam 2006.

is analysed to find problems and design opportunities and finally to put forward an innovative system solution. The target group of this study was a number of middle-class families in selected Asian countries and regions (the Chinese mainland, Hong Kong, Japan and Korea).

The project was divided into two main parts: an early user study (investigation and analysis of external factors) and later concept design (internal factors' integration and creation). In the user study, the project team gathered and classified a great deal of food-related data through a literature review to find the characteristics of food culture, trends, cooking methods and people's behaviour in modern society. After the positioning study of the middle class in Beijing, the project team selected ten sample households and began the user study with mainly sociological and ethnographic methods such as questionnaires, photo diaries, observation, video ethnography and in-depth interviews. Through an extensive collection and analysis of the background as well as an in-depth study of consumer lifestyles, a system of dietary needs of a middle-class family in Beijing was ultimately identified. Therefore, key insights were proposed and design-related opportunities were identified as the foundation of the later concept design.

COOK-BAR is one of the five solutions proposed by the Academy of Arts & Design, Tsinghua University, in the stage of concept design, aiming to meet the requirements of the target members and furthermore create a new self-catering system to both inherit and develop traditional, healthy and frugal eating habits in China. COOK-BAR focuses on the following problems: fast-paced lifestyles leading to the prevalence of a fast food culture, and in turn over-reliance on fast food that adversely affects people's physical and mental health. Food preparation is very time-consuming for most of the Chinese middle class. Dining in restaurants is becoming the first choice for urban office workers, but most restaurants cannot guarantee green and healthy food and often imply high prices and much waste. Based on a deep study of these problems and analysis of the constraints of the 'matter', the COOK-BAR food product-service system was proposed, which encourages consumers to cook and enjoy food themselves. People can have fun cooking Chinese food and share their cooking skills with family, neighbours and friends to enhance their close relations. In addition, it guarantees healthy, delicious and adequate food. The new system encourages users to enjoy shopping, food preparation, cooking and eating experiences based on an advanced digital/management system, which makes e.g. the tedious job of cleaning a provided service. It also provides services such as culinary training, cooking assistance and nutrition consultation. It differs significantly from traditional supermarkets and restaurants.

Young Generation Contact and EASY-RIDE

This project was derived from a cooperative project between the Academy of Arts & Design, Tsinghua University, and Nokia Research Center on Young Generation

Contact.[2] It aimed to study the lifestyles, needs and design opportunities related to the 'Contact' of young Chinese in urban areas and propose a concept design accordingly. EASY-RIDE[3] is one of six system design concepts.

The project was divided into three steps. The first two steps involved an intensive study on the external factors of the target system. The first step was to define the concept, the research scope, and Young Generation Contact, to compare and study the characteristics of young people's contacts horizontally (between age groups) and vertically (chronologically) and then to further define the subject as 'Mobile Virtual Contact'. The second step was to conduct a literature review on the features, basic patterns, applied technologies and behavioural processes of Mobile Virtual Contact to outline specific interviews. The project team carefully selected 14 sample target users for field study. Methods of the user study included photo diaries, interviews and observations. Finally the project team obtained many significant findings indicating that an arising and developing *Pin* and *Shai* phenomenon in the young generation deserves our attention. The findings especially indicated design opportunities.

As a social behaviour, *Pin* (sharing) has a long history in China. It has become popular in recent years and can partly be traced back to illegal *Pin Che* (or *Pinker*) (car-pooling) among private car owners. *Pin* means to complete a task or activity in a group and realise individual profits and goodwill by earning collective profits and goodwill. People in this group may be friends or strangers. The purpose is to share costs, discounts, happiness, and experience, express oneself and strengthen and expand social relations. *Shai* (a word that is difficult to translate into English) not only has the same meaning of share and show but also a sense of ease (like 'lying in the sun'), non-individualism and exposing the truth. If *Pin* is more focused on economic concern, *Shai* emphasises spiritual fulfilment.

After a sufficient study of external constraint factors, the project team selected six directions for creative design and system improvement. The ultimate goal was to guarantee the sustainability of the new Product-Service System, i.e. to find more efficient solutions and save more resources while satisfying the needs of the target users and identifying appropriate profit models to attract enterprises. The EASY-RIDE service system aims at solving the commuting problem of young office workers in urban areas. The original inspiration for this concept comes from the following issues. First, the public transport system in some regions of China is not complete. It is not convenient for young office workers to take the subway or bus in their daily commuting. Second, although private cars can ensure comfort, they cause heavy traffic jams and air pollution. The rising price of oil also increases the

2 This project was one of several long-term cooperative research projects of the Academy of Arts & Design, Tsinghua University, and Nokia Research Center, led by Professors Cai Jun, Liu Jikun, Liu Xin and Researcher Wang Wei from the Nokia Research Center jointly. The project lasted from 2009 to 2010.

3 The EASY-RIDE PSS concept was designed by Liu Qing, Li Jian, Hanwei, Li Bai and Wang Yu, students of Tsinghua University. See Xin 2010.

financial pressure on the users. It should be noted that 3,000,000 vehicles run on the road in Beijing every day, but 2,400,000 are single-occupied. Third, because of the problems above, *Pin Che* (car-pooling) appears in some regions, but it lacks effective management, hardware devices and software systems. Furthermore, there is no fair pricing system or credit mechanism, which may easily cause disputes.

EASY-RIDE aims to tap the potential of car-pooling in urban transportation and use modern communication and network techniques to rebuild a new car-sharing service system, as well as to integrate a public supervisory mechanism with the idea of *Shai*. The system first builds a car-pooling service network platform. Drivers willing to provide transport services and passengers willing to take another's vehicle can register as members. The service system would identify its members and provide mobile terminal application software to ensure easy and timely use. The EASY-RIDE platform provides for its members such services as travel information and settings of travelling preference, search, fast identification of travel routes, matching, mobile payment, security monitoring, information communication, credit rating, invoicing, and taxation. After each *Pin Che*, the service platform charges a certain amount of money from clients via online payment; passengers will spend less than taking a taxi to reach their destination and may get to know more young friends on the way; and drivers can reduce operating costs significantly and efficiently decrease the chances of no passengers. The resulting potential environmental benefits (reducing pollution and congestion) and social benefits (new morality and consumption concepts to encourage sharing but not possessing) are also considerable. EASY-RIDE as a new product-service system is thereby a win–win solution for different stakeholders, which not only fully satisfies the needs of the users, but also ensures social, environmental and economic benefits.

14.5 Conclusions

'A workman must first sharpen his tools if he wants to do his work well'. Powerful tools are the bulwark of the goal. Technology and modelling are selected as the means of achieving the goal, whereas the goal is to deal with 'matters'. 'Matter' is the relationship of the existence rationality of 'thing' and 'technology'. Therefore, the essence of 'design' is to explore, find and understand the relationship of 'matter', thus finding a reasonable 'solution'.

Design science may be divided into two sub-disciplines: determining the target system and reorganising problem-solving methods, further boiling down to 'goal–means'. Design in the information era and knowledge economy will focus on exploring the 'mode innovation' of goods, process and service, in other words, planning 'matters' whose research is meaningful both in theory and practice. Design will be defined by such concepts as 'integration'.

'Context' is interpreted as the continuation of meaning, with technology and forms as means. However, if we pay excessive attention to means, it becomes the

goal. 'People often stay on the bridge leading to the final value but forget the final value.' This is how means colonise the goal. When the context where culture exists has changed, as it has in today's world, we will need designers to create a new culture by Design for Sustainability.

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15

Modern Product-Service System design and the concept of an ecological civilisation

A traditional Chinese view

Zheng Shuyang
Academy of Arts & Design, Tsinghua University
Sustainability Design Research Institution, Art & Science Centre, Tsinghua University

15.1 Design culture as a worldview

The concept of harmony and sharing between humans and nature runs through the history of Oriental culture and affects the formation of its view of design culture. In traditional Chinese philosophy, the relationship between humans and nature is fundamental, namely the so-called 'interrelation between heaven and human'. Here heaven refers to the extensive objective world as well as the natural world and this relationship is mutually beneficial. Xuzi, who lived during the period of the Warring States, first pointed out in *Tian Lun* (*Xunzi's Theory of the Relationship between Heaven and Human*) that, 'he who understands the respective functions of *Heaven* and Man may be called a perfect man'. Xuzi thought that nature has its own operating rules; will not survive or perish because of man; is not necessarily linked to poverty, diseases and disasters of human society; and cannot decide humanity's destiny. Laozi, the first philosopher of Taoism, pointed out that,

> It is the way of Heaven to offer where there is a great abundance and to supplement where there is deficiency. This is not so with men's way. He takes away from those who have not enough to serve the powerful and the rich…

and suggested that man should obey nature.

The theory that man is an integral part of nature was first proposed by Zi Si and Mencius.[1] They believed that humanity is in communication with heaven, and the innate goodness of humanity is bestowed by heaven. Man can understand heaven if he concentrates his mind on understanding his own nature to become one with heaven. Zhuangzi thought that, 'Heaven and earth co-exist with me, and I am identified with everything in the universe'. This unity was only destroyed by humanity's subjective differentiation. Thinkers after the Song Dynasty mainly elaborate views by Mengzi and *The Doctrine of the Mean* by demonstrating the unity between human and heaven from the perspectives of 'reason', 'nature' and 'life'. Wang Fuzhi who lived during the late Ming and early Qing Dynasties (in *Commentary on Zhangzi's Correct Discipline for Youth Taihe*) stressed the need to 'contribute to the way of nature', 'take control of one's own destiny' and 'put the way of man before the way of heaven'.

The theory that humanity is an integral part of nature therefore strives to highlight the connection in an attempt to achieve coordination, harmony and consistency between them (Xincheng 1999: 1486). A view of design culture based on such a philosophy and the buildings, gardens, and urban planning nurtured by such a concept reflect the particularity given by cultural connotations. Buildings combined with the natural environment set off and complement each other; gardens with their natural landscape patterns reflect profound artistic conceptions.

The concept of humanity as the *master* of nature, in contrast, runs through the history of Western culture and affects how its view of design culture has been formed. In the traditional foundations of Western culture, humans are the wisest of all creatures, the centre of the universe; everything else is arranged for the benefit of humanity, subject to humans' needs and at humans' disposal. Plato (427–347 BC) said in *Theaetetus* that, 'Man is the measure of all things, of the existence of things that are, and of the non-existence of things that are not.' Aristotle (384–322 BC) in *Politics* wrote: 'Now if nature makes nothing incomplete, and nothing in vain, the inference must be that she has made all animals for the sake of man.' Francis Bacon (1561–1626) said in *Prometheus* (*Of the Wisdom of the Ancients*) that,

> Man, if we look to final causes, may be regarded as the centre of the world; insomuch that if man were taken away from the world, the rest would seem to be all astray, without aim or purpose, to be like a besom without a binding, as the saying is, and to be leading to nothing. For the whole world

1 Note: Use of the word 'man' in place of 'human' or 'humanity' has been retained in parts of this chapter, for example, to retain the integrity of an ancient text. The intent is not to emphasise gender bias.

> works together in the service of man; and there is nothing from which he does not derive use and fruit.

Kant (1724–1804) proposed in the *Critique of Judgment* that,

> Man is the ultimate purpose of creation here on earth, because he is the only being on earth who can form a concept of purposes and use his reason to turn an aggregate of purposively structured things into a system of purposes.

Design culture in the West is also nurtured by this type of philosophy. Buildings with their upward stretched forms display the power of humanity and gardens with their regular geometric figures reflect the will of man.

As the world enters the 21st century, a mode of social operation led by a global market economy has resulted in a comprehensive orientation of design culture in China towards the Western world, including the environment-polluting and high-carbon design standards of Western 'developed' countries. However, continuing this orientation 'will not only affect the harmony of the world, but also lead to internal discord' (Xiaoyi 2010: 3). Abandoning anthropocentrism and carrying forward the traditional Eastern cultural view that 'man is an integral part of nature' is of universal value in the world's transition towards an ecological civilisation.

15.2 Acceptance of the *essence* and rejection of *dross* in traditional culture

How the environment was viewed in the context of traditional Eastern culture gave birth to the farming civilisation; in contrast the view of the environment in the context of traditional Western culture initiated industrial civilisation. The spectacular leapfrog development in modern Chinese history enabled us to take a direct step from the social form of farming civilisation to the post-industrial civilisation of the information age. Old traditional concepts with worthless elements, i.e. 'dross', have not yet been completely broken; new concepts in line with sustainable development strategies have not been promptly established. Meanwhile, we easily discarded old traditional concepts with valuable elements, i.e. 'essence', and quickly accepted the values created by Western cultures without distinction, leading to many obstacles to the implementation of sustainable design today.

Contemporary China is at a crossroads of development: we need to achieve sustainable and harmonious development while re-examining the choice between the *essence* of Western industrial civilisation and our own traditional civilisation. China's national development strategy is to reach the level of moderately developed countries by the middle of this century. The report of the 17th National Congress of the CPC proposed in a historic move to 'construct an ecological civilisation' and build a moderately prosperous society in an all-round way by relying on a path of

scientific development. This so-called 'moderate prosperity' aims to have a slight surplus in all aspects of life on the basis of meeting people's basic needs for food and clothing. In other words, this is an intermediate state between poverty and affluence, which is not yet an internationally recognised level of middle class and certainly cannot be measured by the so-called material standard of 'having a house and car', for that is not in line with China's national conditions. With China's population and natural conditions taken into consideration, it will be a difficult target to achieve if every Chinese person cherishes the 'American dream' and takes the middle-class way of life of the United States as a relatively comfortable standard of living; therefore the positioning of the core standards must be moderate.

The Chinese word *Du* (度) expresses a sense of propriety, temperance, etiquette, balance and harmony. *Du* in philosophy means that a certain object maintains a quantitative limit on its quality. An increase or decrease in quantity within this limit does not change the quality of the object while exceeding the limit will lead to a qualitative change. From the perspective of tradition and culture, *Du* is a concise expression of the ecological wisdom of the East, and the virtue of moderation in everything has been passed on from generation to generation in traditional Chinese cultural education. This concept of moderation or 'thriftiness' is precisely the *essence* of traditional Chinese culture, while the concept of immoderation is 'extravagance', which is the *dross* of traditional Chinese culture. Explanatory notes to both can be found in the concept that 'man is an integral part of nature'.

The prevalence of consumerism and materialism, however, has become a specific manifestation of 'economism' in contemporary social and cultural operations. Under the guidance of economism, humankind has adopted a 'mass production–mass consumption–mass rejection' mode, a mode of production and life that has caused a global ecological crisis. Under the conditions of a market economy, production operators aim at maximising profits, tend to plunder natural resources destroying the ecology and environment, and consequently jeopardise the public interest. In such circumstances, design revolving around products under the banner of innovation will become an accomplice in wrongdoing. Such a design concept built on the basis of consumerism and materialism clearly goes diametrically against the sustainable development principle of rationalising the allocation of resources and energy to the maximum.

> The core of sustainable development thinking lies in correctly regulating two basic relations: the first is the relationship between 'man and nature'; the second is the relationship between 'man and man'. It requires man to regulate his own behaviour with the highest level of intelligence and a sense of moral responsibility to create a harmonious world (Sustainable Development Research Group 2000: 12).

Sustainable design oriented towards an ecological civilisation needs to be regulated in the three aspects of 'human and human', 'human and objects' and 'human and environment' to reach three ideal states.

The first state is the communication principle of treating each other with kind-heartedness and interpersonal equality for the relationship between 'human and human'. The second state is the value target of cherishing objects and making the best of everything for the relationship between 'human and objects'; the third state is a constructed positioning of respecting nature and living in harmony for the relationship between 'human and environment'.

15.3 Connotations of the concept that 'man is an integral part of nature'

It is clear that the concept 'man is an integral part of nature' belongs to the traditional ecology of farming civilisation and is in line with China's feudal social and political rules. It connotes both complete harmony between humans and heaven as the highest ideal and the relationship between humans and society as the highest state of personal perfection. For contemporary China, cultural transmission of such a concept is obviously a selection process of extracting the essence and discarding the dross. However, fellow countrymen still adopt an 'other-worldly' attitude towards the relationship between 'man and nature' and a 'this-worldly' attitude towards the relationship between 'man and society'. As a result, protection of the natural environment is but an abstract concept, while economic operation of society is a concrete reality.

This point can be fully verified by comparing traditional and contemporary building construction. The Imperial Palace (Forbidden City) in Beijing is a typical case in architecture that declares the worldview that 'man is an integral part of nature' by using the concept of feudal imperial power. The Forbidden City as the imperial palace of the Ming and Qing dynasties is situated on the central axis of Beijing city, which starts from the Yongding Gate in the south and reaches the bell tower in the north. It starts from the Great Ming Gate of the forecourt of the Forbidden City, runs through the Thousand-Step-Corridor, passes over the Golden Water Bridge, enters the Gate of Accepting Heavenly Mandate, goes through the Upright Gate, then enters the Meridian Gate and Gate of Supreme Harmony of the Forbidden City; passes through the Hall of Supreme Harmony, the Hall of Central Harmony and the Hall of Preserving Harmony, goes through the Gate of Celestial Purity, the Hall of Union, the Palace of Earthly Tranquility and the Hall of Imperial Peace, and finally cuts through the Gate of Divine Might and proceeds northward (the full length from the Great Ming Gate to the Gate of Divine Might is more than 2,200 metres). The incomparably spectacular, neat and symmetrical combination of two-way axial and lateral expansion forms an overall pattern of halls in the front and sleeping places in the rear. The core of this axis is undoubtedly the throne displaying imperial power in the Hall of Supreme Harmony. It is on such a coordinate that the general layout of the Forbidden City was designed. The distance from the

Great Ming Gate to this point is twice the distance from this point to the Gate of Divine Might. The power and influence of the emperor, the impressive manner of the Son of Heaven and the momentum of the sovereign descending the world are fully explained by the spatial sequence of buildings (Shuyang 2008: 12).

Today, almost all the numerous administrative office buildings found all over the country try to imitate the spatial and temporal sequence of the Forbidden City. Buildings with large facades and grand dimensions in inner courts are situated on squares that occupy a considerable expanse of land and whose central axis layout is incomparably vast. However, government agencies that 'serve the people' do not need a spatial arrangement for accepting people's worship. As a result, in actual social operation, the gates of many buildings are tightly closed all day long, while their side doors become passageways through which thick crowds of people pass. The waste of land and building space is staggering and entirely contrary to China's strategic positioning for sustainable development.

15.4 A branch of knowledge dealing with environmental selection: the theory of *fengshui*

Fengshui is also known as 'geomancy'. According to the explanation in the *Cihai* (Xincheng 1999), it 'considers that conditions including wind directions and water flows around homesteads or graveyards may bring bad or good fortune to families of people living or buried there'. Liu Peilin reminds us that 'In the course of thousands of years of civilisation in China, *fengshui* has always been synonymous with Chinese people's pursuit of an ideal environment' (Peilin 1995). At the very least *fengshui* is a branch of knowledge dealing with 'environmental selection'; that is to say, 'only if mankind selects an appropriate natural environment, can they bring advantages to their own survival and development' (Peilin 1995). *Fengshui* as a combination of philosophical theories and architectural practices is congruent with the concept of environmental design: it pays attention to the interaction between humans and the environment, and such a relationship is similarly expounded in the concepts of 'human geography', 'behavioural geography', and 'environmental psychology'.

China's *fengshui* thinking emphasises the harmony between humans and nature and stresses the fact that humans and the earth are an organic whole. In his book *Science and Technology in China*, Tong B. Tang pointed out that, 'Chinese tradition is holistic and humanistic and does not allow the separation between ethics and aesthetics. Reason should not be separated from goodness and beauty' (Tang 1984). *Fengshui* ideology and culture are guided by the ancient Chinese yin-yang theory, where yin and yang are the origin of everything in heaven and earth and the changes of nature are deduced from the universal phenomenon of intercourse

between human beings and between animals for the purpose of producing offspring. It is from such a fundamental point of view that the science of *fengshui* built upon the yin-yang thinking in classical Chinese philosophy comes to understand earth and terrain. The theory of *qi* in *fengshui* theory, based on the premise of yin and yang, is an important ideological pillar: *qi* is a kind of invisible and continuous substance in *fengshui*. The view that heaven comes from *qi*, earth comes from *qi*, man comes from *qi* and all things come from *qi* reflects the ancient Chinese concept of organic nature, that the earth is a living being. Since heaven, earth and humanity are all generated by *qi*, there must be some commonality between them; moreover they may also communicate with each other telepathically. This view of natural telepathy between heaven, earth and humanity inevitably led to creation of the theory that the earth is organic. The value of *fengshui* is precisely built upon this premise. In fact the result of modern scientific research has proved that the earth's ecosystem is an interlocking organic chain; once a link has problems, the entire organism will certainly be affected.

The goal of *fengshui* is to select an environment conducive to the development of people's production and life. An ideal place that is precious geomancy-wise shows a kind of 'wind-storing and water-acquiring' environment model. An ideal place to live is surrounded by mountains and girdled by rivers among lush vegetation. In ancient *fengshui* texts such as *Ten Books on Dwellings of the Living*, it is written that, 'people's dwelling places should be mainly mountains and rivers on earth'. Dwelling sites 'fronting water and with hills on the back' became a typical environment model for folk houses in ancient China, especially guided by the ancient Chinese concept that 'houses are the foundation of man'. Much attention is to be paid in folk house interior arrangements to sitting positions and orientation towards mountains and outdoors to courtyard function and drainage rules. In short, the goal of *fengshui* is the highest ideal pursued by today's environmental design; both are different in approach but equally satisfactory in result. *Fengshui* as an environmental selection theory therefore involves the consideration of many factors such as ecology, landscape, security, behaviour and psychology.

15.5 The science of *fengshui* and modern Product-Service System Design for Sustainability

As global environmental problems become increasingly severe, experts and scholars in various countries and industries have turned their attention to the East, based on the wish to study *fengshui* in traditional Chinese culture. Although it is a tradition of the Eastern world concerning environmental selection, its in-depth embodiment of the essence of 'man and nature' and 'man and society' provides obvious inspiration for sustainable **design** that is moving towards an ecological

civilisation. Replacing the one-sided view of a product arising from industrial civilisation, these new views on design have been gradually accepting user-oriented, comprehensive service system design approaches with a comprehensive view of the environment. This makes it possible for the two (i.e. *fengshui* and sustainable design) to draw on each other's merits.

Compared with traditional design disciplines, Product-Service System design uses a holistic approach to assess needs, products and strategies and provide services through a variety of channels. PSS design focuses on identifying and providing satisfaction, increasing value and improving relationships among stakeholders. The science of *fengshui* is an ancient Eastern integrated design system; Product-Service System design is a new integrated design system of the West. Ecological civilisations oriented towards the future of humankind share an irreplaceable theoretical foundation of environmental ecology and thereby have clear dimensions of sustainable design. Strong support for the theory and practice of sustainable design can be formed by combining the advantages of traditional and contemporary design ideas.

Today humankind needs to make radical changes at the ideological level to steer the economy, politics, technology and education of society onto the road of an ecological civilisation. Industrial civilisation is reaching a dead-end: 'the basic principles of modern industrial civilisation are…incompatible with ecological scarcity. The whole modern thinking developed from the Enlightenment, especially the core principles such as individualism, may no longer be effective' (Worster 1999: 412). Design also has to face the challenge of the ecological civilisation, which entails mobilisation of all the wisdom and capacity of humankind. The operation of design can only be built on the theoretical basis of environmental ecology: how to use less energy and resources to acquire more social wealth; how to realise closed-loop material cycles; how to turn the real economy of industrial civilisation into a knowledge-based economy of ecological civilisation. In short, we should use all the wealth of human ideas to rationalise the allocation of resources and energy to the maximum through scientific design.

Regarding the establishment of an ecological civilisation, if we keep to the stereotyped thinking pattern of industrial civilisation and repair the environment by only relying on scientific and technological means, we can never fundamentally solve the problems. *We must steer the relationship between humans and nature away from opposition as in industrial civilisation towards harmony in an ecological civilisation*. To solve such issues, we need to return to the level of humane studies. We need to find a way out by giving full cooperation to science and technology. Design that proceeds from the perspective of art and science and is based upon the concept of environmental design is none other than an alternative road at the many tactical levels of strategies for sustainable development—this is sustainable design.

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Section 5

New Ways to Educate

16

New ways of educating

Articulating experience*

Geetanjali Sachdev
Sristhi School of Art, Design and Technology, India

16.1 Introduction

This chapter traces the development of a specific pedagogical approach I am beginning to articulate through my teaching practice. This approach has provided the space for public action, aesthetic protest and discourse to emerge as outcomes. It is rooted in the provision of certain types of experience that pivot the design of course instruction. The chapter is based upon the assumption that it is the nature of our *experiences* that influence and guide the material manifestations of our thought. Along with sustainable outcomes in the form of Product-Service Systems and radical new system concepts, new ways of educating must include a parallel focus on the *experience* of the individuals who create these processes and outcomes.

There are five types of human experience proposed in this chapter: **subjective** experience, **objective** experience, **participative** experience, **contesting** experience and **reflective** experience. These facets of experience are offered as considerations towards designing enactive programmes for design education. Narayanan (2010) states that education for a sustainable future needs *enactive programmes* that

* I would like to thank Avy Varghese, Colin Davies, Geetha Narayanan, Lata Mani and Yashas Shetty for their influence on my thoughts.

provide space for both discourse and public action. She questions the conventional starting points of education for sustainability, and in crafting starting points for design pedagogy she argues for an integrated approach that combines being with doing and creating capacities for ways of knowing, sensing and seeing our world, an approach that has, in all its initiatives, the ideals of social and ecological justice as its basis for an education in sustainability. Enactive programmes are those that replace the art of making products and artefacts with the art of doing, conversing and performing as the centre stage of design education for sustainability. They embody a concern for others with whom we act and act upon as we lead our lives.

This chapter draws upon examples from my teaching practice to describe how this pedagogy has been developed. Each pedagogical endeavour described here aims to provide the opportunity to engage in the five kinds of experiences, and each has been able to elicit, in terms of student outcomes, ideas and concepts of new models of actions, interactions and understandings. This approach has led to actions that are autonomous and participatory, and it offers a methodology that encourages student engagement with the public and social realm, both in terms of action and discourse. It allows for a conceptualisation of design beyond that of the artefact, product or service and into a broader enquiry into the relations that sustain individuals socially with one another and their environments.

The four endeavours occurred sequentially and are articulated here in that order. By drawing upon my practice as a form of research, the learning from each of the endeavours has thus enabled a 'prototype' to emerge. I draw upon theory to support some of my observations and therefore the five types of experiences are offered as considerations relevant for design pedagogy; they nevertheless need a more systematic and long-term study of their effects in order to be asserted strongly. The chapter concludes by proposing that the confluence of the five experiences described together produce an aesthetic of experience that lies in its residual impact on the learner. Dewey's views on art, aesthetics and learning are revisited in this final section, which puts forth the notion of pedagogy as *residue*.

The notion of **pedagogy as residue** moreover shares important similarities with a systems thinking approach to design. A central feature of any design activity is the complexity of issues that such a consideration involves. Systems thinking offers a way to approach complex issues that concentrates on understanding the relationships between elements that constitute an emerging whole, which is why it is a crucial constituent of any product-service system/stakeholder interaction design process. A system is any entity with emergent qualities at the scale of the whole. Systems thinking looks at the resulting qualities of the whole as it interacts in situations within a larger context. It provides a holistic approach to problem solving (and setting) that is *relational* and addresses the inherent complexities of a situation by taking many factors into account in trying to understand the basis of action and intervention. Where the concept of pedagogy of residue steps in to fill the gap is the entry point for art and design students: a potentially more profound means to engage, challenge and imprint on students the relational, shifting qualities of wicked problems.

16.2 Epistemological beliefs of Indian undergraduate art and design students

My first proposal—that both subjective and objective experiences of students be considered as critical components in instruction design—is rooted in the results and conclusions drawn from my Master's dissertation on the epistemological beliefs held by undergraduate students in art and design and the implications it held for art and design instruction. The idea of drawing upon facets of experience as pedagogical strategies arose during this study.

Epistemology is an area of philosophy that refers to the origin, nature and justification of human knowledge and is concerned with the processes by which individuals come to claim that something is true. Although investigations into personal epistemology use varying terminologies, they all address an individual's conceptions concerning knowledge and the process of knowing. The study of one's personal epistemological belief system is the study of how individuals develop their conception of knowledge or knowing and then use these conceptions to develop an understanding of the world (Hofer 2002).

My curiosity in the nature of beliefs about knowledge and knowing originated in my interest in the practices of judgement that occurred during the assessment of aesthetic aspects of student work and in the kinds of knowledge involved in the passing of aesthetic judgements. What was objective that allowed a shared understanding between teachers and students, and what was subjective or personal to the individual that was often considered invalid or irrelevant and that needed to be made explicit? How did these two kinds of knowledge come together and if they did not, why was objective knowledge often more valuable than a student's subjectively held position that asserted or validated his or her history?

The study was framed based upon Marlene Schommer's (1990, 1994) theoretical framework that refers to epistemological beliefs as a collection of 'more or less independent beliefs' about the general nature of knowledge and knowing. Schommer (1998) claimed that certain core beliefs influenced students' attitudes towards learning and designed her questionnaire to assess these dominant epistemological beliefs. She proposed at least five dimensions to the epistemological belief system: the structure, certainty, source of knowledge and the control and speed of knowledge acquisition. These five dimensions of beliefs could be clustered into two central areas, the *nature* of knowledge and the *process* of knowing. Beliefs about the *certainty* of knowledge and the *structure* of knowledge concerned the nature of knowing. Beliefs about the *source* of knowledge concerned the process of knowing, of how an individual came to know something. Beliefs about the speed of learning and control of learning, she explained, had been found to be related to various aspects such as persistence and motivation to learn (Schommer-Aikins 2002). As an example she described how students' belief about their role as active or passive listeners was a reflection of the belief that knowledge is absolute and that authority has knowledge.

The outcomes of my study could be interpreted only to the extent that the questionnaire was applicable and valid in a cultural setting that was different in many ways from the setting the research instrument was designed in and for. The sample size, the gender of the students, their backgrounds, and the number of contexts explored limited the generalisability of the findings. However, the study lent several insights into the nature of experience and its impact on learning.

16.2.1 Observations made and conclusions drawn from the study

From the analysis of the data gathered through the questionnaire it was observed that the way in which knowledge is organised and presented to students, in this case by fixed and unchallengeable and authoritative sources, influenced the students' beliefs about the characteristics of knowledge. Beliefs about the process of knowing are likely to be determined by the way in which students perceive what the characteristics of knowledge are, and not the other way round. Facets of the epistemological beliefs of Indian students appeared to be shaped largely by an educational environment influenced by legacies of educational thought, both colonial and indigenous, and to a lesser degree by a cultural environment impacted by ways of thinking encouraged by the Hindu religion.

The analysis of the data led to three main conclusions that have implications for practice. The first was that epistemological beliefs could bear specific cultural traits: the epistemological belief system of this sample, the sample in this case being Srishti undergraduates, seemed to be sustained by beliefs in the root of all knowledge being an authority, either a figure or texts. Second, the source of knowledge seemed to influence beliefs about the nature of knowledge and subsequently also the process of learning. The third conclusion reached was that epistemological beliefs are impacted by either different factors or by similar factors but to differing degrees across cultures. The conditioning of children by the educational system appears to be a powerful influence and the knowledge acquisition process primarily takes place in formal educational settings.

16.2.2 Implications for educational practice

In designing instruction, assessing students' beliefs about the nature of knowledge and learning may help in deciding learning strategies. Hofer (2004) studied the way by which instructional practices were epistemologically interpreted by first-year college students; students with a relatively simple view of knowledge, who considered it to be a collection of discrete facts, found open-ended problems difficult. This difficulty was compounded when instructional styles held a simplistic approach to knowledge but tests required complexity and synthesis. Students raised in cultures that discouraged them from asserting conflicting views and who perhaps tend to avoid working with complexity needed instructional strategies

that emphasised student perspectives, involved challenges and included open-ended tasks that offered the choice of many answers. Hofer's findings suggested that students' sources of knowledge, i.e. beliefs about the authoritative source of knowledge, were more external than internal. A student's belief in authorities may have its source in teachers, their religion, texts, media or family. If they hold a belief that what is right comes from authority, it may explain repeated clichéd responses made by students where creative responses were required in design tasks assigned in courses or projects. In planning instruction teachers often ask students to build on knowledge gained from the popular press, the media and experts, instead of knowledge gained from their own unique personal experiences. Bell and Lin (2002: 342) concluded that the 'propensity to analyze controversy stems from instruction'. They cite Lin and His (2000) who state that there are two important design principles in instructional experiences: instruction should leverage a student's previous experience and epistemic knowledge, and instructions should enable students to revisit their ideas in naturally occurring learning situations.

16.3 The role of experience

16.3.1 Experience as a unit of analysis

John Dewey's philosophy of experience and his views on art, aesthetics and education offer a foundation on which to build a claim that the design of instruction for design education can be approached from an understanding of the nature of experience. Dewey proposed that human activity ought to be studied from an analysis of the unit of experience as a whole versus the smaller components of cognition, emotion, or action. It was through our experiences in the world that we came into contact with our environments and were able to continue to live in them. Experience was the interaction between an individual and the world and had as its goal unity and stability between the two that would allow for a continuity of existence (Dewey 1938). However, experience does not automatically lead to learning and the learning process involves the meaningful organisation of experience; a mediating process assists the learner to make sense of the experience in which mediating resources are ones that help the learner critically assess, interrogate, and reflect on their experiences and consequently learn effectively from them. Dewey distinguished the learning experience from other experiences that could arrest or negatively impact the growth of further experience and described them as those in which the changes made by an individual's actions are reflected back into the changes made in the individual person (Dewey 1916). Dewey also believed that experience was independent of desire or intent in its ability to continue to live in further experiences (Dewey 1938). In proposing that experience was the basis for learning, he asked for a consideration of two aspects of the quality of experience, the degree to which it is an agreeable experience and its influence upon the desirability of

later experience. It is their union that determines the significance and value of any educative experience. In acknowledging that there is an intimate relation between the process of experience and that of education, we need to recognise that social factors operate in the constitution of individual experience in that there are sources that reside outside the person that constitute one's experience and that all sources of experience are valid (Dewey 1938).

16.3.2 The subjective nature of experience

Branches of study are a net product of past experience in a form that assists the benefit of future endeavour. For effective learning, the subject matter needs to be psychologised or translated back into the immediate and individual experience within which its origin and significance lies and restored back to the experience from which it has been extracted: this supplies the motive for learning (Dewey 1916, 1938). In the case of Srishti students, their educational experiences are rooted mainly in a legacy transmission model of education that stresses rote learning and the acquiring of objective knowledge, and where students' personal experiences as internal sources of knowledge are given a lesser priority. To combat the force of their prior educational influence, to show that knowledge does not only reside in authoritative texts or figures and that there are sources of knowledge internal to the students that are also valid, it is not enough to only draw upon student's personal knowledge, with the hope of increasing motivation, in the introduction of objective subject matter. It is also important to provide opportunities for students to access their subjectivities and to use their personal experiences as foundations upon which to *build*. This is why the subjective nature of experience is proposed as the first element in instruction. A student's subjectivities are a source of a person's individuality and his or her particularity of experience that individuates them from the general: it cannot be neglected in any curriculum for art and design education that seeks imagination and creativity as outcomes of the educational experience.

16.3.3 The objective nature of experience

The study of public pedagogy explores forms of pedagogies that are different from those found in schools, pedagogies that beg a reconsideration of what counts as pedagogy and of where the educative process is located (Sandlin, Schultz and Burdick 2010). As a theoretical construct, the term is underpinned by an acknowledgment of the public as a strong pedagogical force and provides new ways of understanding educational practice both within and outside of schools. The objective nature of experience is thus proposed as a second element in recognising that instructional strategies also need to identify other sources of knowledge within and beyond the classroom. Instructional strategies need to first identify and acknowledge them, then draw upon them, and validate, challenge or reframe the ideas and values transmitted through them.

Individuals construct their own worlds, but they do so within a social context of shared meanings. These meanings are constructed from the concepts and ideas that emerge through what is seen every day or experienced directly, as well as through concepts that are scientifically arrived at and are dependent for their meaning on their inter-relationships and not on direct experience. The values and assertions made by the different disciplines and specialist communities are the widely accepted claims about knowledge, and theoretical and practical disciplinary knowledge allows students' access to specialist communities. Experiences drawing upon objective knowledge provide opportunities where the sociality of knowledge can be recognised, accepted, criticised, challenged and reframed. Reframing and re-imagining are necessary if design education is to explore new futures that have more sustainable ways of living.

The following four sections describe the pedagogical endeavours through which the relevance of contesting, participative and reflective experiences was highlighted for instructional design.

16.4 First pedagogical endeavour: Fear and Gender in Public Spaces

The Fear and Gender in Public Spaces project was part of Srishti's Interim semester curriculum that sought to explore the nature of learning experiences leading to agency and participation by students in improving the social, cultural and ecological spaces that they inhabit. It was a five-week project that explored the power of artistic practice to research and affect civic and social concerns through encounters with the city's architecture and society designers.[1]

In the first half of the course, for two weeks, six participating artists led the students in interventions that involved performance, sound and other forms of media. Through a series of creative interventions in the city of Bangalore, the students confronted spaces in the city that evoked in them a sense of fear and explored how this experience related to their gender. All the students were female. Some examples of these interventions included temporarily converting a 'fearful' gay area of a public

1 The course had two components. The first component was a two-week workshop that included a series of performative, visual and sonic artistic explorations and interventions in Bangalore. It was part of a collaborative project inspired by earlier workshops on the same theme conducted in Colombia, Sweden and South Africa by the Swedish artist-and-curator duo Sissi Westerberg and Veronica Wiman of LAND Contemporary Art Practices. Participating artists were Liz Kueneke, Karoline H. Larsen, Ana Paula Albé, Richard Widerberg, Vinayak Das, Jatin Vidyarthi, Mangala Anebermath, and Vera Maeder. Zeenath Hasan coordinated in bringing the project to Bangalore. In the second part of the course, co-facilitated with Radha Chandrashekharan at Srishti, students worked independently on self-defined individual and group projects.

park into a place for conversation for an evening, using the feminine act of hair braiding in an attempt to reclaim male dominated spaces, and inviting passers-by in a park to sew on an embroidered map of Bangalore, using places where the students had experienced happiness and fear and, through a series of small performances, challenging patterns of interaction between men and women.

One of the interventions was a public protest that took the form of a walk and was the students' response to the fear invoked by an extreme right-wing political group that had attacked women in a pub in the Indian city of Mangalore and outside pubs in Bangalore, claiming that their 'Westernised' behaviour was disrespectful of Indian values. Asserting their right to multiple identities as Indian women, the students coined the slogan 'Say I Am', designed tags and banners for people to wear, and circulated invitations for this protest walk using different forms of social media. Around 200 people walked the streets in a peaceful expression of protest amid considerable political tension in the city.

In the latter half of the course, students defined themes for themselves that were related to civic and social concerns in Bangalore. Their projects had to reflect the following principles of social art as described by the artists: interaction with a community; creating an output through participation and dialogue with people or a community; creating settings that remodel and change or establish a new relation for people who interact with the work; and establishing a new relation for people who participate in the process of developing your work, while they are participating in the work with you. Four projects emerged at the end of these three weeks: a soundscape composed of sounds of fear that was played back to people on the streets; a workshop with schoolchildren and their experiences of fear in public spaces that used paper forms as a medium of expression; a collection of garments visualising invisible boundaries that women held while experiencing public spaces; and a workshop with domestic household help comprising a series of exercises through which the women of a different economic and social class from the students confronted their fears in public spaces.

16.4.1 Reflections and insights: contesting, participative and reflective experiences

The Fear and Gender project presented the opportunity to understand how in design teaching, the impetus for social or civic engagement, public action and protest could be evoked. The depth of interest, the force with which the public protest was planned and executed, and the sustained engagement the students exhibited while doing their personal projects held several implications for design pedagogy. The students' projects at the end of the course showed that artistic practice did indeed hold possibilities to research and affect civic and social concerns.

In keeping with the principles of social art defined by the artists, two common threads ran through all these interventions: that of reframing one's own experience and of interaction with a wider public through participation during the process. These implied a visibility of one's contestation and the presence and involvement

of a wider public as witnesses to these contestations. However, it was upon reflecting on their subjective standpoints and an understanding of the wider context within which the issue arose that the students decided how to act. Their actions came after considerable reflection upon their reactions, emotions and feelings and a reasoning process that explored the consequences of their actions and intended expressions. Contestation, participation and reflection as strategies had motivated students to actions that were aesthetic and whose beauty lay in the nature of their embodiment in that they embraced a wider sphere of concern.

There seemed to be an aesthetic that resided in action and participation that went beyond material form, in the relationship between crowds and the sense of pleasure experienced during the protest walk, in a sense of validation or 'truth' residing in the public, in there being an origin of our motivations for social action, and in the possibilities not just of different modes of expression used by artists, but also of different ways of knowing the world through these different modes. Lewis (1990, cited in Pajares 1992) describes how ways of knowing are ways of selecting values and how the origin of all knowledge lies in belief systems. People start by believing through their senses, their intuition, and laws of nature or logic. He claims that there are six ways that individuals believe or know: believing in an authority, deductive logic, the experience of the senses, the emotion of feeling that something is true or right, rational intuition, and personal use of the scientific method. He suggests that one of these modes becomes the dominant mode by which personal values develop. However, individuals can acquire beliefs from all six modes even though one surfaces as their primary mode of knowing. Claxton (2000) describes three ways of knowing, of which intuition is one. He contrasts the intuitive way of knowing with an analytical way of knowing and a reflective way of knowing. These ways of knowing represent the three ways in which teachers think: intuitive thinking relies on patterns and holistic interpretations extracted unconsciously from prior experience; analytical thinking on logic and reasoning; and reflective thinking on contemplation and rumination. Students surely need a range of experiences with which to engage, to develop various ways of accessing different kinds of knowledge and experience. If epistemological beliefs are impacted by ways of knowing (Pajares 1992), then instructional strategies ought to consider whether all these ways are offered to students.

16.5 Second pedagogical endeavour: Public Space and Pedagogy

In July 2009, Public Space and Pedagogy (PSP), an eight-week course, explored through an open-ended, project-based enquiry method how public spaces could serve as pedagogical sites where individuals learn to construct knowledge, values and identities. At the end of the course, students had to challenge and reframe

these constructions and locate these alternative viewpoints back in the public space as a pedagogical endeavour. The course comprised different types of instruction involving various artistic, activist and visual modes of expression.[2]

Drawing upon Henry Giroux's work on the concept of public pedagogy, the project used the marketplace as a pedagogical public location to examine how it functioned as a site of learning. Giroux's use of the term 'public pedagogy' encompasses the political and educational impact of a globalised culture and the knowing and learning that operates through new forms of digital and media technologies, which are driven by corporate power. The dominant neoliberal corporate culture, according to Giroux, has produced new sites for pedagogies that operate within the public sphere. These operate within a variety of institutions and formats and produce, disseminate and circulate ideas that emerge from the influence of this larger educational force, and they aim to produce competitive, self-interested individuals seeking their own material and ideological gains (Giroux 2010).

In all these varied modes and experiences, the course content emerged from the needs of the students and the space of engagement. Similar to the Fear and Gender methodology, in the latter half of the course students framed their own projects drawing upon the range of experiences provided to them during the initial six weeks. The projects that emerged included: 'Equilibrium', an interactive installation in a public park where visitors were invited to reflect upon their gender biases and the process by which they personally created (or not) gender hierarchies; 'Nayi Dastaan', which concerned clothing as a visual identifier of gender and in which students created fictional movie posters with the hero portrayed in a sari, displaying these posters on the street to provoke a dialogue with the public on their attitudes towards cross dressing; and 'I Never Ask for It', where using virtual public spaces students looked at the notion of street sexual harassment and safety as a negotiated circumstance for women in public spaces.

16.5.1 Reflections and insights: the nature of contestations

The nature of the projects that emerged from the PSP course could be considered activist in content but perhaps more artistic in form.[3] From the students' perspectives, the projects seeded new models of actions, interactions and ways of understanding our environments. Most were identifiable protests in differing

2 The PSP course was planned so that students worked with different modes of enquiry with different visiting faculty members: performance artist and media practitioner Deepak Srinivasan, photographer Anna Fox, historian and cultural critic Dr Lata Mani, graphic and type designer Mahindra Patel, artist and social activist Jasmeen Patheja, and academic and philosopher Dr Sundar Sarrukai. The course was co-facilitated by Smriti Mehra, Ravindra Gutta and Ayisha Abraham.

3 Deepak Srinivasan, in conversation, October 2010, about the hierarchy prevalent in the existing validation of different modes of knowing.

degrees, manifestations of dissent or resistance against some form of ideology or impositions of rules.

> Public pedagogy…is an activism embedded in collective action, not only situated in institutionalised structures, but in multiple spaces, including grassroots organizations, neighborhood projects, art collectives, and town meetings—spaces that provide a site for compassion, outrage, humor and action. Such pedagogy disrupts processes of injustice and creates opportunities for the expression of complex, contesting, and subaltern perspectives (Brady 2006: 58, as cited in O'Malley and Roseboro 2010).

The course mooted the idea that public pedagogies could be engaged to both research and inform the kinds of action that design students could engage in through instruction. A range of forms was used and these expressed dissent and resistance, through visual forms, embodied action and performance as mediums.

16.5.2 Other observations: aesthetics of form versus interaction

The PSP course projects also had a high quality of student engagement in terms of their degree of motivation and commitment. However, some projects held an excessive emotive appeal—while they resulted in interesting and evocative forms of expression, the resistance did not appear to originate in the students doing those projects but in sources external to them. They were using issues that had an emotional appeal, similar to the way a designer uses emotion to attract the attention of a consumer. They seemed reactionary responses, aroused through another's feeling and not matching the depth of one's own personal experience of that emotion.

The projects showed that artistic methods can be used to enhance the aesthetics of current social arrangements or to protest against them and rather to seed ideas of new models of social understandings, actions and interactions. The nature of these new arrangements posited and the subsequent impact of these ideas could be considered an aesthetic aspect of protest. These observations and insights from the course led to an enquiry into the use of aesthetics to gain attention and evoke a sense of pleasure that was temporary versus a form that was more sustaining. These questions subsequently led to two other courses, described briefly in the following section.

16.6 Third pedagogical endeavour: Aesthetics of Protest

This course explored the nature and context of protest and looked into the different forms of expression by which artists and designers engage with the notion of protest when they exercise their power to reframe, imagine and posit alternative

realities, especially in their use of emotional appeal in communicating to a wider audience.[4] The students looked at ideals of beauty that they were consuming as members of the public, through media and other channels, their discussions being highlighted during a recent advertisement by a popular film star endorsing a fairness cream called Fair and Lovely. They questioned the association of fairness with beauty and the processes by which this notion is sold as an ideal of beauty and then ran a series of interventions in public spaces where they articulated their positions on the issue. The course ended with a demonstration on the street that the students referred to as an 'aesthetic protest' against fairness being imposed as an ideal, calling it 'Dark and Lovely'. Students held conversations with the public, painted their faces with shades of dark brown and white paint, and created posters for the event. They lined the roads and footpaths with protest statements and made hand bands called 'fairness meters' that graded and compared the shade of one's skin numerically, which were given to people invited via Facebook and through their street conversations.

16.6.1 Reflections and insights: sequence of experiences, embodiment

This pedagogical endeavour showed how the aesthetics involved in protesting actions could involve a consideration beyond the creation of iconography and visual forms. It could extend itself to the nature of the interaction of the protest and its subsequent and residual impact on both the participants and the observers. The course also reinforced the notion that when expressed through embodied actions and performance, positions held by an individual and the wider public of which they are a part provoke a more active response and exchange when the body is used as the primary medium of expression.

In order to enter into any issue and design around it, pedagogical approaches can attempt first to find the personal or the subjective that lead into the political and social, or the objective, if that is the aim of that pedagogical experience. Normal pedagogical practice in contrast uses the objective and then finds the personal link for the student in order to motivate them. The sequence of introduction is nonetheless relevant: the subjective needs to locate itself in the objective; the individual first needs to find him/herself in the crowd and then see how he or she participates as a part in forming the whole. Locating one's personal stand visibly in a wider public shows individuals their part in the whole of human experience. A reflective process needs to guide this journey into a dialectical process, to contest for its space and its voice and then reflect it back again.

4 The other facilitators in this course were Ravindra Gutta and Allison Kudla from Srishti.

16.7 Fourth pedagogical endeavour: Aesthetics of Experience

In making visible the students' contestations together in the presence of a wider public and in not knowing how the message being communicated would be received, once again there was an excitement, a heightened sense of awareness during those moments. There seemed to exist an aesthetic in the excitement of participation and in the unpredictability of an outcome, experienced when the students were on the streets, making their stand visible in several ways. The experience of risk could be an aesthetic in that it consumes our entire attention, as Dewey refers to the aesthetic experience. There may be some common dimensions to human experiences that are perhaps found in the emotions, feelings and perceptions that we share, that have the potential to transcend class, position, gender and other differences and are unlike the limitations of visual aesthetics that we apply to the judgement of form conditioned by our ways of seeing and learning about what is considered beautiful or not.

These observations and insights led to the next course on the Aesthetics of Experience in which the aesthetic dimension of perception and experience and its implications for design pedagogy were explored. The Aesthetics of Experience ran as smaller modules within two other courses.[5] The first course, titled Matters of Form: The Aesthetics of Experience, looked at forms of human perception and was underpinned by the idea that the integration of the arts and the sciences should be based on the recognition of a shared set of skilful, embodied practices. In the second course, Bengaluru Pride, the underlying aim was to co-create material with a larger community in the design of an experience that encourages public participation.

The experience of cooking and eating was used as one of the main contexts within which to explore the notion that there are dimensions that render an experience memorable, characteristics that impact on those undergoing the experience with more force than others. The other context was a movie experience and two participatory screen-printing parties where students printed T-shirts they designed for the pride parade, along with a large community. These were integrated into the larger enquiries of both courses. The Aesthetics of Experience attempted to uncover some of the dimensions that contribute to the sense of pleasure that participation evoked and to facilitate a conversation about the potential relevance of these dimensions to artists and designers. The students participated in a blindfolded dinner experience among other activities. They also planned and executed three dining experiences. Of the three, the last had minimal inputs from the faculty and had over 200 people as guests. The students were involved in everything, from

5 The first course was facilitated along with Ramesh Kalkur, member of the Srishti faculty, and Dr Rajesh Kasturirangan, a cognitive scientist. The second course was co-facilitated with Ramesh Kalkur and Ravindra Gutta.

buying the ingredients to serving the invited guests at the LeNS Conference Dinner held in November 2010.

16.7.1 Insights and reflections: events as discourse

In his doctoral dissertation chapter, 'Learning as Aesthetic Experience', Patrick Parrish (2008) draws from Dewey's work to demonstrate that a useful model of learning should include a place for the aesthetic experience. Parrish explores the integration of the affective and cognitive domains in individual experience and argues that the aesthetic experience is central to this integration. Dewey's conception of the aesthetic experience went beyond the conception of aesthetics as an evocation of feeling through responses to the beautiful and elevating. He referred to the wider notion of art as an aesthetic experience that unites diverse nature and human activities and one that creates a unity in all types of experience. It is the depth and intensity of one's engagement and the achievement of a state of fulfilment that bestows upon it the characteristic of aesthetic (Dewey 1934/1989). The aesthetic experience is distinguished from other experiences by its integral nature, in that it runs its course to a state of fulfilment and leads to internal unity.

All the three events that were a part of this course had high degrees of motivation overall. Once again, I was able to observe the excitement of participation that I would call aesthetic, in that it solicited deep involvement in the actions that were participative, collaborative and existed in the dynamic that operates between people as they reach towards a shared goal—elements similar to the protest walk in Fear and Gender and in some of the interventions in Public Space and Pedagogy and the Aesthetics of Protest. Hazra (2010: 6) also refers to the 'aesthetic excitement of participation' in describing a fictional participatory sonic art event.

16.7.2 Other observations: co-creating experiences, residual impact

While walking the streets with the students in the Fear and Gender course, in the excitement of being part of the crowd there was an awareness of the density and proximity of bodies, of the unfamiliar, of the common objective that the group shared in expression and in action and of the risk associated with making one's personal stand a political and public statement. In the Aesthetics of Experience course, a similar excitement was visible when the crowd at the dinner was at its peak, not in making visible any contestation, but in participating beyond a spectator in the event and in moving towards a common objective. In his book *Crowds & Power* (1962) Elias Canetti speaks of the crowd as a universal and mysterious phenomenon. He refers to the fear of touch of the unknown as being man's largest fear and states that it is only in a crowd that man becomes free of this fear of being touched, the only occasion where the experience of fear changes into its opposite. No distinctions count, not even that of sex and all are equal there. McLuhan (1964)

refers to numbers being an extension of our tactile sense, of people wearing brands as an extension of being in a relationship with many others. Perhaps there is a comfort in multiples, a pleasure in being a part of crowd, and this idea is one that design pedagogy could consider exploring in what makes experiences sustain in memory. Perhaps it is this freedom from distinction where all are equal in a crowd, where one no longer cares who is being pressed against the body that contributes to the aesthetic of being part of this crowd. It could also be the quality of intensity of emotion one experiences when one is part of a crowd: Canetti refers to the fear of the unexpected causing an intensity of panic unlike our other fears.

The last dinner event in Aesthetics of Experience, the dinner for 200 people, stands out in terms of being memorable, the 'residue' the course left in terms of thought. Perhaps there is a residue of action, and of what happens after we relate with one another, similar to the residue of production processes, and that designers of the future need to become cognisant of. Knowing these may help design experiences around any intended activity with greater awareness of impact and residual outcomes. In co-creating an experience, it may be necessary to show as well the location of the individual in a crowd, the dish on the table made by one individual that contributes to the entire beauty of the spread—details that make possible and visible how one single part participates in the making of the whole. It can make everyone conscious of their individual experience as contributing to the gestalt and wholeness of a greater human experience.

16.8 Conclusions

16.8.1 Artistic practice, design pedagogy and imagining a sustainable future

Design educators use different tools to familiarise students with the contexts within which their designs will circulate and subsequently impact. Through readings, texts, films and other media we are able to give students knowledge of the various perspectives through which a context is viewed and educate them on the issues that a design may need to consider. These are sources of knowledge that are external to them: they reside outside the students, and they learn about them through objective sources or others' interpretations. However, the issues surrounding and embedded in any context can also be entered through our inner and personal experiences and our subjectivities—along with sources that are objective, external or distanced from us but are necessary to understand as they explain to us the interrelationships we share with others and in our world as social beings. Artistic practice uses modes of expression encouraging subjective exploration into contexts. Both objective and subjective knowledge are necessary to be brought together, and this can be achieved by drawing upon artistic modes of expression and through a critical engagement with issues through theory or an engagement

with authorities on the issue being addressed. The first two experiences of instruction design, objective and subjective experience, are suggested under the premise that learning and knowing about any context through a balance of both subjective and objective sources leads to a deeper, engaged and active understanding of the complexities surrounding the contexts.

We can provide students with perspectives on the world that would benefit from design interventions, and when the concerns correspond to the students' own interests, the actions that emerge will have the force of their personal motivation. This begins often by recognising unequal or undesired social arrangements, protesting against them or laying seeds of new models of social understanding, actions and forms of interactions. Artistic ways of knowing and expression also offer ways in which to open conversations about the nature of existing social arrangements and imagining newer, more sustainable ones. They offer methods for us to express the realm of possibilities through our imagination, with the hope of realising them sometime in the future. The other three experiences, contesting, participative and reflective, are offered as considerations for instructional design as experiences through which new modes of practice, new models of actions, can be imagined—and they too could introduce new conceptions from which future practices can spring.

16.8.2 Enactive action as aesthetic action

Narayanan (2010) claims that the challenge for design education in India is the design of enactive programmes, the provision of spaces for discourse, aesthetic protest and enactive action that allow for our concerns to emerge and operate within a wider realm of care. She draws upon the theoretical work of Ervin Laszlo and Roy Ascott and Srishti's pedagogical and project-based interventions in the field of culture, environment and education as case studies, and she proposes the holistic development of consciousness grounded in autonomy, experience and agency as the core to a new form of design thinking. The courses described in this chapter have led students to engage in different kinds of discourse and public action: aesthetic protests, enactive actions, contestations of imposed identities, values, ideologies, seeds of new ideas and social arrangements and social realities. The students exhibited autonomy, motivation and agency, the qualities that help develop the capacity for enactive action and aesthetic protest according to Narayanan (2010).

New ways of educating in design must focus on the development of a practice that embodies our concern for others, for the people with whom we enact a world (Varela *et al.* 1993, cited in Narayanan 2010). The impulse to act upon our environments and in the world arises within the context of a range of many different kinds of experience. Dewey, in proposing that experience was the basis for learning, put forth the two principles of continuity of experience and interaction as criteria to discriminate between the inherent values of different experiences (Dewey 1938). They represent the longitudinal and lateral dimensions of experience and he claimed their union determined the significance and value of

educative experiences. An education based in experience would require selecting experiences that would cohere in their continuity and live constructively in future experiences. They would evoke the desire for similar experiences of coherence and unity. The second principle, that of interaction, implied that both objective factors and an individual's internal conditions impact the formation of experience. Dewey stated that aesthetic experiences begin with a strong urge or a compelling reason to engage. It starts with a need that demands a resolution and continues its movement until that need is consummated. Within this movement or journey we feel the anticipation of our final goal, and we engage in actions along the way that have consequences and resultant conditions. We also care about those conditions that bear upon our intended and anticipated goal (Dewey 1934/1989).

16.8.3 Pedagogy for residue

When we get in touch with our subjective feelings and emotions, when they are allowed a continuity of expression through an outward movement in the world, when impulses originating in our internal realms connect and unite with objects in the social realms that promise both unity and continuity, when we see ourselves as individuals participating and contributing to a larger whole with a common goal, when we are able to recognise that which is imposed and have the choice to challenge these impositions, when we are offered the possibility to imagine with our experiences as the material with which we reframe our lives, and when we are able to reflect upon and attend to our growth—all these experiences contribute to the quality of learning experiences and lend it dimensions of the aesthetic. The impulses to act in the world for oneself and for others are connected: they are both part of one continuum as extremes of the same desire. Enactive action locates individual action within the broader context of its consequences. It calls for an awareness of the self as it moves through the world and impacts it with the residues of meaning and material.

In my recent teaching practice, I have attempted to understand whether one can distinguish between the aesthetic experience and the aesthetics *of* experience. In ending this chapter, I put forth the idea that the aesthetic of an experience perhaps lies in the residue of what it leaves behind in those impacted by the experience, and which encourages the pursuit of similar experiences or seeks continuation of the same one. The five elements of experience, subjective, objective, participative, contesting and reflective, are attempts to articulate a pedagogy for residue, an approach to the design of instruction that asks us to consider the residual impact of our actions as being a critical component of the whole.

16.8.4 Pedagogy for residue, teaching for sustainability and systems thinking

When we teach Design for Sustainability, we are asking about what gets created as much as the quality of what remains and what sustains. A systems approach

can be integrated into design thinking and action by drawing upon instructional strategies that encourage a reflection on consequence. The five elements of experience, subjective, objective, participative, contesting and reflective, that comprise the elements in planning pedagogy for residue aim to build the capacity for enactive action that locates individual action within the broader context of its consequences. In asking that we consider the residual impact of our actions as being a critical component of the whole, this pedagogical approach proposes a way of looking at how we interact within the larger dynamic of participation and consequence of actions. In the context of designing an education for sustainability, pedagogy for residue thus offers a way to integrate a systems thinking approach into design thinking and action.

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17

Creative sustainability

The role of (design) education

Helena Hyvönen, Pekka Saarela and Tatu Marttila
Aalto University School of Arts, Design and Architecture, Finland

17.1 Creative sustainability[1]

The title of this chapter has been chosen for a specific reason. It is the name of a new multidisciplinary Master's programme launched in Finland in 2010 for the students of three universities—or schools, after their merger into the new Aalto University[2]—that brought students from the fields of business, technology and art and design together. This name also nicely represents a way of thinking: creativity is the starting point for achieving our goal to use the expertise of the designer or artist to make this world more sustainable.

As a nation Finland is a success story in its own right. About 150 years ago the country suffered a year of crop failure and people starved to death. After the wars before the middle of the previous century the country was very poor. Older generations wasted nothing, all materials were used with care, clothes were handed down from older to younger children and were ultimately woven into rag mats, and

1 As in a book with the same title, by E. Nieminen (2008), one of the initiators of a Master's programme with the same name.

2 Aalto University is a national Finnish project, which was formed from three academically independent universities: the University of Art and Design Helsinki, the Helsinki School of Economics and the Helsinki University of Technology. The new university began operations at the beginning of 2010.

people got about by bicycle or on foot. Today the country has been rated the best in the world by the international magazine *Newsweek* (2010).[3]

The dimension that raised Finland to the top of *Newsweek*'s list was *education*. Finland's overall competitiveness is world class due to positive development in 'education and training, research, high technology and its utilisation, a reliable public sector and Finnish values and attitudes' (Ministry of Education 2003b: 6). The world's best basic education and the efficiency of Finnish society are not only matters of pride, but, if used correctly, also effective tools. We therefore take the position in this chapter that Finland is a viable subject for study when analysing what education, especially Design for Sustainability education, in any institute of higher learning can and should strive to achieve.

This chapter examines the emerging new role for academia and new ways to produce knowledge for education and for society. It studies examples of modern design and art education through examples at Aalto University in Finland, to understand what actions should be taken to reach this goal. It presents several trends in government policies and initiatives supporting art and design. It also attempts to identify future developments in art and design education and proposes transdisciplinary activities in order to consolidate and evolve PSS know-how in curricula and thereby better implement sustainable design education for a future society.

17.2 A new role for academia

The role of academia has gradually changed during the last decade. While national and EU-level initiatives promote a more active role in producing new knowledge for society and the economy, global awareness of climate change drives increased concern with education on sustainability.[4] Two main roles for universities have traditionally been academic research and higher education. In Finland at the beginning of the new millennium there was discussion on as well as actual changes in legislation to add a third role for Finnish universities: creating practical knowledge for the use of our society.[5] Knowledge was considered to be an increasingly important factor of planning and production, and the demand for labour in knowledge-intensive fields was considered to grow (Ministry of Education 2003b: 5). From the universities' point of view this third role is generally perceived to mean societal collaboration, service activities or, more narrowly, business-related activities.

3 See statistics online at www.newsweek.com/2010/08/15/interactive-infographic-of-the-worlds-best-countries.html.

4 The UN has assigned the years 2005-2014 as 'The United Nations Decade of Education for Sustainable Development'. See also Part 1, Chapter 1 in this volume.

5 SITRA (the Finnish Innovation Fund), a national institution promoting research, elaborates upon the third role in their publication 'Yliopistojen kolmas tehtävä?' (Nieminen 2004), translated as 'universities' third role'.

Global competition and rapidly changing markets have created the need to develop solutions that can safeguard national vitality in the future and 'stress the importance of innovations as the main product of all higher education'; this need also lies behind the establishment of the new Aalto University (Evaluation Panel 2009: 48). In addition to this national condition, however, universities are required to show international and global responsibility. With respect to sustainability, the necessary innovations for transformation are not only technological but also socio-cultural (Vezzoli 2005). Moreover the European Union has defined the capacity for interdisciplinary education as one of the three preconditions for 'achieving excellence' (European Commission 2003: 17). Consequently universities must also take the transdisciplinary path, combining business and technology with art and design, for research and education, and in real-life contexts.

17.3 Design and art for a sustainable society

The role of design in Finnish society has been strong throughout history, and 'Finnish Design' is a well-known term also in the international design community. The basis for this reputation was built by a generation of designers after the Second World War, whose appearances at international exhibitions was noted and celebrated. In the 1990s there arose a need to update awareness of design competence, and the government thereby drew up a design agenda. It was based on competitiveness in industry and business, skills improvement and diversification, significant strengthening of research effort, and promotion of design opportunities. The Finnish government's Decision-in-Principle on Design Policy (later the Design 2005! programme[6]) underlined how design can contribute to the innovation system (Ministry of Education 2000). Policy objectives suggested design be integrated into management programmes and into undergraduate programmes in business and technology, as successful product development was perceived to be the result of 'multi-professional collaboration' (Ministry of Education 2000).

Design practice, being solution-oriented, creates practical knowledge and has recently been evolving towards a more systemic approach by connecting a growing number of stakeholders in the design process through methods for user-led or participatory design. Alongside such changes and the development in governmental policies, the design profession has also increased its role over time in relation to sustainable development (Vezzoli 2007). Design addresses culture, policies and technology and is strongly related to both consumer issues and environmental issues; hence, socio-political and economic values merge with technological realities in the domain of design. Art observes and stimulates this development. Art relates to a skill but also to the ability to reflect and take part in societal discourse.

6 Pekka Saarela, one of the authors of this chapter, was extensively involved in drawing up the Design 2005! programme.

Both art and design merge values from several different domains of knowledge as well as set values for the societal practices they address. Reflection in design, collaborative design and research, and artistic processes can support such a process.

17.3.1 Promoting sustainability

In Aalto University, the role of art and design has been recognised as one of the strong points of the whole university (Krause *et al.* 2009). In its School of Arts, Design and Architecture (formerly known as University of Art and Design Helsinki), research and development related to sustainability has also been traditionally strong. Most obviously, the arts, design and architecture play a clear role in the construction of a 'high-quality, obstacle-free and aesthetically high-standard environment' (Ministry of Education 2003a: 9). Furthermore, designers have an important role to play within the framework for sustainability, since they are able to 'form a bridge between the consumer's cultural sphere and the world of production' (Vezzoli 2003: 2).

Art has the power to challenge and make questions, visions and future plans visible to citizens when speaking about sustainable development. Art is thus an excellent tool for arousing discussion and emotions about changes to the environment and their impact on people's lives, but it also engages and activates: it provides means for creative self-expression, emotional development and self-realisation, through which the individual can 'analyse reality' and by which communities can generate 'creative, social, cultural and economic capital' (Ministry of Education 2003a: 6). Artistic activities can also fuel Design for Sustainability processes with 'migrant creative-thoughts' that travel between different meaning systems and are able to reflect on 'cognitive references and values' (Vezzoli 2005: 4).

17.3.2 Research on design and art

The interconnected and multicultural nature of contemporary social reality provides a 'specific opportunity to stimulate the design creativity aiming at socio-sustainable innovations' (Vezzoli 2005: 2). In other words, if we agree that sustainable innovations should be diffused as 'improvement, plausible and articulated to fit into different modern contexts' (Vezzoli 2007: 27), art and design are then fundamental parts of this articulation. Formal assessment of research in Aalto University identified several benefits related to research on art and design: art and design actors work as integrators, think holistically, leverage visualisation, contribute to the cultural industries, and underpin radical social software and collaborative knowledge building developments (Krause *et al.* 2009). Innovative intellectual inquiry and artistic work are thus not inherently in conflict with each other (Evaluation Panel 2009) but can instead support a common goal.

The design research environment in Finland can be described as democratised, immaterial, digitalised, fragmented, politicised, strategised and integrated. Artistic

research, by the same token, has shown 'many departures from the traditional formation of knowledge' which thus poses 'a challenge for all the parties involved' (Evaluation Panel 2009: 50). Productive creativity requires appreciation of diversity and the freedom of research, culture and voluntary activities (Ministry of Education 2003b: 7). Debate in the art and design community is increasingly directed towards methods of research that 'best serve the field' (Evaluation Panel 2009: 22), indicating methods that enable transdisciplinary interaction among professions and with society.

17.4 A transdisciplinary approach to (design) education

In Finland the growth in interdisciplinary approaches to scientific research—and further on to education and society—has been addressed by several national research projects (for example by the Academy of Finland, see Bruun *et al.* 2005). This development, and its potential for innovation activities, has also been identified as one of the future opportunities for Aalto University (Aalto University 2010: 4) and is present in the form of multidisciplinary research and education.

17.4.1 A new approach to disciplinarity

One of the initiatives towards a new approach to disciplinarity is the launching of Creative Sustainability (CS), a new multidisciplinary Master's degree programme that bridges the departments of design and architecture, business management, industrial management, and real estate. The education in the CS programme promotes a systems approach and enhances strategic thinking in various scales in order to support a sustainable future: from complex ecosystems, urban and industrial infrastructures, technologies and business to individual choices. Students in sustainable design courses come from all the CS departments and—with or without a traditional basic training in design—experience the reality of designing PSS solutions and developing innovation strategies for a complex world. The disciplinary cores are still sustained, as students graduate with degrees related to their departments and professional study programmes.

In CS the areas of expertise of three schools are combined under a single influential theme—sustainability. The starting point of the programme is the individual, whose consumption habits and behaviours are ultimately decisive in relation to a sustainable future. Societies and infrastructures, and industry and production methods stand in a key position, alongside the organisation of society, architecture and environmental planning and construction. The last dimension consists of the ecosystems that support everything else (see Figure 17.1).

Figure 17.1 **Creative planning in relation to the individual and to the ecosystems**

Source: Nieminen 2008: 39

The aim of the Creative Sustainability programme is to holistically educate broad-minded, multidisciplinary, creative experts with the ability to solve problems, in order to make the world a better place in which to live and work. The objective of the programme is to strengthen sustainable development as a mindset, through shared visions and ethics, enabling the multidisciplinary approach to evolve further towards interdisciplinarity (see Marttila and Kohtala 2010). The programme also helps Aalto University to integrate the perspective of sustainable development more strongly into its research and daily activities at an operational level through student cases and cooperation between departments and other modules and courses.

17.4.2 Implications for knowledge creation

Scientific knowledge has influence in at least three dimensions: the relevance of the knowledge, transfer of knowledge and the receiver's possibility to utilise it (Nieminen 2004). This denotes a need to create structures to connect knowledge to real-life cases in society, to connect several disciplinary domains of knowledge together, and to design means of using and spreading this shared

knowledge with various stakeholders. As information in this process should be distributed, local-based, case-dependent and network-structured, real-life stakeholders and business could play a key role in system innovation, especially towards more sustainable consumption and production patterns (e.g. Vezzoli 2007). In Aalto University new connection points between such cases and stakeholders can create fruitful interaction, and the combination of different professional fields and expertise can lead to bold initiatives where art and design can better accompany the worlds of business, technology and science and act as entities that actively influence it.

Equality in the form of equal access to services or knowledge is also required to achieve the most innovative setting for research and design. We must create the education and research framework in such a way that it supports information flow between the society and the separate disciplines. The effectiveness of knowledge is a question not only related to its dissemination, but also tied to the values and goals of activities between several actors, such as universities, companies, government and civil society (Nieminen 2004). These values should promote sustainable development and open diffusion of knowledge within society.

17.5 Afterword: experiences

A major challenge for design in the future is to make the solutions that support sustainable ecological, economic and social development more desirable. One of the main questions is how consumers can be empowered to choose the services and products that support sustainability. In sustainable PSS design processes, this requires input not only from these consumers but from a diversity of stakeholders and bodies of knowledge. As designers and artists this also means defining 'the aesthetics of sustainability' individually in our practice (Vezzoli 2007: 43; see also Part 2, Chapter 1). These aesthetics are manifold, growing from different values and contexts (Vezzoli 2007). In sum, as global challenges continue to arise, more connections between stakeholders, professionals and fields of knowledge are needed. Along the way we must support environmental responsibility, social equity, economic health and cultural vitality.[7]

Moreover, international and intercultural cooperation is important. As design educators and researchers we should share knowledge on best practices, collaborating in an open manner. Similarly to the interaction between different disciplines and even nationalities, the interplay between design and art can also create a cultural dialogue promoting new innovative outcomes. The LeNS project aimed for

7 These aspects are also present in a framework for designers by AIGA, the professional association for design, which has conceived 'The Living Principles for Design' (www.livingprinciples.org), developed in 2009 and officially unveiled at the AIGA Design Conference in Memphis on 9 October 2009.

'transcultural' dialogue (Vezzoli 2005: 5); future design education should also call for the negotiation between cultures of nations, cultures of work, and cultures of thought.

The political programme for design that was adopted in Finland in the early 2000s, as well as design education in general, both require updating. The starting points for this updated programme and developing education should be system and service design as well as a human-centred and -led design focus, in a transdisciplinary manner, and for sustainable development. The ambitious goal set by Aalto University is to foster change through top-quality and interdisciplinary research, pioneering education, continuous renewal and by boldly surpassing traditional boundaries. If 'truly interdisciplinary efforts' to connect the elements of Aalto University are robustly followed through, then it has the possibility to become an institution that is 'well suited to the twenty-first century' (Evaluation Panel 2009: 29).

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18

Transdisciplinary platforms

Teaching sustainability to design students

Tatu Marttila and Cindy Kohtala
Aalto University School of Arts, Design and Architecture, Finland

18.1 Introduction

In 2009, the Academy of Finland conducted an extensive evaluation of art and design universities in Finland. The research in the Department of Design where the authors of this chapter both teach and do research was classified as mainly applied research, directed to a class of problems or group of cases, with 10% being termed 'clinical research': research 'directed towards a specific case or client—much as a doctor treats an individual patient' (Evaluation Panel 2009: 29). Addressing social and environmental problems in the context of Design for Sustainability is certainly applied as well as clinical: specific focus on local issues with localised 'symptoms'. However, it is apparent that to address the causes behind the symptoms and even the epidemic, the required systemic approach necessitates input from an ever-increasing range of specialised scientific knowledge bases. If we are to effect the radical changes proposed in Part 1, Chapter 1 of this volume, we also need a radical approach to learning, problem framing, and problem solving. Such an approach transcends disciplinary borders and produces new knowledge and know-how, as well as students with competence to design radically novel PSS solutions in transdisciplinary contexts. This chapter examines existing research on transdisciplinary knowledge-building and design and applies this understanding to design education, through examples and ongoing research at Aalto University.

18.2 Transdisciplinarity: what and why

It is necessary to first clarify what is meant by different descriptions of inter-professional collaboration[1]—by multidisciplinary, interdisciplinary and transdisciplinary processes—as the terminology can be misunderstood and is often misapplied in ways that cause bias in the scientific debate.

18.2.1 Definitions

In *multidisciplinary* research, several disciplinary perspectives are juxtaposed side by side, each perspective having its own autonomy. The goal is an aggregation of knowledge: to broaden the knowledge base with more information sources, methods and theories but not to produce a holistic view of the study area (Hukkinen 2008; Bruun *et al.* 2005). There is little cross-fertilisation among the disciplines and no explicit goal to achieve synergy in the outcomes (Pohl *et al.* 2008).

In academia in the 1970s[2] recognition began to grow that disciplinary specialisation carries its own risks, particularly the inability to recognise possible negative side effects, to consider long-term implications, and to meet the needs of society at large. Hence, more integrated approaches to research were stimulated that were labelled interdisciplinary or transdisciplinary (Hirsch Hadorn *et al.* 2008; Klein 2008; Bruun 2000). *Interdisciplinarity* thus aims for a more comprehensive or even unified understanding of the given issue, calling for more sharing and merging of vocabulary, frameworks, methods and mental models. This has important implications regarding cognitive processes, the hierarchies implicit in both institutes and knowledge bases, and interaction between such knowledge domains pursuing shared goals.

Currently, increasing demand for *transdisciplinarity* is emerging, causing a shift in academia from science *on* or *about* society towards science *for* and *with* society (Scholz and Marks in Bruun *et al.* 2005: 31). Transdisciplinary research, especially in the arena of sustainability, needs to extend into society itself, involving for example political actors and other societal sectors beyond academia, according to our preferred definition of the term (as in Hukkinen 2008; Bruun *et al.* 2005). Transdisciplinarity 'raises the question of not only problem solution but problem choice' (Klein 2004: 518), thereby necessitating research processes that are more normative and socially responsible than what was perhaps considered appropriate in traditional science in the past.

1 The term 'inter-professional collaboration' is used here simply to describe collaboration among different professions and professionals.

2 The seminal event in this evolution was the first international conference on interdisciplinarity organised by the OECD (Organisation for Economic Cooperation and Development) in Paris in 1970.

18.2.2 Responsibility and commitment

While some have argued that multidisciplinary research deliberately does not 'interrogate the status quo' (Bruun *et al.* 2005: 27), transdisciplinary research tackles issues and improvements in the existing state of affairs that deal with the diverse interests and inputs of individual stakeholders and disciplines within the process (Pohl 2005). The motivation for participating in transdisciplinary research is thus a sense of social responsibility, a need to orient research towards the common interest (Pohl 2005). Challenging the status quo can provoke resistance on the part of institutions and individuals, becoming one of the main barriers to a successful inter-professional research, design and implementation process. In a well-managed project a normative element, however, can support the negotiation process via enhancing commitment and engagement, and this may help to mitigate some of the inherent challenges in cross-boundary work. Studies on expertise have shown that in situations where experts are genuinely concerned about the outcomes of their actions, the highest level of professional behaviour emerges (Hukkinen 2008). To refer again to the clinical, medical metaphor, transdisciplinary approaches take a significant step 'away from detached analysis toward committed diagnosis' (Hukkinen 2008: 67).

This characteristic of engagement also applies in the case of collaboration with laypeople—the very stakeholders who will be most affected by environmental decision-making. Engaging stakeholders with participatory strategies ensures a better chance of commitment in the implementation and follow-up processes (Thabrew *et al.* 2009). Furthermore, such an approach promotes more holistic and systemic assessment of the different elements of a system and of the flows of information, money and materials among them. In a complex, interconnected system 'collective and inclusive decision-making' can serve as a guide towards a more sustainable outcome, since it is informed by a broader knowledge base (Wahl and Baxter 2008: 76). Lay stakeholders are therefore no longer only 'heard' during problem solving as they are in the more disciplinary approaches, but become 'active analysts and problem solvers' themselves (Hukkinen 2008: 67). In sustainable PSS design this implies that stakeholders must be strategically taken into more intensive collaboration, beginning already from the point where problems are framed and initial aims and even activities are planned.

18.2.3 New institutions and new platforms

In today's complex society, university research is still largely responsible for knowledge production and distribution in the world; leading research bodies have become the 'gatekeepers and standard bearers' in this dissemination process (Duderstadt 2000: 48-49). Universities are also defining a new, emerging 'third role', where they seek to establish their position in the political and economic structures of an increasingly knowledge-driven society (Nieminen 2004: 22).[3] Such

3 See Part 2, Chapter 17.

a role emphasises knowledge production for society around existing problems and projects, calling for stronger connections between research and education. Interdisciplinarity and transdisciplinarity cannot be seen as passing fads; they rather represent a 'fundamental and long-term restructuring of the nature of scholarly activity' (Duderstadt 2000: 121).

Moreover, basic disciplines 'cannot in isolation provide sufficient and necessary solutions for sustainability' (Shin *et al.* 2008: 1833); instead, sustainability requires widespread participation among stakeholders, laypeople and experts (Wahl and Baxter 2008). Second, as stated throughout this volume, the transition to a sustainable society necessitates radical change and a system discontinuity from existing consumption and production patterns, and this simply cannot be effected by maintaining the status quo via disciplinary conservatism and protectionism. Instead, it calls for more adaptive systems intelligence.[4] Third, knowledge production is becoming increasingly complex and 'socially distributed' (Bruun 2000: 13). More institutes are adopting interdisciplinary practices and new actors become involved such as private enterprise and government agencies (Bruun 2000; Bruun *et al.* 2005). Education must also reflect this development.

Based on the discussion above, we conclude that interdisciplinary processes—and transdisciplinary where possible—are appropriate inter-professional approaches when dealing with socio-ethical and environmental sustainability problems, in both research and education. This also relates to capacity-building for successful PSS design that is able to adjust itself towards sustainable outcomes in the real-life setting and be sensitive to all the stakeholders and their understanding. Consequently, we argue that students are best served if they 'learn sustainability' in collaborative and inter-professional teamwork that simulates what they will experience in working life and involves them in real-life projects and problems. What is not immediately apparent, however, is the orientation for design in this type of problem solving, as well as the pedagogical implications of teaching design students Design for Sustainability in these new types of inter-professional and transdisciplinary learning platforms.

18.3 Transdisciplinarity: who and how

Several experts on interdisciplinarity highlight that the concept of disciplines itself may be problematic, as differences between specialisations within one discipline may be greater than the differences between some disciplines themselves (e.g.

4 A 'systems approach' (and 'systems thinking') has become a popular framework in sustainability (Porter and Córdoba 2009). It can be further divided into systemic perspectives ranging from 'functionalist' to 'interpretative' and 'adaptive' (Porter and Córdoba 2009), having respective pedagogical implications from positivist to constructivist approaches. 'Systems intelligence' introduces the perspective of an 'adaptive, acting and feeling' human approach to the systems framework (Saarinen and Hämäläinen 2010: 19).

Bruun 2000). Bruun's tactics are therefore to refer instead to epistemic communities and especially 'epistemic frameworks' (2000: 29). Because science and post-secondary education are organised according to disciplines, which themselves are defined according to both epistemic contents as well as social processes of institutionalisation and professionalisation (e.g. Després *et al.* 2004), we will nonetheless refer to expert actors as belonging to disciplines. The concept of epistemic approach or framework remains important, however, because the essence of interdisciplinarity lies in the integration and synthesis of knowledge and frameworks that meet in an 'epistemic encounter' (Bruun 2000) between actors.

Critics of inter-professional approaches fear that crossing or dissolving boundaries also entails a dissolution or at least debasement of specialised knowledge and know-how (see e.g. Marttila and Kohtala 2010). According to our understanding, however, sound disciplinary inputs are crucial if the research is to be meaningful, and in fact inter- and transdisciplinary research have the potential to stimulate innovation in the participating disciplines (Wiesmann *et al.* 2008). A cohesive approach enables disciplines 'to better perform their proper functions' (Shin *et al.* 2008: 1834). Our standpoint is that such cohesion is necessary when dealing with complex sustainability issues in socio-ecological systems simply because values, interests and mental models of actors vary so widely. Specifically, actors easily disagree on actions to be taken since proposed actions are based on assumptions coming from individuals' and groups' worldviews (e.g. Carew and Mitchell 2008). Actualising the full potential of disciplinary contribution and integration requires participants who are capable of *bridging* disciplinary knowledge components[5] (Wiesmann *et al.* 2008). Transdisciplinarity and interdisciplinarity thus do not intend to damage the 'disciplinary core', but the integration and synthesis processes mentioned above do involve a 'rearrangement' of a particular discipline's knowledge (Pohl 2005: 1175) that eventuates in a new and distinct form of specialisation (Wiesmann *et al.* 2008: 436). As Bruun emphasises, interdisciplinarity focuses as much on *knowing how* as *knowing that*: knowing how including the 'capacity to differentiate, compare, contrast, relate, clarify, reconcile, and synthesize' (2000: 17; see Section 18.3.3).

18.3.1 The hierarchy of knowledge

We have not yet addressed the issue of *who* should be involved in transdisciplinary research. According to Wiesmann *et al.*, 'the canon of participating disciplines and competences from the natural, technical and social sciences, and the humanities, as well as from the life-world cannot be pre-defined' (2008: 436). A participatory approach involving stakeholders from the real world is required, which can then

5 In studies of social networks, 'bridging' is a concept describing the transmission of information from one group (or disciplinary domain) to another. The potential size of information flow depends on the number and connectedness of the 'bridges' available for information exchange.

determine during the research process itself which bodies of knowledge need to be integrated (Wiesmann *et al.* 2008). This has implications regarding the hierarchy of knowledge: how facts and information are prioritised and indeed what is considered 'fact' and relevant information. Hukkinen emphasises that the lay knowledge contributed by real-life (or 'life-world') stakeholders is actually expert knowledge on the basis of being socially relevant: the 'quality' of the knowledge is therefore based on a criterion of being socially robust more than scientifically reliable, and its testing involves 'public deliberation' (2008: 67).

For transdisciplinary processes this implies that the 'idealised context' of science must be set aside if practically relevant knowledge is to be produced (Pohl 2005: 1160). It is a set of circumstances that disciplinary experts can easily find threatening or unfamiliar and uncomfortable, at the very least. Transdisciplinary researchers must be capable of dealing with the tension between their professional identity and their disciplinary specialisation, on the one hand and the complexity of the reality to be understood, on the other (Després *et al.* 2004). If this tension becomes an obstacle, and traditional knowledge hierarchies are artificially maintained in the interests of protecting disciplinary borders, any problem setting/solving processes are likely to lack a shared goal and/or relevance to real-life contexts.

18.3.2 Shared problem space and epistemic translation

The sources of knowledge in transdisciplinarity are heterogeneous, deriving from the natural sciences, social sciences, lay actors and various sectors. Three types of knowledge and knowledge components have been classified: 1) **systems** knowledge (the analysis of complex empirical questions); 2) **target** knowledge (needed in defining goals to better deal with problems); and 3) **transformation** knowledge (how existing practices can be changed) (Wiesmann *et al.* 2008: 436).

As stated earlier, this knowledge needs to be shared, rearranged, integrated and synthesised in inter-professional, complex environmental problem solving. What results is a new blended or 'hybrid' knowledge that is qualitatively different from its partial inputs (von Ghyczy 2003, as cited in Hukkinen 2008: 65; see Figure 18.1).[6] In simple terms, when one expert meets another expert, they begin to explore where they have a common understanding. This is not merely a semantic process of understanding each other's 'language', although this is also a necessary introductory phase. Sharing of cross-boundary knowledge is a cognitive process that happens through the use of analogies or pattern recognition: from each expert's input, the 'familiar input spaces', selective elements and relationships are adopted

6 Knowledge emerging from transdisciplinary collaboration resembles 'Mode 2' knowledge (Gibbons *et al.* 1994), transcending from the 'old paradigm of scientific enquiry' (i.e. 'Mode 1') characterised by an 'internally-driven taxonomy of disciplines' (Nowotny *et al.* 2003: 179). Such knowledge is socially distributed, application-oriented and transdisciplinary and not necessarily simply 'derived from pre-existing disciplines' but generated within the context of application (Nowotny *et al.* 2003: 186).

in the construction of a new human-scale mental model that is easy to understand (Hukkinen 2008: 71). Two partial domains of knowledge—two partial mental models—thereby meet and meld, creating a new shared 'input space' (according to Hukkinen 2008: 71) or a 'mediation space' (according to Després *et al.* 2004: 475). In our earlier study, this was referred to as an 'opportunity space' (Marttila and Kohtala 2010: 175). In the Human Computer Interaction (HCI) field, this is known as a joint problem space.

Figure 18.1 **Creating the joint problem space and hybrid knowledge**
Source: authors

What actually happens in the shared problem space? According to Roschelle and Teasley (1995: 70), in the HCI field the joint problem space is 'a shared knowledge structure that supports problem solving activity by integrating **goals**, descriptions of the current **problem state**, awareness of available problem solving **actions**, and **associations** that relate goals, features of the current problem state, and available actions' (emphasis added). In problem solving for sustainable development, it is described as a mutual learning process whereby the actors define the **sustainability goals**, examine the **current status**, **evaluate options** (through e.g. constructing scenarios), and **build strategies** and develop indicators for monitoring and evaluation (e.g. Thabrew *et al.* 2009).

Successful facilitation aims to build the trust and respect that are essential cornerstones of transdisciplinarity. Fostering a mutual learning attitude—as opposed to protecting disciplinary positions—is important, as sustainable development is a value-laden arena. Attention must thus be paid to values and stakes in all stages of

the process, which on a practical level requires adequate time and on a facilitation level requires reflexive processes that build 'value-consciousness' among researchers (Wiesmann *et al.* 2008: 438). Such an attitude requires new skills and emphasis on epistemological reflection (see Section 18.3.3). This then allows non-traditional types of knowledge to enter the problem space, it allows due respect and understanding of another discipline's epistemic input and ways of working, and it enables the necessary first step of defining goals.

According to Bruun (2000), integration of data in a shared problem space may occur simply by virtue of its circulation, where one expert can use another expert's data directly, or concepts may simply be transferred from one discipline to another. In this case the experts have the same conception of the input. In many cases, however, data circulating or transferred from field X to Y may need to be 'translated' by scientists in field Y if it is to carry meaning and relevance: the status of the data and therein its meaning then changes. Similarly, in concept transfer between X and Y, the meaning of the concept in X may be completely changed in field Y. Bruun refers to these changes as 'epistemic translation' (2000: 32; Figure 18.1: [3]). For example, environmental sociologists translate ecological or chemical data produced by environmental scientists into sociological data (Bruun 2000). Concepts from the natural sciences or engineering will undergo an epistemic translation when architects adopt them in urban planning projects. Stories from real-life provided by lay stakeholders will be translated so they are relevant to scientists and the researchers studying their context. Naturally this can also be a potential cause of failure or confusion, but in a well-functioning process epistemic translation of concepts can be a key to the renewal of knowledge fields (Bruun 2000).

18.3.3 Knowing-that and knowing-how

In sum, participants in successful transdisciplinary processes are competent in their own disciplinary know-how but are also able to encounter another knowledge base, merge mental models, and construct new meaning and knowledge through synthesis and reconciliation (see Figure 18.1: [1], represented as the light grey arrows). At the same time even the most basic team activity requires certain social, participatory and collaborative skills. In interdisciplinarity, these social skills are devoted to the *creation* and *maintenance* of the shared problem space, through e.g. monitoring of activities and meanings and rectifying misunderstandings that impede the progress of collaboration (Roschelle and Teasley 1995; see Figure 18.1: [2], represented as the dark grey arrows). According to Sarmiento (2009), this twofold competence accords with group cognition theory, which regards the dialectical relationship between social interaction and the construction of meaning as one of its central principles. Després *et al.* describe it as 'communicative rationality' that is at work, alongside 'cognitive rationality' (2004: 476). Hence, added to the skills needed mentioned earlier—defining, contrasting, synthesising, etc.—are what we regard as truly 21st century skills: 'decoding value patterns and normative assumptions governing theories, frameworks, concepts; the shifting from absolute

answers and solutions to tentativeness and reflexivity; and reflexivity including epistemological reflection and critique of disciplinary knowledge' (Egneus *et al.* 2000, as cited in Bruun 2000: 46).

18.4 Design at the boundaries

Students studying sustainability issues in inter-professional collaboration must accordingly be capable of rearranging their knowledge towards a meaningful outcome oriented by a shared vision of the problem and the goal. New understanding is collaboratively and iteratively mediated upon and in relation to existing knowledge, often derived from earlier professional and personal experiences (e.g. Marttila 2011b). As sustainability is a 'process of co-evolution and co-design' (Wahl and Baxter 2008: 72), Design for Sustainability students are required to understand participatory approaches and simultaneously address the ethical dimension and the values behind the choices made. Without a mutual understanding and agreement on visions, scenarios and indicators in problem choice, problem solving and follow-up, true progress cannot be made (e.g. Marttila and Kohtala 2010).

18.4.1 Hybridised knowledge for design

In the creation and development of transdisciplinary processes involving higher education and society, different actors are increasingly involved from the realms of business, scientific research, and politics (see Nieminen 2004). In the process the values and knowledge of these domains interact through 'hybridisation' in the 'in-between', producing novel innovations, scientific knowledge, and societal policies (Nieminen 2004; see Figure 18.2).[7]

In our view, designers are trained to hone the ability to translate data from other fields into design attributes, systematically as well as according to a sensitised intuition. Using quantitative ergonomic or usability data in a design process is a clear example; using user self-documented probes data is more challenging. It is our contention that design as a practice is suited to help bridge these gaps between concepts and values within a hybridisation process, since the design process, and even more so sustainable design, is influenced by several value sets by default. More precisely, from this perspective design is not considered as a discipline but instead

7 Deleuze and Guattari (1980) have coined the term 'rhizome' and 'rhizomatic' to describe a theory of knowledge production that allows for multiple, non-hierarchical entry and exit points in representation and interpretation. As a model for culture, the rhizome resists fixed organisational structures—it is characterised by 'ceaselessly established connections between semiotic chains, organisations of power, and circumstances relative to the arts, sciences, and social struggles' (Deleuze and Guattari 1980).

Figure 18.2 **PSS design supporting hybridisation between domains**

Source: Figure adapted by authors from Nieminen 2004

as an *epistemic approach* that is able to integrate and facilitate several stakeholders' opinions in a sustainable, holistic and transdisciplinary design concept. Design in this sense can be seen as something of an 'epistemic translation machine': capable of translating stakeholders' values and disciplinary concepts and data into practical application. Design then acts as a 'cultural broker', operating in the connection zone in order to facilitate hybridisation.

The solution-oriented approach taken in design—as a societal and epistemic activity more than mere profession—is what produces culture, culture from, out of, with, or in spite of nature. Several authors have suggested the term 'metadesign' to describe the processes within the non-material 'upstream' of design activity (e.g. Wahl and Baxter 2008: 74). Wahl and Baxter define the 'downstream end' of the design process to be 'cultural artifacts, institutions, patterns of production, and consumption' that express intentionality materially, whereas the 'upstream' is the immaterial dimension of our value systems, worldviews, aspirations and 'conscious awareness' that define the 'intentionality behind materialised design' (2008: 73). In this larger sense, design as producer of social content, functions and culture operates in the liminal spaces, in the boundary zones between domains: between the user and the machine, the stakeholder and the system, the citizen and policy-making, and the need and its satisfaction. Sustainable development furthermore necessitates design to perform more robustly between human cultural systems and natural systems. Such a notion as 'upstream' is important in assessing sustainability, as its context-dependent definitions can only be created in negotiations among several stakeholders' knowledge, value systems and worldviews.

18.4.2 Mediating radical innovation

While incremental changes do not affect the status quo, the most innovative solutions—i.e. the radical transition needed—happen at the system level (e.g. Sherwin 2004), and this requires a creative approach that is able to reflect on its own values and concepts. Creativity involves divergent thinking and facilitating, and both creativity and design practice benefit from domain-relevant skills and real-life contexts. At the meta-level, in the shared problem space, this means that sustainable design processes must be open to contributions from diverse disciplines and perspectives and simultaneously remain aware of the epistemological and ontological 'metadesign assumptions that define the perspective of each discipline' (Wahl and Baxter 2008: 74). Design for Sustainability and for sustainable PSS should therefore not be about prediction and control, but instead about 'appropriate participation, flexibility, and constant learning' (Wahl and Baxter 2008: 83).

Sustainable design is possible only if the 'unsustainability' in real life is first understood appropriately and the problem context is further defined (Clune 2009). The process of framing and evaluating a problem can be seen in Figure 18.3, which illustrates the phases of transdisciplinary research. Here design can make contributions to all phases of the process, but it is real-life implementation and testing (bringing results to fruition) that we see as the most obvious opportunity to exploit design competence. In these circumstances, we suggested the expression 'cultural broker' above; John Thackara, for one, would like to see new design practice operating as a *filter*: 'We're swamped by innovation, but starved of meaning. We are confronted by such a cacophony of contradictory ideas and solutions, it's immobilising' (2007: 61).

Figure 18.3 **Three phases of research in a transdisciplinary research process**

Source: Hirsch Hadorn *et al.* 2008: 35, with kind permission from Springer Science+Business Media B.V.

Contributing to these three phases entails contribution of specific design-relevant knowledge and knowledge components. Regarding the three types of transdisciplinary knowledge delineated earlier (see Section 18.3.2), designers can provide their own perspective and input regarding target knowledge [2] and transformation knowledge [3]. With regard to systems knowledge [1], designers can increase its adaptivity and attune it better according to stakeholder interests, to create the aforementioned 'systems intelligence' (Saarinen and Hämäläinen 2010). Acquiring robust systems knowledge is challenging, as it needs strategies to deal with uncertainties: uncertainties about problem origin and possible development, as well as problem interpretation related to perceptions of goals and options for change. These uncertainties can be tackled and reflected upon through 'life-world' experiments (Hirsch Hadorn *et al.* 2008: 31-32). Strategies such as rapid prototyping, experience prototyping and iterative processes are characteristic design methods and modes of working, what many authors call 'design thinking',[8] and serve well as experimental modes. The design approach thus has a clear role in setting up and evaluating these solution-oriented, real-life experiments.[9]

18.4.3 Design intelligence for sustainability

To summarise, design as an epistemic framework is problem-based and solution-oriented, includes participatory tactics, and embraces creativity; we therefore propose the term 'design intelligence' in place of the popular term 'design thinking'. According to Fry (2008), design intelligence has to be distinct from the mere 'process, product and expression of a professional practice' (Fry 2008: 14). Design intelligence assesses the systemic effects of different innovations and aims for 'an exploration of how things come into being and act' (Fry 2008: 12). Our design intelligence is twofold, knowledge and know-how, involving cognitive and social processes (as explained in Section 18.3.3); it is embodied in the designer as an individual but existent also in other interdisciplinary team members or problem-solving actors. Through iterative facilitation and interaction, a design approach (promoting design intelligence) can help solve the challenges of sustainability in a truly transdisciplinary way and raise the level of solutions from merely incremental (i.e. eco-design) to innovative, enabling the implementation of radical system changes. This suggests that rather than introducing new artefacts and technical fixes, design practice and education should transform itself (see Fry 2008) and the role of design should aim higher towards changes in 'worldview, intention, and

8 Design thinking, as popularised by Tim Brown, CEO of IDEO, can be understood as a 'set of principles that can be applied by diverse people to a wide range of problems' (Brown 2009: 7). It has a human-centred approach, is iterative and about sharing of knowledge, and is focused in making new ideas visual (Brown 2009).

9 Such an approach resembles the 'constructive design approach' by Koskinen *et al.* (2011) that aims to integrate design and research to 'stimulate imagination and thinking' through experiments with prototypes and mock-ups, in the real contexts of use.

lifestyle, facilitated by dialogue and education' (Wahl and Baxter 2008: 80). It therefore seems crucial that Design for Sustainability students are sensitised to such problem-solving already in course-work: that they learn to decode the normative assumptions and frameworks people use in their value judgements and that educators can make this structure transparent through critical reflection and discussion.

Based on these notions, we suggest that design know-how can be used as a method or approach to inter-professional sustainability problem setting/solving, given its characteristic abilities to facilitate collaboration and participation among several disciplines, to creatively experiment and reiterate. A design approach can thereby foster 'design thinking' in all team members, and as a 'transdisciplinary design dialogue' it should be based on a dynamic, iterative process among stakeholders, supported by an 'integral framework' (Wahl and Baxter 2008: 82). Furthermore, design (i.e. 'metadesign') knowledge is comprised of sector or disciplinary knowledge translated into information relevant when designing a PSS solution for a specific real-life problem context. Because of the real-life context, the ethical dimension also comes naturally into play. Together this forms design intelligence, a competence that we see as a goal not only for sustainable PSS design, but more widely for Design for Sustainability education.

18.5 Transdisciplinarity in education

In order to tackle challenges in transdisciplinary approaches, what is then needed from contemporary design academia? How can design education bring forth such delicate and sensitive abilities?

The first key point was stated earlier: educators themselves need to be aware of their own worldviews and biases when working with students. Studies have shown that teachers tend to pass on their own assumptions and frameworks to students, especially regarding the issue of sustainability, implicating how actions are chosen and prioritised (e.g. Carew and Mitchell 2008; see also Marttila 2011a). Defining sustainability itself is less the issue than being able to define specific sustainable development goals in an interdisciplinary context. We do agree with Carew and Mitchell that sustainability being a nebulous concept is actually healthy even as it is inevitable, as it 'offers a means to give voice to different stakeholder perspectives, to further evolve the concept, and supports the continuing flexible application of sustainability in contextualised consultative decision-making' (2008: 106). We support these authors' proposal that successful teaching of sustainability thus requires a more transparent process on the side of the teacher, who is courageous enough to flesh out the complex range of options, the various frameworks by which experts work, and especially to inspire debate on the assumptions that underpin these preferences. This in turn would boost students' ability to work in a variety of future professional contexts, as flexible and creative experts (Carew and Mitchell 2008: 114).

Second, there is general agreement in the literature that education for 21st-century students needs to be active and constructive (e.g. Segalàs *et al.* 2010; Klein 2008; Leiviskä 2001; Duderstadt 2000). Active learning encompasses problem-based learning, case studies, and the like, while passive learning refers to the more traditional pedagogical approach of lecturing, writing exercises, and demonstrations of problems. Active learning is further divided into instructive, explorative and constructive approaches, where instructionalism denotes knowledge transfer and the submission of learners; explorative approaches stimulate intentional searching for information and knowledge and development of hypotheses; and constructivist education emphasises construction of and confrontation with meaning as well as the social aspects of learning (Horvath *et al.* 2004, as cited in Segalàs *et al.* 2010: 278).

Third, there is also general agreement in the literature that students' disciplinary core must be established and maintained: before interdisciplinary course-work is introduced, the disciplinary foundation—the disciplinary and supplementary knowledge base and know-how—must be built. The students must have a certain degree of confidence and a professional profile before they can enter into cross-boundary work (e.g. Leiviskä 2001). In addition, as confident students and later as researchers or designers, they will be better able to confront what Wiesmann *et al.* (2008) identify as the most common stumbling block in transdisciplinary education and career building: exposure to the conflicting reference systems of their own discipline, the interdisciplinary research context, and the society concerned. This applies in research and real-life practice beyond the educational level. On the basis of a strong professional and disciplinary identity, students can disperse the stereotypes that often emerge at the beginning of interdisciplinary teamwork.

Ongoing research at Aalto University has been looking into inter-professional education in both design and business management contexts (e.g. Leiviskä 2001) and in the context of sustainability (e.g. Marttila 2011a, b). In the following section, we relate this existing understanding to the findings from an ongoing study of an inter-professional Master's programme called Creative Sustainability (CS)[10] launched in 2010.

18.5.1 Design for Sustainability competence

Design students learning to solve environmental problems in transdisciplinary contexts need the same twofold skillsets as interdisciplinary experts (see Section 18.3.3 and Figure 18.1): knowledge synthesis competence and collaborative social skills to be able to build a shared problem space. According to Klein, the literature

10 CS is a joint Master's programme between several schools and departments in Aalto University, in which the students participate in shared intro courses and projects but graduate from their own respective professional programmes. It was launched along with the initiation of Aalto University operations in 2010. See Chapter 17 'Creative sustainability' in this section for more information.

on transdisciplinary education emphasises especially the following skills (2002, as cited in Klein 2008: 407; numbering by authors):

1. The ability to find and gather the relevant information and then work with it (resembling systems knowledge [1], as in Wiesmann *et al.* 2008)
2. The ability to compare and contrast different methods and approaches, and how this relates to the target task (resembling target knowledge [2])
3. The ability to generate a synthesis, an integrative framework, or a more holistic understanding for a particular theme, question, or problem (resembling transformation knowledge [3])

Successful sustainable design education, also according to the literature, aims to transmit as well as create knowledge on the three dimensions of sustainability, develop critical and systemic thinking, and enhance interpersonal and intrapersonal skills (Svanström *et al.* 2008). This is best achieved through a constructivist education approach, as mentioned earlier, since it boosts students' integrative abilities and facilitates systems intelligence. Moreover, according to e.g. Segalàs *et al.*, constructivist learning emphasises 'distributed cognition' (2010: 278), which means that students learn how to contribute and construct knowledge and make decisions in heterogeneous collaborative teams (see also Madhavan and Grover 1998). This view was confirmed in our ongoing study on inter-professional design education; one interviewee reported the following:

> It's not enough that you have an ideology for sustainability. That means that you also have to have an understanding of the…real processes that are in use currently, and then that are in the opportunity space that can be created through the combination of professions.[11]

In such education, students also need to develop a mind-set open to transdisciplinary processes, a 'cognitive flexibility', and an enthusiasm for self-directed as well as lifelong learning (Klein 2008: 408). Moreover, they are expected to foster values and attitudes consistent with the 'sustainability paradigm' (Segalàs *et al.* 2010; Svanström *et al.* 2008). Such a value-laden approach emphasises the importance of a constructive attitude. One of the interviewees in our study emphasised how this mind-set is central as a motivating, unifying, and normative, guiding value: '[What is] most important is…to increase the sustainable attitude, and to teach our students that this is the…key point in everything we do. In *everything*. So there's no other choice'.[12]

Finally, Design for Sustainability students need to acquire what Svanström *et al.* term 'change agent' skills (2008). These refer to communication and conflict-solving competences in interpersonal and intrapersonal interactions, which can be bolstered by a shared sustainability 'value system', as suggested above (Svanström

11 Interviewee 2, 17 May 2010
12 Interviewee 1, 26 June 2010

et al. 2008: 347). Success is due largely to team members' ability to explain and clarify ideas to others as well as listen to others in order to foster a common understanding (Leiviskä 2001). This was also highlighted in our study: 'Those who are insiders…have to talk about their understanding in ways that others who don't have the same kind of background can also get the idea [of] what it's about'. '[They]…try to *communicate what they understand* and then try to get *a common understanding*…from that point of view'.[13]

Building the shared problem space is thus a cognitive and social dance with the creation of hybrid knowledge, requiring iterative feedback loops and continuous formation of new knowledge and new proposals. Another interviewee in our study explained it thus:

> [We have] these types of interacting skills for…giving space…but [the group is] still processing the emerging ideas further through new networks…bringing feedback back to the…multi-professional context, and then…keep[ing] the process going on through new types of inputs depending on the kind of solutions that are emerging.[14]

Performing such reflexive and reflective activities successfully in practice is as difficult as it sounds on paper, which is why there are no 'manuals' as yet on transdisciplinary practices. How, then, can we expect students at the beginning of their career learning curve to attempt such challenging circumstances? Based on our own study and the literature on sustainable design education, transdisciplinary research and creative teamwork, we offer the following guidelines for teaching sustainable PSS design and Design for Sustainability.

18.5.2 Sustainability learning platforms

First, inter-professional education for sustainability should be structured to promote active, constructivist and explorative learning, as explained above. When possible, projects should involve a real or hypothetical 'client' with a specific problem space, as exploration embedded in a real work context increases students' motivation as well as the authenticity of the learning tasks (Segalàs *et al.* 2010). In addition, group and community-oriented pedagogical approaches, as opposed to individual-oriented approaches, build the type of dynamic, collaborative, interactive environment that best develops sustainable design competences. Involving stakeholders where possible enables the introduction of a transdisciplinary perspective and enhances the cognitive learning benefits associated with the community-oriented approach (Segalàs *et al.* 2010; see also Leiviskä 2001).

Active, constructivist, and collaborative learning seems to suggest in turn that training in teamwork is essential at the outset. In Aalto University, the Creative Sustainability programme provides introductory courses on teamwork, mind-sets and

13 Interviewee 2, 17 May 2010; emphasis added
14 Interviewee 2, 17 May 2010

systems thinking that are mandatory for all students. These shared introductory courses follow the idea introduced already in the university's first inter-professional programme, IDBM,[15] and its course called 'Creative Teamwork'. This course enables students to understand team and group processes and the social skills needed for successful interaction. Perhaps most importantly, the course introduces students to the teaching and learning patterns each discipline is exposed to in their own schools; i.e. each student learns how the others learn and how they work. For design students, learning is by doing, by simply jumping in and starting work. Business students experience more passive pedagogical approaches and begin with a more analytical approach, while engineering students place importance on systematic progress (Leiviskä 2001). Understanding these learning and working styles before actual problem solving can help build trust and respect, resolve conflict and enhance communication in order to foster collaborative creativity. It is also reflective of what is to come in real work processes, where disciplinary experts will carry with them the work routines and learning styles of their own respective institutions.

Second, inter- or transdisciplinary courses focused on sustainability issues should aim to develop experts who are able to integrate and synthesise knowledge. 'T-shaped experts' have the cognitive capacity to integrate multiple knowledge bases in their own experience, to understand how other knowledge inputs relate to and interact with their own disciplinary knowledge (Madhavan and Grover 1998: 3). These experts must be socially skilled to work as 'bridges' between different people and perspectives. In the process we describe in this chapter, they are therefore also competent in epistemic translation and building hybrid knowledge in the shared problem space. Madhavan and Grover call hybrid knowledge 'embedded knowledge' that is created by the team in question, which encompasses both tacit knowledge and explicit knowledge (1998: 2). The short horizontal top of the 'T' in a T-shaped expert thus refers to this ability to bridge knowledge and know-how; the long vertical stem of the 'T' represents the deep knowledge and know-how (i.e. both tacit and explicit knowledge) of their own discipline. Strengthening the top of the 'T' is best effected by exploring the boundaries and connections between the disciplines in creative teamwork, emphasising reflexivity and the methodological, conceptual and theoretical skills needed in this exploration (Wiesmann *et al.* 2008).

In practice, this necessitates frequent, direct and trustful personal interaction that builds strong ties and enhances knowledge building in the team. Moreover, this interaction should be informal and allowed to happen in a spontaneous and unplanned way, as informal interaction is associated with variance in routines as well as significant information transfer, and therefore regarded as elemental in innovation and creativity (Madhavan and Grover 1998). Effective and efficient teams are hindered by overly formal procedures and gatekeepers that have the potential to stem information and knowledge flow. Madhavan and Grover suggest

15 The International Design Business Management (IDBM) Master's programme was initiated for the students of the three universities in 1995, even before their merger into Aalto University.

instead that teams be led by A-shaped experts who have their feet in two disciplines at once and are therefore capable of fostering the team's ability to share and integrate knowledge, to recognise the value of new and external information, absorb it, and apply it productively (Madhavan and Grover 1998). Hukkinen (2008) in his turn suggests the term 'hybrid expert' for this role.

In addition, we suggest that teams be encouraged to build different work modes and individual work phases into their project schedule, in order to allow the divergent thinking necessary in creativity and to mitigate the potential for 'groupthink'. According to Hoegl and Parboteeah (2007), collaborative teamwork involves convergent thinking when seeking consensus, and this actually inhibits the creative potential of the team. The authors suggest that creative processes thus integrate less collaborative elements, where individuals separately develop ideas, alongside the collaborative elements, where the teams collectively discuss and elaborate these ideas and alternatives (Hoegl and Parboteeah 2007).

Third, in the interests of fostering systems intelligence—an adaptive systems approach to design and assessment—we propose that the social dimension of sustainability be emphasised in interdisciplinary education over the environmental and economic dimensions (in the three-dimension model of sustainable development), to ensure students truly understand how sustainability affects human beings and how problems can be solved in ways that are not overly technologically driven. According to a study of engineering education by Segalàs *et al.* (2010), in most cases students strongly relate sustainability to environmental and economic issues, over-emphasising the role of technology in solving problems of unsustainability. The authors stress that this imbalance needs to be addressed through educational contents: teachers need to pointedly increase students' awareness of the social and institutional relevance of sustainability and the societal aspects of technologies (Segalàs *et al.* 2010: 275).

We propose that this 'bias' or imbalance may be partly related to the hierarchy inherent in disciplinary professionalisation, where socially relevant knowledge may be ranked lower in priority compared to scientifically reliable knowledge in some disciplines' teaching. This ranking impedes transdisciplinary research and systems understanding, as socially relevant knowledge (provided by lay-stakeholders, for example) is key to any change processes to be implemented in the particular social context being studied. Transdisciplinary design dialogue can help to introduce more qualitative considerations regarding 'whole-system health, happiness, well-being, meaning, and quality of life' into decision-making and design processes (Wahl and Baxter 2008: 83).

One solution for an educational platform is to ensure that understanding of environmental and economic sustainability dimensions—together with their technological aspects—is promoted in disciplinary-related education and that socio-cultural sustainability and the institutional perspectives are emphasised in projects. In the interests of transdisciplinarity, where possible lay-stakeholders should also be involved in a co-design process, facilitated by design students with experience in participative co-creation methods.

In summary, an ideal teaching platform for inter-professional and transdisciplinary sustainability problem solving—including sustainable PSS design—enables collaborative teamwork, where the teams are first trained in teamwork processes and are then encouraged to interact informally, directly and frequently on a specific problem context. Team members also have individual work segments and are encouraged to reflect on new information they receive with respect to their own disciplinary experience: to explore the disciplinary boundaries through both private reflection as well as interactive dialogue. Students are thus encouraged to 'keep' and develop their own disciplinary professional identity, but in a way that promotes shared understanding and fosters communication skills, discouraging the protection of knowledge and know-how. Ideally the team is led by a facilitator with both the social skills to facilitate as well as experience in more than one discipline. Teachers themselves need to acquire adaptive and ethical systems intelligence and be open and accepting of transdisciplinarity. They need to be capable of both helping students in the epistemic translation of complex data into design-relevant information, as well as boosting students' abilities to facilitate a transdisciplinary dialogue among a wide range of participants.

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19

Learning the unlearned

Product design for sustainability

Benny Ding Leong and Brian Y.H. Lee

Asian Lifestyle Design Research Lab, School of Design, Hong Kong Polytechnic University, Hong Kong, China

19.1 The three transitions

Since the mid-1990s, the world has been experiencing three macro transitions: a transition towards *digital connectivity*, from physical interaction and communication to virtual networking of people; a transition towards a *service-based economy*, from the production of mass physical commodities to the production and delivery of highly customised product-services; and a transition towards *sustainable culture*, the urge to improve the quality of life by means of drastic reduction in environmentally unfriendly consumption and depletion of natural resources. The convergence of these three transitions is resulting in a post-industrial economy and ecology that is based on *knowledge, information* and *service* (Leong 2004; Manzini and Leong 2001). This change not only dramatically alters business and industrial practices globally and locally, but also the perception of people's values.[1] The rise of the so-called 'conscience consumer' from about the early 2000s, who seeks well-being,

1 Values can be defined as *quantitative*, emphasising physiological and psychological needs (e.g. proper nourishment, safety, and affluence) and *qualitative*, emphasising spiritual needs and socio-psychological desires (e.g. intellectual cultivation, self-esteem, love and solidarity).

togetherness, and sustainable living, is clearly evident around the world (Ray and Anderson 2001; *Viewpoint* 2005) and more recently in China[2] (Leong 2010).

19.2 The rise of DfS and its learning in China

In reaction to the transitional change mentioned above, a systemic change, which aims to sustain economic growth and maintain people's well-being while reducing the consumption of environmental resources, was proposed in the West about a decade ago. At the same time, within the design arena, the idea of **Design for Sustainability (DfS)** was initiated to supplement the prevailing practice of **Design for the Environment (DfE)** or eco-design in order to ensure a swifter transition towards sustainability (Charter and Tischner 2001; Leong and Manzini 2006; Tukker and Tischner 2006; Vezzoli 2010). In collaboration with Professor Ezio Manzini, Professor Zhao J.H.[3] and Professor Carlo Vezzoli in 2000 and 2003, respectively, the principal author of this chapter assisted and initiated the promotion of the concept of DfS, SPSS (Sustainable Product-Service Systems) and SpD (System-Product Design)[4] via a series of workshops and several pilot projects at key design universities in Hong Kong, Beijing, Hunan, Wuxi and Guangzhou in China. The idea of DfS thereby eventually landed in China.

Although DfS was welcomed initially as a novel concept or idea, it could not take root properly at that time in China. Quite a number of student participants who had taken part in the DfS or SpD workshops were doubtful about the practicality of DfS's solution-based approach for the industries of China (Leong 2008). The feedback and experience suggests that this doubt was especially due to the clear difference between China's actual situation and stage of economic development and that of the West in the early 2000s. China's economy was still at the rising stage of industrialisation. For instance, China's manufacturing productivity accounted for a 35.3% share of the gross domestic product in 2003 (Economy Watch, undated).

2 According to the findings of a recent large-scale research project, 'Lifestyle China', over 90% of middle-class households in urban China opted for environment protection over economic development for their own cities.

3 Together with Professor Ezio Manzini and the main author of this chapter (Benny D. Leong), professor Zhao J.H. from Hunan University helped to cofound the first DfS organisation in China named the *Chinese Network on Design for Sustainability* in June 2001. Network members include Hong Kong Polytechnic University, Hunan University, Tsinghua University and Guangzhou Academy of Fine Arts.

4 SpD (System-Product Design) is 'a design approach and process which aims to identify, design and strategise needed products to be utilised within the Product-Service System (PSS) of a designated Sustainable Solution' (Leong 2002). A series of workshops was conducted in Hong Kong, Guangzhou, Hunan and Wuxi by Leong and Ms Elaine Ann, Director of Kaizor Innovation Ltd, in 2003 for the promotion of the concepts of SpD and Design for Sustainability in China.

The whole industrial environment was then very much production and OEM (original equipment manufacturing) oriented. Obviously China was still in the developmental phase of its **product-based** economy, while the West had been heading steadily towards a **service-based** alternative.

19.2.1 The dilemma of 'unlearning'

Under such an economic reality, teaching and learning of industrial design within most design schools and universities in China were unsurprisingly *production* focused and product driven. As a result, the promotion of Design for Sustainability was not an easy undertaking, as learning of DfS emphasises first the 'unlearning' of the product-based approach. It involves the uptake of an entirely alternative, if not *contradictory*, set of design skills, which poses a challenge for most design students with their affinity for physicality and materiality and conventionally trained faculties. Many of these *contradictions* are experienced from design inception to the finalisation phases of typical industrial design projects, as can be seen in Table 19.1.

Table 19.1 **How DfS learning differs from conventional industrial design learning**

Phases of project	DfS learning	Industrial design learning
Research	People-centred (real-life context)	User-centred (i-methodology based)[5]
Analysis	Socio-culturally driven	Economics-driven
Ideation	Co-creative (participatory)	Expert mind-set
Design approach	Strategic: service-based	Operative: product-based
Idea development	Integrated, system thinking	Linear, process thinking
Design formation	Physical consumption alleviation	Materials production reinforcement
Outputs	Dematerialised solution	Physical product

Because of the distinctive nature of DfS practice, most leading design schools in China were having difficulties aligning their teaching with the existing design curriculum or were inclined to set it aside as a 'decorative' pedagogic component of the mainstream syllabus within the industrial design discipline. As a result, teaching of DfS was unable to draw sufficient attention from students and the senior management of design schools in China, and its promotion within the design education arena had slowed by around 2004 to 2007.

5 I-methodology is a basic form of user-based design methodology where designers design with themselves or their friends in mind (Lindsay 2003).

Ironically, soon after moving into the 'bottleneck' that its *production-led* economy created—the appreciation of the Chinese yuan,[6] widening social disparity,[7] and the rapidly deteriorating environment[8]—China now has to move up the value chain of its industrial economy while considering how to address its environmental and social problems through an alternative developmental strategy. In its most recent 11th and 12th five-year plans, the Chinese central government has demonstrated its determination to seek major socio-economic transitions for the future development of China, which include turning export-oriented industries towards **domestic-focused** ones; replacing the high-carbon economy with a **low-carbon** alternative; and switching from national-focused development towards **people-centred enrichment** (CPEIN 2010).

Under this particular context of sustainable transition, the strategic, solution-based DfS and sustainable PSS design has made its return and been placed in the 'spotlight' of design and in particular design education in China once again.[9]

6 From 2003 to 2008 alone the Chinese currency (the yuan) had appreciated 21% while the cost of China's manufacturing was merely 5.5% (compared to 22% in 2003) lower than that of the US. According to the Ministry of Commerce of the People's Republic of China, a further 3% rise in the value of the Chinese yuan may result in bankruptcies in the most labour-intensive industries such as textiles, clothing, toys, furniture and electrical appliances in China (as cited in Forex Finance People 2010).

7 Today, there are large income and social inequities between the rich and poor in China. According to a survey by the CASS (Chinese Academy of Social Sciences) in 2009, the top 10% of the highest income population controls 40% of the country's assets, while the poorest 10% possess just 2% (Hickey and Kawamoto 2010). The income disparity between these two groups of people is 65-fold, according to Mr Wang Xiaolu, deputy leader of the National Economic Research Institute, China Reform Foundation (*China Reform* 2010). This leads to inequalities of educational opportunities and accessibility to healthcare. As grievances by China's poor grow, it is the will of the central government to swiftly address this before trouble erupts.

8 Today, over 40% of the surface water and 90% of water in aquifers in China is unusable; about 40% of its land is affected by soil erosion. Acid rain affects one-third of its agricultural land and diminishing agricultural outputs. China's air carries suspended particulate matter loads that are more than twice the highest level of the 'reasonably safe' standard of the World Health Organisation. A total of 400,000 people die yearly as a result of air pollution. Economically, this cost 8 to 15% of China's GDP in 2007 alone (*The Economist* 2007; Economy and Lieberthal 2007). Socially, because of the rapid environmental deterioration in China, there were over 50,000 environmental protests in 2005 alone. The total sum of environmental litigation cases in 2008 was equal to the total of the previous decade. Moreover in 2009, environmental proceedings increased 87% over the number in 2008. Environmental issues have become the ninth major cause of social unrest in China (Yang 2010).

9 Two particular networks related to DfS have been established recently in China. One is LeNS (the Learning Network on Sustainability), which extended to China as **LeNS-China** in 2009, coordinated by the Academy of Art & Design, Tsinghua University and with members such as the School of Design, Hunan University, the School of Art and Design Wuhan University of Technology, the School of Design, Jiangnan University, and the School of Design, H.K. PolyU. Another network is **DESIS-China** (Design for Social

19.3 The myth of 'T-shaped' design training

At the same time, since there was a need for China's industries to move up the value chain to seek further growth, *innovation* became a buzzword in the worlds of business and design at the dawn of the 2000s. In fact, especially because of the rise of Japanese industrial might in the 1970s–80s, the emerging industrial tigers of Taiwan and Korea in the 1990s, and finally the rapidly developing 'world factory' of China at the end of the 20th century, the desire for innovation in remodelling industries originated much earlier in the West. The phrases *value innovation* and *strategic differentiation* began to diffuse and deepen within the business arena after the publication of, for instance, *The Experience Economy* (Pine and Gilmore 1999) and *Blue Ocean Strategy* (Kim and Mauborgne 2005). For industrial design, because of the rapid shrinking of business in the United States at the beginning of the 2000s (McGetrick 2006), design industry leader IDEO took the lead to advertise designers' *strategic* and *design thinking* skills via books and articles (particularly led by David Kelly and Tim Brown, founder and CEO of the company) where design and *design thinking* is inherently a prototyping process that is ideal for meeting the needs to visualise and communicate strategy for business innovation (Brown 2005). In an article in the renowned business journal *Harvard Business Review*, Brown stated that:

> Design Thinking…is a methodology that imbues the full spectrum of innovation activities with a human-centered design ethos… As economies in the developed world shift from industrial manufacturing to knowledge work and service delivery, innovation's terrain is expanding. Its objectives are no longer just physical products; they are new sorts of processes, services…ways of communicating and collaborating—exactly the kinds of human-centered activities in which design thinking can make a decisive difference (Brown 2008: 86).

In other words, the *strategic* value of design thinking for innovation was clearly pronounced.

19.3.1 The 'T' design thinkers

While affirming the strategic values of design thinking, Brown also advocated the recruitment and promotion of *T-shaped people* (or 'design thinkers') to enable innovation for business. In his view, the so-called T-shaped people are people who

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Innovation and Sustainability Network of China) established in March 2009 (promoted by Professor Ezio Manzini) and involving six key design schools in China: the College of Design & Innovation, Tongji University; School of Design, Jiangnan University; School of Design, H.K. PolyU; School of Design, Hunan University; Academy of Art & Design, Tsinghua University; and Guangzhou Academy of Fine Arts. The Network is developed based on the former connection established in 2001.

'have a principal skill that describes the vertical leg of the T—they're mechanical engineers or industrial designers. But they are so empathetic that they can branch out into other skills, such as anthropology, and do them as well' (Brown 2005: 3).

Brown was not the only design leader who advocated the importance of the 'horizontal' (design thinking) skill of T-shaped designers within and outside the realm of design. Leading design institutes such as the Institute of Design, IIT, and Stanford's d.school have long been pursuing the value of design thinking training that emphasises the capabilities of a macro (or big-picture/strategic) perspective, systems thinking, integrative knowledge (knowledge of related disciplines such as business, social science and marketing), process innovation, and co-creation facilitation. These design schools alleged that *design thinking* as methods can be applied to many real-world problems such as 'catalyzing organisational transformation, defining new markets, designing new experiences and shaping corporate strategy' (Banerjee 2008: 20). In other words, once a designer possessed *design thinking* capabilities, he or she could take on various types of design works such as service design, system design, organisational design, business innovation, and even social design.

19.4 The risks of blurring the 'old' discipline for DfS

19.4.1 A rush towards T-shaped design training

In China, two core developmental concerns have become top of the national agenda since 2000: 1) turning '**made in China**' to '**create in China**'; and 2) balancing '**environment**' and '**development**'. Industrial design education in China has therefore been aiming *massive* and *high*, with annual enrolment of over 14,000 students today (from a few hundred in the mid-1990s) and more and more shift from *vocational* towards *T-shaped* strategic, innovative training.

Such changes within some design schools have even started at the undergraduate or BA level. For example, in 1996, with the arrival of a new head of school, the School of Design within Hong Kong Polytechnic University initiated a revolutionary BA programme within which design teaching and learning was to be redefined. The whole curriculum was broad, multi- and interdisciplinary. Core subjects and projects were *theme-based* instead of discipline-specific. Students were encouraged to practise teamwork, multi-skill design, integrated, strategic thinking, while deeply exploring user-centred, socio-cultural issues (Lo 2003). Unfortunately, the whole 'experiment' did not last long; immediate feedback from industry was not particularly positive and the 'goodwill' reform ceased abruptly in 2002.

19.4.2 Queries over being a design 'generalist'

Some of these trials to remodel the industrial design profession in design education cannot simply be judged as either *right* or *wrong*, especially within a short timeframe. However, there are many perspectives to be contemplated if making

similar attempts, particularly for teaching and learning of DfS in the context of China today. Some key viewpoints are outlined below.

Economic perspective

No matter how much we (as designers or design educators) would prefer to see a swifter removal of the title 'world factory' from China, we have to accept the fact that: 1) China's economy is still heavily reliant on manufacturing today;[10] and 2) even if it could evolve into a more sustainable economy with smaller quantity and scale in domestic trade, physical production and consumption would still be required, not to mention the 'transition phase' towards a possible sustainable economy that is surely required.

Pedagogic perspective

As design educators, we have advantages over our apprentices regarding early exposure to new design ideas[11] such as the concept of *design thinking* from the industrialised West. Additionally, with essential design skills learned at an early stage of our professional life, we have taken basic skills for granted. At the same time as we are likely to design syllabi from our own perspective, it is always tempting for us to plan the 'most advanced' curriculum and introduce the 'latest' design theories to our students, forgoing the level or even the nature of the programme[12] that we are teaching. 'T-shaped' design training is one such 'advanced', 'hot' subject that several design educators are willing to promote in China these days. However, we may neglect the question of whether students *should* be taught or told to be a T-shaped designer, no matter if they are prepared or interested. Are the extended horizontal design competences truly preferable? Is it appropriate for China?

Disciplinary perspective

In July 2010 at a London DMI conference, Geoff Mulgan (a former director of the Young Foundation), the world's leading expert in social innovation, explained how designers 'entered' the social entrepreneurs' space but failed because of their 'naivety', lacking domain knowledge[13] and hence the ability to make change.

10 In 2009 China's manufacturing industry was still around 48.9% of GDP, while the same sector in the UK and the US was 25% and 20%, respectively (Liu 2010).

11 For instance, design educators have opportunities to attend international design conferences and visit leading design institutes abroad.

12 Industrial design programmes in China are traditionally developed from Arts and Engineering disciplines. 'Design' is still a very new discipline in China. The notional graduate or undergraduate degrees of BA, BEng, BSc, MDes, MFA, MA, MEng, MSc or Mphil can be confusing for inexperienced educators or newly established design institutions in China still today.

13 According to Mulgan designers who enter the field of social design are normally quite unaware of their new domain's background and often propose failed ideas that were tried decades ago (as cited in McCullagh 2010).

The idea of extending the *horizontal* capabilities of design or promotion of *design thinking* as a new design skill has also been questioned by renowned design scholar Don Norman and design practitioner Kevin McCullagh. Norman (2010) simply disagreed with the claim of both the uniqueness of *design thinking* and the designer's right to hold a monopoly on creativity. He argued that 'what is being labeled as "design thinking" is what creative people in all disciplines have always done' and 'design thinking is a public relations term for good, old-fashioned creative thinking'. McCullagh (2010) suggested that 'without a strong vertical stack of capabilities that are relevant to their chosen problem domain, designers stop being designers—and join the legions of free-floating generalists'.

As a matter of fact, since the whole notion of T-shaped people originated from management consultants before IDEO popularised it in the 2000s, there are reasons to be cautious about its recent popularity in design. In addition, not long after the publication of Brown's article 'Design Thinking' in *HBR*, another article titled 'The Innovator's DNA' was published. It released the result of years of studies on creativity by a group of business management professors, whose proposed approach much resembles the design thinker's profile promoted by Brown and IDEO (Dyer, Gregersen and Christensen 2009).[14] There are, in fact, plenty of intelligent people who are as strong or stronger than designers in terms of the so-called T-shaped capabilities or even in design thinking. Therefore, instead of trying to expand *horizontal* skills to reach new or higher grounds for design, we should seriously re-examine the risk of over-stretching the horizontal capability while diminishing our *vertical* stack of expertise.

19.5 Learning the unlearned

19.5.1 Revisiting design basics

In view of a rapid convergence of the three transitions (i.e. towards *digital connectivity*, *a service economy* and *a sustainable culture*) at the turn of the 20th century, industrial design has become a somewhat odd and even embarrassing discipline, or an approach better to be *unlearned* in favour of promoting the immaterial practice of DfS. We believe that industrial design as a discipline should be *revisited* and its potential for green applications should be *explored*.

In terms of learning DfS within industrial design, the basic values and set of physical skills of the discipline should be *revised* and treated as new *essentials* for the promotion of DfS.[15]

14 The proposed 'Five Discovery Skills' of Associating, Questioning, Observation, Experimenting and Networking by Dyer, Gregersen and Christensen (2009) in their article resemble Brown's (2008) design thinkers' profile.

15 To reinforce the idea of lessening mass production and hence consumption, **Product Design** should be revised (in traditional Industrial Design learning) as a new discipline that focuses on green, batch and customised design and production. Design for the Environment or Eco-design learning should also be modified and be taught as the core basics of this revised discipline.

Our argument is based on *reality* and a *vision* as follows:

- **The reality**. To transform the 'world factory' into a sustainable economy, a transitional period is required. During this period, creative, sustainable products are essential to enable a smoother transition of today's economies towards a better and preferable one
- **A vision**. A sustainable society that we would like to envision will rely on a large variety of customised services, supported by specially designed products (mostly systemised to be shared) for serving people's daily needs. These products may no longer be mass produced. Basic knowledge and skills such as form semantics, prototyping skills, and know-how of ergonomic, material and fabrication techniques of industrial design today will likely be *revised* with new significance

19.5.2 'V' instead of 'T'

With this *vision* and *reality* in mind, we would like to advocate the training of 'V-shaped' designers rather than the T-shaped thinkers that have been promoted today. For a V-shaped designer, the required design training starts from (and is very much founded on) the bottom tip of deep 'V' expertise: acquiring relevant **skills**, **knowledge** and **methods** (see Figure 19.1), accumulating capabilities from **specific**, **generic** to **extended** levels and sharpened through years of training and practice (see Table 19.2).

Figure 19.1 **Core and initial framework of V-shaped product-based design training**

Source: authors

Table 19.2 **Examples of capabilities required for V-shaped product-based design training**

	Product Design training ← ← → → Extended Design training		
	Specific	**Generic**	**Extended**
Skills (tacit-based know-how)	- handling of surface geometry - 3D visualisation/ drawing - empathy - model-making - etc.	- creativity - visual sophistication - problem framing - communication skills - etc.	- leadership - opportunity framing - analytical thinking - collaboration, etc. (+ extended domain skills)
Knowledge (codified-based know-how)	- form aesthetics & semantics - 3D principles & related colour theory - material properties - basic mechanic - fabrication processes - drafting - ergonomics/human factors - Eco-design (DfE), 4DfD, PDfS, etc. - etc.	- critical, creative thinking - representational drawings - visual literacy - computer literacy - user research / UCD - design theory & methodology - art/cultural appreciation - design history - DfS	- design management - project planning - systems/strategic thinking - process innovation - cross-silo facilitation, etc. (+ extended domain knowledge)
Methods (tool-based know-how)	- scale, proportion & orientation - colour wheel - I-methodology - CAD/CAID - Task analysis - LCA, MET, strategic wheel, etc. - etc.	- brainstorming, mind mapping, etc. - figure, objective, perspective drwgs. - 2D, 3D, 4D software - observation, contextual inquiry, etc. - storyboarding, map/ matrix - etc.	- 5Cs analysis - strategic mapping/ frameworks - NPD, PCP, PIP, etc. - product development strategy - creative workshops, etc. - scenario, SOD, PSS, etc. (+ extended domain methods)

The idea of such V-shaped product design training focuses much on the core expertise and yet provides a perceivable framework of learning—within a boundary of designated **tacit** (artistic), **codified** (literacy) and **tooled** (technical) know-how.[16] This aims to avoid probable drawbacks of T-shaped design training that over-stretches the horizontal capabilities (without knowing where to start or stop), while weakening vertical expertise and encouraging 'free-floating generalists'.

19.5.3 Product Design for Sustainability?

In order to promote V-shaped design training to enhance DfS learning, we would like to focus on 'product' led DfS (also called **Product Design for Sustainability**, PDfS) in this chapter. In order to complement 'system' based DfS (or **System Design for Sustainability**, SDfS), PDfS focuses on *product-based* solutions and relies more on the operative, core competences (the bottom tip of the 'V' shape) of design training.

To summarise, the notional PDfS embraces the following elements:

1. Beliefs and purposes

- **Subjective based** (or i-methodology) user-centred design ideology as a starting point of design. Emphasis on the ethics of designing things for others as for oneself
- **Individuals** are vital to enable collective change towards sustainability. Every seemingly tiny contribution of individuals counts and could stimulate and influence many others
- **Products as key** to drive (both behavioural and mentality) changes in individuals. Enable people to act and take responsibility for their daily consumption
- **Products as a vehicle** to alter social perception and enable sustainable forms and/or practices of production and consumption

2. Potentials

The practice of PDfS could be employed:

16 **Tacit** know-how of design comes from the combination of artistic skills and knowledge that could only be learned by doing and experiencing, while **codified** design know-how consolidates from the fusion of literate knowledge and methods that can be encoded in various symbolic forms such as textual, audio, and visual and can be acquired by anyone who understands the code (e.g. visual and form language); **tooled** know-how of design is accumulated from both technical skills and methods through years of training and practice. It can be embodied into forms of physical artefacts (hard-tooled), programmes, standard processes or methods (soft-tooled).

- To promote sustainable lifestyles or ways of living via creative product solutions
- To design and strategise product(s) to be utilised within the Product-Service System of a designated *sustainable solution*
- To revitalise indigenous crafts and skills or small-scale fabrication for facilitating knowledge and capital exchange among social strata of the marginalised and the affluent (Leong 2002; Siu, Pan and Lee 2009)

19.6 Sample cases of PDfS practice

Based on the beliefs and purposes above, we would like to briefly present two sample cases of Product Design for Sustainability (PDfS) training and practice at the School of Design, Hong Kong Polytechnic University (SD, HK PolyU) in China.

19.6.1 A case of PDfS training

The first case is about the teaching and learning of PDfS. A subject named *Sustainable Product Design-SPD* for the final year students of Industrial and Product Design at SD, HK PolyU, aims to reinforce students' learned design skills, knowledge and methods, while introducing them to the ideas of Design for Environment (DfE), system design thinking and most importantly to learn to develop products from a broader social and ecological context based on the notional DfS. Students are asked to take up three particular design challenges during the course.

1. 'Mini' project

The 'mini' project is a short warm-up design exercise in the initial stages. In 2009, for instance, students were required to make use of discarded PET (polyethylene terephthalate) bottles and come up with a simple design that explored the quality of the original material and could be reproduced with simple hand tools at home. In addition to the seminars the course tutors had provided, students were encouraged to conduct field and desktop research to locate where discarded PET bottles could be collected within Hong Kong (logistics issue) and tests to explore the physical and structural possibilities of PET bottles. Hands-on design experience was the key emphasis of this small project.

2. PDfS project (phase I)

The second challenge is another short design undertaking that aims to introduce students to the basic concepts and tools of system design particularly related to sustainability. In this phase, students are asked to work in groups on the following

tasks: to conduct field research to obtain deeper understanding and insights of a given promising case; to visualise and communicate the case with selective photos, images and text; to analyse the documented case (focusing on weak spots and links on the usability, desirability, socio-cultural and socio-environmental quality of the case); and to redesign and improve the case. Throughout the project, tutorials, reference seminars, and samples of tools (such as *mental models, system maps* and *storyboarding*) are provided.

PDfS project (phase II)

Phase II of the PDfS project is the core of the whole subject.

In this stage, students in 2009 were expected to design a new product together with women sewing workers from the Hong Kong Women Workers Association (HKWWA),[17] based on discarded banner materials and marketing advice provided by the ECOLS shop (a company that trades recycled furniture, household products and bags made out of used materials). With this particular project setting, students were expected to complete three major tasks.

1. **Design research**. Study and analyse the sewing skill of the workers; properties and construction possibilities of the banner materials; organisational and operational characteristics of HKWWA; and potential product competition on the market
2. **Product design**. Make use of the used banner materials and come up with a competitive design
3. **Solution visualisation**. Visualise an initial service flow idea for the operation, production and marketing of the new design

Alongside the professional expertise provided by the ECOLS, HKWWA and the SD faculties, the students were expected to make use of the knowledge learned from both the 'mini' project and the first phase of the PDfS undertaking, such as use of the *system map* tool.

At the end of the subject, two projects were selected by ECOLS, the HKWWA and the teaching team for further development. Eventually, one of these two projects was further developed and commercialised by SDWork, a unique platform established within the School of Design to encourage entrepreneurship by commercialising items designed by talented students. The project was named 'Living Pixels' by the students who created it.

17 The HKWWA is an NGO established in 1989 to assist low-income, marginalised women workers in Hong Kong, such as the sewing workers who became unemployed after garment factories moved to mainland China in the 1980s. HKWWA has also initiated a few recycling programmes and eco-friendly community services (e.g. soap making out of used cooking oil, a secondhand shop, and green cleaning services) from 2005 to 2008.

'Living Pixels' is a series of colourful lighting mainly made of used banners (as light diffusers) and discarded lamp stands. The originality of the design came from the translucent property of the PVC banner material (usually printed with semi-solvent or solvent ink on one side), which the students discovered after rounds of material tests, structural experiments and a thorough process of prototyping together with the skilful sewing masters from the HKWWA. This wonderful series of creative lighting can be designed and assembled flexibly, differently each time, as it is constructed mainly of standard pieces of square-formatted banner 'pixels' and discarded lamp stands collected from garbage stations and secondhand shops.

Through the 'Living Pixels' design series, the forgotten sewing skills of the women workers (and their professional pride) have been revived. With the 'Living Pixels' collection now on sale online by SDWorks, we are able to witness an alternative format of small-scale production and consumption practice spawn locally in Hong Kong.

19.6.2 Reviving indigenous craftsmanship via product design

The second case is about an actual yet experimental project employing product design skills for social innovation and sustainability in Hong Kong. The project, named *Transforming wooden cart*, was one of the undertakings within a larger design research initiative started in mid-2007.[18] This project aimed to revive traditional wooden cart making (a declining craft) into new design and alternative forms of production and consumption practice.

Background of project

The *Transforming wooden cart* project was led and coordinated by Brian Lee, the second author of this chapter, and an experienced furniture and product designer. The project focused on a trolley shop named 'Yau Kee' (located in one of the poorest districts of Hong Kong, Sham Shui Po), owned by an elderly couple Mr and Mrs Li who have been specialised in wooden trolley production (Figure 19.2) for over 50 years. Yau Kee's practice of wooden cart fabrication has been socially viable and environmentally sound all these years. For instance, the construction materials are discarded bed planks and used tyres, while the finished products are mainly made and sold to construction workers and street cleaners as a handy collection tool within the same district (CMP 2007).

The Yau Kee trolley shop is a typical handicraft workshop that operates in a unique, small and local scale, highly connected with proximate business partners

18 The design research initiative was called 'In Search of Marginalised Wisdom', initiated by Mr Siu King Chung from the SD, HK PolyU and sponsored by the Sham Shui Po District Council of Hong Kong.

and clients within an urban district. It is also a craft-based business that carries the DNA of local culture and conserves indigenous values of the Sham Shui Po community. However, as mass-produced metal carts have become more popular and are prevailing, Yau Kee's craft-based business model and skill might soon be eliminated through keen competition.

Figure 19.2 **The elderly couple and owners of Yau Kee; their environmentally friendly wooden cart**

Source: authors

Transformation of declining handicraft

From Lee's perspective, the urban handicraft industries residing in the old communities are full of vitality and social relevance. This model of handicraft and fabrication could be learned, revived or even replicated for similar social contexts of Hong Kong. Lee also believed that product design as a physical-based discipline could be employed to help to regenerate traditional designs while preserving the essential techniques, processes and values of fading crafts such as wooden cart making in Hong Kong. In order to test this, three concurrent product co-design processes—a *craftsman driven process*, a *designer plus craftsman process*, and a *designer driven process*—were planned to transform the wooden cart-making skill into a new design and product solution (Siu, Pan and Lee 2009).

This was also backed by an *operational model of design for social concern* (see Figure 19.3) that outlined the relationships of activities involving the exchange of materials and human resources, as well as the types of partnerships, as proposed by Siu, Pan and Lee (2009).

At the end of the co-design process above, a simple yet innovative design emerged: with some simple rearrangement and re-use of materials and skills, the old wooden cart was transformed into a table. Later the same year, together with Yau Kee, Lee developed further the wooden cart furniture series into stool and rack categories.

Figure 19.3 **Operational model of design for social concern**

Source: authors

19.7 Conclusions

While many design professionals reckon that product design may become outmoded and irrelevant due to the rapid transitions towards a service-based sustainable economy, both the *transforming wooden cart* and the *Living Pixels* projects presented above have demonstrated just the opposite: solid product design competences are invaluable—even when (or in preparation for) teaching and learning sustainable PSS design. From this perspective the learning and training of DfS could begin with **design skill** (in preference to strategic *design thinking*); **physical products/product system** (instead of *immaterial solutions*); and **emotional empathy** (rather than mere systemic, rational analysis).

Moreover product design skills could be employed in preserving indigenous crafts and material cultures while addressing social issues and promoting sustainable forms of business practice for a better future.

Therefore, before we blindly mimic the 'high flying' *design thinking* training from the West and believe that the *T-shaped* mind-set will help to transform design from the world of *form* and *style* to that of *system* and *strategy*, we need to reconsider this conception. After all, 'strategy without form is an empty container these days' (Klinker and Alexis 2008: 30), and we believe it is time to relearn the 'unlearned' core of design for better promotion of DfS and sustainable PSS design in and for China.

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20

Bringing streamlined LCA into the sustainable PSS design process

Tatu Marttila
Aalto University School of Arts, Design and Architecture, Finland

20.1 Introduction

In PSS design, products within systems provide functions whose efficiency can be improved by redesigning stakeholders' interactions. PSS solutions can support sustainability by reconfiguring and optimising systems, to produce more services with fewer environmental impacts. Life Cycle Design (LCD) is a design approach focusing on the reduction of negative environmental impacts of a product or a system along all its life cycle phases, i.e. in material extraction, production, distribution, use and end-of-life. There exist a variety of Life Cycle Assessment (LCA) tools and methods for measuring the ecological impacts during these phases. Some of these tools can be used in the early phases of the PSS design process to support choices regarding the product system at hand, particularly regarding the *material* (i.e. product) side of the system offered, and some address socio-economic dimensions.

This chapter investigates the connections between PSS design methods and LCD methods to improve the Design for Sustainability (DfS) process. It examines how and in what dimensions of the system life cycle the impacts are analysed in particular student concepts that were created using the design methods for sustainable PSS introduced and disseminated in the LeNS project. An extended process

model for PSS methodology is proposed, which combines a Simplified Life Cycle Assessment (SLCA) method—the META matrix tool—into the initial phases of the PSS design process. Such a method has the potential to help designers locate areas for PSS improvement during initial design stages but also to increase overall understanding of the system life impacts.

20.2 Life Cycle Assessment and PSS design

Life Cycle Assessment (LCA) has been described as a cornerstone of current practice in industrial ecology (Matthews and Small 2000). It is part of the ISO environmental management standards (ISO 14040 and 14044) and promoted by the European Union (CEC 2001) and the United Nations Environment Programme (UNEP) (2002). The value of LCA lies especially in its ability to identify a product's environmental impact across its whole life cycle (Lewis and Gertsakis 2001), studying the inputs and outputs of the processes related to its production, use and end-of-life. The impacts addressed are usually environmental but can be expanded towards the socio-economic dimension as well (see e.g. Social Life Cycle Assessment[1] by UNEP). LCA as a tool can: 1) benchmark performance of existing products; 2) develop targets to pursue; 3) provide a 'work-in-progress' assessment tool; 4) guide in making decisions regarding materials and components; and 5) identify previously unknown impacts within the product-system (Lewis and Gertsakis 2001: 17).

LCA methods can generally be divided into full LCA and simplified or streamlined LCA (SLCA).[2] Full LCA is often described as difficult and time-consuming (Lewis and Gertsakis 2001; Hochschorner and Finnveden 2003) or targeted only to specialists (Niemelä 2010). In this chapter the focus is on the latter: easy-to-use and time-effective SLCA methods that can be used by designers and design students themselves. SLCA methods, as LCA methods in general, can be used for two general purposes: to identify areas in the system for improvement or to help comparison between different choices or concepts (e.g. Lewis and Gertsakis 2001). The methodologies used in the SLCA process can be divided into approaches utilising quantitative, semi-quantitative or qualitative life-cycle assessment methods and data (Hochschorner and Finnveden 2003). One generally utilised SLCA method is a matrix-based approach.

1 Social or socio-economic Life Cycle Assessment is widely addressed by UNEP in their 'Guidelines for Social Life Cycle Assessment of Products' (2009), available online at: www.unep.fr/shared/publications/pdf/DTIx1164xPA-guidelines_sLCA.pdf.

2 On this see for example Lewis and Gertsakis (2001); the terms 'simplified' and 'streamlined' are used here as synonyms, in line with earlier publications, e.g. Hochschorner and Finnveden (2003).

20.2.1 Matrix-based SLCA: MET matrix tool

Matrix-based SLCA tools often include qualitative assessment matrixes that can also hold quantitative information when available, to address a selected range of environmental concerns (among others) in different life stages of the product (or system). Various impact categories can be addressed, such as material, energy and toxicity as in the well-known MET matrix by Brezet and Hemel (1997).

Qualitative approaches are valuable in order to reveal new information about the system or 'identify critical aspects of products', as well as to complement quantitative studies at the outset when adjusting system boundaries to ensure the appropriate scope of assessment (Hochschorner and Finnveden 2003: 127). This suggests that a qualitative matrix-based approach such as the MET matrix seems suitable for a fast analysis that can give more detailed information on the system for further guidance. The MET matrix has also been identified as one of the most favoured tools for eco-design practice (Knight and Jenkins 2009). For PSS ideation a similar approach could provide a valuable tool to assess the differences between several possible design choices, service components and/or material flows and selections of technologies within the system.

20.2.2 Socio-ethical dimension: META matrix tool

In sustainable PSS and system design, environmental and socio-ethical dimensions are connected (Vezzoli 2007 [2010]). One potential approach to expanding LCA is similarly to broaden assessment from environmental towards social and economic dimensions (Jeswani *et al.* 2010), but this implies further assessment within socio-ethical and socio-technical domains. A qualitative matrix approach is taken further in the META matrix (Niemelä 2010), which is an expanded version of the MET matrix tool. The META matrix combines the three categories of the MET matrix with a fourth (A) representing aesthetic, but also social, ethical, cultural and economic dimensions (Niemelä 2010). When specifically developed to be more compatible with system-focused PSS design, 'A' could simply mean socio-ethical or stakeholder-related issues and impacts within the system (see Figure 20.1).

Figure 20.1 **META matrix**

Source: based on Niemelä 2010; see also Marttila 2010

META Criteria / LC	Material production	Manu-facture	Use	Disposal	Transport
M: Materials	*Selected materials in the system and the environmental impacts of production*				
E: Energy	*Used energy in the system and the environmental impacts of production*				
T: Toxicity	*Toxicity of different chemical substances and processes related to the system*				
A: Stakeholders	*Socio-ethical dimension related to the system (social, cultural, ethical, etc.)*				

20.2.3 Expanding the life cycle approach towards the system

Many studies conclude that sustainable design requires a combination of several methods in relation to the design phase and context, involving a combination of various LCA tools targeting different levels of the system (see for example Hur *et al.* 2005; Jeswani *et al.* 2010). Furthermore, current LCA tools are limited in their ability to address stakeholders in the system and hence the scope could be further deepened towards interactions and cross-sectoral inter-linkages (Thabrew *et al.* 2009). In parallel two potential opportunities to expand LCA are apparent in the aforementioned strategies and have been suggested in the literature (Jeswani *et al.* 2010: 120): 1) deepening guidance in relation to definition of the system boundaries, allocation methods, dynamic aspects and so on; and 2) broadening LCA towards the socio-economic dimension and towards new stakeholders.

System design can support eco-efficiency and is congruent with the fundamental criteria of LCD (Vezzoli and Manzini 2008). In PSS design stakeholders interact with a mix of products and activities connected to the system that can be optimised to create more services with fewer impacts. The LCA approach incorporates the idea of functional units: the assessment of impacts is bound to the units selected to describe an activity (often a product or a process). In PSS such assessment uses 'satisfaction units' as a reference (e.g. satisfaction of hunger) (Vezzoli 2007 [2010]: 34). A system's service value can be measured in **satisfaction units** and its environmental value is 'estimated as a summarised impact of all life cycles of the products and activities that constitute the supply system' (Vezzoli and Manzini 2008: 259).

PSS methodology acknowledges the fact that 'each environmental effect is based on an impact of exchanging substances between the nature/environment and the production and consumption system' in the form of inputs and outputs from and to the environment (Vezzoli 2007 [2010]: 17). In essence, the inputs should preserve resources and the outputs should prevent pollution (Vezzoli 2007 [2010]). System life optimisation thus reaches 'beyond a single product life cycle to an interconnected series of product and service life cycles' (UNEP 2002: 7). It refers to the optimisation of a system's components and subparts, its stakeholder interactions and the material flows inside it, but is still in line with conventional life cycle thinking.

20.3 Understanding the system in PSS

In the PSS design process as defined in this volume, the Methodology for System Design for Sustainability (MSDS),[3] the phases of strategic analysis and exploration of opportunities are conducted by extensive system mapping and by ensuring the

3 The Methodology for System Design for Sustainability (MSDS; see Part 1, Chapter 4) has been developed from the Methodology for Product-Service System (MEPSS) project (see for example van Halen *et al.* 2005; Vezzoli 2007 [2010]).

necessary continuity of impact assessment in the chain of production and consumption (Vezzoli 2007 [2010]). MSDS builds on life cycle thinking but reaches further with a systemic understanding of the stakeholder interactions, to create an optimised service with satisfaction unit as its reference (Vezzoli 2007 [2010]: 34). Hence, a PSS solution must be assessed as a system and a service, and the borders for assessment have to be defined accordingly.

To illustrate the system under design and the interaction within it, the EU-funded MEPSS (see footnote 3) and LeNS projects introduced a set of tools, including the 'Interaction Storyboard', 'Offering Diagram', 'Stakeholder System Map' and the 'Sustainability Design-Orienting (SDO) toolkit' that help to assess impacts of the system including environmental, socio-ethical and economic aspects, but also technical and cultural dimensions. These tools are explained in more detail in Part 1.[4] In this chapter's exploration the focus is on the Stakeholder System Map, with its specified symbols to both illustrate and explore various system interactions, and on the SDO toolkit as an impact assessment tool, where one can prioritise and compare dimensions of the existing system and of a system under development.

20.3.1 System boundaries and Stakeholder System Map tool

When assessing the impacts of a PSS a crucial issue is where the system boundary lies. A systems perspective requires 'appreciation' at minimum and 'understanding' at best with regard to the interaction among various areas and stakeholders, including 'environmental, financial and social systems' (Shedroff 2009: 5). The MSDS methodology proposes two boundaries for the design concept: the (PSS) platform boundary and (PSS) system boundary (Vezzoli 2007 [2010]). The platform boundary contains the functional services within the system, targeted to the main stakeholders that can be easily identified. The system boundary contains secondary stakeholders (with the 'system life cycle' represented), providing system functions or 'contributing as subcontractors' (Vezzoli 2007 [2010]), thus involving a number of 'secondary' services and reaching outside the system boundaries.

The Stakeholder System Map is an iterative tool for PSS design, being simple at first but developing in the process (Vezzoli 2007 [2010]). When the impacts of the functions within the platform are assessed, many of the material and service flows reach further towards the system side (including stakeholders such as component manufacturers and subcontractors). These actors should be included in the system map, which would then show the 'system life cycle' (upstream and downstream) more comprehensively (Vezzoli 2007 [2010]: 222; see Figure 20.2). Material flows created by and between the secondary stakeholder activities are usually, however, left out of the system map.

4 See Part 1, Chapter 4.

Figure 20.2 **Conventional flow of production on a PSS Stakeholder System Map (see Part 1, Section 4.3.6)**

Source: author

20.3.2 System assessment in the SDO toolkit

Another PSS design tool—the SDO toolkit—aids in the strategic analysis and exploring phases to identify the system dimensions and to orientate the design concepts in the system context by using six criteria in environmental, socio-ethical and economic dimensions (Vezzoli 2007 [2010]). The SDO toolkit focuses on the system as a whole and a qualitative assessment in the three above-mentioned dimensions of sustainability. It helps to create an overview of the potential impacts created by the system and offers guidelines for design in extensive checklists among several focus areas. New and emerging concepts can be tested in comparison with existing ones in six-axis radar graphs (see Section 4.3.1 in Part 1 of this volume).

The life cycle approach is visible in the SDO toolkit's environmental criteria and also in its checklists and guidelines, but the tool cannot be used to assess impacts in different life cycle phases of the supportive subparts and components of a system. System life is addressed as a whole but is not assessed specifically in its subparts' different life phases or in connection to system level actors. While production and transport within and for the system are in the criteria, the SDO toolkit does not address secondary stakeholder level activities clearly. This simplifies the process, and it is therefore easier to focus assessment on the system's core functions and flows related to them. On the other hand this may lead to overlooking some of the largest impacts created by the overall system.

20.4 Life cycles in the LeNS Student Design Competition

To discover how life cycle is addressed in a real PSS design process, and more specifically in the ideation phase, the focus here is on the student concepts created

within the LeNS project. The LeNS Student Design Competition[5] provides a good set of examples for this purpose. The Competition called for entries in three categories: food, mobility and healthcare/well-being. The MSDS (MEPSS at that time) methodology was used during the competition-registered courses but always with some adjustments, with locally preferred tools, and without a fixed process.

The analysis examines several entries and their stakeholder system maps and investigates how they address impacts of production created within the system. In this analysis the student cases are separated into two groups, one representing the 13 highest ranked cases in jury evaluation and the other 13 randomly chosen cases that were not awarded or specially acknowledged.[6] The winners and non-awarded concepts were separated into tables only after analysing the works together as one group. This evaluation process does not take into account the points graded in the actual competition's jury process: only the life cycle approach is examined.

20.4.1 How do the entries' system maps address the system life aspects?

To determine how systematically the concepts address certain system life aspects, the system maps were analysed. For reasons of simplicity the focus was limited to end-of-life. The assessment of the impacts (primary and secondary) created by the system were qualitatively graded in a simple and straightforward manner (from '-' to '++'), according to how and to what depth the system flows are addressed in the design concepts.

The system maps in the students' concepts were clearly not consistent in the way they addressed the impacts created by the inclusion of specified products. One of the entries addressed all production and related end-of-life aspects but did not assess transport. Another addressed several stakeholders but not the supportive hardware or its production. Many cases addressed only the use-related end-of-life (11/26), and in almost half of the examples end-of-life was left unaddressed (12/26).

In short, although this analysis stays on a general and qualitative level, it shows that the impacts of production related to the whole system are not addressed

5 The LeNS Student Design Competition was held in 2009–2010, accepting sustainable PSS design concept entries from eight pilot courses of the LeNS project and external entries from PSS courses in design schools worldwide (non-LeNS teachers had to register their course in the competition). The eight LeNS pilot courses were implemented in the partner universities, and they shared teaching materials and were based on intercultural teacher exchange.

6 The LeNS Student Design Competition altogether awarded 20 entries: prizes from 1st to 3rd, ten Honourable Mentions and seven 'promising concepts'. The first 13 cases (prizes and honourable mentions) were selected for this study. The 13 cases outside this group were selected randomly, by selecting every third case from the remaining, from a list of entries that were sent to the jury. The winning concepts are available online from the conference website (www.emma.polimi.it/emma/events/lensconference/images/LeNS_award-catalogue.pdf).

explicitly by default in these emerging PSS ideas. Only a few of the concepts address end-of-life in the system map outside the use phase or the user activities. In addition, several concepts introduce components ranging from IT services to full-scale human structures involving solar panels and so forth, without truly assessing the impacts of their production. Overall, there seems to be no sufficient consistency in how system impacts are understood and assessed: in these aforementioned PSS concepts usually only the core functions are addressed and many important dimensions are left out of the assessment.

System life optimisation is linked to the identification of system boundaries, and although it is one of the main strategies in eco-efficient PSS design and represents a major factor in creating sustainable solutions in general, some major areas of impact can go easily unacknowledged in the early phases of concepting. To better support designers, both practitioners and students, PSS methods could put more emphasis on life cycles of secondary components of the system (i.e. supportive appliances and their production). In other words, while the Stakeholder System Map tool is a superb method for visualising interactions, it could also help highlight important impacts created by some subparts of the system or their life cycle impacts which may be easily neglected. The SDO toolkit also leaves different components' life cycles outside its main scope, instead focusing on general aspects of the present landscape for a particular PSS solution. System life optimisation is mentioned as a single concept in the assessment, even though it can be difficult to assess as such.

20.5 Implications for PSS methodology

Determining the impacts of production calls for careful scientific analysis, and a 'standardised method' such as the LCA should be used (Nieminen 2008: 18). PSS design acknowledges LCA as the 'most reliable method' to assess the environmental impacts (Vezzoli 2007 [2010]) and perceives it to have the possibility to provide information from all interested and relevant parties about impacts on the environment as well as 'opportunities to improve environmental conditions' (Vezzoli 2007 [2010]: 59). Bringing LCA closer to the core of the PSS design process may help to better understand impacts in relation to specific dimensions of the system, its boundaries and the functions within.

In sum, if assessment of impacts stays only on the system life level and 'back office' components and service providers are neglected, there is a chance that a major portion of the true impacts of the system remains unaddressed. At the same time, the implementation of SLCA tools for PSS design may be somewhat useless if focusing on system life only and neglecting the socio-ethical aspects. Instead, it may be more meaningful to assess life cycle impacts of the centrally involved products and the interactions of crucial stakeholders, even outside the system borders.

Combining the whole system in one matrix may well be impossible, but a system could be split into several lightweight sub-assessment exercises.

20.5.1 Strengthening the life cycle approach in PSS design

While full LCA can be time- and resource-consuming, semi-quantitative SLCA methods are quicker. They, however, can exclude important information about the system if it is left out of the assessment by default (Hochschorner and Finnveden 2003). The problem with qualitative approaches, on the other hand, is the lack of quantitative values for comparison between different aspects of impacts (Hochschorner and Finnveden 2003). Hence, there is no method preferable over all others (Hochschorner and Finnveden 2003; see also Hur *et al.* 2005; Jeswani *et al.* 2010). Nevertheless, the qualitative matrix-based SLCA method is easy and quick enough to be suitable to accompany the ordinary designer's work (Niemelä 2010).

The SLCA matrix tools are appropriate for identifying critical aspects in the system and can help to identify key stakeholders and impacts, as they can be repeated to focus on several parts of the system. In a simple PSS map with a single material flow loop in focus, the important system phases can easily be identified for further assessment (see Figure 20.3). In a more complicated system the different interactions can still be assessed individually. Hence, the qualitative SLCA matrix tools can be combined into the PSS design process to assist in creating a more accurate picture of the impacts of parts of the system and to locate areas for development within the system level flows.

Figure 20.3 **Different target areas for life cycle design in a product (-service) system: A) resource extraction; B) product use; C) end-of-life**

Source: author

The META matrix tool is a relatively quick to use SLCA method that can easily be focused on certain subparts of the system if necessary (see Table 20.1). Its use should be accompanied by a checklist (Niemelä 2010: 126), and in this regard the SDO toolkit offers checklists that are compatible with the analysis. In PSS design the META matrix could be used to identify problematic aspects of the system and its components.

Table 20.1 **Comparing the META matrix and SDO toolkit in the strategic system analysis phase**

Criteria	META matrix tool	SDO toolkit
Ease of use	Easy	Medium, requires tutoring
Duration	Less than an hour	Several hours
Emphasised areas	Emphasis in resource-effectiveness over use	Emphasis in effectiveness during use over production
How is system addressed? How is system life cycle optimisation addressed?	Has some qualitative system understanding but has to be repeated for several parts of the system	Has qualitative ecological, economic and socio-ethical system understanding but addresses only 'system-life' instead of inspecting parts of the system separately

Streamlined LCA methodologies can be used to assist the initial phases of a PSS design process, but their use should be carefully planned and positioned. If LCA is utilised in a larger context and with expanded system boundaries, a qualitative matrix SLCA tool such as the META matrix is time-effective and will have a broader set of results. The design process model supported by such a tool can be used in DfS and sustainable PSS design to: 1) shorten the time needed for strategic analysis; (2) locate areas of the system that create relatively large impacts and their socio-ethical implications; and (3) bring the time and life cycle perspective more robustly into early phases of PSS design.

An evolved model for the PSS design process could therefore incorporate the META matrix method in the following sample phases:

1. PSS concept and stakeholder system definition and mapping, possibly also addressing some flows in the background
2. META matrix assessment to study the system as a whole but also certain sub-parts, taking socio-ethical aspects and stakeholders into account; continues with the SDO toolkit
3. Concept search (preferably) involving a more detailed SDO toolkit exercise or even more quantitative SLCA for chosen area(s) of interest
4. Concept visualisation and dissemination (with for example PSS tools) and eventually implementation

After the strategic assessment and analysis during steps 1 and 2 the design process will proceed traditionally, either by using PSS methods or other approaches to compare different concepts. Other LCA methods could also be connected to support the PSS design process, since they could further on help the assessment of impacts of the system. For example, some semi-quantitative SLCA tools can be used to easily assess certain simple material- or energy-related choices in a PSS.[7]

20.5.2 Example of the iterated approach

To illustrate the iterated approach and proposed process model, an example is drafted based on the winning entry of the LeNS competition. The concept *2Gen Cooking Club* brings local organic farming—and farmers—together into an intergenerational cooking service system working within campus premises. Besides the flows of food in the service, which are assessed in the impact analysis, the concept orbits around a clever kitchen design, which is, according to the entry, provided by an external provider on a 'pay-per-use' contract. The efficiency in the manufacture and the use of these service components, however, remains mainly unaddressed (it is 'externalised' from the system), even if it seems rather crucial in regard to improving the sustainability of the system.

A simulation of a META matrix assessment for the ideation phase is performed in Table 20.2 to reflect on the importance of certain design choices. Two main system parts are assessed, supportive 'service appliances' and 'food products'. This exercise aims not to analyse the system more thoroughly, but rather to showcase the benefits of including more extensive life cycle assessment in the early phases of a PSS design process (see Table 20.2).

It seems that such an exercise as that shown in Table 20.2, even if quickly implemented, would have been beneficial to conduct, in order to guide certain design choices and emphases regarding the components of the service. With such an SLCA assessment it becomes clear that some of the main causes of system impacts involve parts that have their front- and end-of-life outside the system or in the secondary domain, pointing out the importance of assessing the connected 'pay-per-use' process of these appliances. Such elements should have been connected to the overall assessment to make a better approximation of the benefits of the PSS.

This remains as a single example and cannot be generalised to all PSS designs: many systems have a multitude of system components, and it becomes too time-consuming to assess everything individually. Nevertheless, loosely interpreted, such a matrix can help in the 'fuzzy front-end' of PSS design. Moreover, in the example above, it can highlight potential bottlenecks in the implementation phase: the designers must be as vigilant with the service provider's procurement process with the appliance provider (regarding, for example, its take-back policy) as they are managing the stakeholder relationships among the farmers, elderly and students.

7 For a simple assessment method see e.g. the Eco-indicator 99 method by PRé Consultants (www.pre-sustainability.com/download/manuals/EI99_Manual.pdf).

Table 20.2 **Sample META matrix created from the LeNS Student Design Competition winner concept 2Gen Cooking Club, identifying system components and their possible impacts**

Criteria / Life cycle	Material production	Manufacture	Use	Disposal	Transport
M: Materials	Service apps (kitchen system): *metal, plastic etc., electrical components* Food products: *organic farming; continuous…*	Service apps: *modularity, efficiency, processes & materials* Food products: *organic farming; continuous…*	Service apps: *longevity, usability, maintenance* Food products: *continuous…*	Service apps: *repairability, reusability, recyclability* Food products: *recyclability, reusability? continuous…*	Service apps: *manufacture, maintenance, take-back* Food products: *continuous…*
E: Energy	Service apps: *energy intensive raw material production?* Food products: *use of water, use of electricity; continuous…*	Service apps:*energy intensive manufacture?* Food products: *use of water, use of electricity; continuous…*	Service apps: *use & energy efficiency* Food products: *not an issue?*	Service apps: *take-back* Food products: *not an issue?*	Service apps: *not an issue?* Food products: *continuous…*
T: Toxicity	Service apps: *possibly toxic materials?* Food products: *organic farming; not an issue?*	Service apps:*possibly toxic processes?* Food products: *organic farming; not an issue?*	Service apps: *not an issue?* Food products: *organic food; not an issue?*	Service apps: *possibly toxic parts?* Food products: *organic waste; not an issue?*	Service apps: *pollution from transport* Food products: *pollution from transport; continuous…*
A: Stakeholders	Service apps: *labour for raw-material production* Food products: *local farmers; sub-contractors*	Service apps: *labour for manufacture* Food products: *local farmers; farm labour*	Service apps: *students and elderly; labour for service & maintenance* Food products: *local farmers & students; labour for service*	Service apps: *labour for service & maintenance* Food products: *labour for service*	Service apps: *labour for service* Food products: *labour for service*

20.6 Conclusions

To be truly sustainable, PSS design should also assess all the important impacts created within the subparts of the system, in all system life phases, including the supportive technologies and impacts created by them. The model for DfS and sustainable PSS design process proposed in this chapter is an effort to expand the LCD approach towards PSS design and vice versa, with the use of a simple SLCA method—the META matrix tool. This process model helps to ensure environmental gains are not actually reversed by other parts in the same PSS, especially in future, thereby better ensuring sustained eco-efficiency.

From the perspective of sustainability designers are distressingly eager to produce 'new stuff' even if it is not better or the old does not need replacing (Shedroff 2009). In marketing terms, a futuristic visualisation of a new device undeniably makes a concept look more attractive. In eco-efficient PSS design, however, as in many of the student concepts, the actual strength of the system solution is not tied to new products but instead to new ways to use them. Of course, outdated technologies require updating to be more efficient, but a successful PSS must evaluate the benefits and impacts of system components to an appropriate level of detail in order to evaluate appropriate environmental break-even points for each solution. System life optimisation requires at least a rough assessment of such elements. SLCA tools such as the META matrix can be connected to the PSS design process and can help to assess different alternatives and options in early phases of ideation and incubation of a PSS solution, to help achieve the most sustainable system.

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Greenleaf Publishing
Aizlewood's Mill, Nursery Street,
Sheffield S3 8GG, UK
Tel: +44 (0)114 282 3475
Fax: +44 (0)114 282 3476
sales@greenleaf-publishing.com
www.greenleaf-publishing.com

Cover design: lali@laliabril.com