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Envisioning structural transformation — lessons from a foresight project on the future of innovation

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ABSTRACT

The paper aims to contribute towards building foresight capacities for systemic and structural transformations. Experiences from a foresight project exploring future innovation patterns (www.innovation-futures.org) are discussed. Four specific features were applied in order to underpin the recognition of structural transformation:

- Inductive foresight approach with an emphasis on capturing indications for extra-systemic change at a micro level instead of extrapolating seemingly dominant macro-trends.
- Visual inspiration, to mobilise tacit knowledge, support a creative spirit and an easy exchange of ideas among people with different disciplinary backgrounds.
- Rigorous assessment of coverage of dimensions of change, to foster the explicit consideration of possibly unrecognised/hidden structural changes
- Extended openness for diversity, to avoid the exclusive interpretation of weak signals only in the context of the existing structures.

The findings of the project indicate interesting changes in the nexus of innovation demand and innovation supply. A wide variety of hybrid value creation models with novel configurations of innovation actors emerged. We explain the approach and findings of the project and discuss in particular the implications for foresight methodology. We argue that all four innovative methodological features contributed in a specific way to opening up new perspectives on the future of innovation and potential structural transformation of innovation processes.

1. Introduction

Envisioning structural transformation in foresight exercises is challenging. When exploring alternative futures, many foresight exercises do not look into paradigm shifts but rather tackle different variants of the established system view. In many cases "mode 1 foresight" [1] that fosters the recognition of intra-systemic alternatives, underpins the optimisation of robust strategies within the existing paradigm, and aligns aspirations and ideas across stakeholder groups is suitable for meeting the objectives of the foresight exercise. For a growing number of cases, however, the need to think about "change in the conditions of change" [2] is being recognised.

One prominent example is the case of priority setting for science, technology and innovation policy—a highly relevant domain of foresight activities. Increasingly, innovation policy strategies such as the European Commission's Innovation Union flagship initiative [3] are addressing socio-economic challenges such as sustainability, health, and security.

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In such "mission-oriented" STI strategies the socio-economic impact becomes the key criterion for STI priority setting. Accordingly, picking "key technologies" is no longer sufficient. Transformative priorities [4] that indicate the arenas for "collective experimentation" [5] with various solutions for societal problems are required.

Sustainability is another realm where the need for foresight methods that are able to unlock the potential for paradigmatic change rather than just highlighting incremental improvements along current trajectories is strongly emerging. Sustainability researchers are emphasising that optimisation of current patterns of production and consumption is not sufficient to achieve the order of magnitude in reduction of ecological footprint required to preserve the earth's eco-sphere. A number of studies are pointing towards the need for more fundamental changes using notions such as "transformative innovation" [6], system transition [7], and systemic eco-innovation [8]. All these concepts are calling for transformative visions, scenarios and roadmaps challenging today's paradigms and basic assumptions on system dynamics.

A third arena where systemic change needs to be addressed is "innovation" itself as its very definition seems to be shifting. Early models saw innovation processes as a linear sequence of functional activities distinguishing only between "technology push" and "market pull". The limitations of such a model are clear; in practice innovation is a coupling and matching process where interaction is the critical element [9]. Rothwell's "fifth-generation innovation" concept describes innovation as a multi-actor process which requires intensive interaction at intra- and inter-firm levels [10]. For decades the dominant definition of innovation as "new products and processes that are introduced to the market" combined with the common understanding of companies as the main actors in this process was hardly ever questioned. Nowadays new innovation concepts are being suggested from a number of different directions.

Increasingly, phenomena like social innovation, service innovation, low-tech innovation, relational innovation and value innovation are recognised as highly relevant innovation arenas extending the standard definition [11–13]. At the same time, with the notion of "open innovation" the focus on the firm as the key innovation actor has substantially broadened towards social entrepreneurs, users, customers, public sector and citizens [14,15]. Creativity as the innovation competence is no longer exclusively assigned to specific professions such as designers and artists or entrepreneurs but extends to "ordinary people" and everyday life. Accordingly, a change in innovation can no longer be investigated as a change in direction or priority but needs to be recognised as a change in kind. Future innovation landscapes may function according to a different logic all-together.

The INFU (Innovation Futures) foresight project was set out to explore such future innovation landscapes. INFU was financed by the European Commission in the 7th Framework Programme Area Social Sciences and Humanities (SSH). It was carried out between 2009 and 2012 by the Austrian Institute of Technology AIT (Austria), Fraunhofer ISI (Germany), Z_punkt (Germany) and Solutioning Design Scenarios SDS (Belgium). The foresight project comprised four distinctive phases with different methodological approaches:

1. screening for signals of changes linked to innovation in a wide range of online and print media
2. stepwise clustering of the findings into visions in interaction with innovation actors through interviews and an online survey
3. development and assessment of scenarios of future innovation landscapes
4. generation of policy implications.

The INFU findings were documented in a number of reports and policy briefs which can be found on the project website.[1]

When investigating new patterns of innovation INFU was focussing on fundamental transformation in the way innovation is organised in business, public sector and society [16]. Accordingly, the methodological concept of INFU was tailored to capture systemic and structural transformation.

In Section 2 we outline the methodological framework of the INFU foresight exercise and highlight in particular the features that were foreseen to enable the capture of structural transformation. In Section 3 we introduce the main findings of the INFU project and discuss lessons learnt in terms of methodology. Section 4 presents conclusions for future applications of "transformative foresight".

2. INFU methodology

The INFU project envisioned and discussed possible future innovation landscapes together with innovation actors from a wide range of backgrounds. In order to do justice to the transformative nature of the subject, the methodological framework comprised several specific elements. In particular, the following four features served to enable the discovery of structural change in innovation:

- Inductive foresight approach
- Visual inspiration
- Assessment of coverage of dimensions of change
- Extended openness for diversity (prolonged divergence).

In the following sub-sections these features are described in more detail.

2.1. Inductive foresight approach

There is a wide variety of foresight approaches differentiated not only by their objectives but also by the distinct steps for building the scenarios or visions of the future. In the case of scenario building the model-based approach is in widespread use in Europe, whereas an intuitive approach without any software support has been practiced for many years in the US [17]. Both these

[1] www.innovation-futures.org.

approaches can be termed inductive because they start by looking for diverse indications of change without predefined restrictions. Common ground of almost all the approaches is the consideration of impact and uncertainty as the main criteria for selecting the factors to be used for actually constructing the scenarios [18]. As a consequence, in many cases the scenario logic is dominated by very general macro-level factors such as "globalisation" or "societal values". Confronted with totally new and unanticipated situations, the scenario approaches, as commonly practiced, tend to exclude such patterns as "inconsistent" [19]. When the micro level is added in the "fleshing out" phase of the scenario building, it sometimes merely serves to illustrate the pre-conceptualised macro-structures. In the past years approaches have been developed to integrate disruptive events into scenario building in the form of wildcards [20]. While this will certainly open up the scenario arena towards taking into account unexpected events and possible trend reversal, it does not enable the recognition of structural change and long-term transition emerging from within the system. For this reason, Postma and Liebl [21] suggest to neglect complex causalities and to create scenarios by clustering trends that are assumed to occur simultaneously.

The INFU project followed a similar approach by combining the inductive scenario building concept with a weak signal scanning activity. After the initial scanning process for signals of change the signals were clustered by dimensions of change. The relevance of a signal was derived from the number of signals pointing in a similar direction [22]. No impact/uncertainty analysis was conducted. Instead, after discussing all signals each project member selected the most surprising and interesting signals according to their personal opinion. Consistency of the development of different signals was not emphasised. This approach attempts avoiding the exclusion of situations that seem illogical or inconsistent judged by characteristics of today's system. The aim is to explore the future of innovation in a rigorous inductive approach with a strong emphasis on open collection of phenomena and continuous re-opening of interpretation patterns.

In the first phase, by scanning "weak signals" [22], all sorts of observations of striking innovation practices were collected in a loose and open manner. Weak signals in the INFU project were defined as "signals of emerging issues". They can "sometimes hint about future changes. (…) Their visibility is characteristically low" [22] p.4. The definition included uptake of new ways of doing innovation in fields where they were previously unknown even if they were common in other areas. In addition to a free search, which aimed at finding phenomena that stand out from established innovation patterns, the project team agreed on a list of sources, which was then scanned systematically back to the year 2007 by the project team members, who acted as signal scouts in this phase of the project. The list of sources was extended during the scanning process in order to include knowledge gained while searching. The sources selected include daily newspapers from Europe and other world regions, daily newspapers with a business focus, magazines with a technological, business, or innovation focus and websites as well as blogs on innovation and research. Scientific journals were excluded from the weak signal scanning. Instead, a thorough review of academic literature on new innovation patterns was carried out [16]. A total of 63 weak signals were identified, fed into a common framework, and published on the internet site of the project.

For each signal of change a possible impact on the future of innovation was estimated in an intuitive manner by the project members and roughly described in a template. Based on these short descriptions the signals were clustered according to their possible impact. As a result 19 clusters of signals of change were identified. Each cluster pointed towards a specific change in innovation patterns, derived from diverse signals of change from various sources of information.

For each cluster, a fictive vision was developed by the project consortium by way of "amplification" using the three principles "Transfer, Generalisation, Radicalisation" as shown in Fig. 1. Fig. 2 illustrates the amplification process for one of the clusters [23].

The resulting "visions" were discussed with innovation experts with different perspectives on innovation patterns through interviews and an online survey. The online survey was set up to support the qualitative interviews. Accordingly, participation was limited to a restricted circle of people with special expertise in relevant aspects of innovation or candidates for an interview. In total, 56 experts participated in the survey. The majority of the participants were researchers, consultants, and inventors but a couple of people from industry and two policy-makers also took part. The focus was mainly on Europe but one expert from China, one from the USA and two from Russia answered the survey.

The vision based survey was received very positively by the responding experts. The INFU visions generated high interest in the project and in further interaction and participation. This interest was not only due to the attractive presentation of the visions but also due to the focussed and clear description and the perceived novelty of at least some of the visions (Figs. 5 and 6).

The expert interviews were carried out by different researchers from the project consortium. Therefore, it was essential to use a structured outline for the interviews to ensure comparability. In most cases the expert watched the movie describing the set of visions[2] and answered the online survey in advance to the interview. By adding qualitative information to the results of the survey, a valid interpretation of the results was ensured. In addition to the assessments given in the survey the experts were asked to point out missing aspects and to suggest a clustering of the visions. Finally, it was discussed which visions were most interesting and should therefore be considered in more detail. In total 25 experts were interviewed by phone or personally [24].

Both interviews and survey were referring directly to the weak signals without introducing any assumptions on the socio-economic context or causalities among the respective developments. Accordingly, a structured assessment of very different aspects of changing innovation patterns was possible within interviews of 30 min up to 3 h. Considering that the participation in the online survey was restricted to a specific circle of people a very high response rate was achieved (only about 40 experts were asked to participate in the survey but via co-nomination 56 experts answered the questions). Many participants stressed their interest not only in the visions but also in the weak signal collection available on the internet.

[2] The movie is available at www.innovation-futures.org.

Transfers to other sectors, to other user groups...

e.g. from fashion to furniture industry; elderly people instead of kids or vice versa...

Generalisation as the mainstream practice...

e.g. what if active users involvement in innovation processes would become the default…

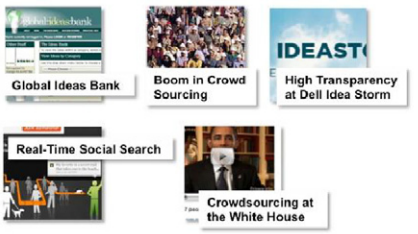
Radicalisation of the principle...

e.g. what if user involvement in innovation process developed into an innovation actively developed by the demand...

Fig. 1. Sketch of different "amplifications".

Web-Extracted Innovation

Starting weak signals:



Amplification

Today data on the behaviour of people is already constantly collected and used for individual marketing based on user behaviour. What starts with Web 2.0. features on the internet could lead to a society where customers become completely transparent. At the same time more and more companies look into diverse databases and use crowd sourcing to foster their innovation, to get inspiration and to benchmark creative dynamic in their sectors.

What would happen if it became possible to scan the internet for ideas and to filter those ideas according to current customer needs automatically?

Sophisticated filters would automatically extract ideas with outstanding market potential. Changes in the behaviour or the use of a product would be detected without delay and the most appropriate ideas for product optimatisation would be available immediately. The innovation would then be triggered by changes in the behaviour of people and there would be no time lag, thanks to real time investigation.

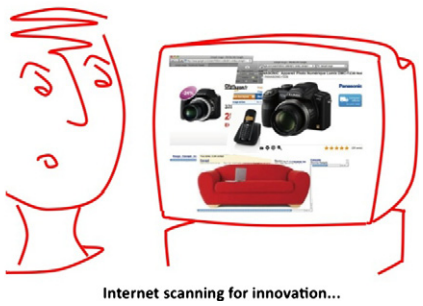


Fig. 2. Amplification example: web-extracted innovation.

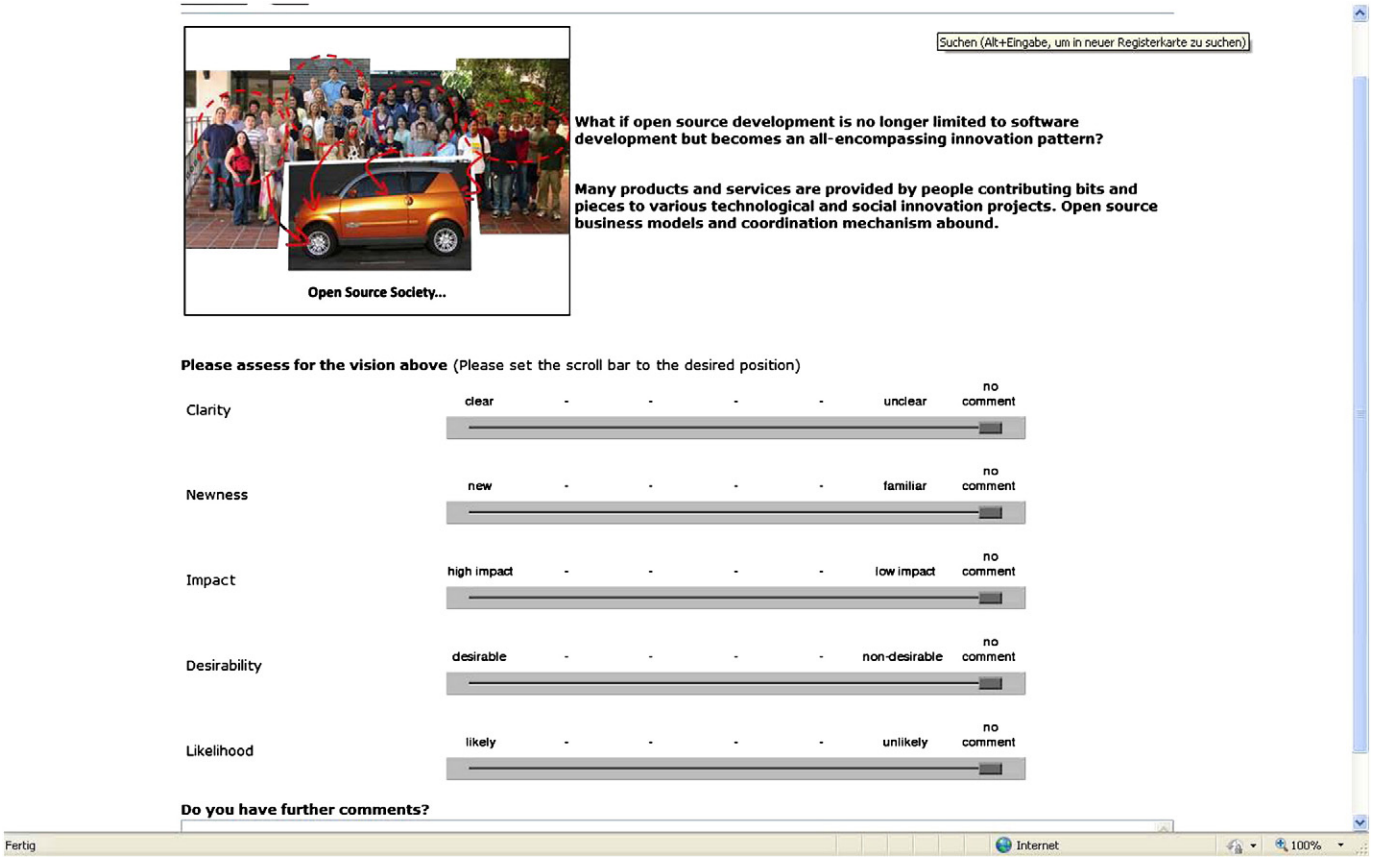


Fig. 3. Screenshot from the INFU web-based survey.

Fig. 4. Visualisation of all INFU visions.

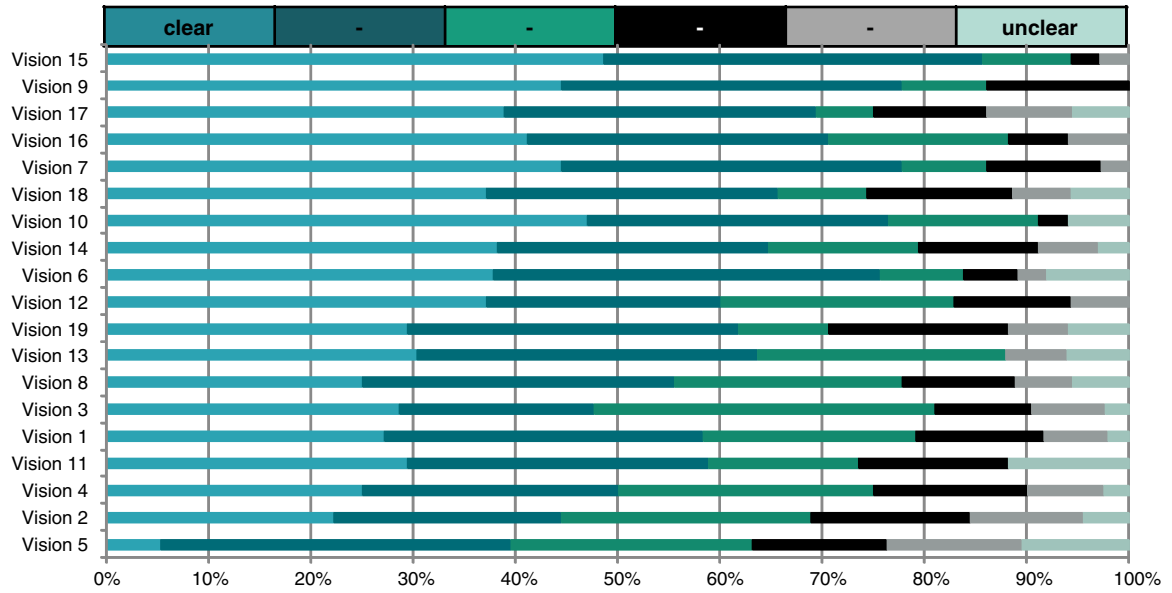


Fig. 5. Clarity of INFU visions assessed in the survey (n = 56).

2.2. Visual inspiration

The INFU "amplifications" were illustrated in a visual, easy to grasp format consisting of one image with commenting text line (c.f. Fig. 3). A trailer introducing all 19 visions with a short introduction was created and used as a base for both the interviews and the online survey. By using visual rather than textual information it was aimed to mobilise tacit knowledge and intuition and partly transcend established pathways of reasoning.

Since the visions describe a still unknown and abstract situation, so called "story-scripts" were used for the visualisation. Story-scripts combine pictures and drawings for visualising a fictive future situation. The photographic image facilitates immersion into a possible situation in the future, whereas the drawing distorts the pictures and expresses the remaining uncertainty. The sketchy style of the drawings underlines that the story-scripts express only a very rough idea of what a situation in the future could look like. The exclusive use of pictures from today is not suitable for facilitating the imagination of a possible situation in the future. On the other hand the exclusive use of drawings is missing the link to today's reality and might be misinterpreted as something fully invented

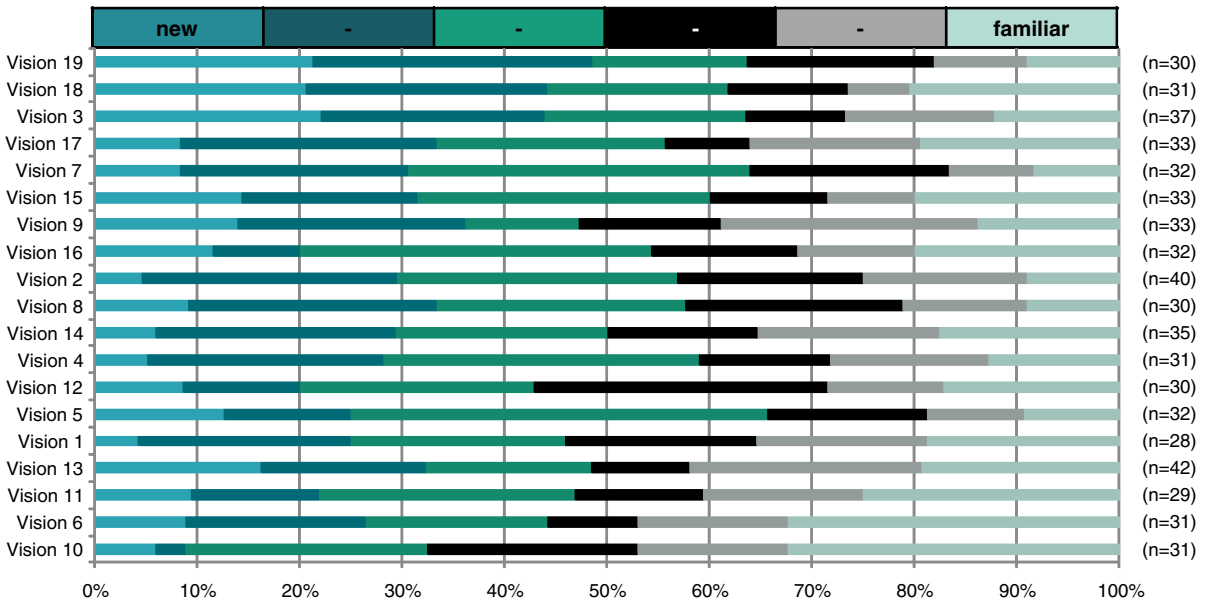


Fig. 6. Degree of novelty of INFU visions assessed in the survey (n = 56).

without any root within phenomena that can be observed today [25,26]. The story-scripts aim to inspire the imagination of a concrete situation in the future and therefore avoid using symbols. This type of story-scripts has successfully been applied in previous foresight projects with similar objectives e.g. [27].

The willingness of experts to engage with the survey was greatly enhanced as respondents appreciated the thought provoking nature of the amplifications and the visual experience (Fig. 4).

Participants expressed their appreciation of the visualisation not only explicitly in the interviews but also in the written feedback included in the survey. Furthermore the high number of people watching the trailer in the internet can be interpreted as an appreciation of the visualisation.

Participants of the online-survey extensively used the possibility to comment on the visions. Looking at the comments it is striking that many participants used a very informal language. They expressed their personal beliefs and thoughts using phrases like: "I think that …", "My personal opinion is that …", "I do not believe in …". Participants felt free to put open questions to the project team. The emotional language used by some participants indicates that visual inspiration mobilised intuition and emotional engagement. This holds especially true for the vision "Darwin's Innovation" that was quite provoking. It received highly controversial assessments by the experts ranging from "very interesting" to "bullshit".

In order to test the approach (only very short textual information) respondents were asked to assess the clarity of the visions in the INFU online survey. Most visions were assigned a high degree of clarity by the majority of the survey respondents (Fig. 5). At the same time almost all of the visions were assigned a high degree of novelty.

Concerning the novelty of the visions there was no consensus among the experts (Fig. 6). This result is quite striking since all of the experts considered the visions to be clear, but still they assessed the novelty quite differently. Except for vision number 5 (public experimentation, evaluated less clear than all the other visions) and vision number 10 (innovation imperative) all the visions showed a similar distribution, but for each vision different people considered the vision familiar or unfamiliar. These results show that by using weak signals from diverse sources of information it was possible to generate visions covering a wide range of different perspectives.

The format of "story-scripts" with very short textual description proved quite challenging for describing a vision that is new to at least some of the respondents. Therefore it was important to ensure a congruent understanding of the visions among the experts. During the interviews, the project team analysed whether the individual perception of the visions by each of the experts corresponded to the comprehensive descriptions of the visions previously developed by the project team. The interviews revealed that for some visions the visual information was interpreted in a slightly different way by the diverse experts. After discussing the variations of the perception of these visions the project team decided that the slightly differing understandings remained within a tolerable interval. For one vision the visual information was connected to a specific association leading to a strong emphasis on one specific aspect of the vision. This was the case for "Innovation on request" showing an election with personal attendance. This image seemed to foster the idea of time consuming and slow participative processes. This interpretation did not correspond with the intention of the project team and the comprehensive description of the vision. For this vision the visual information combined with the short textual information was not sufficient to communicate the vision adequately to the experts. The same phenomenon was observed for the vision "public experimentation". These two visions were thereafter excluded from further interpretation.

2.3. Assessment of coverage of dimensions of change

A third innovative feature developed within INFU to underpin the capture of structural change is the application of a framework of "dimensions of change" at the very beginning of the project. This framework was developed by the project consortium based on the review of academic literature on innovation patterns and the initial analysis of the signals of change described above [16]. Throughout the project the team discussed and assessed how far the emerging visions were covering the different ends of these dimensions. Fig. 7 shows the results of one assessment in an early stage of the process. The findings at that point were indicating a shift towards demand-driven innovation combined with a much more diffused involvement in the innovation process and more diverse innovation skills. While some visions reflected a permanent and continuous innovation process, others illustrated a more focussed, occasional innovation pattern. Concerning the motivation for innovation the observations represented a large diversity from strictly profit-oriented innovation patterns up to mission-driven innovation patterns aiming to support social benefits regardless of profit expectations.

The framework developed within the INFU project supported an analysis of structural changes hinted at by several visions. Throughout the project emerging findings on changing innovation patterns were situated in this scheme. One-sided modifications towards one specification extreme triggered a deliberate search for possibly opposing signals and the results were discussed among the project team. E.g. in the case of "openness" special efforts were made to check for possible signals of closure in innovation patterns. In this way INFU systematically addressed one-sided modifications. The aim was to avoid misinterpretations because of hidden signals (blind spots) caused by intra-systemic perception filters of the project team.

2.4. Prolonged divergence

In the initial phase of a scenario building exercise, the environmental scanning, a wide range of opinions and observations is recruited often through interviews or surveys. In the INFU project this was done by a literature review and screening for weak signals by the project team as described above. Secondly, at classical scenario building workshops people with different viewpoints and expertise are requested to assess the influence factors, their possible evolution and the consistency of projection bundles [28]. Usually

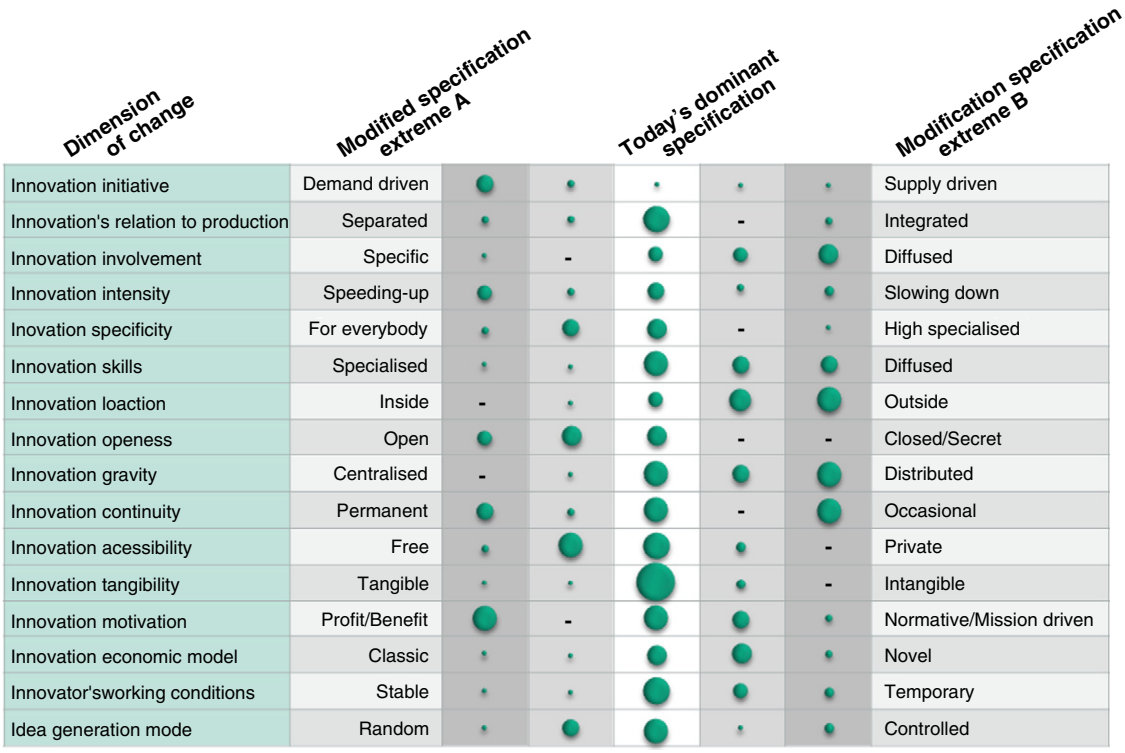


Fig. 7. Assessment of coverage of dimensions of change.

the scenario building activity is looking for a consensus building process among the participants and is therefore closing the phase of divergence at a quite early stage of the process. In a classical scenario building process participants' contributions are channelled through the scenario building framework. This can be more or less rigorous depending on the approach. In the INFU project it was explicitly sought to postpone convergence and consensus, avoid early closure and prolong the phase of divergence and openness, aiming at the assessment of diverging rather than converging elements of changing innovation patterns. From all reactions collected on the 19 visions through the survey and the interviews, the project team identified eight critical issues that seemed to have special potential for changing today's innovation patterns. These so-called "nodes of change in innovation" [24] were then subjected to in-depth discussion within the INFU mini panels (Table 1). The co-ordinators were identified in the course of the interviews as people with particularly relevant ideas and high interest in one or several different visions. They were subcontracted by the INFU consortium to further develop the vision of a future innovation landscape without any constraint as to the visioning approach. As shown in Table 1, each mini panel adopted their own approach to the visioning, but all of them integrated other experts' and actors' opinions and knowledge. Several co-ordinators decided to reach out to a wider community of actors. The smallest group comprised 5 and the largest one 42 participants.

The INFU team imposed only a very rough indication on the format for the vision's delivery. Accordingly, the groups came up with completely different types of outcome as shown in the Figs. 8–10. Typical means deployed by the mini panels to express their visions were:

- emblematic images (e.g. for widespread creativity, Fig. 8)
- abstract schemes (e.g. for social experimentation, Fig. 9)
- stories from the future ranging from short "day in a life segments" (e.g. for deliberative innovation, Fig. 10) to full scale descriptions of future events and actions
- archetypes of persons, organisations or infrastructure.

3. INFU findings and lessons learnt

3.1. The future of innovation—preliminary insights

The findings indicate interesting changes in the mediation between innovation demand and innovation supply [29]. A wide variety of hybrid value creation models with novel configurations of innovation actors emerged. Prominent features appearing across

Table 1
INFU mini panels.

Node of change covered	Mini panel co-ordinator	Visioning approach
1. Citizens role in innovation governance	Anders Jacobi Danish Board of Technology, Denmark	Visioning session among CIVISTI[a] consortium in Copenhagen
2. Automatising innovation	Patrick Corsi Consultant, Belgium	Four interviews with key companies (IBM, EPFL, INSEAT, ISTIA innovation) and group phone discussion
3. New spatial distribution of innovation—innovation chain management	Anna Trifilova and Bettina von Stamm Professors, Innovation Management; Innovation Leadership Forum, UK (Russia)	Three seminars in the framework of international conferences with researchers and company representatives in Nürnberg, London and Exeter)
4. City-driven systemic innovation	Daniel Kaplan FING—association pour la Fondation Internet Nouvelle Génération, The Next Generation Internet Foundation, France	Workshop envisioning the "open innovation city" with actors from city councils and companies involved with city level innovation in Paris
5. Innocamp Society	Dominik Wind Until we see new land (Innovation camp Start-Up), Germany	Workshop with stakeholders of future innovation camps in Berlin
6. Ubiquitous Innovation (including dark sides)	Rolandas Strazdas Professor, Innovation Management, Lithuania	Creative session with Global Creators in Vilnius by an Innovation consultancy
7. Waste Based (open) innovation	Jay Cousins Founder of Open Design City Berlin, Germany (US)	Workshop in Berlin with stakeholders and key actors from cradle to cradle community[b] in Berlin
8. Social experimentation	Stéphane Vincent La 27e Région, France	Drafting of Citizens Agency in a visioning session in Brussels with actors in social innovation

[a] Citizens Visions in Science and Technology FP7 SSH project.
[b] Cradle to Cradle: A Model of industrial systems in which all waste materials are productively re-incorporated in new production and use phases.

mini panels were the emergence of more active roles for users and citizens, the need for adequate enabling platforms between innovation demand and innovation supply, the need to adopt new innovation formats in order to address societal needs and the increasing use of collective self-production facilities. These findings imply new topics and approaches to innovation policy as outlined in the INFU policy briefs. Some of the proposed aspects of new innovation patterns such as the "waste based innovation" or the "city level open innovation platform" seem particularly suitable for aligning social and technological innovation towards structural transformation. As described in the INFU deliverables 5.1 and 6.1, the framework supported the extraction of the following structural changes in innovation patterns [30]:

(1) *Mediation and co-ordination*: The position of markets as the main mediator between innovation demand and supply is challenged by several new innovation patterns. Other co-ordination mechanisms such as web-based co-design are on the rise.

Fig. 8. Element from INFU vision "Ubiquious innovation".

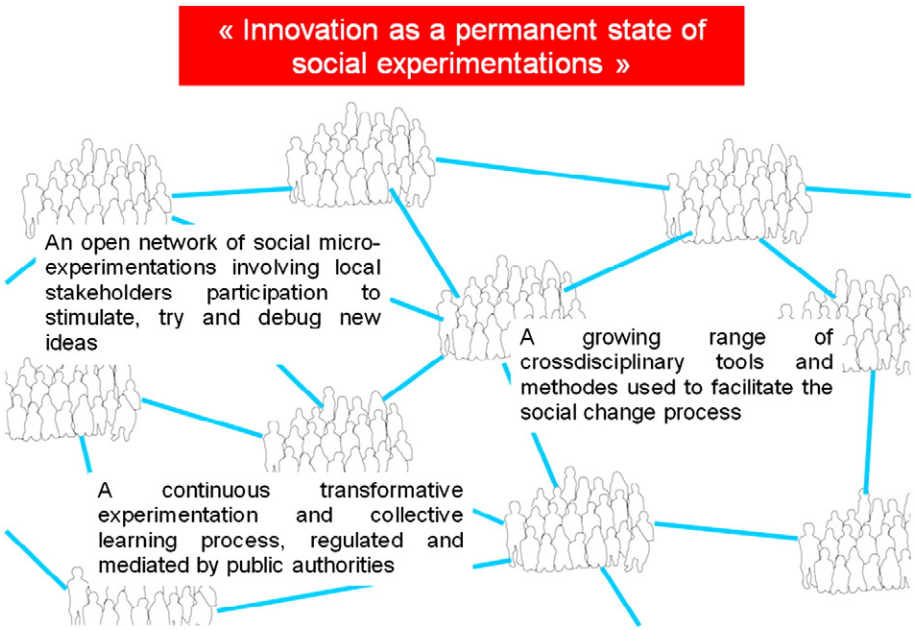


Fig. 9. Element from INFU mini panel "Participatory Innovation".

(2) *Participation*: Citizens seem to gain relevance in innovation both in deciding on innovation priorities and in contributing to the innovation process. Finding the right level and instruments to enable this kind of co-creation of solutions seems a crucial future challenge.
(3) *Motivation*: The motivation of organisations and individuals for developing and using innovation is changing. Company profit as the main driver of innovation activity is being complemented. Solving social problems become an important driving force to innovate for both companies and individuals. In addition, individual persons are motivated to contribute to innovation activities (such as crowdsourcing initiatives or idea competitions) for their pleasure.
(4) *Automatisation*: Software will play an ever-growing role in innovation. More and more innovation steps may become partly or fully automatised (e.g. by using web crawlers to identify ideas). New forms of interplay between human creativity and automatised combinations of elements are emerging.
(5) *Infrastructures*: New innovation enabling infrastructures emerge alongside with new innovation formats. In particular enabling infrastructures for community innovation such as the innovation camps, shared fab-labs and co-working spaces are likely to become more important. In addition virtual/digital global infrastructures may increasingly be required.
(6) *Perception of creativity*: The very meaning of being innovative is shifting. Creativity may become a key aspect in all professional activities. Formation of identities and social relations as well as everyday creativity may increasingly be recognised as core aspects of innovation.

John: Making his contribution at the yearly I-day of Innovation

People liked it! John was a bit surprised, then he got euphoric! Maybe his idea would go on and become an innovation for the future. He posted his idea only 45 minutes ago and already 1206 people had voted for it as being interesting and something that should be taking further. He could also see that the selection committee had looked at it… What was that – now the idea was not just at the idea interface, they also put it on the partnership interface. Now it was no longer just an idea, now they wanted to find people who could actually carry out an innovation process based on his idea, scientist, entrepreneurs, funding.

Back at the idea interface he could see that quite many people had started to work on with his idea, putting new angles to it, combining it with their own ideas, suggesting specific technological development. Most of it was not in line with his original thoughts, but he had to admit that some of the suggestions where really good. Improving the first idea a lot!

Fig. 10. Element from INFU mini panel vision "Deliberative Innovation"—"A day in a life of a Citizen in the Deliberative Innovation Scheme".

(7) *Spatial shifts*: Innovation will change its spatial patterns: local elements are likely to gain relevance resulting in a more distributed innovation scenery while new regions become more important in global innovation chains.
(8) *Systemic sustainability innovation*: Innovation patterns fostering system transitions towards sustainability rather than isolated product development are more and more required in order to address societal challenges. This requires consideration of social and ecological aspects throughout the entire innovation process.

In subsequent phases of the INFU project, the findings were assessed by actors from various stakeholder groups with respect to impacts for society, economy and ecosystems [29]. Finally, policy implications arising from the changing nature of innovation were discussed with policy makers from various realms and levels in interviews and within one dedicated policy workshop. Across policy perspectives the need for different types of innovation policy instruments to deal with newly emerging innovation patterns rather than just different priorities was stressed.

As this paper is focussing on the methodological insights emerging from the INFU project we will not go deeper into the findings and conclusions which are documented in-depth elsewhere [30].

However, it is to be noted that among the around 80 actors involved directly in the INFU futures dialogue and many more that heard of the INFU findings at conferences and other events there was an overwhelmingly positive response towards the thought-provoking and transformative nature of the INFU findings. In particular the policy actors welcomed the fact that INFU underpinned the exploration of fundamental changes in the innovation landscape rather than isolated responses to individual trends.

3.2. Lessons learnt—methodology

From a methodological point of view the aim of the INFU project was to contribute towards building foresight capacities for systemic and structural transformations. Four methodological innovations were adopted in the project and contributed in a specific way to opening up new perspectives for thinking about the future of innovation and potential structural transformation of innovation processes:

- The *inductive approach* of the project was successful in integrating diverse perspectives and stimulating diverse experts to participate in the process. Diverse signals were considered in the project and the collection of the signals provided at the website was assessed as very valuable by experts dealing with innovation patterns. Reflecting the process of weak signal collection it can be noted that when looking for signals the inclusion of diverse experts is crucial. The consideration of very diverse perspectives can be seen as an important starting point for the assessment of systemic change. The key challenge encountered was the widening of filters to discern signals beyond the obvious. Compared to other weak signal scanning processes the inductive vision and scenario building approach used the signals of change to develop diverse visions without using an impact/uncertainty matrix which is often described as the backbone of the scenario process [18].
- *Visual inspiration* turned out to be one of "the" main characteristics of the project. It not only fostered strong interest in the project but also supported a very straightforward exchange of ideas among many participants and facilitated a creative interaction of people with different perspectives. Furthermore the visual approach succeeded in mobilising tacit knowledge and personal, emotional assessments.
- As concerns the *assessment of coverage of dimensions of change* the framework was used to discuss and clarify the visions included in the project. In addition this classification provided information about the convergence and divergence of the visions and fostered the search for specifications of dimension of change not covered in the first draft. The systematic assessment of the findings supported deliberate inclusion or exclusion of dimensions of change. Acknowledging the impact of mindset filters (even when working in a project consortium) [31] the assessment of coverage of dimensions of change supported the project team in looking for specific signals of change that had at first been neglected due to perception filters. Some experts noted in the interviews that the assessment of coverage could have been emphasised even more in the INFU project.
- The *prolonged divergence and open research approach* turned out to be very suitable to avoid early closure and challenging the research team's own pre-conceptions. A deepened understanding of the different points of view and perspectives was achieved compared to many other approaches looking for early convergence rather than emphasising divergence. The "co-nomination approach" not only proved to be very helpful during the survey but also allowed the spreading of information, the extension of the expert network and the integration of very diverse perspectives. In particular the fact that the external experts were identified only throughout the progress of the project depending on the interview results proved extremely useful as the project was able to respond to the insights in a very flexible manner. Network building was supported and additionally it was advocated to avoid a bias by including only familiar experts. However, the integration of the high diversity of outcomes proved challenging in later phases. As a further critical point it can be mentioned that the effort needed for formal contract arrangement increased notably by including a large number of external experts.

All four features described above are not completely innovative and have been used to some extent in other foresight activities. However the combination of those four features has not been described before and turned out to be quite helpful in analysing structural transformation. The inductive approach (focussing on signals of change at the micro level) and the extended openness for diversity are typical elements of weak signal scanning processes. These processes are usually not aiming at envisioning structural transformation and are not designed to sketch out a comprehensive vision or scenario encompassing structural transformation. "Mapping and interpretation of weak signals is still in its infancy and thus an important challenge for further studies" [31]. The assessment of dimensions of change is similar to the concept of alternative logics, which has been proved to be a robust and resilient approach to develop alternative scenarios [32], p.111. By combining this concept with the two features described above, the

dominance of the macro-level and the influence of today's perception of consistency were reduced to give room for creative assessment of structural transformation. The fourth feature, the visual inspiration, was not only a means to support communication of the project results but was integrated in the process of building visions and scenarios. Similar to approaches of participatory design [33] the "story-scripts" allowed people with different backgrounds to imagine a situation in the future without comprehensive textual information. In addition the appealing visualisation symbolised the creative, inspiring approach which is needed to envisage structural transformation challenging today's paradigms.

4. Conclusions

As INFU was being finalised at the time of writing it is too early to assess the usefulness or even the impact of its findings in a reliable manner. However, the feedback received from the numerous participants during the INFU process as well as from audiences of INFU presentations in several different communities[3] allows for some methodological conclusions. The majority of these responses indicate that the project succeeded in opening up new perspectives for exploring the future of innovation with relevance for strategic conversations among various actor groups. The INFU visions gave rise to fundamental discussions among stakeholders regarding possible cultural transitions, new economic principles, new principles organising resource flows, different notions of learning, new working patterns and different modes of democratic governance. The discussion among policy makers went beyond simple priority setting within today's strategies. The debate tackled fundamental concerns such as adequate consultation procedures, new types of R&D projects and pathways for integration of policy strategies across diverse policy realms.

We feel that these fundamental discussions were triggered because to some extent the INFU perspectives were transcending the underlying assumptions dominating today's perception of innovation. This leads us to the conclusion that some of the features of the INFU methodology proved indeed suitable for tackling structural transformation in foresight exercises. This progress however can only be a first step. In order to envision and explore pathways for system transformation, foresight methodology needs to be further developed. We would like to highlight some of the aspects of the INFU experience that seem to be of particular relevance to be further explored by foresight practitioners, users and clients.

The "open research approach" of subcontracting mini panel co-ordinators without any constraints on the visioning methodology and the involvement of experts and stakeholders, helped avoiding premature convergence into established pathways and fostered the integration of diverse perspectives not only at the beginning but throughout the project. In our view the effort put into realising contributions of external actors beyond mere workshop participation was fully justified by the diversity of the outcomes. The value of the contributions of actors from different perspectives was much better exploited than in conventional workshops where participants' contributions are documented by the foresight team. Therefore we recommend this approach of "prolonged divergence" to be further developed and frequently considered.

As discussed above, the inductive scanning of signals with only minimal imposition of predefined categories proved an adequate approach for the INFU case. Nevertheless, re-introduction of rigour in later phases was challenging. We feel that the integration of elements from different foresight approaches such as weak signal scanning and diverse scenario approaches might help in addressing structural transformation. Further methodological research in this direction is required. In particular pros and cons of deductive and inductive methods, model-based and inductive methods as well as various options for combinations should be assessed in a systematic manner.

There are many indications that the visual inspiration deployed throughout the INFU project for generating anticipatory intelligence was crucial for stretching the imagination beyond established pathways and for introducing out-of-the-box perspectives. We feel that this kind of approach holds a considerable potential for complementing established foresight methodology and that this potential is only just at the beginning of being exploited. Intuition-based methods fostering creative processes may be needed to capture structural transformation.

The framework of "dimensions of change" used to assess the results of the signal screening phase enabled the INFU team to systematically question anticipatory assumptions and to reintroduce opposing views in a reflexive manner. Accordingly, we conclude that similar approaches could serve in other foresight exercises to uncover and transcend perception filters. This is of particular relevance when structural transformations are at stake as these are most prone to be missed out due to intra-systemic perception filters. In particular in the case of an inductive approach where a large number of micro-level findings need to be structured and restructured several times, the check against "dimensions of change" seems promising. Accordingly it seems worthwhile to further develop and test the approach.

Throughout the project it was recognised that people are attracted by provocative ideas and visions. They serve very well to mobilise debates and engagement of the actors dealing with the topic, but at the same time there is a high risk, namely that only positive visions that go along very well with the personal value system are taken up and further developed. Actors who considered a structural change as a positive transition were willing to be involved in the further development of the visions. Therefore an in-depth analysis for these "positive" visions can be easily conducted whereas more gloomy visions may be neglected.

Finally, it is important to note that while INFU may have been successful in developing diverse visions *pointing at* potential structural change, the next issue that will have to be tackled is the use of such "transformative visions" in actually *managing* transformative transition processes [34,35].

[3] E.g. ISPIM conference Hamburg, 17–20th of June 2011, Lift conference Marseilles 2/3 July 2011 (INFU workshop), FTA conference Sevilla 2011, and R&D Management Conference Manchester 2nd of June 2010 (INFU workshop).

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