UNIVERSITY OF LONDON

Interaction design

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CO3348

2010

Undergraduate study in
Computing and related programmes

Goldsmiths
UNIVERSITY OF LONDON

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University of London
Publications Office
32 Russell Square
London WC1B 5DN
United Kingdom

london.ac.uk

Published by: University of London

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Preface

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About this course unit

CIS 348, Interaction design, is a half unit Level 3 option for the BSc/Diploma in Computing and Information Systems (CIS) and the BSc/Diploma in Creative Computing. The course has no specific or formal pre-requisite course unit or technical requirements. However, students should have a good general awareness and experience of a range of current computer-based systems, ranging from stand-alone and mobile applications to internet-based and commercial ones. To obtain the most benefit from this course unit, students should be interested in the human aspects of using new technologies and novel interaction media. The course unit does not cover applications programming, software development, technological solutions or analysis of such systems. An interest in and willingness to learn about aspects of user psychology, most especially some basic concepts in experimental and cognitive psychology, will be necessary. Although this may appear challenging for those with no prior experience in this area, the core Essential and Further reading should suffice.

CIS 348 is an updated replacement for CIS 315, Human Computer Interaction, and shares some basic material with it. Prior material on sample examination questions and past *Examiner's reports* will still be broadly applicable. The course unit has been brought up-to-date, its emphasis refocused more on the design of human-computer and human-technology interactions, based on the needs and requirements of the users of such technologies, and assessing how such interactive applications are used in real-life. This course unit introduces the study of Human Computer Interaction (HCI) together with the newer area of Interaction Design (ID).

Knowledge of interface design and user requirements is critical to many aspects of software development and applied computing. Increasingly, resources are devoted to the design and optimal functioning of interfaces to an increasing range of interactive technologies. Standards and accessibility legislation and guidance are now a crucial element in commercial interface design, which means that new applications are being created with an emphasis on good design and user participation. The world that HCI investigates and researches is developing into a mobile, ubiquitous and ambient one. The 'computer' has been extended and, in many cases, replaced by numerous mobile interactive devices. Users are no longer homogeneous but increasingly form new and distinct user groupings. The concept of a usable interface has been revolutionised by devices such as the iPod and iPhone, and people increasingly recognise and expect to be able to use electronic devices easily and without difficulty. The global expansion of technology means that localisation and internationalisation issues assume greater importance. The expansion of commercial web-based applications in e-commerce and e-government will undoubtedly continue apace. New types of interaction based on gesture, touch, motion and speech are increasingly common and can be seen in current commercial products. Social networking, community computing and immersive technologies have become a fundamental part of the lives of many, and home-based applications of new technologies abound. Games and the associated new markets in entertainment computing, learning technologies and virtual applications continue to push the boundaries of creative computing. An increasingly elderly population in many parts of the world has led to a new emphasis on assistive technologies and for health-related technology-based applications.

Given this snapshot of current impacts, students need to be able to engage with future technologies and to fully appreciate and understand the design principles which create effective interactive applications, and to be well-prepared to apply them in their future jobs and careers as computer professionals and practitioners. This introductory course unit is thus essential for anyone who will be involved in the analysis, design, development or evaluation of interactive applications of any kind. The aim is to go beyond mere ‘guidelines for good design’ and to enable students to develop an understanding of the principles of interaction, to identify problems with an interface, to understand how such interactions may be improved and to gain the knowledge necessary to be able to design better interfaces. This Study Guide will introduce and discuss the topics and technologies described in the previous paragraph and will enable students to gain an up-to-date understanding of what it means to be an Interaction Designer.

Assessment

Important: The information and advice given in the section below are based on the examination structure used at the time this guide was written. Please note that subject guides may be used for several years. Because of this we strongly advise you to always check the current *Regulations* for relevant information about the examination. You should also carefully check the rubric/instructions on the paper you actually sit and follow those instructions.

The course unit is assessed by an examination of three (out of a choice of five) questions. The examination questions are essay-based but do have a strong element of applied design and interpretation of the techniques studied during the course unit. Guidance is given in the next section. There are also coursework assignments. The essay- or report-type assignments are similar to those that have recently been set for the CIS 315 course unit and will change in topic every year. They should allow students to become better informed about selected specific aspects of Human Computer Interaction and Interaction Design and to enable exploration of the extensive online information available for this subject. Again, specific details and guidance can be found later in the Study Guide.

Examination guidance

For appropriate examination preparation, please take note of the following points:

- Take a few minutes to make a plan of each question and to gather your thoughts instead of immediately starting to write.
- Ensure that you fully understand the topic area of the question.
- Ensure that you can answer every part and section of the question. Being able to answer only part of the question will not help you achieve a good overall mark.
- Do not spend unnecessary time restating the question, either in your own words or in repeating the question text. This is not required and will use up valuable time.
- Do not spend examination time answering one question at the expense of others: it is generally better to answer three questions in full than one in great detail and two very briefly.
- Do not repeat details from one section in another section: it is unlikely that this is what the Examiner intended and the focus of your answer in each section should be quite distinct.
- Ensure that the level and detail of the answer you give corresponds to the marks allocated. Do not spend too much time and effort on a part of the question that is worth only a few marks. Similarly, do not merely write cryptic notes or single points for a part of the question that is worth a large number of marks. Try to achieve the balance reflected in the marks indicated.
- Read the question carefully and answer in the way that is requested: wording such as ‘describe’, ‘compare and contrast’, ‘itemise’, ‘illustrate’, ‘explain with diagrams’ tells you what sort of answer is expected and what sort of detail you should go into. Make sure you understand what type of answer is required and do provide diagrams or examples where requested as this is part of the marking scheme for the question.
- Do not spend time providing unnecessary diagrams. If diagrams are requested, they should be clearly labelled and described. Providing as an answer an unlabelled diagram from memory without a description will not attract good marks.
- Do try to use tables and lists where appropriate – for example, in a question which asks you to contrast two approaches or itemise the differences between two aspects of a topic.
- Organise your time to allow sufficient time to read over what you have written and to make any necessary corrections.

Coursework guidance

Coursework will generally be in an essay format. A detailed statement of what is required will be produced, with the marking scheme clearly indicated and suitable references given. The following guidance will help you to produce high quality coursework:

- You will be required to provide an electronic copy for plagiarism checking purposes. Any submission without any electronic copy will not be marked. Very short submissions are also unacceptable.
- You should write in a report or essay format – not in note or bullet-point form – with a defined structure as detailed in the coursework instructions. You do not need to restate the question asked or provide a

table of contents, an index or a cover sheet, or any extra information or appendices, and you should attempt to minimise the use of paper.

- The structure, clarity and organisation of your work will be assessed and some marks awarded for it. Your submission must be well-presented in a coherent and logical fashion. It should be spell- and grammar-checked and you should structure it so that you have both a clear introduction and a conclusion. A concluding section is a required part of your coursework submission.
- You should include relevant diagrams, drawings, illustrations or images such as graphics and screenshots as coursework is likely to involve a design scenario and production of paper-based prototypes. These will have an impact on the readability and presentation value of your work.
- Remember that the focus of coursework will normally be on HCI aspects and on design principles for user interactions, not about applications as such, the hardware and software involved, or business elements. You should be assessing how humans use interactive applications and what the elements of a good user-computer interface are.
- You must provide a Bibliography and References section at the end of your work, showing the books, articles and websites you have referenced and consulted. All books cited, reports referred to and any material used (including all online resources) must be referenced. Students who do not provide references, or cite only the course textbook and Study Guide, will be marked down.
- Websites should be referenced by the date of access and a complete and correct URL (generic site names are not acceptable). Other references should be in a standard format (i.e. author names (correctly spelled), year of publication, title, publisher, actual page numbers referenced). For a useful guide to referencing procedure, look at: http://education.exeter.ac.uk/dll/studyskills/harvard_referencing.htm
- The submitted assignment must be your own individual work and must not duplicate another person's or an author's work. Copying, plagiarism and unaccredited and wholesale reproduction of material from textbooks or from any online source are unacceptable. Any such work will be severely penalised or rejected. Any text that is not your own words and which is taken from any source must be placed in quotation marks and the source identified correctly in the References section. Failure to do so will incur very serious penalties.
- Do be extremely careful about the validity of information on internet sites and world wide web sources. Citing and copying from Wikipedia and other encyclopaedic sources, for example, is not appropriate for a coursework submission. Be aware that many information sites are commercial advertising, or simply repeat material from elsewhere. Do check the date of all material and do not use out-of-date sites, sites which list student work or projects, references from commercial publishers to journal paper abstracts only or those which are simply personal opinions, blogs or comments. Please be selective and critical in your choice of material.

Course aims

This course unit provides an understanding of the theoretical and methodological issues that can be applied to the design and evaluation of interactive computer-based systems.

Learning objectives

Students should, at the end of the course unit, understand a broad range of basic concepts in HCI and ID, and be able to apply HCI principles, guidelines and techniques to the analysis, design and evaluation of interactive systems, no matter what the underlying technology.

Learning outcomes

By the end of this half unit, and having completed the relevant readings and activities, you should be able to:

- gain a historical perspective of the field of HCI and its relationship with software engineering, psychology and ergonomics
- understand what Interaction Design is and be able to think critically about design
- appreciate HCI theory, practice and a set of design approaches
- understand the concept of usability and techniques of usability evaluation
- make use of usability concepts in appreciating, using and building interactive solutions for a range of applications
- criticise and improve poor interface designs, and so develop the skills to design and evaluate interfaces
- demonstrate awareness of new application areas and up-and-coming advanced technologies in order to better understand the potential of new technologies and techniques in the design of future interactive systems and applications.

The Study Guide

This course unit offers a multidisciplinary introduction to interaction with technology (and not just human computer interaction), concentrating on the design concepts which underlie current Interaction Design. This course will provide a basic-level grounding in the knowledge and skills applicable to the specification, design, prototyping and evaluation of advanced interactive systems. These tools and methods are used by software developers, user experience and interaction designers, designers of applications for mobile and hand-held devices, games developers and usability and Human Factors specialists.

How to use the Study Guide

This Study Guide is not a course text but sets out topics for study in the CIS 348 course unit. Additional background material is provided where applicable and links to useful information sources and examples (such as case studies, online examples, video material, and downloadable e-books and PDFs) are given. Essential reading is listed at the start of each chapter; Further reading and websites at the end. There is a recommended course textbook, with supporting online material, linked to the topics in this course unit. Required reading is identified and linked to specific chapters of this textbook; it should be undertaken along with the study of each topic and chapter in this Study Guide. Further personal reading and study to enhance overall understanding of the subject is an essential part of this course unit. Additional recommended readings are provided, full details of which are given at the end of each chapter and in Appendix 2: Bibliography. The Study Guide is intended to support and reinforce this personal study, not to supplant it. It will not be possible to pass this course unit by reading only the Study Guide.

Structure of the guide

a. Chapters

- Chapter 1, **Introduction to HCI and Interaction Design**, introduces HCI and ID and positions them both within surrounding disciplines. A brief history of the field, showing its genesis and development towards a design discipline, is given.
- Chapter 2, **Interaction and design approaches**, provides an overview of design approaches, with examples and descriptions.
- Chapter 3, **Techniques for Interaction Design requirements**, details selected specific approaches and techniques for studying users and carrying out user-centred task design and user analysis.
- Chapter 4, **Usability**, gives an explanation of usability requirements and **usability engineering**.
- Chapter 5, **Evaluation and usability assessment techniques**, details some usability evaluation and assessment strategies and techniques.
- Chapter 6, **Designing for different users**, considers design guidelines and standards, accessibility requirements, and issues involved in designing for specific populations. This encompasses globalisation and internationalisation aspects.
- Chapter 7, **Design case studies**, is devoted to case study material.
- Chapter 8, **Interaction Design and new technologies**, considers current Interaction Design questions and approaches for new and emerging technologies and paradigms.
- Chapter 9, **Real world interactions**, follows on by considering real-world applications and sectors where HCI and ID are having a wider societal impact, such as healthcare, collaborative and communicative technologies, and the developing world.

Each chapter is introduced by a pertinent quotation from an HCI 'guru'[1] and is preceded by a tag cloud and a graphical roadmap outline of that chapter. The main text is organised in numbered sections. Each chapter concludes with a summary of the main points and a statement detailing the learning objectives for that topic. Each chapter indicates the essential reading required for full comprehension of the topic.

[1] These quotations are personal communications to the Study Guide author and cannot be cited.

To assist with revision, Appendix 3 at the end of the Study Guide contains the roadmap, the summary and the learning objectives for each chapter. There is no Summary in the Preface.

b. Essential reading, references and footnotes

Essential reading will normally be a chapter in the designated course unit textbook, or one of the alternative, older textbooks. Additional references to other material and recommended Further reading can be found at the end of a chapter. These have been chosen to enhance knowledge and expand coverage. They are usually books or free-access websites. The Bibliography appendix has the full citable details (and, where available, the online link to the publisher's website page for that book) of all the textbooks and print sources referred to in the Study Guide. At the end of a chapter, the recommended reading is referenced in a short format only, for example:

Surname, Initial (Date of publication). Book title. Chapter or page numbers to look at. URL.

Footnotes are usually citation details for quotations or for particular articles or websites referred to. These additional links and citations can be followed up, if wished, but it is not mandatory: they do not necessarily appear in the bibliography appendix.

c. Exercises and Sample examination questions

Themed short questions, suggested exercises and discussion points, together with sample examination-type questions, are provided to facilitate revision and to test understanding of the concepts covered in that chapter. Local tutors may also wish to use these to lead discussion groups, so model answers are not provided. A Sample examination paper, together with possible answers in note form, can be found at the end of the Study Guide.

Suggested study time

The *Student Handbook* states the following: 'To be able to gain the most benefit from the programme, it is likely that you will have to spend at least 250 hours studying for each full unit, though you are likely to benefit from spending up to twice this time'. Note that this subject is a half unit.

It is suggested that a chapter be read in detail, and immediate notes taken, each week. At the same time, the associated readings and web-based material should be accessed and noted. It is advisable to attempt the practice questions and to access relevant case study or video material when studying a particular topic. Some of these may be design exercises involving paper and pen prototyping, so sufficient time should be set aside, depending on how many are chosen. Revision should take place over a number of weeks before the examination, and practice examination questions undertaken on a timed basis.

Recommended texts

The recommended textbook for this course unit is an updated and revised edition of a long-standing text.

> Shneiderman, B., C. Plaisant, M. Cohen and S. Jacobs *Designing the user interface: strategies for effective human-computer interaction*. (Boston: Addison-Wesley, available from Pearson Education, 2009) [ISBN 0321537351; 9780321537355] fifth edition. Price in 2010: £40–80. www.pearsonhighered.com/dtui5einfo/

The book includes much practical advice, research-supported design guidance and instructions for starting a first HCI design project. Each chapter begins with coverage detail and a chapter outline and concludes with a 'Practitioner's Summary' and a 'Researcher's Agenda' giving contrasting or complementary views of the topic covered. A useful companion website (http://wps.aw.com/aw_shneiderman_dtui_5/) comprises a blog written by one of the co-authors, self-assessment quizzes, discussion questions, projects, useful general web links, links to available online case studies and video material, and copies of PowerPoint presentations allied to the text of the book. Some of this text is free to view, other parts of the site are restricted access and available only to those who purchase the textbook and associated access codes. This edition of the textbook is the most up-to-date one; previous editions are not suitable since there is much new material. If this book is not available then the two alternative textbooks indicated below (those used for CIS 315) may be used – but do make use of the online resources for this textbook.

Three additional textbooks are recommended, but are not mandatory. It should be possible to access them from a library, or to share between a number of students. Again, these are recently published texts and it is unlikely that many used copies will be available until after 2011.

1. Lazar, J., H.F. Jinjuan and H. Hochheiser *Research methods in human computer interaction*. (John Wiley and Sons, 2009) [ISBN 9780470723371; 0470723378]. Price in 2010: £34.99. http://eu.wiley.com/WileyCDA/WileyTitle/productCd-0470723378.html

This book concentrates on the practicalities of carrying out user research and testing and gives very specific detailed advice and information on the whole area of research methodology. References will be made to this textbook at appropriate points in the Study Guide. It might also be a useful purchase for those considering a design-based, HCI or ID flavoured third year project. Note that another textbook with the title 'Research Methods for Human Computer Interaction', edited by P. Cairns and A. Cox, exists; this is not the textbook which is recommended but is an edited collection of essays on research methods more suitable for students with a background in social sciences. It is suggested as an alternative, if necessary.

2. Norman, K.L. *Cyberpsychology: an introduction to human-computer interaction*. (Cambridge University Press, 2008) [ISBN 0521687020; 9780521687027]. Price in 2010: £24.99. www.cup.cam.ac.uk/us/catalogue/catalogue.asp?isbn=9780521867382

Kent Norman's book concerns the psychology of how humans and computers interact. It contains a brief history of psychology and computers and an introduction to theories and models of human–computer interaction, covering relevant topics in sensation and perception, learning and memory, individual differences, motivation and emotion and social relations. Some specific issues in assistive technologies, video games, and electronic education are also discussed. Reference will be made to this textbook at appropriate points in the Study Guide.

3a. Buxton, B. *Sketching user experience: getting the design right and the right design*. (Morgan Kaufman, 2007) [ISBN 0123740371; 9780123740373]. Price in 2010: £29.99. www.elsevier.com/wps/find/bookdescription.cws_home/711463/description#description

3b. Buxton, B., S. Greenberg and S. Carpendale *Sketching user experience: the workbook*. (Morgan Kaufman, 2010) [ISBN 9780123819598]. Price in 2010: £12.99. www.elsevier.com/wps/find/bookdescription.cws_home/723098/description#description

Bill Buxton's book (and the associated workbook) is a masterclass in design, which helps non-designers understand and become practised in the skills of sketching, prototyping, creating mock-ups and interactive modelling which underlie much of Interaction Design. Various techniques and strategies are explained and opportunities given for personal practice which should lead to a better understanding of storytelling, critiquing and evaluating designs. This book is strongly recommended for Chapter 2 and for many of the exercises, especially those concerned with design and prototyping. It would be invaluable for those students committed to carrying out a design-based project. Other similar books do exist and some are referenced in Chapter 2 but Buxton's book is the only one with a workbook specifically linked to it. Note that there are, at the time of writing, no online support materials available.

Links to alternative texts (associated with course unit CIS 315)

Dix, A., J. Finlay, G. Abowd and R. Beale *Human-computer interaction*. (Prentice Hall, 2006) [ISBN 0130461091; 9780130461094] third edition. Price in 2010: £30–65. www.hcibook.com/e3/

Sharp, H., Y. Rogers and J. Preece *Interaction design: beyond human computer interaction*. (John Wiley and Sons, 2007) [ISBN 0470018666; 9780470018668] second edition. Price in 2010: £20–40. www.id-book.com/

The two textbooks which were recommended for the previous course unit CIS 315 are now increasingly outdated, even though both have been published in new editions and future editions are currently being prepared. The original and first issues of both textbooks are not at all suitable as both are very much out of date. Both textbooks now have associated websites and teaching resources. The former has an associated set of PowerPoint presentations and online examples and questions (www.hcibook.com/e3/) whilst the latter is especially valuable for its case studies (www.id-book.com/casestudy_index.htm) and for the links associated with chapters and interactive educational tools (www.id-book.com/interactivities_index.htm). References in both of these texts will be listed under essential reading material at the end of relevant chapters in this Study Guide.

Supporting resources

Each of the three previously listed HCI textbooks has a set of supporting extra resources, accessed from dedicated websites. A brief listing is given below of the chapter headings and support material in Shneiderman et al. (2009).

Recommended textbook

Shneiderman et al. (2009).

Each chapter ends with a 'World Wide Web Resources' section at the companion website. http://wps.aw.com/aw_shneiderman_dtui_5/

Part I: Introduction

1. Usability of Interactive Systems
2. Guidelines, Principles, and Theories

Part II: Development Processes

3. Managing Design Processes
4. Evaluating Interface Designs

Part III: Interaction Styles

5. Direct Manipulation and Virtual Environments
6. Menu Selection, Form Fill-in, and Dialog Boxes
7. Command and Natural Languages
8. Interaction Devices
9. Collaboration and Social Media Participation

Part IV: Design Issues

10. Quality of Service
11. Balancing Function and Fashion
12. User Documentation and Online Help
13. Information Search
14. Information Visualization

Afterword: Societal and Individual Impact of User Interfaces

Each chapter ends with a 'World Wide Web Resources' section at the Companion website: http://wps.aw.com/aw_shneiderman_dtui_5/

The Open Reader Resources http://wps.aw.com/aw_shneiderman_dtui_5/110/28381/7265752.cw/index.html include:

- A blog composed by co-author Steve Jacobs
- Additional discussion questions linked to each chapter
- Links to topics mentioned in each chapter
- User Interface Video Links which point to 40+ videos from past to present, and which link to video libraries.

The Protected Reader Resources are available to those who purchase the textbook and contain:

- Self-assessment quizzes
- Powerpoint slides for all chapters
- Project topics in 'Rapid Prototyping', 'Serving the Users' Needs', 'Information Visualization' and 'HCI Theories'.

Alternative textbook 1

Sharp et al. (2007)

Selected Interaction Design resources under the heading of 'Starter' ranging from blogs to software recommendations. www.id-book.com/starters.htm

Chapter headings, with links to each chapter's introduction and aims. www.id-book.com/chapter_index.htm

1. What is Interaction Design?
2. Understanding and Conceptualizing Interaction
3. Understanding Users
4. Designing for Collaboration and Communication
5. Affective Aspects
6. Interfaces and Interactions
7. Data Gathering
8. Data Analysis, Interpretation and Presentation
9. The Process of Interaction Design
10. Identifying Needs and Establishing Requirements
11. Design, Prototyping and Construction
12. Introducing Evaluation
13. An Evaluation Framework
14. Usability Testing and Field Studies
15. Analytical Evaluation

- Web resources which extend the subject treatment in each chapter consist mainly of further readings, links to blogs, presentations and slideshows (all were current in 2006/7 but have not been updated).
- Comments on the relevant assignments set at the end of each chapter.
- A set of teaching materials as PowerPoint slides based on the content of each chapter content. www.id-book.com/slides_index.htm
- Supporting case studies which illustrate the practice of Interaction Design. They are summarised in the book, but the online files contain more detailed descriptions and additional visual material. www.id-book.com/casestudy_index.htm
- A section entitled **Interactivities** which contains downloadable interactive educational tools. www.id-book.com/interactivities_index.htm

Alternative textbook 2

Dix et al. (2006) www.hcibook.com/e3/

Chapter headings, with a chapter outline, exercises and links to more specific topics (again, current in 2006 and not all available). www.hcibook.com/e3/chapters/intro/

Part One: Foundations

1. The human
2. The computer
3. The interaction
4. Paradigms

Part Two: Design Process

5. Interaction design basics
6. HCI in the software process
7. Design rules

8. Implementation support
9. Evaluation techniques
10. Universal design
11. User support

Part Three: Models and Theories

12. Cognitive models
13. Socio-organizational issues and stakeholder requirements
14. Communication and collaboration models
15. Task Analysis
16. Dialogue notations and design
17. Models of the system
18. Modelling rich interaction

Part Four: Outside the Box

19. Groupware
20. Ubiquitous Computing and augmented realities
21. Hypertext, multimedia and the World Wide Web

- Exercises and solutions relevant to each chapter. www.hcibook.com/e3/exercises/
- Slides available in PowerPoint format or as student handouts. www.hcibook.com/e3/resources/
- Additional online only extra material which is linked to specific pages and sections in the book, or to certain exercises. Further links lead to relevant other material and sites. www.hcibook.com/e3/online/
- Case studies. www.hcibook.com/e3/casestudy

Sources of further information

A very wide range of HCI and ID material is available online. HCI-related search terms will provide a plethora of potential sources, some more reliable and trustworthy than others. The lists below are selected sources that are deemed pertinent and useful but such a list is not exhaustive and is very time-sensitive. There is also an extensive annotated list of resources in Shneiderman et al. (2009) Chapter 1, pp.42–53.

Glossaries of terms

Glossaries are available online and elsewhere:

- Glossary of terms in: Lindgaard, G. *Usability testing and system evaluation: a guide for designing useful computer systems.* (London: Chapman and Hall, 1994) [ISBN 0412461005].
- SAP usability glossary. www.sapdesignguild.org/resources/glossary_usab/
- Usability first glossary. www.usabilityfirst.com/glossary/main.cgi

HCI, ID and usability interest groups

- ACM Special Interest Group on Computer Human Interaction (SIGCHI). www.sigchi.org/
- interaction (formerly known as The British HCI Group). www.bcs.org/

server.php?show=nav.14296

- Interaction Design Association (IxDA). A global network dedicated to the professional practice of Interaction Design. www.ixda.org/
- The Information Architecture Institute (IAI). Supports individuals and organisations specialising in the design and construction of shared information environments. www.iainstitute.org/
- The Usability Professionals Association (UPA). www.upassoc.org/

Magazines

- Interfaces (BCS interaction Specialist Group). www.bcs-hci.org.uk/about/interfaces/archive
- Interactions (ACM SIGCHI). http://interactions.acm.org/
- User Experience: The Magazine of the Usability Professionals' Association. www.upassoc.org/upa_publications/user_experience/ (subscription)
- Communications of the ACM (Association for Computing Machinery). http://cacm.acm.org/magazines/
- Computer Journal (British Computer Society). http://comjnl.oxfordjournals.org/; http://comjnl.oxfordjournals.org/archive/ (subscription)

Journals

- Behaviour & Information Technology (Taylor and Francis). www.tandf.co.uk/journals/tf/0144929X.html
- Cognition, Technology and Work (Springer). www.springer.com/computer/journal/10111
- Computer Supported Cooperative Work (Springer). www.springer.com/new+%26+forthcoming+titles+(default)/journal/10606
- Computers in Human Behavior (Elsevier). www.elsevier.com/wps/find/journaldescription.cws_home/759/description
- CyberPsychology and Behavior (Liebert). www.liebertpub.com/products/product.aspx?pid=10
- Entertainment Computing (Elsevier). www.elsevier.com/wps/find/journaldescription.cws_home/717010/description#description
- Foundations and Trends in Human-Computer Interaction (NOW). www.nowpublishers.com
- Human-Computer Interaction (LEA). http://hci-journal.com
- Interacting with Computers (Elsevier). www.elsevier.com/wps/find/journaldescription.cws_home/525445/description#description
- International Journal of Human-Computer Studies (Elsevier). www.elsevier.com/wps/find/journaldescription.cws_home/622846/description#description
- International Journal of Mobile Human Computer Interaction (IGI). www.igi-global.com/journals/details.asp?id=8050
- Online International Journal of Usability Studies (UPA). www.upassoc.org/upa_publications/jus/jus_home.html
- Personal and Ubiquitous Computing (Springer). www.springer.com/computer/hci/journal/779
- Pervasive and Mobile Computing (Elsevier). www.elsevier.com/wps/find/

journaldescription.cws_home/704220/description#description

- Transactions on Accessible Computing (ACM Press). www.is.umbc.edu/taccess/index.html
- Transactions on Affective Computing (IEEE). www.computer.org/portal/web/tac
- Transactions on Computer Human Interaction/TOCHI (ACM Press). http://tochi.acm.org/charter.shtml
- Transactions on Human-Computer Interaction (AIS). http://aisel.aisnet.org/thci/
- Universal Access in the Information Society (Springer). www.springerlink.com/content/107725/
- Virtual Reality (Springer). www.springer.com/computer/computer+processing/journal/10055

Conference Proceedings

- Human Factors in Computer Systems, Proceedings of the ACM SIGCHI Conferences, Special Issue of the SIGCHI Bulletin. (ACM Press, 1983 to present). www.sigchi.org/conferences, www.interaction-design.org/references/conferences/series/chi.html
- People and Computers, Proceedings of the HCI conferences of the BCS HCI Specialist Group. (Cambridge University Press; Springer; other publishers, 1984 to present). www.interaction-design.org/references/conferences/series/bcshci_people_and_computers.html
- Proceedings of Interact Human-Computer Interaction Conference. (North-Holland; Springer; other publishers, 1984 to present). www.interaction-design.org/references/conferences/series/interact.html
- Proceedings of some ACM SIGCHI sponsored specialised conferences. (ACM Press, various dates).
- ASSETS (conference on Assistive Technologies)
- CSCW (Computer Supported Cooperative Work)
- DIS (Designing Interactive Systems)
- Hypertext (Hypertext and Hypermedia)
- ITS (Interactive Tabletops and Surfaces)
- IUI (Intelligent User Interfaces)
- NordiCHI (Nordic Conference on Human-Computer Interaction)
- UbiComp (Ubiquitous Computing)
- UCMEDIA (User Centric Media)
- UIST (User Interface Software and Technology)
- Proceedings of conferences in associated areas (various publishers)
- ACE (Advances in Computer Entertainment Technology)
- ECSCW (European Conference On Computer Supported Cooperative Work) www.ecscw.org
- ETRA (Eye Tracking Research and Application)
- HAPTICS (The Haptics Symposium)

- IDC (Interaction Design and Children)
- INTETAIN (Intelligent Technologies for Interactive Entertainment)
- ISWC (IEEE International Symposium on Wearable Computers)
- IWEC (International Workshop on Entertainment Computing)
- MobileHCI (Human-Computer Interaction with Mobile Devices and Services)
- PDC (Participatory Design Conference)
- Pervasive (Pervasive Computing)
- TEI (Tangible, Embedded, and Embodied Interaction)
- UMAP (User Modelling, Adaptation and Personalization)
- UX (User Experience)

Web-based and online resources

It is notoriously difficult to maintain correct and up-to-date address details for web-based material, so the list below is presented with the caveat that it was checked and available at the time of writing, but continued correctness cannot be guaranteed. The list below contains a number of useful websites and resources for information in HCI, ID and Usability. Some are personal blogs, some commercial organisational sites, some are research community resources, some are quasi-official. View all with a critical eye.

Web resources

Blogs/Personal commentaries

- Alertbox www.useit.com/alertbox/
- Don Norman www.jnd.org/
- Johnny Holland http://johnnyholland.org/
- The Cooper Journal www.cooper.com/journal/

Commercial organisations/Company sites

- AM+A http://amanda.com/
- Fidelity Investments http://fcat.fidelity.com
- Putting people first www.experientia.com/blog
- SAP www.sapdesignguild.org/resources/resources.asp
- STC www.stcsig.org/usability/topics/index-alpha.html
- Foviance www.theusabilitycompany.com
- Usability First www.usabilityfirst.com/about-usability
- Usabilitynet www.usabilitynet.org/home.htm
- Usability Partners www.usabilitypartners.se/usability/links.shtml
- Usernomics www.usernomics.com/index.html
- Webcredible www.webcredible.co.uk/user-friendly-resources/
- WQUsability www.wqusability.com/articles/more-than-ease-of-use.html

Government/official sites

- Usability.gov www.usability.gov/index.html
- Web Access Initiative www.w3.org/WAI/

Newsfeeds and information dissemination

- Interaction Design www.interaction-design.org/
- Usability News www.usabilitynews.com/
- SURL Usability News http://psychology.wichita.edu/surl/usabilitynews

Research Community Resources

- HCC Education DL http://hcc.cc.gatech.edu/
- HCI Bibliography www.hcibib.org/
- HCI Index http://degraaff.org/hci/
- HCI Resource Net www.hcirn.com/
- The UX Bookmark www.theuxbookmark.com/
- UPA www.upassoc.org/usability_resources/
- Usable Web http://usableweb.com/
- UX Matters www.uxmatters.com/

Design related sites

- A List Apart www.alistapart.com/
- boxes and arrows http://boxesandarrows.com/
- Design Academy www.coolhomepages.com/cda/usability/
- Digital Web www.digital-web.com/
- Interaction Design Association www.ixda.org/resources
- Infodesign www.infodesign.com.au/usabilityresources
- Just Ask www.uiaccess.com/accessucd/index.html

Video material (libraries)

- Bill Buxton's Research Videos
  www.billbuxton.com/buxtonVideos.html
- HCC Education Digital Library
  http://hcc.cc.gatech.edu/taxonomy/videos.php
- Matthias Rauterberg's Videos in User-System Interaction
  www.idemployee.id.tue.nl/g.w.m.rauterberg/videos.html
- The Open Video Project
  www.open-video.org/collection_detail.php?cid=18

Special collections

- CSCW Video Special Collection
  www.open-video.org/featured_video.php?type=Special&cid=18
- SIGGRAPH Video Special Collection
  www.open-video.org/featured_video.php?type=Special&cid=19
- UIST Video Special Collection
  www.open-video.org/featured_video.php?type=Special&cid=20
- UBICOMP Video Special Collection
  www.open-video.org/featured_video.php?type=Special&cid=21
- CHI Video Retrospective Special Collection
  www.open-video.org/featured_video.php?type=Special&cid=8
- University of Calgary, Grouplab Videos
  http://grouplab.cpsc.ucalgary.ca/Videos

- University of Dundee, Computing Department Inclusive Digital Economy Network
  www.iden.org.uk/videoplayer.asp
- UTOPIA Project (Usable Technology for Older People: Inclusive and Appropriate)
  www.computing.dundee.ac.uk/projects/utopia/utopiavideo.asp
- University of Maryland Human Computer Interaction Laboratory (HCIL) library of videos
  www.cs.umd.edu/hcil/pubs/video-reports.shtml
- YouTube (usability)
  www.youtube.com/results?search_query=usability
- YouTube (Interaction Design)
  www.youtube.com/results?search_query=interaction+designandsearch=Search

Case studies

See Chapter 7 for the main list and other specific chapters for selected topics.

Acronyms

AH	Augmented Human
AI	Artificial Intelligence
AmbI/AmI	Ambient Intelligence
ANS	Autonomic Nervous System
ANSI	American National Standards Institute
BSI	British Standards Institute
CAD/CAM	Computer Aided Design/Computer Assisted Manufacturing
CBT/CAI	Computer Based Training/Computer Aided Instruction
CHI	Computer–Human Interaction
CSCW	Computer Supported Cooperative Work
DIN	*Deutsches Institut für Normung eV*
EIP	Exchanging Information with the Public
GOMS	Goals, Operators, Methods and Selection rules
HCI	Human Computer Interaction
IA	Information Architecture
ID	Interaction Design
IEC	International Electrotechnical Commission
ISO	International Standards Organisation
IT	Information Technology
KLM	Keystroke Level Model
MHP	Model Human Processor
MWBP	Mobile Web Best Practices
PD	Participatory Design
RFID	Radio Frequency Identification
RNIB	Royal National Institute for the Blind
SE	Software Engineering
TUI	Tangible User Interaction/Interfaces
Ubicomp	Ubiquitous Computing
UCD	User-Centred Design

UCSD	User-Centred System Design
UPA	Usability Professionals' Association
UX	User Experience
VDT	Visual Display Terminal
VE	Virtual Environment
VR	Virtual Reality
VRML	Virtual Reality Modelling Language
W3C	World Wide Web Consortium
WAI	Web Accessibility Initiative
WCAG	Web Content Accessibility Guidelines
WOZ	Wizard of Oz
WWW	World Wide Web
WYSIWYG	'What You See Is What You Get'

A picture is worth a thousand words. An interface is worth a thousand pictures.

Ben Shneiderman

Chapter 1
Introduction to HCI and Interaction Design

Introduction » Definitions » Why study user interaction? » Early HCI » Why it changed » HCI in the 1970s and 1980s » The situation today » Summary

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- understand the definitions of HCI and ID and associated terminology
- demonstrate knowledge of the historical development of the discipline
- define and describe common HCI terms
- describe how future developments in interaction, design and technology link to the history of the study of ID and HCI.

Essential reading

Note: Further reading and websites are listed at the end of the chapter.

HCI textbooks

Shneiderman, B., et al. *Designing the user interface*. (2009) Part 1.

Sharp, H. et al. *Interaction design*. (2007) Chapter 3.

Dix, A., et al. *Human-computer interaction*. (2006) Chapter 1.

Introduction

A recent Microsoft research report entitled ‘Being Human’, takes as its starting point what life might be like in the near future:

> *What will our world be like in 2020? Digital technologies will continue to proliferate, enabling ever more ways of changing how we live. But will such developments improve the quality of life, empower us and make us feel safer, happier and more connected? Or will living with technology make it more tiresome, frustrating, angst-ridden, and security-driven? What will it mean to be human when everything we do is supported or augmented by technology?*[1]

[1] *Harper, R., T. Rodden, Y. Rogers and A. Sellen* Being Human: HCI in the Year 2020. *(Microsoft Research, 2008) [ISBN 978095547612].*

The aim of this report was to assess the changing interactive world and attempt to come to a better understanding of human relationships with advanced technologies. Some predictions are positive, some negative. On the one hand lifestyle changes assisted by technology can be extremely beneficial to health and well-being; digital media and tools can stimulate creativity; the ever-expanding world wide web enables immediate access to ever-growing information and data sources. On the other hand:

> *…governments become more reliant on computers to control society, criminals become more cunning via digital means and people worry more about what information is stored about them.*[2]

[2] *Harper, R. et al. (2008) op. cit.*

Why should this be important? The ways in which humans interact with computers, technology and devices continues to evolve rapidly and no end can be realistically envisaged. Ubiquitous Computing based on miniaturisation, portability and new display technologies is a reality; innovations in input modalities have brought about new forms of education and entertainment, and communication between people has been revolutionised because of unprecedented advances in network and communications technologies. The widespread use of computers and a vast range of interactive devices in commerce and industry means that we do now really live digital lives in a digital age. Wider access by those previously not part of the computer revolution has led to global social concerns – the impacts are all around us. To be able to engage in and change our future, it is critical to understand what those impacts are and how they can be mediated.

1.1 Definitions

Human Computer Interaction investigates the interplay between a human user and a computer system or interactive device through the medium of a user interface. The joint performance of tasks by humans and computers depends on human capabilities to use machines on the one hand, and the design (and design trade-offs) and implementation of interfaces on the other hand. HCI research concentrates on user needs and assesses interface designs and implementations according to usability criteria – it has science, engineering, and design aspects.

Interaction Design makes use of novel techniques and technologies to design, build, test and produce interactive applications. Interface, Interaction and User Experience Designers apply usability design principles to create productive, usable and enjoyable systems – and more satisfied users.

1.2 Why study user interaction?

Knowledge of Interaction Design, HCI and usability is increasingly recognised as a business requirement and design is now an integral part of the computer business, not least because of international standardisation and accessibility regulations. As the potential user population grows in size and diversity and computers become ambient, pervasive, ubiquitous and increasingly 'invisible', there is both an expanding awareness amongst users of what can be achieved and a blindness to the idea of the computer as a distinct separate device. Interaction and HCI design and research try to accommodate human diversity in cultural and international locations. As a basic tenet of usability, people deserve systems that are easy to learn and easy to use even though they have different physical and cognitive abilities.

Poor design choices are all too common. We need to understand why disasters, accidents and frustrations happen. Many safety and life-critical systems depend on computer control, including air traffic control; nuclear power plants; manned spacecraft; emergency services and medical instrument monitoring. There have been many documented critical failures due to identified design problems. Knowledge of how to design for human needs can, however, help minimise such errors and enable computer systems to adapt to user requirements, rather than the human having to fit to the demands of the technology.

1.3 Early HCI

HCI is about understanding and designing the relationships between people and computers. As a field of study, it is an amalgam of several scientific disciplines since the early 'man-computer symbiosis' suggested by Licklider in 1960.[3] The human side of HCI derived from physiology and applied psychology, and in particular, from ergonomics (an applied science with close ties to engineering and industrial applications). Ergonomics is essentially the design of equipment so that its operation is within the capacities of the majority of people. Human factors is similar but stems from the problems of designing equipment operable by humans within the limitation of sensory-motor features (e.g. the design of flight displays and command-and-control applications). In the 1950s ideas from communications engineering, linguistics, and computing led to a more experimentally-oriented discipline concerned with human information processing and performance. Human operation of computers was a natural extension – there were new problems with cognitive, communication, and interaction aspects not previously considered. The first applications of this research were to large-scale process control systems with mainframe computers and in military systems, with restricted input and output modalities. At the same time, cognitive psychologists concentrated on the learning of these and early Computer Based Training/Computer Aided Instruction systems, the transfer of that learning, mental representations, and human performance.

[3] *Licklider, J.C.R.* 'Man-computer symbiosis. IRE Transactions on Human Factors in Electronics'*, HFE 1, 1960, pp.4–11.*

The advent of microcomputers and time-sharing systems led in the 1960s to studies into 'Man-Machine Integration' before further input from computing sciences, software engineering and information and systems sciences led HCI research towards personal computing applications and those singular problems. In particular:

- Computer graphics and the CRT (Cathode Ray Tube) and pen devices used in then current Computer Aided Design/Computer Assisted Manufacturing systems led to the study of interaction techniques in interactive graphics.
- Work on operating systems developed techniques for interfacing input/output devices, for tuning system response time to human interaction times, for multiprocessing, and for supporting windowing environments and animation.

In the early 1970s the minicomputer and then the microcomputer came into widespread use and a rapid expansion in computing power and functionality led to concerns about 'usability'. HCI has since been developing and applying design and evaluation methods to ensure that technologies are easy to learn and easy to use. A large body of evidence on what is 'good' and 'bad' usability was produced and methods for the production and analysis of such evidence were developed at that time.

1.4 Why it changed

Partly what changed was that the type of computer user and their expectations were no longer homogeneous. Originally, the users of computers were also the builders, engineers and software specialists, but as the minicomputer and remote terminal access to time-sharing mainframes brought computer usage out of the laboratory, scientists became superseded by commercial and business users and data processing professionals. John Carroll's essay on 'Where HCI came from'[4] also identifies the fortuitous coming together of a number of disparate strands in the late 1970s and early 1980s:

[4] *Carroll, J.M. (2009)* Human Computer Interaction (HCI). *Retrieved from Interaction-Design.org: http://www.interaction-design.org/encyclopedia/human_computer_interaction_hci.html*

[5] *Carroll, J.M. (2009) op. cit.*

- The emergence of personal computing, both that of personal software applications (text editors, spreadsheets and interactive computer games), and the development of robust computer platforms (operating systems, programming languages and hardware) made anyone with access into a potential computer user. This also 'vividly highlighted the deficiencies of computers with respect to usability for those who wanted to use computers as tools.'[5]
- Human factors engineering techniques for analysis of human-system interactions in command and control systems became viable in the wider context of user interactions.
- Developments in the methodologies and technologies of software engineering: on the one hand towards non-functional requirements which could include usability and maintainability; and on the other rapid development of interactive systems for CAD/CAM graphics and information systems.
- The newly formed discipline of cognitive science (incorporating cognitive psychology, artificial intelligence, linguistics, cognitive anthropology, and the philosophy of mind) provided the tools, skills and researchers to study cognitive engineering aspects of interacting with new technology.

> *All these threads of development in computer science pointed to the same conclusion: The way forward for computing entailed understanding and better empowering users.*[6]

[6] *Carroll, J.M. (2009) op. cit.*

In terms of technologies and innovative uses for computers, a number of pioneers were already, in the 1960s, laying the foundations of what would be the design science of HCI. All of these, and much of the earlier graphics work and activity, is discussed and illustrated comprehensively in HCI textbooks.

- At the Stanford Research Institute, Douglas Engelbart led a group developing the concept of augmenting human intellect via advanced computer tools. SRI pioneered the mouse and effectively invented WYSIWYG word-processing, multi-window display, and electronic meeting rooms.
- Ivan Sutherland's 'Sketchpad' system stimulated the development of computer graphics techniques before the technology was sufficiently powerful to develop them in full.

- Ted Nelson's focus was upon the way in which the computer could facilitate a new structural concept (hypertext) which overcame purely linear presentation of text.

1.5 HCI in the 1970s and 1980s

The starting decade for HCI as a separate discipline was the 1970s when leading research centres in two continents were set up: HUSAT in Loughborough, UK and PARC in California, USA. The HUSAT group played a leading role in applying the concerns, methods, and knowledge traditional to the field of ergonomics to the study of computer design and use. The Xerox Corporation's Palo Alto Research Center (PARC) built on Engelbart's work at the nearby Stanford University, and research there into networked workstations using the Smalltalk programming language led to the design of the Xerox STAR workstation, from which 'look-and-feel' the Apple Lisa and Macintosh were derived. Alan Kay and Adele Goldberg specified in outline a personal, portable information manipulator. The 'Dynabook' was the precursor of our portables, netbooks, laptops and e-readers. Elsewhere, other work was presented at small international workshops and the first input to European (German DIN) standards (for visual display terminals and for keyboard and keypad layouts) were proposed and the seeds of usability sown. Growth in personal computer technology led to an explosion in applications – text- and word-processing, graphics manipulation, the first interactive games, spreadsheets and the direct manipulation interaction paradigm.

The 1980s saw an increase in HCI publications and the first major attempt to formulate a theoretical basis for HCI (Card, Moran and Newell, 1983). The Model Human Processor[7] described human performance when interacting with computers as a model which could be used, together with operational models (Goals, Operators, Methods, Selection rules and Keystroke Level), to analyse human-computer tasks and to predict total task performance times. The human is seen as an information processor, with inputs (visual), mental processing, and outputs (keyboard strokes and mouse actions), which themselves 'input' information or data to the computer.

[7] *Card, S.K., T.P. Moran and A. Newell* The psychology of human-computer interaction*. (Lawrence Erlbaum Associates, 1983) [ISBN 0898598591].*

In the 1980s and 1990s the expansion of the communication networks linking computers together – that had started with the US Advanced Research Projects Agency's network, ARPANET, and continued with the world wide web from CERN – created new applications (electronic mail and computer conferencing) and the exponential growth of the internet we know today. HCI research concerns shifted towards communication between people enabled by computers; that is, how users might interact with each other via a computer. Researchers from social sciences (notably from Anthropology and Sociology) increasingly became involved and initiated a paradigm shift in studying how computers and interactive technologies were interpreted and appropriated by groups of users. An initial focus on Computer Support Co-operative Work was swiftly expanded to include ways in which to investigate user activities and to determine user requirements. The study techniques of social sciences were assimilated into the HCI mainstream.

This shift in emphasis to a social and emotional relationship with technology, matched the concerns of many in determining how to allow users to interact efficiently and effectively with a computer and saw the emergence of 'Usability

Engineering'. This approach was stimulated by the realisation that design, as a set of related practices in its own right, could provide valuable input to HCI research and to product design and evaluation. There was a move away from psychological and experimentally-based research and design, towards a quantitative but practical engineering approach to product design (i.e. early goal setting, prototyping and iterative evaluation). Together with a more commercial ethos (developing usable and functional products to improve productivity, integration of usability and product design teams and cost-benefit assessments of design decisions), usability methods began to develop beyond long-held academic roots towards the concepts of engineering and testing products and interfaces for usability. Usability testing had been focused on experimentation and inspections of interfaces based on good practice guidelines, but in the early 1990s new methods such as Heuristic Evaluation, cognitive walkthrough and usability questionnaires became widespread. Comparisons between usability evaluation methods and tools specific to a Usability Engineering approach were developed and a usability industry was created.

1.6 The situation today

We now view HCI design as looking past the simple interaction between user and computer/technology (and beyond even computer-mediated interaction between people) to involve wider social, cultural and aesthetic attitudes. Thus, by the mid-1990s designers and 'design practice' became the attitude of choice in HCI, emphasising practice-based approaches at the expense of information-processing models of user behaviour. HCI now encompasses many philosophies, perspectives and types of expertise. Different aspects of human–computer interaction mean using and learning different techniques, depending on different goals. Interaction Designers, HCI researchers and usability specialists now must be familiar with design, engagement, the practice of technology design ethnography and theories of social action, as well as with the more prosaic human and usability engineering techniques which have been progressively developed since the inception of HCI as a discipline.

Summary

The scope of HCI has progressed from ergonomics/human factors to human cognition and psychology; from effects on workflow and communication to effects on culture and society. We now investigate the relationships between people that computers and computer networks enable, such as patterns of behaviour between people and within social groups, and study the digital artefacts which shape aspects of our everyday lives.

A reminder of your learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- understand the definitions of HCI and ID and associated terminology
- demonstrate knowledge of the historical development of the discipline
- define and describe common HCI terms
- describe how future developments in interaction, design and technology link to the history of the study of ID and HCI.

Exercises

1. 'User interface design is all common sense!' Discuss.
2. Define the terms 'User Interface', 'Human Computer Interaction', 'Interaction Design' and 'User Experience'. Differentiate between them.
3. Investigate disasters or accidents that hinged on an HCI failure. What went wrong, and why?
4. Draw up a table showing the development of input devices over the last 30 years. What has been the major change? What might come next?
5. Informally assess the growth of mobile phone technology and applications in your home community. Who uses them, why, and to what purpose? How did those activities take place before the advent of mobile phones?

Sample examination question

What can the study of the historical roots of HCI bring to current design practices?

Further reading

For original articles and source material on the history of HCI

Baecker, R. and B. Buxton (eds) *Readings in human-computer interaction*. (Morgan Kaufmann, 1987).

Baecker, R., et al. (eds) *Readings in human-computer interaction*. (1995).

For general discussion on HCI and ID topics

Harper, R., et al. *Being human*. (2008) Appendix.

Lazar, J., et al. *Research methods in human computer interaction*. (2009) Chapter 1.

For basic concepts in user psychology and cognitive aspects of user interaction

Norman, K. *Cyberpsychology. Part ii: systems*. (2008).

Sutcliffe, A. *Multimedia and virtual reality*. (2003) Chapter 2.

Coverage of individual differences in psychology

Norman, K. *Cyberpsychology*. (2008) Chapter 9.

Oral history interviews from the Charles Babbage Institute, University of Minnesota

J.C.R. Licklider: www.cbi.umn.edu/oh/pdf.phtml?id=180

Allen Newell: www.cbi.umn.edu/oh/pdf.phtml?id=208

Ivan Sutherland: www.cbi.umn.edu/oh/display.phtml?id=100

Notes

To err is human; to forgive, design

Andrew Dillon

concept **design** development evaluation experience hci ideas interaction interface metaphors model process product prototypes requirements system techniques usability user work

Chapter 2
Interaction and design approaches

Introduction » What is design? » Some principles of design » Problem space and design space » Design methodologies and approaches » The design activity » Idea generation » Summary

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- demonstrate a realistic appreciation of ID processes and activities
- discuss the variety of approaches to ID and the range of design techniques and methodologies
- describe how and when such methods are used in a design activity
- describe what a metaphor is, and identify its importance
- demonstrate practice in drawing, sketching and designing paper prototypes.

Essential reading

Note: Further reading and websites are listed at the end of the chapter.

HCI textbooks

Shneiderman, B., et al. *Designing the user interface*. (2009) Chapter 3.

Sharp, H., Y. Rogers and J. Preece *Interaction design*. (2007) Chapters 1 and 2.

Dix, A., et al. *Human-computer interaction*. (2003) Chapters 6 and 7.

Idea Generation

Buxton, B. *Sketching user experiences*. (2007).

Greenberg, S. et al. *Sketching user experiences: the workbook*. (2010)

Introduction

Design work in HCI and ID stems from a pre-existing design tradition and employs techniques used for many years in design disciplines which were not originally computer-based, such as architecture, urban design and planning, visual design, printing and graphics. The use of prototypes, storyboards, sketching, personas and even the words used to describe what Interaction Designers do (such as 'understanding the problem space' or 'generating ideas') derive from Design Studies, or from craft-based technical activities. More so than the wider discipline of HCI, the field of ID gives priority to designers and allocates them an essential role on every software and interface development team. It is about 'design' as an activity – providing designers with tools to operate effectively without compromising the overriding goals of making products which are usable, useful, and desirable. Interaction Designers – who can also be known as Usability Engineers, Visual Interface Designers, User Experience Engineers, or Information Architects – try to understand and shape human behaviour to achieve this goal, but the value of design, although now recognised as being an essential component of product development, is still often misunderstood. One way of looking at the nature of ID work is that it is a means of managing the complexity of interaction in an engineering-centric world; a way of connecting and thinking about people and their activities, emotions and experiences. It is about computing but also about language, communication and technology and the aesthetics of human interaction. For many in the ID world, it is the need to not lose sight of the elements of craft, execution, and appropriateness when working towards creating the 'great user experience'.

2.1 What is design?

All design is driven by requirements, the focus being on the core need – not on how it is to be implemented – since there may be multiple ways of achieving a goal. In order to design or build any type of system, two basic requirements exist: the designer must understand the fundamental and underlying requirements of the product, and then must 'develop' that product to fit those requirements as best as is possible. Such development includes creating or producing a range of representations (or 'models') of the system; some theoretical or conceptual ('mental models'), some illustrative such as storyboards or scenarios, and some physical, such as artefacts or prototypes. Effective representations should be accurate enough to reflect relevant features of the final system, but also simple and clear enough to avoid confusion. Such representations fulfil a variety of purposes, including:

- exploring the problem space
- communicating, illustrating and expressing ideas to others
- making predictions of user performance, effort and outcomes.

A design is a simplified representation of the desired outcome so one approach to developing effective representations is to ask a set of questions:

- What do you want to create?
- What are your assumptions?
- What are your claims for what it will do?
- Will it achieve what you hope it will? If so, how?

In thinking about and determining the answers to such questions, it is useful to have an overall strategy or plan to follow. In design disciplines this tends to follow a well-recognised sequence.

Look at similar artefacts » Analyse users' needs and abilities » Sketch different designs, make prototypes » Show to users and test » Build as a physical artefact

For simple design exercises and for small systems, this procedure is a tried and tested one and works well. However, with more complex systems and large-scale interactive applications, such a craft-based approach becomes time-consuming, unwieldy and expensive. A more systematic approach is required. Design of interactive systems then comprises the following activities or processes, the design of the final system being determined by the nature and content of the requirements definition. The overall process is, of course, similar to any software engineering or system development process and, later in this chapter, the relationship between SE principles and ID strategies will be explored.

An initial feasibility study » Followed by a requirements definition » The design is implemented » The implementation is tested » After the system has been in use for some time it is updated and maintained

In many situations, a feasibility study will not be relevant and will not be carried out, and for much of the design of interactive applications, maintenance is not a standard activity. This Study Guide concentrates on the intervening activities of 'Conceptual Design' followed by what could be termed 'Illustrative Design' before the final 'Physical Design' is produced.

Conceptual Design is essentially and simply about taking some requirements and turning them into a description of a future artefact (a system, device, application or interface) in terms of a set of integrated ideas and outline concepts about:

- what that artefact should do
- how that functionality can be achieved
- how the built artefact will behave or look – in a manner that will be comprehensible to its expected users.

This type of approach to requirements definition (which, in design communities, is not usually described in these terms) can be based on a set of design principles derived from an amalgamation of theory-based knowledge, experience and common-sense practice which can identify such specifics as:

- generalisable abstractions for thinking about different aspects of design
- the do's and don'ts of ID
- what to provide and what not to provide at the interface.

It can be shown simply as in Figure 2.1. By focusing on users and their needs, as stressed in the previous chapter, and specifying the usability and user experience goals that a design solution will achieve, four basic steps emerge within an iterative overall process of design refinement (i.e. repeatedly evaluating and correcting designs).

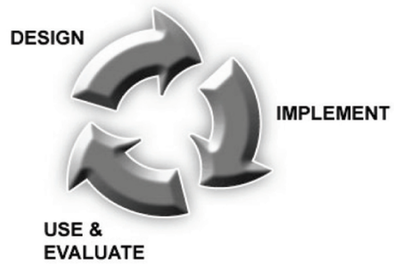

Figure 2.1 User-Centred Design (courtesy of Penn State University)[1]

These four steps encompass many activities. Establishing requirements is about carrying out investigations to fill in any gaps in knowledge about the intended users, user characteristics, and the use of the product or the task. After settling on draft specifications (possibly with performance and cost estimates) an analysis of the practicality of alternative activities or design solutions can be carried out. This extensive conceptual design stage leads to the next stage of building and testing of prototypes as Illustrative Designs which can be tested or tried out and then modified and revised as necessary. Then testing – or evaluation – can be carried out on a succession of designs and repeated until a satisfactory result is achieved. At that point, the final design, or solution which equates to the Physical Design, can be constructed as an implemented artefact.

[1] © Penn State University. Human Factors and HCI; http://www.personal.psu.edu/cwc5/blogs/coursedesign/media/110_s1406_g01.jpg

Determine user needs and establish requirements » Develop alternate designs that meet the requirements » Prototype, and evaluate with the different designs » Create and build a solution

In the remainder of this Study Guide specific chapters deal with each aspect of this activity. If the prime focus for HCI/ID design is to identify the user's needs and ensure that the designed functionality of the final built artefact matches that need, then Interaction Designers must develop a User-Centred Design mindset to think of the world in the user's terms and of what the benefits to users will be, rather than being technology-centred or feature driven. There are, of course, practical considerations to be taken into account in real-world design and many factors which affect design practices relate to issues such as cost, project size, development time and the design methodology to be used. However, the HCI stance, whilst acknowledging such needs, breaks down the design approach to two basic views and sub-activities embedded in a cyclical design process, as in Figure 2.2.

Understanding users and their tasks

- Task-centred system design process:
  - developing task examples
  - task scenarios and walkthroughs

Designing with the user

- User-Centred Design and prototyping:
  - User-Centred system design
  - low fidelity prototyping methods

- Evaluating interfaces with users:
  - observing people using systems via various methods
  - detecting inappropriate design and correcting by iterative design.

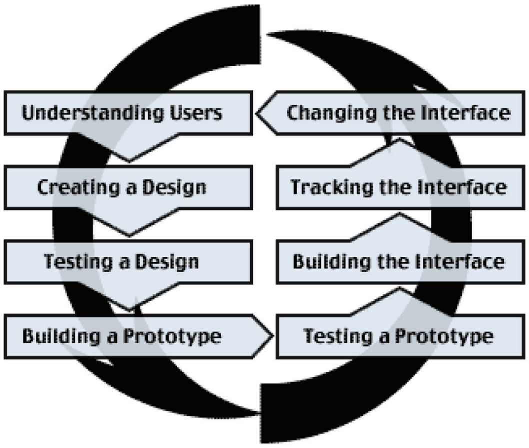

Figure 2.2 HCI Design Process (courtesy of Penn State University)[2]

[2] © Penn State University. Human Factors and HCI; http://www.personal.psu.edu/cwc5/blogs/coursedesign/media/110_s1407_g01.gif

In this chapter, User-Centred Design and prototyping concepts are highlighted and explained. In Chapter 3, the emphasis is on understanding users and their tasks. That chapter describes some techniques for ID requirements, essentially user requirements elicitation in a task-centred system design process. User Narratives (scenarios and personas) and Scenario-Based Usability Engineering are discussed in detail and prototypes in a more general fashion. Chapter 5 is concerned with the specific techniques for evaluating interfaces or designs with users in terms of usability and how well a design or implemented system meets its requirements. Usability itself is discussed in detail in Chapter 4.

Before going into more detail on UCD and prototyping, it is useful to take a step back and to look more closely at the process of design itself, namely, what is happening during that initial creative process and how to understand and describe it. The rest of the chapter will explain, first of all, some design principles which contribute to what can be called the ‘problem space’ or ‘design space’ and what some solutions may be. The various design methodologies commonly employed in HCI and ID will be introduced, before concentrating on the practicalities of the design activity itself and the range of techniques available for creating mock-ups, prototypes, storyboards (and similar) for testable Illustrative Design solutions.

2.2 Some principles of design

There are many designers and a multitude of approaches – extensively written-up – to ID and the creation of interactive computer applications. Many, however, are concerned solely with website design and web interactivity or with an area which has emerged called User Experience Design. Fewer concentrate on the wider issues of design for interaction as such, but useful information is given and many graphic design ‘tricks of the trade’ and generic guidelines can be found. There are too many books, guides, websites and blogs to discuss in detail in this Study Guide and it is impossible to advocate one over another: see the selected Further reading

[3] *See also, http://www.rosenfeldmedia.com/zeitgeist/book/index*

for this chapter and the web resources given in the Preface for listings.[3] It is strongly recommended that students study at least one of the suggested additional readings and access some design-oriented websites to gain a rounded view of this area.

[4] *http://www.jnd.org/index.html*

In terms of an overall design approach, we will concentrate on a design basis put forward by Donald Norman, an early HCI advocate, guru and proselytiser. The focus is on a core set of principles, as discussed in his series of books on the design of everyday and computer artefacts and on his discursive website.[4] Numerous amendments have been made to such principles over the years but these basic elements will help to clarify later expansions. The concept of 'affordance' is an especially important one to grasp.

Consistency

'Consistency' is one of the most widely known user interface design principles. Simply put, it means that mechanisms should be used in the same way wherever they occur. Consistency is expressed as:

- Internal consistency of a design with itself.
  - For example, the use of consistent command names, selection of menu options, size and style of icons, number of mouse clicks to select items, etc.
- External consistency with other interface designs and other systems.
  - This allows users to switch between systems and applications without undue effort.
- External correspondence of a design to features in the world beyond the computer domain.
  - Examples include the desktop metaphor and the arrangement of arrows on cursor control keys to match the arrangement of compass point arrows on a map.

Trade-offs have to be made between internal and external consistency but what is more important is the context of use (i.e. users' tasks and the way they are best carried out). This may mean that aspects of interfaces are actually internally inconsistent but consistent with the way users perform their tasks.

Feedback

[5] *Norman, D. (2002).* The Design of Everyday Things. *(Basic Books).*

'Feedback' can be defined as '...sending back to the user information about what action has actually been done {and} what result has been accomplished'.[5] Another way of describing it is in terms of its absence, for example, using a cash machine without a screen would be virtually impossible as there would be no feedback as to which request had been accepted or if any mistakes had been made. Feedback is an integral part of the interface. A key aspect of designing metaphors for both everyday applications and novel interfaces is to provide appropriate visual, auditory and tactile feedback. Examples of good immediate feedback at the interface include simple ones like those listed below:

- displaying the details of the date and time when a file was updated
- the percentage bar showing the rate and progress of a process that is being performed

- 'Busy' icons showing that the system is processing and temporarily unable to respond to other commands
- an effective sound tone which acts as a warning and attracts a user's attention
- the clicks of simulated key presses on touch screens.

More examples can be found in all of the recommended HCI textbooks and in Norman's writings and website. A pertinent and timely discussion of the new ways in which users can interact with the latest mobile phones and the Apple iPad highlights just these issues and why they are so important.[6]

[6] *Norman, D. and J. Nielsen (2010), 'Gestural Interfaces: a step backwards in usability'; http://www.jnd.org/dn.mss/gestural_interfaces_a_step_backwards_in_usability_6.html*

Mappings

'Mappings' refer to the spatial and conceptual relations between different parts of a system or between controls and their outcomes. Mappings are 'good' if they appear natural and intuitive to users. Poor mappings are when the relations are inconsistent or incompatible – Norman uses the example of light switches, lift controls, door handles and car indicators and their relative directionality to illustrate this point.

Affordances

For controls to be easy to use, mappings should be obvious and demonstrate a good 'affordance'. The term originally referred in psychology to actionable properties between the world and an actor – as a perceived relationship between them. Norman first linked the concept to design stressing that what he identified was actually 'perceived affordance'.

> *'I introduced the term affordance to design … the concept has caught on, but not always with true understanding. Part of the blame lies with me: I should have used the term "perceived affordance," for in design, we care much more about what the user perceives than what is actually true. What the designer cares about is whether the user perceives that some action is possible (or in the case of perceived non-affordances, not possible). In product design, where one deals with real, physical objects, there can be both real and perceived affordances, and the two need not be the same. In graphical, screen-based interfaces, all that the designer has available is control over perceived affordances. The computer system, with its keyboard, display screen, pointing device (e.g. mouse) and selection buttons (e.g. mouse buttons) affords pointing, touching, looking, and clicking on every pixel of the display screen. Most of this affordance is of no value. Thus, if the display does not have a touch-sensitive screen, the screen still affords touching, but it has no result on the computer system. … All screens afford touching: only some detect the touch and are capable of responding. But the affordance of touchability is the same in all cases. Touch sensitive screens often make their affordance visibly perceivable by displaying a cursor under the pointing spot. The cursor is not an affordance; it is visual feedback. In similar vein, because I can click anytime I want, it is wrong to argue whether a graphical object on the screen "affords clicking." It does. The real question is about the perceived affordance: Does the user perceive that clicking on that location is a meaningful, useful action to perform?'*[7]

[7] *Norman, D. http://www.jnd.org/dn.mss/affordances_and.html*

For example, does the handle on a door indicate if it should be pushed or pulled, or does a slider or scroll bar intuitively indicate its direction of movement? If not, does it require extra perceptual cues (such as the addition of direction arrows) or instructions to make its use transparent? The definition which has come to be used is: 'the behaviour of an object is that which is permitted and perceptually obvious'. The term refers to the properties of objects – what sorts of operations and manipulations can be done to that object. What is important is the 'perceived affordance' (the functionality that is suggested by an object's placement, or its look, or its associations, or the feedback it provides).

Constraints

When designing an interface it is important to think about how the information to be displayed or presented is constrained so that it exhibits good affordance and can be used easily and simply. Constraints limit the number of possibilities of what can be done with an object. Norman originally suggested four main types:

Physical, Semantic, Cultural and Logical.

- Physical Constraints restrict the possible operations of an object:
  - A key can only fit a lock in a certain way.
  - The scroll bar in graphical interfaces is physically constrained by the shaft that restricts movement of the scroll box to one of two alternatives; up or down (vertical bars) or left or right (horizontal bars).
- Semantic Constraints depend on the semantics (the 'meaningfulness') of the situations which users know about. They depend upon a user's knowledge of the world and on how the computer system is being used.
  - The icon of a wastebasket is semantically constrained because it is represented upright on the desk top. It could be represented on its side but this would contravene our knowledge of how waste baskets are used.
- Cultural Constraints consist of information and rules that help us to know what to do in social settings. Many icons have been designed to capitalise on cultural conventions.
  - Pictorial signs on toilet doors signal that one set is meant for women and the other for men.
  - The Apple Macintosh had a warning icon that consists of a bold outlined icon with an exclamation mark.
- Logical Constraints work through constraining the order, position or location of objects.
  - The order in which items are displayed in menus is logically constrained by appearing as lists of horizontal items. It would seem illogical if the items were randomly displayed across the screen in any direction.

2.3 Problem space and design space

An important issue in design is to identify and analyse what is called the 'problem space' and to move from that to the 'design space'. In a similar fashion to that of 'identifying the design artefact' and creating representations of it, questions can be asked of a UX design:

- Are there problems with an existing product or user experience?
- Why do you think there are problems?
- How do you think your proposed design ideas might overcome these?
- When designing for a new user experience, how will the proposed design extend or change current ways of doing things?

Having a good understanding of the problem space, that is specifying what is being done, why, and how it will support users in the way intended, can help inform the design space. Before deciding upon what kind of interface, behaviour and functionality to provide, it is important to develop a conceptual model and to think about how the system will appear to users. A conceptual model is not a description of the user interface but is a high-level description of a product showing what users can do with it and the concepts they need to understand how to interact with it. A conceptual model is the 'mental model' users have of the 'system' and how it works. It is built up from actual interaction with the system through what is termed the 'system image' (i.e. the interface and many other aspects such as physical properties, documentation, icons and instructions). The designer's mental model is how user interaction with a system is envisaged. Actual realisation of this concept is what is produced as the 'system image' – an interpretation of an idealised interface. This concept is discussed widely in HCI textbooks and is often illustrated as in Figure 2.3.

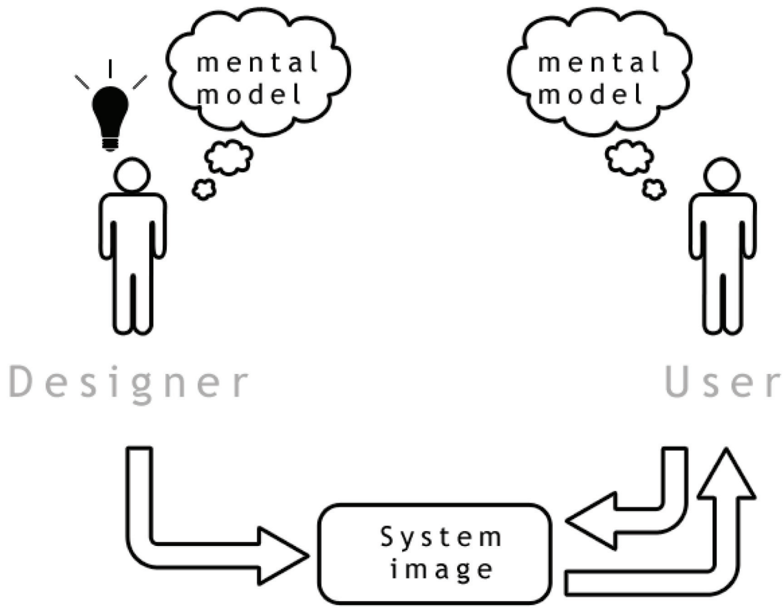

Figure 2.3 Conceptual Models (after Norman)[8]

[8] *© interactiondesign blog.com, 2008–09. How designers communicate with users; http://www.interactiondesignblog.com/2008/06/how-designers-communicate-with-users/*

Decisions about the conceptual design must be made before commencing any Physical Design and, if based on the approach outlined above, will be effective:

> *The most important design tool is that of coherence and understandability which comes through an explicit, perceivable conceptual model. Affordances specify the range of possible activities, but affordances are of little use if they are not visible to the users. Hence, the art of the designer is to ensure that the desired, relevant actions are readily perceivable.*[9]

[9] *Norman, D. http://jnd.org/dn.mss/affordance_conventions_and_design_part_2.html*

2.3.1 Metaphors

'Interface metaphors' and analogies are commonly used as part of a conceptual model to convey to users how to understand what a product is for and how to use it for an activity. They are concepts that users are exposed to through the product, the relationships between the concepts and the mappings between the concepts and the user experience that the product is designed to support.

Based on Norman's constraints, an interface metaphor is designed to be similar to a physical entity but to also have its own properties. Metaphors exploit a user's familiar knowledge, helping them to understand 'unfamiliar' functionality since people find it easier to learn and talk about what they are doing at the computer interface in terms familiar to them. The general benefits are that metaphors:

- help users understand the underlying conceptual model
- make learning new systems easier
- are accessible to a greater diversity and number of users.

Metaphors can be powerful design tools, able to generate new associations from existing knowledge but the ability to communicate complex ideas can also have the effect of constraining thought and the user's own discernment. Sometimes connections that may make sense in the source concept do not match up to the target concept. The use of metaphors in HCI and ID has been extremely successful in some cases – the desktop metaphor is now endemic – and a distinct failure in others – the Microsoft Office paperclip ('Clippy') is now universally derided. A number of texts listed as Further reading give guidance on how and when to use interaction metaphors and how to design with metaphors.

Problems with interface or interaction metaphors counter some of Norman's guidance in that they can:

- constrain designers in the way in which they conceptualise a problem space
- limit designers' imagination in coming up with new conceptual models
- conflict with other design principles
- break conventional and cultural rules
- force users to only understand the system in terms of the metaphor.

Metaphors can go wrong in so many ways – or can simply become mixed and confused – so it is crucial that the choice of metaphor should start with the expectations, needs, desires and actions of those involved. One author of a current Ubiquitous Computing and UX design book[10] highlights a

[10] *Kuniavsky, M. (2010).* Smart Things: Ubiquitous Computing User Experience Design.

way of thinking about metaphors as a design tool by asking the following practical questions:

- What is the comparison that this metaphor is making? What class does it say that the design and the metaphor belong to?
- What is the list of tools and activities associated with the source concept? How would those map to the experience being designed?
- What are the visual images the source concept evokes? What are the interaction patterns that it implies? Are there necessarily positive outcomes to those patterns? Negative ones?
- What is the purpose of using the metaphor? What exactly do you need it to accomplish? What associations is it supposed to evoke and what actions will the metaphorical associations make easier?
- What are the boundaries of the metaphor? At what point do the differences between domains become so great that the metaphor hurts more than it helps?

2.4 Design methodologies and approaches

As discussed in the previous chapter, we saw that HCI was derived from software sciences combined with cognitive sciences. The first design methodologies generated were based upon classic software engineering models – partly because of the type of computers in use and partly because the early interfaces were to CAD and graphics applications and to control systems which required an understanding of how data was input and the type of input devices used. As software became more of a design science and issues of practical management and efficiency became more prevalent, newer design methodologies were developed, supported for the most part by large corporations who were in the business of developing and selling first mini-, and then microcomputers. Mass production and popularisation of personal computers and a change in the styles of computer companies from large mainframe retailers to small start-ups (such as Microsoft and Apple once were) meant that hardware development inexorably led to newer forms of programming languages, different types of operating system and newer applications (such as spreadsheets and drawing packages like MacPaint) with a wealth of new input devices and interface display options. This heralded a gradual change in the focus of software engineering, away from programme efficiency, code optimisation and even ‘elegance’ to the user, usability and, ultimately, the user experience. At that stage, creative designers began to get interested in something more tangible and to use the devices themselves.

HCI in the 1980s essentially grew out of graphics research and applications whilst Usability Engineering was more of an outgrowth from the impacts of increased user input, from developments in requirements capture methodologies and from standardisation and the use of usability metrics. Pre-existing standard methodologies and frameworks were subjected to user-centred modifications to enable newly-created ‘discount’ usability evaluation methods to be used for obtaining structured feedback from users about aspects such as usability and accessibility. This required that a cycle of prototype building and testing be done iteratively. With each iteration, prototypes move from low-fidelity sketches or simulations to more functional versions of a final design. The rationale is that the transition from formative evaluation of design concepts to summative evaluation of a final artefact minimises the emergence of unexpected usability problems or unforeseen user responses.

Figure 2.4 illustrates the iterative development cycle.

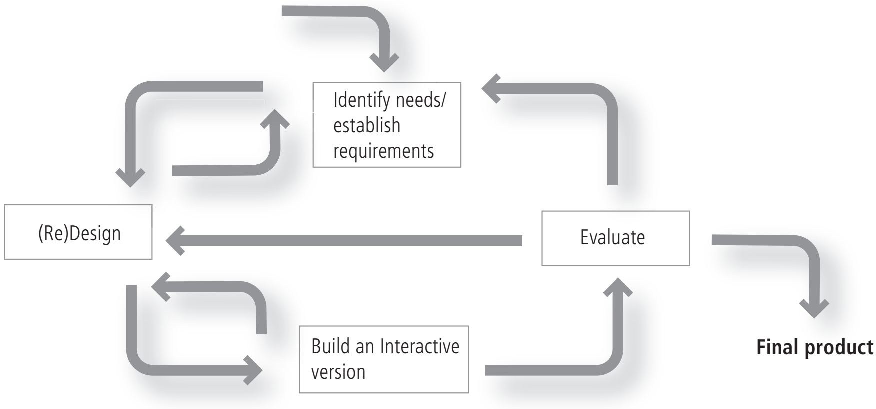

Figure 2.4 Iterative Design Model

A paradigm change occurred with the move towards concepts of experience-centred design. The inclusion of techniques such as ethnography – from sociological and anthropological disciplines – and technological developments led to a more co-operative design focus. ID and UX design came to the fore as the conceptual and methodological contributions of the 1990s addressed the challenge of understanding the user and the context of use. It became evident that there was a need to study work in detail and 'in situ', determining what people actually 'do' in their work practices before making design interventions. Such approaches were part of a widespread movement to assist and encourage researchers 'in the field' to communicate their findings to systems designers and software developers, and to help those designers and developers to represent users and the use context during the design process so that user-centred decisions could be made. These representations include personas and Scenario-Based Design and are discussed in the next chapter. To further incorporate users into the design activity and to foster greater participation meant input from other design disciplines and so Participatory Design – from Scandinavian work practices – became a greater feature in ID.

2.4.1 Expansions of software engineering models

ID can make use of a number of different software life-cycle models, the simplest being that described in general terms in Section 2.1, but with the addition of an iterative cycle to the process.

ITERATE: Needs identification » Design »

Build alternative prototypes » Evaluate

The Waterfall and the Rapid Applications Development models, derived from 1970s software engineering, enforced linear progression from requirements to testing with documented completion criteria at each stage. Although there is the possibility of some user involvement at the requirements stage, the design is forced into smaller project 'boxes' and cannot be easily iterated, as shown in the step process below.

Requirements » Design » Detailed Design » Code »
Integration » Implementation » Test

A need for design approaches which could cope with iteration and complexity was thus recognised and 1980s HCI developers started to build upon pre-existing SE developments. The Spiral and the Star Models were accepted as suitable approaches for UCD with its emphasis on determining users' needs, understanding the user and task context and designing products from that basis rather than from developers' preconceptions or rigid procurement briefs. Both are extensively described in the recommended textbooks.

Spiral Model
One model, developed by Hartson and Boehm-Davis[11] and shown in Figure 2.5, is in that spiral shape to reduce the risks of early design commitment. It is derived from an earlier model[12] in classic waterfall software development lifecycle methods and describes an iterative, incremental approach to dealing with change and managing risk. It is a sequential but iterative approach since incremental development allows developers to define and implement features in order of decreasing priority. An initial version of the system is developed, and then repetitively modified based on input received from external (customer or user) evaluations. The development of each version of the system is carefully designed using the steps involved in the Waterfall Model. With each iteration around the spiral (beginning at the centre and working outwards), progressively more complete versions of the system are built. Thus the model relies heavily on prototyping in that it explicitly encourages alternatives to be considered.

[11] *Hartson, H.R. and D. Boehm-Davis 'User interface development processes and methodologies',* Behaviour & Information Technology*, Volume 12, Issue 2, March 1993, pp.98–114.*

[12] *Boehm, B. 'A Spiral Model of Software Development and Enhancement'* IEEE Computer*, 12(5), May, 1988, pp.61–72.*

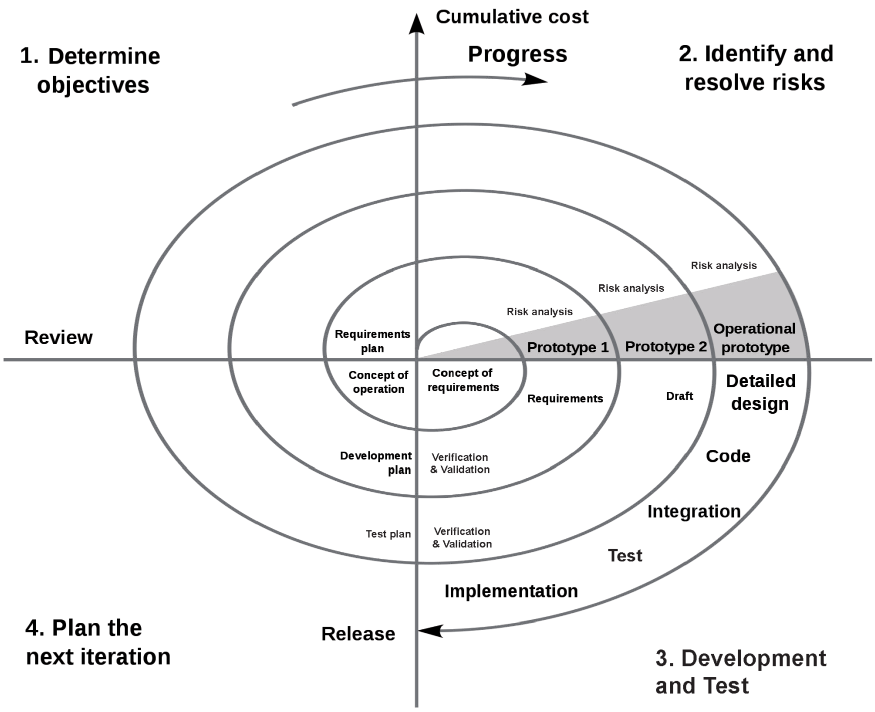

Figure 2.5 Spiral Model [13]

[13] *Source: http://commons.wikimedia.org/wiki/Category: Spiral_model_of_Boehm/ Reproduced under a Creative Commons Licence.*

Star Model
Another model, more useful to HCI design practices, is one that constantly returns to evaluation as its core process: the Star Model from Rex Hartson

and Debbie Hix, shown in Figure 2.6. It was derived from empirical studies of how interface designers actually worked. The fundamental concept is that the design of interactive systems typically does not follow a specific order of steps but can start at any stage, always followed by an evaluation activity. Evaluation is the central phase in the development cycle. Development can start from any point in the 'star' and any stage can be followed by any other stage, but evaluation is always carried out before moving to a new stage. The requirements, design and product gradually evolve, becoming increasingly well-defined. This cyclic design emphasises rapid prototyping embedded with alternating waves of analytic (top-down) and synthetic (bottom-up) design steps. The Star Model can give the user a significant role throughout the project since evaluation is so central to the cycle and, since evaluation can be based on any representation of the system, this model too relies heavily on prototyping.

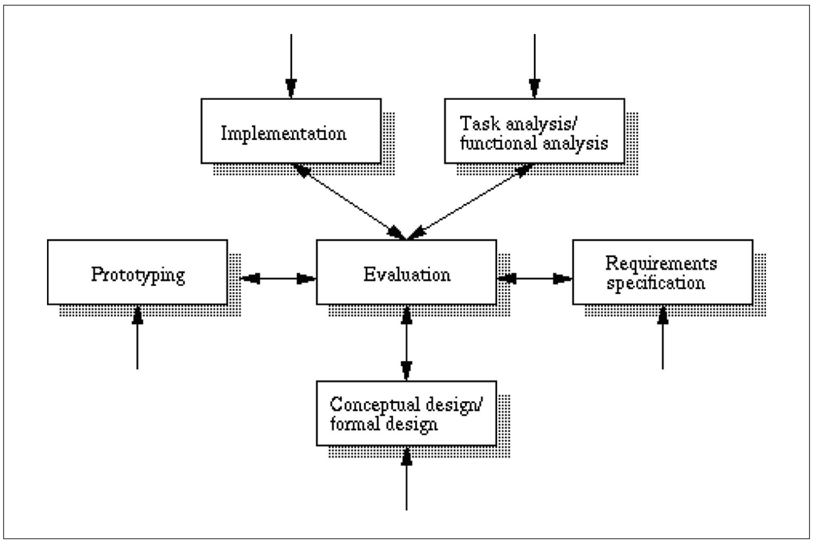

Figure 2.6 Star Model[14]

[14] *Hix, D. and H.R. Hartson.* Developing user interfaces: Ensuring usability through product and process. *(John Wiley and Sons, 1993).*

These two models provide very specific ways of managing the design process and are intended to maximise User-Centred Design strategies. More complex software engineering methodologies are constantly being developed and refined but this Study Guide does not cover any other SE-derived approaches or techniques. Interested students can find further detail in the recommended textbooks and in the Further reading list.

2.4.2 User-Centred Design

User-Centred Design or User-Centred System Design developed from the belief that, in order to design truly usable systems, designers and developers needed to have a much clearer understanding of what the users of a proposed system or application actually wanted from it. Together with considering seriously whether those users would be able to understand and easily use the proposed design, and a better appreciation of how work tasks were currently carried out, this approach grounds the design process in information about the people who will use the product. A research impetus to make digital technologies accessible to, and usable by, ordinary people created a design focus on users throughout the planning, design and development of a product. UCD came to prominence through the design and development of the Olympic Messaging System[15] used at the 1984 Olympics in Los Angeles.

[15] *Gould, J.* et al. *'The 1984 Olympic Message System: a test of behavioural principles of system design'* Communications of the ACM *Vol. 30 (9), September 1987); www.research.ibm.com/compsci/spotlight/hci/p758-gould.pdf*

It identifies the needs of users and those impacted by the introduction of new systems or applications at an early stage and involves a task and a requirements analysis. It is an inherently iterative process emphasising early testing and evaluation with real users. UCD focuses specifically on making products usable by involving users to obtain feedback through the use of prototypes. As with other approaches, designs are modified in light of the user feedback, and the process aims to foster better communication. It has become the classic HCI approach to interactive design, concerned with the specification, delivery and evaluation of systems as a whole. It is the basis for Usability Engineering and for usability and HCI standards (as discussed in Chapter 4). The way in which user requirements can be elicited, and how user needs can be determined, is covered in the next chapter and evaluation processes are detailed in Chapter 5.

Allowing users to become involved in the design process means that designers must:

- Focus early in the design process on users and their tasks.
- Identify appropriate interface functionality to increase user satisfaction.
- Decide how best to utilise design decisions to produce systems which are acceptable to users.
- Establish usability criteria and responsibilities before irrevocable hardware and software decisions are made.
- Measure, record and analyse users' reactions and performance to scenarios, simulations and prototypes.
- Design iteratively – when problems are found, fix them and carry on testing.

Including users in the whole design process, either as co-designer or through evaluation of prototypes can be difficult to achieve. Coordinating high levels of real user involvement involves many practical problems in terms of time, money, scheduling, and, critically, consistency of user input throughout the project. One solution is to use techniques which bridge designer and user cultures. One such is Participatory (or Participative or Collaborative) Design.

2.4.3 Participatory Design

The Scandinavian tradition of social democracy enables the democratisation of computerisation by involving workers and trade unions directly in the design process. It is based on an action research model in which researchers and workers collaborated to produce improved conditions for the workers/users through active and continued consultation and collaboration between designers/developers, managers and workers. This type of approach emphasised workers' own experiences and required that researchers get involved with and develop a commitment to them in order to understand and change their work experience and conditions. The Participatory Design technique enables effective communication between two populations (workers/users and designers) about proposed designs which impact on users' working lives. Social and organisational aspects are emphasised but the process is based on studying designs, model-building and analysing new and potential future systems. Domain experts are part of the design and development team throughout the process. User involvement is built into an overall team process, the team being made up of a range of participants representing the whole user community assisted by a facilitator. The practice of integrating usability into the Participatory Design process has been evident since the early 1980s and one approach to usability testing is to have users engage in co-operative evaluation of prototypes. Successful projects, where information about users was integrated well into the design showed dramatic improvements in the resulting design, with increased user satisfaction and better business results. The benefits of such user/worker involvement can be seen by reference to the high costs of bad design:

- heightened visibility through electronic monitoring
- displacement
- intensification
- reduction or redefinition of skill
- loss of work autonomy and control.

The creation of shared representations in a process of 'co-design' is by using simple tools (such as scenarios or envisionments based on paper or video mock-ups) to explore innovative solutions. The use of personas, user profiles and scenarios derived from a contextual inquiry (essentially, abstract representations of users to guide design, which is discussed in detail in Chapter 3) and newer co-operative design techniques has been growing in recent times.[16] Focus groups, focus troupes and the use of video prototypes means that users are presented with a theatre play or a video of a scenario and discuss it in detail after the performance. Extensions to this approach are to let users develop video scenarios by themselves: such generative tools[17] incorporated into participatory development of scenarios and prototypes help engage participants and enhance the shared context.

[16] *Grudin, J. and J. Pruitt 'Personas, Participatory Design and Product Development: An Infrastructure for Engagement',* Proceedings of Participatory Design Conference *Malmo, Sweden. (ACM Press, 2002).*

[17] *Ylirisku, S., K. Vaajakallio and J. Burr (2007) 'Framing innovation in co-design sessions with everyday people'; http://www.nordes.org/data/uploads/papers/104.pdf*

Attributes of Participatory Design

- The goal of the activity is to improve the work life of users.
- The activity is collaborative, with all goals and decisions actively negotiated and not imposed.
- The activity is iterative – ideas are tested and adjusted by seeing how they play out in practice.

It can be a controversial activity, with both benefits and drawbacks. More user involvement brings:

- More accurate information about tasks
- More opportunity for users to influence design decisions
- A sense of participation that builds users' investment in successful implementation
- Potential for increased user acceptance of the final system.

On the other hand, extensive user involvement may:

- Build opposition to implementation
- Lengthen the implementation period
- Be more costly
- Show that organisational politics and preferences of certain individuals are more important than technical issues
- Build antagonism with people not involved or whose suggestions are rejected

- Force designers to compromise their design to satisfy incompetent participants
- Exacerbate personality conflicts between design-team members and users.

2.4.4 User Experience Design

Experience-based design (see Figure 2.7) involves both the observation of, and involvement in, users' everyday working life (these techniques are described in Chapter 3) in order to be able to represent what users' activity and response to the systems they use actually is. Designing in an experience-centred way means that '*the view of the human in HCI becomes richer and more open once this point of view is adopted, and it thus offers greater surplus and a richer potential with which to work as designers.*'[18] As these authors identify, key landmarks are in:

- *Valuing the whole person behind 'the user'.*
- *Focusing on how people make sense of their experiences.*
- *Seeing the designer and user as co-producers of experience.*
- *Seeing the person as part of a network of social (self-other) relationships through which experience is co-constructed.*
- *Seeing the person as a concerned agent, imagining possibilities, making creative choices, and acting.*

A number of influential authors[19] have described, with reference to how designers actually create designs, how interface development can be seen as an issue in design, claiming that multidisciplinary teams deal best with designing interfaces to systems with a high level of information content or complex web sites, games, and data visualisations. This work created the idea of ID as bridging the boundary between software interface design and media design. Others, more recently,[20] have argued that:

> '*Designing for usability, which had been the primary objective of HCI research and practice, was only one of the many values that User-Centred Design could focus on. Designing for fun, enchantment, adventure, and excitement were equally valid self-centred goals that were resonant with the shift of emphasis from designing office- and work-oriented products to designing for home-based, leisure, and entertainment products.*'

Norman, in his book[21] – with the slogan 'beautiful things work better' – opened up an interdisciplinary debate around beauty and pleasure as a design value. Investigating and explaining the relationship between aesthetics and usability has spread throughout the design research community and feeds directly into the way in which the design of future products (as described in Chapter 9) can be carried out. As one of the major proponents[22] has written:

> '*It takes an experiential approach, putting experience before functionality and leaving behind oversimplified calls for ease, efficiency, and automation or shallow beautification. Instead, it explores what really matters to humans and what it needs to make technology more meaningful.*'

[18] *Wright, P. and J. McCarthy* Experience-centred design: designers, users, and communities in dialogue. *(Morgan and Claypool, 2009) [ISBN 9781608450442].*

[19] *Winograd, T. et al.* Bringing design to software. *(Addison-Wesley, 1996) [ISBN 9780201854916].*

[20] *Blythe, M. et al.* Funology: from usability to enjoyment. *(Springer, 2003) [ISBN 9781402012525].*

[21] *Norman, D.* Emotional design: why we love (or hate) everyday things. *(Basic Books, 2004) [ISBN 9780465051366].*

[22] *Hassenzahl, M. (2010).* Experience design: technology for all the right reasons; *http://hassenzahl.wordpress.com/*

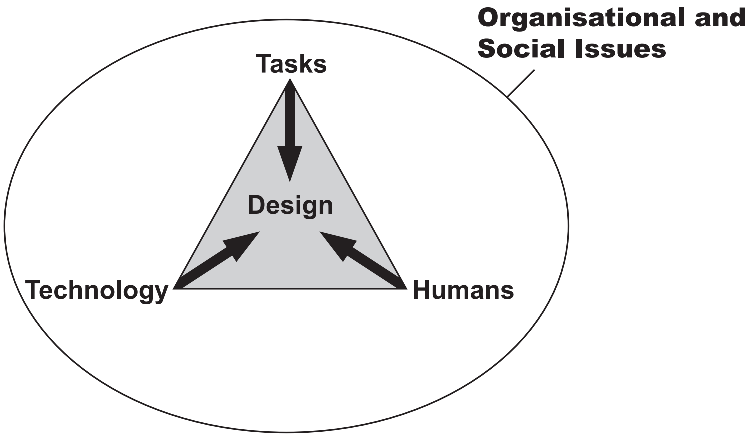

Figure 2.7 User Experience Design

2.5 The design activity

Alongside making requirements identification as real as possible for designers is the need to make emerging design ideas as concrete as possible for potential users, allowing them, as has been stressed before, to be consulted during the design process. A fundamental part of an iterative design process is to create an early partial implementation of the artefact or system: a prototype. Rapid prototyping techniques allow prototype development early in the design process (before time and money have been spent making irrevocable design decisions) with the effect that design solutions can be easily and quickly shown to users at an early stage. Rather than build a fully operational system, it is faster to prototype first, and test out that design solution (first with the design team and then with users for their reaction), since people are generally good at reacting to concrete designs and physical mock-ups or partial prototypes. In addition to fostering teamwork and communication by involving users, this process means that redesign based on feedback occurs until an acceptable state is reached. Of course, a newly generated design may be worse or may have consequences but this is part of the skill set of the Interaction Designer in choosing what to prototype, based on knowledge and experience. With prototyping and testing activity, it is obviously crucial to keep track of the 'Design Rationale' (i.e. the reasons for design decisions and changes, why those changes were made and what the implications are). This Study Guide will not discuss Design Rationale or its associated research areas but interested students are referred to the Further reading list or an HCI Glossary.

2.5.1 Prototyping

Prototypes are not just 'cut-down' versions of a finished artefact. They can be anything from a cardboard mock-up or a cartoon-like storyboard to a software presentation that simulates a system's response to user actions. For user interfaces, representations of the artefacts to be designed can be built with different media, from simple paper to sophisticated interactive screen-based simulations. Mock-ups can range from concept demonstrators with limited pre-scripted functionality to partially implemented software capable of demonstrating interaction sequences and user experiences. The differences between the techniques are in the media employed, production costs, and the realism or fidelity of the representation of the proposed design. A classification and discussion of types of prototyping technique is covered in Section 3.7 of the next chapter but, for now, it is important to remember that all such representations result from the creative design process and are intended to illustrate concrete aspects of a design. Some variants are given below.

- Text descriptions of tasks
- Flow diagrams or outlines showing task structures
- Screen sketches
- Storyboards
- Paper prototypes
- Wireframe models – to make mock-ups
- Screen-based animations
- Walkthroughs
- Rapid video prototypes
- Virtual/Augmented/Mixed Reality mock-ups
- Wizard-of-Oz simulations
- Executable prototypes

Starting out

This section will discuss only a few of these in detail; some are self-explanatory whilst the specific technique of Wizard-of-Oz simulation is covered in Section 5.2.1. The recommended textbooks all cover prototyping and design realisation in extensive detail.

The power of a prototype is that it can create a focus for design conversations based upon something that is tangible and visible; it is a concrete example which provokes a user reaction. The process ideally starts with creative brainstorming to map out a space of ideas, concepts and potential designs (discussed in Section 2.6 in more detail). Once such design conceptions have been assessed and prioritised by a design team, the process of design realisation involving a user–designer dialogue can begin. Scenarios and personae (see Section 3.6) can be collected together in order to provide material for stimulating further discussion and for instantiating concepts which can be tested and iterated. Such design realisations are created in iterative cycles using scenarios and personae and, sometimes, examples of other good designs for inspiration. Initial ideas lead to design exploration in which storyboards, wireframes or mock-ups can be demonstrated to users in interview or workshop settings to elicit their feedback and to allow them to contribute ideas and participate personally in the design process. Representations of designs become more detailed and sophisticated as cycles of creation and evaluation occur; storyboards and early mock-ups are refined into software prototypes. Prototypes tend to be evaluated through a more formal test process (see Chapter 5) of evaluating usability.

One choice which may have to be made is the extent to which the process should be user-centred or designer-led. We advocate User-Centred Design but it can produce quite conservative solutions since users may fix their requirements and visions on prior experience rather than exploring new directions. On the other hand, designer-led exploration can develop rather too complete and complex prototypes based on idealised designs or novelty for its own sake. It is generally better to have design-led exploration when products are being developed for new markets whilst a user-centred approach may be best for applications tailored to specific users and tasks.

Mock-ups

Simple mock-ups can be very useful in allowing users and designers to interact directly, to engage in a conversation and to exchange views. Simple mock-ups can be easily constructed from common office material, since the demonstration focus is on the flow of interaction rather than the visual look and feel of an interface. A more complex physical model is an object which users and designers can interpret in various ways according to their interests and viewpoints: different people may take different meanings from the same model and highlighting such differences aids understanding. Physically interacting with mock-ups means that the visual, auditory and tactile senses are all used, more so than with a paper or screen-based design. As with all types of prototyping, this can help elicit feedback that becomes more and more focused and can strongly encourage creativity.

Scenarios and storyboards

Scenarios and personae are inputs to stimulate design exploration; storyboards are the initial outcomes of design (they may also be called design sketches or wireframe models). Scenarios are mini-scripts that describe situations where a product is used; storyboards visualise a narrative. These techniques can work together to simulate key moments in application usage and to communicate key aspects both within the design team and to those external to it.

Scenarios can take almost any format that 'tells a story' about a product or application and people or users. A scenario will involve a range of parameters, always with people or characters standing for the user and often with objects, circumstances and time as the additional elements. Scenarios should be detailed, evocative and focused on the value of the experience to users. Multiple scenarios can be envisioned; the same people can experience different situations, and the same situation can be played out with different products or users.

> '*For one single product, a team can write scenarios that describe, say, an ideal everyday use situation, a first use scenario and an edge-case (someone who uses the product ten times as heavily as an everyday user, for example). The point is to tell detailed stories about a specific user experience and to use the process of creating the scenario as an opportunity to better understand the details of the experience and to share that understanding among the team.*'[23]

[23] *Sutcliffe, A. (2009).* Designing for User Engagement: Aesthetic and Attractive User Interfaces.

The storyboard concept itself originates in animation and cartooning – ideas for a storyline or script were sketched as a set of drawings. In ID, storyboards usually illustrate 'snapshots' of interaction which is related to the users' tasks or what the application does, or a script of how the product will be used. Since many user experiences can have multiple outcomes based on the users' choices, multiple storyboards can describe possible experiences, or interactions.

Storyboards can be hand-drawn or created as PowerPoint animations or videos which are 'walked through' in order to elicit user feedback and to focus discussion on critiquing and elaborating the design. Such screen-based presentations (and many paper-based ones) can include clip art, found photographs, staged photographs, computer animations, dialogue clips and even cartoons. More recently, video mock-ups and storyboards are being used, since film and video has become so much easier to create on modern computers. They are all useful in showing multiple possible paths through an interaction, interactively, in a presentation that demonstrates how different decisions lead to different experiences. However, a limitation of storyboarding in this manner is that complex interactions can be hard to instantiate since interaction can only be represented by scripted animations or explained using paper materials. Complex ideas which relate to user immersion, presence or flow (see Section 9.2) are often very important parts of interactive design but can be extremely difficult to illustrate with sketches and screen-based presentations. Storyboards do, however, allow the rapid iterative exploration of design ideas we have identified as being a critical part of the design process, and they can be readily transformed into software-based prototypes which allow more interactive functionality to be demonstrated.

Simulations

> '*Simulation is a kind of drama. By using media to create a sensation of realness, an audience can suspend disbelief long enough to provide authentic reactions to the unfamiliar things they're seeing and hearing. Simulation takes place in the world at large, not just on a screen. In fact, simulating Ubiquitous Computing User Experience Design has much in common with theatre. In this theatre of design, devices are props, environments are stages, users are actors and user experiences have internal narratives.*'[24]

[24] *Sutcliffe, A. (2009).* Designing for User Engagement: Aesthetic and Attractive User Interfaces.

Newer techniques that are more appropriate and suitable for Ubiquitous Computing (see Chapter 9) and for ID and UX design make use of concepts appropriated from drama, theatre, film and role-playing games. A short play is produced acting out in a more realistic setting the user interaction scenario. The viewing and/or the production of the play tends to focus discussion as users evaluate ideas, but bring in their own context to the discussion too, producing new insights and ideas. There are many variants: professional actors (see Section 6.2.2) may be chosen over letting users act out parts for themselves. In that case there may be choices:

- give out a role or persona
- allow wholly improvised play (usually to foster evaluation and idea generation)
- allow participants to develop their own scenarios
- 'freeze' the action, discuss and change events, and then replay
- add further objects to the scene (changing the product ecology).

Such ways of prototyping interaction are constantly evolving as technology itself develops and different interaction styles become more common. These techniques can also have other uses – in more specific product evaluation and for demonstrating user difficulties by highlighting specific and problematic situations and settings (see Chapters 6 and 7).

2.6 Idea generation

The design process begins with generating and producing ideas for potential designs and this activity, too, can be achieved in numerous ways. There are as many inspirational brainstorming techniques as there are potential designs, and the recommended books chosen for this part of the course are those by Bill Buxton,[25] a polymath HCI, graphics and design pioneer. His first book describes how to think about the role of design and the principles of 'sketching'. He discusses some of the techniques mentioned above for prototyping and envisioning user experience in an entertaining and informative fashion. The associated workbook contains practical examples, suggestions and guidance on how to generate ideas. Buxton explains his views on sketching in more detail and identifies various methods for capturing aspects of the real world and possible user interactions, from single images to interactive modelling for prototyping. The concluding part highlights and describes some techniques of storytelling, critiquing and evaluating which are used to share the ideas generated with others, whether they be users or the design team. Together they are the best sourcebooks currently available and the most accessible introduction to design idea generation for ID and HCI. There are also numerous examples of prototyping strategies, ways in which to generate new ideas and demonstrations of participants actively involved in design idea generation. Some are presented later as case studies (Chapter 7) while many can be accessed or downloaded as videos (see the libraries of video material indicated in the Preface, under Sources of further information). Video material is especially useful in showing the reality of idea generation in action.

[25] *Buxton, B. (2007).* Sketching User Experiences *and Buxton, B. et al. (2010).* Sketching User Experiences: The Workbook.

Idea generation is an actively researched topic in the HCI, ID, UX and design communities, and articles, studies and investigations are constantly being presented at conferences, especially at the DIS (Designing Interactive Systems), NordiCHI (Nordic Conference on Human-Computer Interaction), UbiComp (Ubiquitous Computing), MobileHCI (Human-Computer Interaction with Mobile Devices and Services), PDC (Participatory Design Conference), Pervasive (Pervasive Computing), TEI (Tangible, Embedded, and Embodied Interaction) and UX (User Experience) conferences referred to in the Preface. Current work and work-in-progress is written up in magazines and journals. Some newer techniques may also be described on the various research community websites or on vendors' and computer consultancies' blogs and news feeds (see, again, Preface: Sources of further information). It is well worth keeping up-to-date with new developments by accessing the latest web-based information.

The process of idea generation is an active one, requiring practice. Some real implementation of storyboarding and early prototyping techniques may be carried out as coursework but students should all try the techniques for themselves, both as individuals and by working in groups. Some suggestions are made in the Exercises at the end of this chapter and there are many more in all of the recommended textbooks. The only way to gain experience and develop expertise is to try sketching and producing design ideas for yourself.

Summary

The goal of Interaction Design is to create products which are useable, useful and desirable. ID attempts to manage the complexity of interaction without losing the feel of a craft when creating 'great user experiences'. The design approach is one of focusing on users and their needs, and is derived both from design theory and from existing SE and HCI User-Centred Design models.

A reminder of your learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- demonstrate a realistic appreciation of ID processes and activities
- discuss the variety of approaches to ID and the range of design techniques and methodologies
- describe how and when such methods are used in a design activity
- describe what a metaphor is, and identify its importance
- demonstrate practice in drawing, sketching and designing paper prototypes.

Exercises

1. What is User-Centred Design (UCD)? What specific knowledge is required to engage in UCD?
2. Assume you are a member of a large software development team.
   i) How could you involve users at an early stage in systems development?
   ii) What problems and attitudes might you encounter?
   iii) How would you get users practically involved, and when?
3. Describe the design approach of Participative or Participatory Design.
4. What new kinds of software support are available for interface designers? How could you envisage yourself using them in the future?
5. Find out about 3D printers and investigate how they are being used in ID and UX Design.
6. How could you as a designer make use of users' prior experience and existing knowledge?
7. Describe the different ways in which designers use mock-ups, storyboards and paper prototypes.
8. Investigate video scenarios and video prototypes. How and when might they be used? What kinds of user might they be most suited to?
9. Sketch out three or four different design ideas for the interface to a new mobile phone application of your own choice. Make one touch-screen based and another keypad-based. How do they differ?
10. Construct a physical mock-up, with any readily accessible and available materials, of a personal diary/appointment calendar system for a laptop or notebook computer. Show it to someone else (preferably not on your course) to get their reaction and feedback.

Sample examination question

The University has a policy that all students must have new iPads for a specific course. From the perspective of an Interaction Designer, how would you apply a recognised design method to the process of designing a suitable application for students to use to access local university information and to participate in a wide range of class and campus activities? Provide mock-ups and paper-based prototypes or sketches of your design solution. Briefly critique your design.

Further reading

For background reading and inspiration for Interactive Design from a number of classic HCI perspectives

Blythe, M., et al. *Funology: from usability to enjoyment*. (2003)

Moggridge, B. *Designing interactions*. (2007).

Norman, D. *The design of everyday things*. (2002).

Norman, D. *The design of future things*. (2007).

Norman, D. *Living with complexity*. (2010).

Winograd, T. *Bringing design to software*. (1996).

New and newly-updated titles and synthesis lectures on design issues, UX and Interaction Design

Goodwin, K. *Designing for the digital age*. (2009).

Kuniavsky, M. *Smart things: ubiquitous computing user experience design*. (2010).

Hassenzahl, M. *Experience design: technology for all the right reasons*. (2010).

Saffer, D. *Designing for interaction*. (2009).

Sutcliffe, A. *Designing for user engagement: aesthetic and attractive user interfaces*. (2009).

Wilson, C. (ed.) *User experience re-mastered*. (2009).

Wright, P. and J. McCarthy *Experience-centred design: designers, users, and communities in dialogue*. (2009).

What do users do and how do they talk about it?

Jared Spool

actions activities analysis collection data design focus information objects observation prototyping questions requirements scenarios system task team techniques users work

Chapter 3

Techniques for Interaction Design requirements

Introduction » Task Analysis » Data collection » Qualitative data » User narratives and prototyping » Requirements gathering » Summary

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- describe a range of user-focused requirements elicitation techniques
- use a number of techniques for obtaining design input from an end-user population
- understand different types of data (qualitative and quantitative)
- describe which techniques to use in which situations
- demonstrate knowledge of the use of prototyping techniques and distinctions between those techniques.

Essential reading

Note: Further reading and websites are listed at the end of the chapter.

HCI textbooks

Shneiderman, B., et al. *Designing the user interface*. (2009) Chapter 3.

Sharp, H., Y. Rogers and J. Preece *Interaction design*. (2007) Chapters 6, 9, 10 and 11.

Dix, A., et al. *Human-computer interaction*. (2003) Chapters 5 and 6.

Introduction

When designing an interactive application, the first activity after having considered and selected an appropriate design methodology is to engage in requirements engineering. This involves requirements elicitation from the users of a proposed new system or application, and functional and non-functional requirements specification of the tasks in this system. The aim is to provide quality user experiences for all of those who will be impacted by the system.

3.1 Task Analysis

Task Analysis is essential to find out who users are and what tasks they need to perform in order to carry out their work. Useful ways in which to find out such information is to observe existing work practices and to create scenarios of actual use. This means that new ideas can be tested and explored before committing to building software and real applications, which can alleviate early design problems. Before this, however, and before even considering what tasks are desired in the new system, we need to identify some or all of the following factors:

- Who is going to use the system?
- How do users communicate with each other?
- What tools does the user have?
- What tasks do they now perform?
- Where are the tasks performed?
- How often are the tasks performed?
- What are the time constraints on the tasks?
- How are the tasks learned?
- What is the relationship between user and data?
- What happens when things go wrong? How do people deal with task-related errors, practical difficulties, or even catastrophes? Is there a back-up strategy?

We need to know about the user, the task and the context in which this all takes place, so consider what (task) detail is requested.

- Knowing what tasks users actually perform is important for both automation and new functionality and in understanding the relative importance of all tasks.
- Knowing where the task is performed will provide information about the effects of the environment on the users. The ambient environment (lighting, noise levels, etc.) may place users under stress, or other factors (such as confidentiality requirements) may be a crucial part of the work.
- Knowing how often users perform tasks and which function is performed most frequently – and by which users – will help in optimising a future system for these tasks and will improve the users' perception of good performance.
- Frequent users remember more details, but infrequent users may need more help so knowledge of frequency, even for simple operations, makes it possible for these tasks to be identified and catered for.

Considering the relationship between users and data, we need to understand if, for example, remote access is required or access to data is restricted, and the implications that has for task and for user interactions. Knowledge required includes whether data is always accessed in the same manner, at, say, a single machine, or if it is used concurrently or passed sequentially between users. Such data can take the form of:

- public data
  - open government records, public websites, etc.
- personal data
  - health data, bank records, etc.
- common data
  - company-specific information, accounting records, etc.

3.2 Data collection for gathering user and task requirements

There are many data collection techniques for gathering initial user and task requirements. They range from collecting information about an existing system through examination of available literature (manuals, textbooks, educational material, documentation, user logs, etc.) to more precise data gleaned from assessments of the good and the poor aspects of a current system. Client specifications and precise usability requirements or user guidelines will provide some information but, for the type of design we are interested in, task analysis and data collection techniques are widely employed.

3.2.1 Which type of data to collect?

There are two types of data relevant to analysing tasks and user activities. Process data can be thought of as observations of what users are doing and thinking, whilst operational data can be thought of as specifics (i.e. summaries of what happened in terms of time spent, number of errors made, or the type of independent and dependent variables used in experimentation). This kind of data can be hard to obtain in a reliable manner (many users are required for statistical significance, for example) and will not always inform design (summaries may just identify that a system is too slow or that there are too many errors). Focusing on process data first gives a good overview of where the problems might lie.

The other major distinction in terms of data is to consider if the information to be collected is 'qualitative' or 'quantitative'. Quantitative measurement is specific data (height, or weight, for example, measured in absolutes and subjected to statistical analysis such as averages, means or medians). Qualitative data is used if you want to understand how a person's height affects them, or what they think about their weight. We can collect data by various methods:

- discussing with a design team what tools, skills, and knowledge users have, or are expected to have
- finding 'real users' and obtaining data from them about what they really do and how a proposed new design would suit them
- observing and interviewing users in their work place.

Some of these methods are qualitative, some quantitative. Many quantitative experimental techniques that control the environment and manipulate variables are excellent for yielding certain types of information (such as whether people find system response times acceptable) but tend to divorce the use of a system from its context of use, that is, the circumstances and practices that drive usage. Qualitative methods emphasise 'situated use' and can seem imprecise. They also require a great deal of care and expertise in use. Situated use means studying something in its use context. It is interpretive since the underlying premise is that reality is constructed by humans in the course of their actions and is not objective or measurable by objective (often quantitative) approaches.

3.2.2 When to use which?

Quantitative methods allow data to be collected from large samples and the data generated is highly generalisable and comparable. Qualitative methods allow deep and insightful data to be collected from small samples.

3.3 Asking users

Asking users directly helps designers learn what is involved in the user's job, what tools are used, what users actually do and how they do it. It extracts not only facts but also behaviours and beliefs. From the designers'/developers' viewpoint, they can demonstrate to users their technical capabilities in order to build a rapport. Giving users an idea of what is possible allows them to comment on whether such ideas make sense. However, there may often be problems in asking users. Sometimes users do not actually know what they want, or how to explain or communicate their needs. They tend to be unfamiliar with what is possible with technology, may not understand good design or be aware of design constraints such as security and privacy issues, or accessibility requirements.

3.3.1 Interviews

Interviews can be structured, unstructured or semi-structured (mixed). In a structured interview, an analyst will have prepared a number of relevant questions. These prepared questions are used to guide the interview, but the analyst should be prepared to deviate a little from the prepared order of presentation. Interviews are a useful technique for providing an initial overview of the task or set of tasks in the domain, suitable for extracting rules, general principles behind task execution and background information, covering low probability events and the reasons underlying behaviour. They take less time to carry out than other techniques but rarely provide specific enough in-depth knowledge descriptions. They can, however, be very useful for obtaining information early in requirements analysis which can be used to guide later observation studies. Since the reliability of answers can be a problem, they should be used in conjunction with direct or indirect observation of the task performance of a number of individuals.

3.3.2 Questionnaires

A questionnaire is prepared in advance and is fairly inflexible since specific and structured questions for a large sample will have been created. Questionnaires are suitable for extracting rules, general principles behind task execution and background information, covering low probability events and the reasons underlying behaviour. The return rate of questionnaires is rarely better than 25% but, since many more questionnaires can be sent out than interviews held, the use of questionnaires is common. One basic feature of questionnaire design is that each should be short enough to allow completion in a reasonable amount of time and that pilot testing is very important since there is no mechanism to correct misunderstandings. There are many varieties of questionnaires, such as fixed order, multiple orderings, yes/no questions, open answer questions, or forced choice questions, and much guidance on questionnaire design is freely available. Online only questionnaires are easily created. They are often used to measure subjective user preferences and as rating scales for many design attributes. The most common rating schema is a Likert scale which has a neutral position and either a 5- or a 7-point scale. For example, asking subjects whether or not they agree with a set of statements often uses a scale with the opposing extreme points used for 'Strongly disagree' and 'Strongly agree' respectively.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
5	4	3	2	1

3.3.3 Focus groups

Interviews with a group are difficult to manage so the more usual technique is to arrange a focus group. This is a collection of users, chosen to be representative of a user population, gathered together and asked to respond to structured questions. A facilitator will lead and manage the questioning and discussion, getting everyone to think about the same set of issues. Often, the session is recorded. Group discussions can be valuable in ascertaining how widespread or common opinions are, in gauging initial responses and reactions, and for limited problem identification. They are not a good form of data gathering for specific low-level detail but can be a useful, if expensive, check on information collected from individuals.

3.3.4 Experimental techniques

A number of techniques which derive from psychology can be used in identifying aspects of a task, either singly or by group consensus. Identifying the similarity of concepts, which attributes are shared and establishing the underlying structure of concepts, can be carried out by the use of techniques such as rating scales, frequency counts, a factor analysis technique named Kelly's Repertory Grid, or the technique most used in HCI and ID, card sorting. All involve identifying task objects and actions through a process such as the following:

Identify who performs the task » Select and list objects, and actions carried out on them » Ask structured questions about them » List relevant descriptors (nouns, verbs) given by the user » Note all objects and actions mentioned » Observe task performance » Note what objects the user manipulates, and how

3.3.5 Card sorting

Card sorting is a very simple and effective method for eliciting the structure of objects and how people organise and categorise their knowledge, resulting in similarity of task components. Object names are written on cards, one card for each object, and participants are instructed to group (or sort, or categorise) 'similar objects' or 'objects which are the same kind of thing' or 'put together the things that go together' into physical piles. Objects can be anything from actions to procedures to low-level tasks. Participants are asked to give the piles a name or phrase that indicates what the concepts in a particular pile have in common, such concepts being either abstract or concrete. Refinements involve restricting the number of piles of cards to be created, or requiring that the piles themselves also be arranged in some kind of order. The result should be a structuring of similar objects which share common attributes. These can then be named and further analysed by concept mapping, or used as the basis for further design strategies.

When using such a procedure, it is critical that participants are representative of actual users and are familiar with the domain being considered. Analysts must be wary of forcing arbitrary classification outcomes, not representative of the task. Although an analyst must have background information, their intervention must be minimal.

Card sorting can be effective in discovering the optimal organisation of information from the potential users' viewpoint. Developers can use this technique when faced with the problem of organising information items, features and functions in a website.

3.4 Eliciting qualitative data

Qualitative field research methods have become increasingly popular as a means of studying users 'in situ' in naturalistic settings. These types of 'observational studies' help clarify changing user needs and in developing design strategies for product requirements. They can be divided into indirect and direct methods:

Indirect	Direct
Diary analysis studies	Think-aloud protocols/Protocol Analysis
Interaction logging	Ethnography
	Naturalistic observation
	Contextual Inquiry

Indirect observation
Two methods will be briefly described before describing more common direct observation methods. Sometimes direct observation is not possible so users' activities are tracked indirectly through diaries kept by the users themselves. Interaction logging collects data such as key presses, mouse or movements of other devices, such data being synchronised with video and audio logs.

3.4.1 Diary analysis studies

Diary studies involve the user in keeping a record in diary format of what they did, how they did it and what they thought they were doing when using a particular system, or in carrying out certain tasks. This method can be useful for collecting data over longer time periods, or where data collection might be difficult because of the nature of the system, or because personal or sensitive data is involved. It can be supplementary to interview data and can be employed when the user population is scattered in different locations. The major drawback is that it is, of course, entirely reliant on users actually completing a diary. The technique, although inexpensive and not reliant on specialised training, does require the active and continuing participation of users and can place extra burdens on those involved. There may also be serious issues in validating the accuracy of user accounts.

In practice, diaries may be open or closed format. Open format diaries are simple to construct and can potentially capture more widespread information. However, analysis of data is time-consuming as a structure and order must be imposed on freeform text. A closed format diary enables greater consistency in data analysis for pre-categorised entries and may be useful if time considerations are important. Practical matters to consider are the provision of standardised recording material (booklets, paper, etc.) since diaries must be straightforward and easy to complete, have clear instructions on how to complete entries with a model example and explanation of any data analysis terms, and sufficient space for additional comments.

Although diary studies are not frequently used, they do have potential, especially in multicultural studies. Technologically, electronic activity diaries can improve both timeliness and speed and can streamline data analysis; shared and group internet-based diaries can be utilised also.

3.4.2 Interaction logging

Interaction logging involves the recording of key presses, mouse movements and touchscreen icon selection by specialist software, often synchronised with video and audio logs. This provides a full record of a user's actions whilst carrying out a task. It is unobtrusive and large amounts of data can be gathered and analysed relatively quickly and easily, given time-stamping and logging intervals. The amount of data that can be collected can be a disadvantage since there may be too much to analyse fully and interpretation can be problematic. This may be limited by selecting representative users and by identifying appropriate small-scale tasks. There are ethical considerations in collecting data from users as part of requirements analysis, so it is not much used at this development stage except in studies for adaptive and customisable systems. The technique is more usual in an evaluation laboratory at a later stage of summative evaluation.

Direct observation
Observational techniques involve collecting data from watching a user/task performer's behaviour. They often provide corroborating evidence for other techniques (e.g. verbal reports and interviews), rather than being used in isolation, and are best employed when tasks have observable stages or when description of the task is difficult to put into words. The observation

should focus on the actions that a user undertakes and changes in the task domain so this technique is most appropriate for gathering detailed knowledge, or for when the task involves many individual steps often overlooked by the person who is carrying out the task. They are, however, time-consuming and require an analyst/designer to make inferences in order to identify the structure of the task and certain types of objects and actions involved. Direct observational techniques (e.g. looking over a person's shoulder) are extremely intrusive and may seriously influence that person's behaviour, creating interference with the natural order of the situation. Indirect observation, usually through video recording, is less intrusive but requires set-up and analysis time and effort and, until recently, specialised equipment. Essentially, the observer is either an 'outsider' or an 'insider' and in a 'controlled' or a 'natural' environment watching 'think aloud' protocols or examining the people, places, and things involved in the task. What is important in all situations is to have pre-determined goals and a viable data recording strategy but still to be able to remain flexible and to refocus if needed. Verification of observations, interpretations and inferences is crucial, either alone, or in a group.

3.4.3 Protocol Analysis

Verbal reports given by a subject constitute one type of recordable user behaviour. 'Protocols' are verbal reports given by the person performing the task, either concurrently (at the same time as actually doing the task) or retrospectively (after finishing the task). These can provide detailed information on aspects such as task goals and plans, procedures, actions and objects. If protocols are well-defined and interpreted they can be valuable sources of data. The instructions given to subjects and the coding of responses are thus of primary importance. However, this does require the analyst/designer to make some inferences about what is happening and what knowledge the person must be using since the subjects are only describing thoughts or impressions, not trying to explain them. There can be other serious drawbacks:

- The whole activity takes time.
- The responses must be carefully coded in a pre-identified schema within some more general framework.
- It is not always wise to rely solely on verbal reports since people are not always able to give accurate, precise or reliable verbal reports about their own behaviour – there are real psychological limitations to introspection and recall, and people can continually revise ideas about how a task is carried out.
- A user's perspective may be overly bound by a reliance on the current ways of doing things with the current technology.

In Concurrent Protocols (CP), users report on and describe what they are doing while they are doing it. This can provide much detailed information, especially if sessions are recorded on video, but a critical drawback is that the activity of describing what is happening may interfere with normal task behaviour, either helping or hindering a subject in carrying out a task, depending on their level of skill. In Retrospective Protocols (RP), the user has to remember what their intentions were whilst undertaking and completing the task, and then describe these after the task is over. This might occur when watching them later on a recording, or in a structured interview. More reliable information tends to be generated since users can be called back to go over the task recording and asked to explain about any specific knowledge needed to carry out the task and to expand on their feelings and emotions at the time. The distinctions between them are that CP means concentrating on physical actions whilst RP concentrates more on why something is being done than on what is being done, and so results in more knowledge being gathered, even if it takes longer to carry out.

3.4.4 Ethnography

Ethnography studies the social character of groups and the socially organised activities of members of those groups, from within the natural setting. It is a technique derived from Social Anthropology and was first brought to bear on HCI issues in a ground-breaking publication by Lucy Suchman[1] in which, while engaged by Xerox Corporation to study the design of a new generation of photocopiers, she posited a new synthesis view of interaction. 'Situated Action' and 'Situated Cognition' can be investigated through sociological analysis techniques, as human action is seen to be constantly constructed and reconstructed from dynamic interactions within an environment as instantiated in both the physical and material world, and the surrounding social context.

[1] *Suchman, L.* Plans and Situated Actions: The Problem of Human–Machine Communication. *(Cambridge University Press, 1987) second edition [ISBN 9780521675888].*

An ethnographic study is a participant-observation, which seeks to uncover the implicit skills and activities (that is, actions that are not explicitly described or practices that are not proscribed) which are embedded in the shared and often unspoken cultural understanding which pervade a workplace setting. Such implicit knowledge is often a vital, though unacknowledged, ingredient of work, and of how tasks are carried out in practice. Many informal practices may subvert formal patterns of work (e.g. frequently-used shortcuts, unrecognised in a formal job description) and are often not accessible to study by other means. Finding out about such practices requires an ethnographer to engage or immerse fully into that work 'society' and to observe in an unobtrusive manner over a period of time so that shared cultural norms become evident. In a sense, an ethnographic study is a bridge between users and designers, demonstrating through action how work is carried out and illuminating hidden or tacit knowledge (i.e. information about working practices which is never recorded but is known by all the participants and without which the work could not be effectively carried out).

This technique was initially used in many of the first studies into Computer Supported Cooperative Work but has since migrated to become a more mainstream practice. It has been much simplified from its original sociological purity into a more usable form. Investigations will normally involve many or all of the following:

- direct observation
- involvement in work activities
- discussions and structured interviewing of key participants and groups
- note-taking, recording (sound and video) and photography
- collection of artefacts, documents and detritus.

3.4.5 Naturalistic observation

More systematic than just 'people watching' – but derived from ethnography and psychological studies – naturalistic observation enables observation of users and their work over time in the context of that work. It is less time-consuming than a full ethnographic study but can be used to identify unarticulated needs for new product ideas, user characteristics for user profiles, common user tasks for Task Analysis, workflow patterns for Interaction Design, and environmental factors that may impact effectiveness of different types of designs. Design teams can learn about users' work in a contextual fashion by identifying a focus (objectives and information requirements) as a team, and then using that focus to guide the observation process, with a 'first-cut analysis' often taking place during observation. Multiple interpretations can be discussed, summarised and analysed in relation to the objectives set out at the start. Some critical issues to consider with this technique are:

- Setting an initial focus
- Managing the group or team
- Practical and ethical issues in observation.

a. Focus

'Focus' can be defined as an appropriate starting perspective, viewpoint or 'entering focus' which directs perception and questioning sequences. Focus is a set of preconceived assumptions and beliefs that creates a shared understanding in a team, used to direct the questioning sequences. Focus provides the 'lens' through which to observe what team members notice and what clarifying questions can be asked. Initially, a review of existing information should be agreed by the team, a list of the team's design questions identified and the focus designated broadly enough to define the scope of the area, but still narrowly enough to be useable in design. Focus generation and identification can be carried out as a brainstorming process and the output analysed as in the card sorting description given earlier, by grouping and refining concepts until a more generalised focus statement is agreed. Focus also provides a framework for recording data and thematically organising that data. An example of a well-defined focus might be observing a system administrator working with a specified tool in a real-life situation, instead of asking more general questions about which and how many management tools are available, and what the names are, and who is allowed access.

b. Teams

Aspects of the management of a team are important, the interpersonal no less than the practical. Numbers should be limited, the make-up and distribution of skills across the team carefully considered and all group members trained in the observational techniques and in maintaining their role as an active participant.

c. Observation considerations

Critically, there are the practical issues of identifying and recruiting users and handling the logistics of recording, and note-taking, and then managing the process of debriefing, analysis and reporting. Not so obvious are the ethics of observation and how observers should conduct themselves.

3.4.6 Contextual Inquiry

Naturalistic observation and Contextual Inquiry are commonly combined techniques and, over time, Contextual Inquiry has become an important tool for understanding work which is complex. It requires interpretation to understand the needs created by users' work contexts. The process involves a team-developed focus which is used to guide questions to, and a discussion with, users as work tasks are performed. It involves being physically present in the workplace, seeing the work as it unfolds and extracting detail from people's natural tendency to summarise, or to abstract. Observers not only note facts but make interpretations and will attempt to validate and rephrase until the phrasing is right and will share interpretations to check reasoning and understanding. Key concepts are:

- context – understanding user needs in the context of their work
- partnership – working in conjunction with users as equal partners in the enquiry
- focus – the observational lens.

The technique has been championed by a small number of analysts and designers, but a simpler form is relatively straightforward to carry out with suitable recording technologies (notebooks, tape recorders, still and video cameras).

The sequence might be that of a first conventional short interview – to introduce the designated focus, deal with any ethical issues and to obtain basic and summary data. Then, in a contextual interview which can last for a number of hours:

User works while Observer watches » Observer interrupts to ask questions and clarify activities » Observer summarises notes » Observer confirms, with the user, what is important

A full Contextual Inquiry can be a difficult process and requires skilled and experienced practitioners to undertake a deeper level of analysis. It can be especially difficult for teams if they are not familiar with ways to guide an enquiry in an open manner since the reality of striking a balance between showing understanding (for rapport) and showing ignorance (for clarification) can be hard to achieve in practice.

3.5 Analysing qualitative data

For all observational approaches, the approach to be taken to the data generated is roughly the same:

- Sort and prioritise the observations made and identify in particular:
    - what was important
    - multiple problems in the same area.
- Summarise the data by:
    - making a list of all critical incidents, positive and negative
    - trying to judge why each difficulty occurred.
- Consider what the data tells you:
    - does the user interaction work the way you thought it would?
    - what features might be missing?

- Give a rating for both the severity and the ease of fixing any critical incidents.

A major difficulty then arises: the communication of such understanding as design input or recommendations. Further and more detailed analysis of qualitative data is very problematic since much of the data will consist of field notes, artefacts, photographs and recordings – all of which must be transcribed. It is time-consuming and a significant challenge to transform field results into product design specifications. Interpretation can be very hard: it demands a great deal of skill to analyse qualitative notes or video and to identify critical incidents of note, patterns, key events within a group, shared behaviours, consistent explanations, or groupings to study in further detail.

As qualitative data that is interpreted and used to tell a story about what was observed is very much sited in the specific context in which it occurred, theory is often used to guide such analyses. Newer systematic qualitative research methodologies, such as Grounded Theory and Activity Theory are becoming a focus for current HCI and ID research. These are beyond the scope of this Study Guide but can be investigated online.

Nevertheless, these research methods do yield much useful information if a suitable communication channel is created, and are currently very popular in media and User Experience Design. Recordings can provide valuable insight, textual descriptions can explain the reality of work actions and some activities can be instantiated in design scenarios or prototypes built and examined. The use of techniques from professional theatre in requirements gathering, as described in Section 6.2.2, has proven to be beneficial in the area of healthcare for the elderly.

3.5.1 Interviewing versus observation

Some advantages of Participant Observation over interviewing can be that prolonged immersion lends itself to a better understanding of a workplace environment because of the sheer depth of contact and the experience of 'seeing through another's eyes'. Learning informal aspects of the surrounding culture, identifying what is taken for granted, observing and noting 'hidden' activities that people would not normally talk about, will not only promote a greater sensitivity to context but will increase an observer's ability to situate action in that specific context. Since interviewing tends to be a fleeting activity, time spent as a participant in a culture builds trust but is also more likely to yield surprises. Flexibility towards unexpected items will enable those surprises to be followed up in a naturalistic fashion.

Interviewing has distinct advantages over Participant Observation in that it is less obviously intrusive and is much easier to accommodate in a workplace situation. Greater breadth of coverage of issues resistant to observation, and the ability to inquire into times when the observer was not present and to force a reconstruction of events, can be powerful. Since participation has natural limits, interviewing can be used when difficult situations or ethical considerations make it hard to observe activity. Interviewing also allows investigators or analysts to find a broader cross-section of users and to quickly respond to and focus in on specific topics.

3.6 User narratives

A number of techniques develop natural language narratives about the people who must use or are part of an intended system – 'telling stories' about users and the tasks they carry out. One variant is that of 'personas'. Another, more widely used in HCI, is that of 'scenarios'.

3.6.1 Personas

One simple technique is Goal-Directed Design, developed by Alan Cooper. Personas are detailed descriptions of 'prototypical' users, incorporating personalities, goals and skills (through a distillation of interview and observation data) into descriptions of target users and task activities. Such personas should be realistic and believable, should be based on real facts and details, should demonstrate characteristics of the real users, and should be given names for future ease of reference and identification. In reality, there may be one persona for each class of user.

In selecting tasks, it is recommended that as near to real tasks as is possible are chosen, and that these include a mixture of the simple (common or introductory) and the complex (infrequent or for experienced users). It is also crucial to include any key tasks identified by users and some more general 'free-form' actions. Specific tasks are useful for understanding usability issues and work sequences, whilst free-form tasks can be good for understanding the usefulness of a proposed design. Tasks should be written up as formal or informal descriptions and tested by the design team (and, potentially, users) to check if they make sense and are realistic, or if further information is needed.

3.6.2 Scenario-Based Usability Engineering

A breakthrough in HCI design thinking was brought about by John Carroll and Mary-Beth Rosson's introduction of the concept of Scenario-Based Usability Engineering, a process based on methods used in the design community to make designs 'concrete' and able to be easily envisioned. A scenario is a story about use – a description of a person's interaction with a system. Scenarios can be thought of simply as stories of people and their activities, characterising what happens when users perform typical tasks. The focus is on usage and activity (user needs, user expectations, actions and reactions). Instead of designing software by listing requirements and functions, a designer focuses first on the activities that need to be supported and uses descriptions of those activities – and the envisioning of new activities and technologies – as the basis for future design of effective systems and software. In this way, design work shifts from functional specifications to describing how users will actually use a system to perform tasks and achieve goals. The design effort thus focuses on user requirements by trying to see the situation from different perspectives, as a design scenario narrative. The progress from 'Problem Scenarios' derived from analysis activities to the design stage where 'Activity Scenarios' and 'Interaction Scenarios' are generated to the prototyping and evaluation stage where scenarios can become 'Usability (or Design) Specifications' is shown in the framework envisaged by Carroll and Rosson in Figure 3.1. Inputs are in the side boxes and the iterative nature of the process is highlighted.

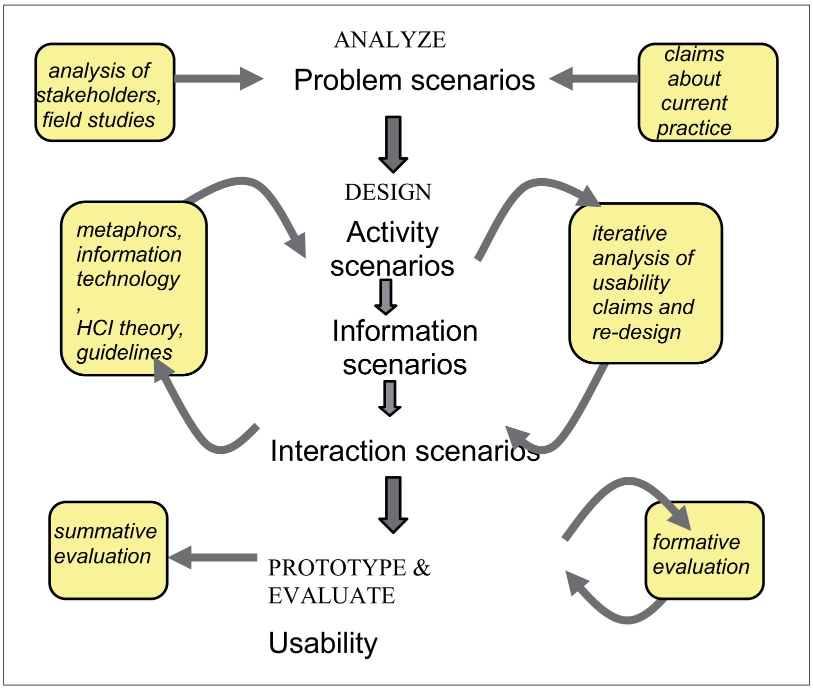

Figure 3.1 Scenario-Based Development Framework[2]

[2] *Reprinted with permission, Figure 1.6, Scenario Based Development Framework, p.24 of* Usability Engineering: Scenario-Based Development of Human-Computer Interaction, *Mary Beth Rosson, John M. Carroll (Morgan Kaufmann, first edition, October 26, 2001).*

A 'storyline' or a 'day-in-the-life scenario', arranged by the sequence of actions and events, can be envisaged and then mocked-up and described as story elements to be acted out as a form of walkthrough. A scenario describes a series of actions and events that will lead to an outcome and consists of:

- a setting involving one or more actors with goals or objectives
- the tools and objects that actors can use and control.

The analysis is further projected, or envisaged, and described by:

- Problem scenarios
  - A narrative of current methods offering a constructed view of the available actors, situations, relationships and artefacts.
- Claims
  - Which list both positive and negative features of the current situation which might have important consequences.

An effective technique for generating problem scenarios is to first create a series of conceptual stakeholders, who represent the different types of users. Their situations and relationships can be made more concrete by claims analysis (determining the features of the scenario that may have a consequence on the actors' experience). The analysis is further elaborated using 'what if' reasoning so that potential negative and positive consequences are investigated. Problem scenarios are then iteratively modified. Current activities are analysed to envision how they might be improved by available technologies, and potential concepts and technologies appropriate to the problem domain are examined for new options and insights. Design envisioning is supported by metaphors – which evoke contrasting views of stakeholder activities – and complementary technology options. Design envisioning is not itself a new design activity: it creates instead a platform for discussion of design reasoning supported by claims.

Continuing interest in, and development of, Scenario-Based Design, aims to increase the stakeholders' sense of 'immersion' and can be achieved by means of additional 'props'[3] or 'cultural probes'[4] or the scenarios can be 'acted out', rather than being 'walked through'. This can help to better focus the attention of both the design team and the stakeholders during Participatory Design sessions and hence lead to greater engagement. This recent approach is also used in other circumstances and is discussed in more detail in Chapter 6.

[3] *Howard, S. et al. 'Using "endowed props" in Scenario-Based Design', in* Proceedings of the Second Nordic conference on Human-Computer Interaction*, Aarhus, Denmark (ACM Press, 2002).*

[4] *Gaver, B., T. Dunne and E. Pacenti* Design: Cultural probes. *Interactions 6, 1 (January 1999), pp.21–29.*

Scenario-Based Design can be used in a number of ways:

- To ensure that all participants understand and agree to the design parameters.
- To specify exactly what functionality the system must support, connecting with the motivations and needs of the envisioned users, through problem scenarios which provide a realistic context of use and set of goals.
- To focus on the value created by a system, by capturing cost-benefit dynamics and showing how it offers an advantage over the way things are for the organisation that is considering the development.
- To envisage a range of possible future outcomes, without having to pre-judge the most likely outcome in difficult or complex situations.
- To translate scenarios into tasks for conducting walk-throughs, Participatory Design activities and usability tests.

3.7 Prototyping

Scenarios are not limited to stories or plots – they can be elaborated as prototypes, by using storyboard, video and rapid prototyping tools. A more interactive version of storyboarding is prototyping, which can be used in order to see how users interact with a design. Storyboards and scenarios are stories which are static whilst prototyping is dynamic, allowing flexibility and reconfiguration of elements based on user suggestions and feedback.

Prototyping can show the idea behind a design in an inexpensive and easily-changeable manner. A prototype design can be evolved gradually to an optimal solution before a system is implemented so that savings on both time and development costs can be made. The other major reason is to create something physical that can be tested with real users. Alternative designs can be quickly experimented with, as a result of immediate user feedback. From an HCI and ID point of view, it is crucial that the design is kept focused and is centred on the user, since iterative user design must test ideas with users and must observe the impacts and outcomes.

A prototype can come in a variety of forms. A paper-based mock-up (using paper, card, Post-its, drawings and sketches) to demonstrate screens and different interface elements is the simplest, derived from design practices as discussed in the previous chapter. A prototype can be developed in software using a simple visual design system such as Visual Basic. A mock-up can be created in applications such as spreadsheets, presentation creators or video editing tools. The more up-to-date multimedia and web-based development tools can create more realistic and functional prototypes. There is a wealth of possibilities, and more become available as technology advances.

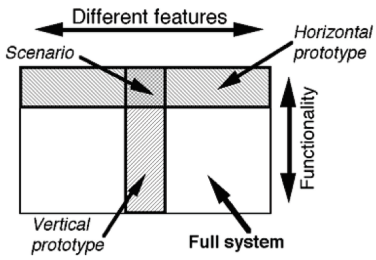

Figure 3.2 The concept of a scenario compared to vertical and horizontal prototypes as ways to make rapid prototyping simpler[5]

[5] *Nielsen, J. (1994) Guerrilla HCI. Figure 1. www.useit.com/papers/guerrilla_hci.html*

One criterion of a prototype is that it need not show all parts of the system and need not have full functionality. The level of content should be sufficient to show the ideas behind the design. As the prototype becomes validated more detail can be added allowing developers to refine the design in a process of Evolutionary or Incremental Prototyping. Prototypes can be instantiated in a number of ways, as can be seen in Figure 3.2, depending on the fidelity or levels of detail embedded, and are described as High Fidelity or Low Fidelity. A 'Hi-fi' prototype may look very like a final product with a high level of functionality and be almost a beta-test version with either horizontal (a wide range of functions in low detail or an overview of a large part of the system) or vertical (a more detailed view of a smaller self-contained segment allowing completion of one task all the way through) functionality. In Interaction Design, the focus of attention is more on the type of 'Low-fi' prototypes which exist as rapid or throw-away prototypes, or as earlier simulations based on sketches or storyboards.

Such paper-based prototypes are used for reasons of speed and to gather fast feedback, but have the advantage of being very easy to implement – minimal levels of skills are required and almost all interaction can be faked or mocked-up in some fashion. This facilitates almost universal participation, enabling commentary from teams and users and allowing for fast iterations of multiple alternatives.

3.8 Task Analysis and requirements gathering in use

Assessing options and choosing to employ a specific technique can be a difficult task. The authors of HCI textbooks give a little guidance[6] and some specific texts which give more detail and can be of assistance are given in the Further reading section. Similarly to the topic of Evaluation (see Chapter 5) more precise and tailored guidance is given by usability professionals (companies, consultancies or individuals) in the many websites and blogs available. A full list has been given in the Preface. In a real-work situation, however, there is likely to be a formal or agreed process to follow and many other factors will be taken into account – context, history, experience and availability, costs and timings. Choosing a technique for a student project depends very much on the task and project aims, but aspects such as time constraints, availability of resources, experience and expertise must be realistically assessed. Expertise in prototyping can be gained through practice, through following some of the design guidance advocated in Chapter 2 and through carefully following the design case studies described later in Chapter 7.

[6] *See Sharp, H., Y. Rogers and J. Preece* Interaction Design. *(2007) and Dix, A. et al.* Human-Computer Interaction. *(2003).*

Summary

Interaction Design is about understanding user needs, taking into account what people are good and bad at, and what can help them best in the way they currently do things. Determining user needs and translating them into system requirements is achieved primarily in user-centred methods by listening to what people want and getting them involved in the design activity. Different data gathering techniques are used to capture and discover user needs, but data interpretation and analysis requires expertise and often an appreciation of the embedded social aspects of work. Task Analysis identifies and describes tasks and user activities, and their inter-relationships; task scenarios, user narratives and prototypes can all be used both to generate designs and to see how users might interact with proposed design alternatives.

A reminder of your learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- describe a range of user-focused requirements elicitation techniques
- use a number of techniques for obtaining design input from an end-user population
- understand different types of data (qualitative and quantitative)
- describe which techniques to use in which situations
- demonstrate knowledge of the use of prototyping techniques and distinctions between those techniques.

Exercises

1. Detail as many different ways as you can of acquiring suitable design input from populations of users. Identify how these approaches differ from one another. What are some of the practical constraints on their use in the commercial world?
2. Describe the differences between indirect and direct observational studies.
3. Carry out the techniques in this chapter on your own interactions. Try out as many as possible, for example, diary analysis, scenarios, Protocol Analysis, card sorting, observations.
4. Investigate the current uses of ethnography in Interaction Design.
5. A computer company is developing a portable tagging system to be used as a tracking device to find children who get lost in large crowded spaces. Imagine you are part of the design team. How would you go about obtaining the user requirements?
6. What are the advantages and disadvantages of using:

   i) software prototyping and;

   ii) paper-based mock-ups for designing:

      a) a laptop computer and

      b) mobile device interfaces?

Sample examination question

Describe in detail what you understand by Scenario-Based Design. How effective are scenarios as a technique for discovering, communicating and organising requirements at different stages in the system life-cycle?

Further reading

Specific techniques and approaches

Burns Wendell, J., K. Holtzblatt and S. Wood *Rapid contextual design*. (2004).

Cooper, A., R. Reimann and D. Cronin *About face 3*. (2007).

Carroll, J. (ed.) *Scenario-based design*. (1995) Introduction and Chapters 2, 5 and 14.

Carroll, J. *Making use*. (2000) Chapters 3, 4 and 10.

Carroll, J. 'Five reasons for scenario-based design' (article) is available as a downloadable pdf from a large number of sites: search Google Scholar for a suitable link.

Mayhew, D. *The usability engineering lifecycle*. (1999).

Rosson, M.B. and J. Carroll *Usability engineering*. (2002).

Prototyping for mobile technologies

Jones, M. and G. Marsden *Mobile interaction design*. (2006) Chapter 6.

Indirect observation methods (interaction logging; user diaries)

Gillham, R. *Diary studies as a tool for efficient cross-cultural design*. www.amber-light.co.uk/resources/whitepapers/international_diary_studies_amberlight.pdf

For further discussion and explanation on the **practical implementation aspects of general Task Analysis and user requirements generation**, and for guidance on when to use a technique, the books noted below may be useful. Note that there are Software or Requirements Engineering textbooks which may describe similar techniques – but from a different perspective, not that of HCI.

Alexander, I. and N. Maiden (eds) *Scenarios, stories, use cases*. (2004).

Burns Wendell, J., K. Holtzblatt and S. Wood *Rapid contextual design*. (2004).

Cooper, A., R. Reimann and D. Cronin *About face 3*. (2007).

Mayhew, D. *The usability engineering lifecycle*. (1999).

Sommerville, I. *Software engineering*. (2007).

Wilson, C. *User experience re-mastered*. (2009).

If we want users to like our software, we should design it to behave like a likeable person

Alan Cooper

applications definition design development goals guidelines interactive interfaces iso process product requirements satisfaction software specified standards systems testing usability user

Chapter 4
Usability

Introduction » Usability » International standards » The Usability Profession » Summary

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- define and describe usability and usability goals
- discuss how to assess usability and know what usability evaluation entails
- describe the business benefits of usability
- demonstrate a good appreciation of international standards concerned with usability
- describe what a Usability Practitioner does.

Essential reading

Note: Further reading and websites are listed at the end of the chapter.

HCI textbooks

Shneiderman, B., et al. *Designing the user interface*. (2009) Chapters 1 and 2.

Sharp, H., Y. Rogers and J. Preece *Interaction design*. (2007) Chapter 14.

Dix, A., et al. *Human-computer interaction*. (2003) Chapter 7.

Introduction

'Usability Engineering' can be simply defined as the process of researching and testing software applications for ease of learning and use. A major problem, however, is not the process itself (as discussed in Chapter 2) but how to define what this 'ease of use' actually is. We can carry out usability testing but must first consider what we mean by 'usability'.

4.1 Usability

The term usability has become central to HCI and User-Centred Design, but rather less so for ID. It can be defined very generally as: 'Making systems safe, easy to learn and easy to use'. A later definition, derived from the ISO standard described below is more formal and specific:

> *The degree to which specific users can achieve specific goals in a particular environment with efficiency, effectiveness, satisfaction.*[1]

[1] *ISO 9241-11, Ergonomic Requirements for Office Work with Video Display Terminals – Part 11: Guidance on Usability.*

This is the definition used in many usability studies, especially those which were experimentally-based evaluations. It had the advantage of identifying quantifiable elements of usability through the measurement of efficiency and satisfaction factors, and led directly to the development of usability metrics which could be used for comparative testing of systems or interfaces. The more recent consensus is that usability is an approach to product development that incorporates direct user feedback throughout the development cycle in order to reduce costs and create products and tools that meet user needs. The definition of usability has thus been broadened:

> *The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.*

The addition of a definition of the design process in which usability is embedded is that:

> *Human-centered design is characterised by: the active involvement of users and a clear understanding of user and task requirements; an appropriate allocation of function between users and technology; the iteration of design solutions; multi-disciplinary design.*[2]

[2] *ISO 9241-210, Ergonomics of Human-System Interaction – Part 210: Human-centred Design for Interactive Systems.*

4.1.1 Aspects of usability

Usability goals may be set to measure and investigate specific metrics – does it (the software/system/application/interface/prototype) meet the defined usability criteria? Users need reliable systems that allow them to perform tasks effectively, achieve their goals efficiently and be motivated by having systems that are satisfying to use, resulting in productive work. Usability is the extent to which a product can be used effectively, efficiently and with satisfaction by specified users, for specified tasks in specified environments with the emphasis placed on the user and the system's ability to help them achieve their specified goals. A working prototype – or an implemented system – can thus be measured against this definition.

There are further aspects of usability which can be assessed, such as:

- How efficient is it? Does it perform tasks quickly? What percentages of tasks are successfully completed?
- How many errors are made? How much time is taken up in performing a given task? Once a user has learned to operate it, is a high level of productivity possible?
- How easy is it for the specified users to learn to use the system ('learnability')? Does a user work faster and better the more times he/she uses it? Can a user quickly start to work?

- How easy is it to remember how to use it from one session's use to another ('memorability')? Can a user return to it after a period of not having used it, without having to learn everything again?
- How flexible is it? Are there multiple ways to accomplish tasks?
- How robust is it? Does it have low error rates so that users make few mistakes? Does it have good feedback so that users can recover easily?
- How useful is it? Does it match the work that the user needs to do?
- How much are the specified users in control?
- How does it affect the user? Does he/she like it? Is it pleasing to use? Is it safe?
- How much mental effort does a user have to expend?
- How much help does it provide to the user?
- Does it allow for collaboration among users (and between users and others)?

User Experience goals may differ and the criteria to be fulfilled may be of quite a different order. Selecting terms like those below to convey a person's feelings or emotions can help designers understand the multifaceted nature of the User Experience.

satisfying	aesthetically pleasing	enjoyable	supportive of creativity	engaging	pleasurable
rewarding	exciting and fun	entertaining	provocative	helpful	surprising
motivating	enhancing of sociability	emotionally fulfilling	challenging	boring	annoying and frustrating

Whilst some of these aspects of usability and of User Experience are easy to understand, others require deeper consideration. Questions can be asked, including some about how the two differ and some about internal conflicts:

- Are some more important and critical than others?
- Is it more important for a system to be responsive, or to be consistent?
- Is it more important to be able to recover from errors than to be easily learnable?
- Can a system be both entirely flexible and easily learnable?
- Are there trade-offs between the two kinds of goals? For example, can a product be both fun and safe?
- How easy is it to measure usability versus user experience goals?

4.1.2 Measuring usability

The first ways in which usability could effectively be measured was through the use of metrics allied to standards (as discussed in Section 4.2.1 below). It was necessary to know:

- the criteria for choosing the most appropriate metric
- how to apply that metric
- how to best use the information it revealed.

The practice of employing more formal usability tests to assess software designs stems from the late 1970s engineering disciplines. Usability inspections, Heuristic Evaluations, field studies and Contextual Design are from the next decade and more psychological in nature. These techniques are used today and have changed little but the same, however, does not hold for either current technology or the user population, or even for the way in which modern interactive products and applications are designed and developed.

For many types of interaction, trade-offs must be made. Most industrial and commercial systems require that applications be very easy to learn in order to reduce training costs but that speed of performance, efficiency and low error-rate be maximised because of the number of transactions that take place. In these cases, subjective satisfaction can have a strong impact on user performance. Office, home and entertainment applications require that ease of learning, low error rates, and subjective satisfaction be paramount, since use is often discretionary and infrequent and the population consists of both novice and expert users.

Modern developments which create issues for usability testing are the type of exploratory, creative, and co-operative systems which characterise new games and gaming devices, mobile communications and applications and the always-on semantic web. Benchmarks are hard to describe for such exploratory tasks and for ambient devices but trust, privacy, responsibility and security are issues of importance. Ease of learning, feedback, transparency, error recovery and satisfaction are prime usability factors.

Ways of testing the usability features of new technologies can be built upon existing strategies and techniques; but how should the usability of the newer complex systems such as information and intelligence analysis or resource and logistics allocation be defined and tested? These types of system are increasingly being developed in high-cost life-critical systems (such as in medicine, air traffic control, nuclear reactors, power utilities and for the military). Although such systems are expected to demonstrate reliability and effectiveness, many of the interfaces are poorly designed, long periods of training are required because of the high cost of errors, and satisfaction is rarely considered. Future problems in such usability assessments are likely to be in determining the factors which contribute to information overload, or those which alleviate it by allowing data in complex information systems to be visualised in specific ways for specific types of users. What will contribute to the usability of systems which support humans in allocating attention efficiently from a multiplicity of information and information sources, whether in a real or a virtual world? How will usability then be tested?

4.1.3 Business benefits of usability

Very often, organisations do not completely track the total life-cycle costs for a software project, including expensive and hard-to-determine support costs, such as wasted employee time and other post-production factors. In reality, projects that have smaller up-front costs and short development cycles are often rewarded even if they result in failed, ineffective, or unusable products. There are very many real world examples of how usability can benefit a project – or how the lack of usability can severely harm it. The business benefits of adding usability to a product development process are that it can deliver the following:

- increased productivity
- decreased training and support costs
- reduced development time and costs
- reduced maintenance costs
- increased sales and revenues
- increased customer satisfaction.

4.1.4 Usability and standardisation

One way of ensuring that usability is of a high quality is by setting standards against which measures of a product's usability can be compared as part of the development process. Compliance with standards and directives can only be assessed using measurements. Such validated measurements (metrics) both act as a safeguard for users by providing an assurance of the quality of software and design as certified as meeting a standard, and support developers by mandating usability as an integral part of the design cycle.

4.2 International standards

Standards are formal agreements on a specific, finely-detailed topic enabling best practices to be codified and shared across industries, disciplines and national boundaries. One of the main purposes of international standards is to impose consistency, compatibility and safety. Standards can focus on processes, on describing principles or on making recommendations for achieving specific results, thus producing guidelines. Standards can also take the form of detailed specifications and authoritative prerequisites that must be met, thus creating mandated requirements. Available from the international organisations that publish them (ISO, International Standards Organization; ANSI, American National Standards Institute) or via the national standards organisations, standards are identified by a specific and unique number.

4.2.1 Standards concerned with usability

There are several international standards on usability-related topics, for establishing a User-Centred Design process or in evaluating the usability of a product. Usability has also been integrated into wider industry standards on software quality.

- Usability assurance standards provide guidelines on usability testing to ensure product usability.
- Human-centred design process standards describe activities which should be carried out to achieve good user interface design and usability, providing a basis for good practice.

Standardisation is not an easy activity and often takes many years of discussion and negotiation to be defined, and later, implemented.[3] The earliest working standards relevant in HCI, still referred to for ergonomic compliance, were the ISO 9241 series which detailed guidelines for user interface design and elements of computer hardware. The first mention of usability – and its definition – was in *ISO 9241-11, Ergonomic Requirements for Office Work with Video Display Terminals – Part 11:*

[3] *See Bevan, N. (2009) 'International Standards for Usability Should Be More Widely Used',* Journal of Usability Studies*, Vol. 4(3), May 2009, pp.106–13. http://www.upassoc.org/upa_publications/jus/2009may/bevan10.html*

Guidance on Usability. The most recent standard, *ISO 13407, User-Centred Design of Interactive Systems* has now been renamed and renumbered as *ISO 9241-210, Ergonomics of Human-System Interaction – Part 210: Human-centred Design for Interactive Systems.* ISO 9241 was the basis for many UCD methodologies, defining a general process for including human-centred activities throughout a development life-cycle. The approach was one of providing conditional guidelines, where designers were expected to judge the applicability of each guideline. The developments mean that the current standard, to quote:

> '*Provides requirements and recommendations for human-centred design principles and activities throughout the life cycle of computer-based interactive systems. It is intended to be used by those managing design processes, and is concerned with ways in which both hardware and software components of interactive systems can enhance human–system interaction*'.[4]

[4] *ISO 9241-210, Ergonomics of Human-System Interaction – Part 210: Human-centred Design for Interactive Systems. http://www.iso.org/iso/catalogue/catalogue_tc/catalogue_detail.htm?csnumber=52075*

For a development process to show conformance it must meet these requirements:

- Project planning shall allocate time and resources for the human-centred activities. This shall include time for iteration and the incorporation of user feedback, and for evaluating whether the design solution satisfies the user requirements.
- Relevant user and stakeholder groups shall be identified and their relationship with the proposed development described in terms of key goals and constraints.
- There are four linked human-centred design activities that shall take place during the design of any interactive system:
  - understand and specify the context of use
  - specify the user requirements
  - produce design solutions
  - evaluate.

4.2.2 Using standards

The very extensive guidelines specified in usability and UCD standards are derived from a very large knowledge-base put together by many individuals and international experts. Since conformance to a standard (and accreditation) can be achieved by following all the relevant guidelines and providing justification for why particular guidelines have not been adopted, they can be problematic for designers to use, as well as being time consuming and requiring detailed familiarity with the standard. However, guidelines as recommended by ISO can provide a starting-point for good practice in user interface design and give added weight to design decisions by its authoritative stance. Usability standards can be used as an evaluation stratagem, testing interfaces against guidelines or, in the earliest usability standards, against definitions of effectiveness, efficiency and satisfaction. ISO 9241-210 and its relatives can be used to assess if a project has adequately implemented human centred design or for objectively assessing an organisation's usability maturity.

4.2.3 Other relevant standards

Research-Based Web Design & Usability Guidelines published by the US Department of Health and Human Services. As quoted:

> '*This resource now contains 209 guidelines for effective Web design and usability and covers a wide range of Web site design issues, including home page design, page and site navigation, graphics and images, Web content organization, and effective Web content writing. Each guideline includes a Strength of Evidence rating that indicates how much research there is to support that guideline. It also includes a Relative Importance rating that shows how important that guideline is to the overall success of a Web site*'.[5]

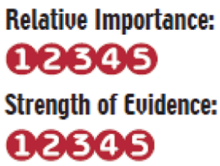

Figure 4.1 Illustrative 'Relative Importance' and 'Strength of Evidence' Guidelines[6]

W3C Web Accessibility Initiative (WAI) has become the basis for many subsequent national regulations (see Section 6.3.1).

British Standards Institute (BSI), BS 7000 series. Design Management Systems which emphasises the importance of design innovation across a range of industry sectors and includes the subsection *BS 7000-6: Managing Inclusive Design*[7] (see Section 6.2).

ISO 14915-1:2002, Software Ergonomics for Multimedia User Interfaces – Part 1: Design Principles and Framework. As quoted:

> '*…establishes design principles for multimedia user interfaces and provides a framework for handling the different considerations involved in their design. It addresses user interfaces for applications that incorporate, integrate and synchronize different media. … gives requirements and recommendations for the ergonomic design of multimedia applications mainly intended for professional and vocational activities such as work or learning. It does not specifically address applications outside this area, such as entertainment, although some recommendations can also be applicable in such domains.*'[8]

By its very nature, standardisation is an ongoing process and one such standard under development is *ISO/IEC FCD 25010, Software engineering – Software product Quality Requirements and Evaluation (SQuaRE) – Quality Model and Guide.*[9] In this, the concept of 'quality in use' has been broadened to embrace a wider set of issues than just usability and also considers different stakeholder perspectives (the end user achieving personal goals, the organisation achieving organisational goals, and technical support achieving maintenance goals).

There are specific standards for low-level implementation of interface elements, objects or widgets such as those for dialogue interaction. These

[5] *U.S. Department of Health and Human Services, Research-Based Web Design & Usability Guidelines. http://usability.gov/guidelines/index.html*

[6] *U.S. Department of Health and Human Services, Research-Based Web Design & Usability Guidelines. http://www.usability.gov/guidelines/guidelines_book.pdf*

[7] *British Standards Institute, BS 7000-6, Design Management Systems: Managing Inclusive Design. http://www.bsigroup.com/en/BS-7000-series/*

[8] *ISO 14915-1:2002, Software Ergonomics for Multimedia User Interfaces – Part 1: Design Principles and Framework: http://www.iso.org/iso/catalogue/catalogue_tc/catalogue_detail.htm?csnumber=25578*

[9] *ISO/IEC FCD 25010, Software engineering – Software product Quality Requirements and Evaluation (SQuaRE) – Quality Model and Guide: http://www.iso.org/iso/catalogue/catalogue_tc/catalogue_detail.htm?csnumber=35733*

define cursor control for text editing, icon symbols and functions for controlling multimedia software applications and for web browser toolbars, screen icons and symbols for personal, mobile, communications devices and for multimedia links and common gestures for text editing with pen-based systems' attributes in pen-based interfaces. Other standards also beyond the scope of this Study Guide include those for VR (guidance on tactile and haptic interactions and the controls of a virtual workspace), VRML, 3-D graphics, software, documentation and software ergonomics.

4.3 The Usability Profession

Many books and websites on usability give exhaustive advice on how to make a good business case for usability and how to effectively pursue a career as a usability analyst, professional or practitioner. To work well as one, it is necessary to understand and integrate what has been discussed above in fine detail:[10]

[10] *Kirakowski, J. (2003) 'Using ISO 13 407 as a guide to personal knowledge and competence': http://www.ucc.ie/hfrg/resources/iso13407_intro.html*

- how to define usability
- how to measure using metrics
- how to design studies (with a good knowledge of different types of data and statistics)
- how to carry out a wide range of studies and investigations
- how to interpret data
- how to present and report the ensuing findings.

The profession, however, is developing in other directions as the software design process matures. The viewpoint is changing to one which sees the usability professional as a member of a design and development team throughout the whole process, adding value to products, not just testing the end results. Nowadays, usability testing has a spectrum of related techniques: merely carrying out usability tests and producing lists of recommendations outwith a design team cannot guarantee design changes. It is only when the whole team attends to the needs of users that values change. Usability professionals now, as a matter of course, make use of 'soft' techniques such as ethnography and cultural probes, and engage in active scenario building, prototyping and envisioning in order to deliver what has become known as the 'User Experience'. The primacy of UX Design has become a strong driver for commercial interactive technologies and products – partly because of Apple's experiences with the iPod, iPhone and spin-offs, and partly because of the many successful e-commerce businesses which now exist. As an experienced usability practitioner explains:

> '*It was the symbol of a well designed product. While usability was only one of the factors that made first the Macintosh and then the iPod and iPhone household words, it was the most often mentioned factor in the growing market share that the Macintosh captured. Afterward, the high-tech world simply assumed that usability was essential. The issue became how much to invest in it. … A great customer experience increases brand engagement, which, in turn, increases customer loyalty and word-of-mouth advertising. Then, customers become a major part of making the product or service a success*'.[11]

[11] *Dumas, J. (2007) 'The great leap forward: The birth of the Usability Profession',* JUS, *Vol. 2(2), Feb., pp.54–60: http://www.upassoc.org/upa_publications/jus/2007_february/dumas_birth_of_usability_profession.pdf*

Summary

Quantifiable elements of usability can be defined through the measurement of efficiency, effectiveness and satisfaction factors. Such usability metrics can be used for comparative testing of systems or interfaces through the definition of usability goals. Standardisation of terminology, approach and techniques have had a great impact within the field of usability testing, on usability design and engineering approaches and on the Usability Profession itself.

A reminder of your learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- define and describe usability and usability goals
- discuss how to assess usability and know what usability evaluation entails
- describe the business benefits of usability
- demonstrate a good appreciation of international standards concerned with usability
- describe what a Usability Practitioner does.

Exercises

1. Give a definition of 'usability'.
2. What is meant by the term 'subjective satisfaction'?
3. Define and explain the meaning of each of these terms: efficiency, effectiveness, safety, utility and usability. Illustrate with examples from your own experience.
4. What would you expect to study in order to become an accredited Usability Analyst?
5. What codes of conduct are applicable to the Usability Profession?
6. Identify five benefits of standardisation: i) in general and ii) for accessibility in particular.
7. How have usability standardisation and definitions impacted on the study of Interaction Design and Human Computer Interaction?

Sample examination question

Discuss what you understand by the term 'Usability Engineering'.

Further reading

Detail on usability practices

Lindgaard, G. *Usability testing and system evaluation*. (1994) Chapters 1, 7 and 8.

Trenner, L. and J. Bawa *The politics of usability*. (1998) Parts 1 and 2.

Recent books on Usability Design and testing from experienced practitioners with a wealth of practical information

Tullis, T. and B. Albert *Measuring the user experience*. (2008).

Albert, B., T. Tullis and D. Tedesco *Beyond the usability lab*. (2010).

In Multimedia design, some guidelines with four different perspectives

EMMUS Project: '*WP3 Deliverable: multimedia and the user-centred design process*' (1999): www.ucc.ie/hfrg/emmus/wp3doc.htm

Client's View 'Understanding the interaction between Multimedia, usability and the Multimedia developer'

Developer's View 'Communicating with the client to get it right first time, and avoid unnecessary changes late on in development'

Multimedia Manager's View 'How to employ usability to improve productivity'

Human Factor's View 'How to apply the methods, and how to sell them to Managers and Clients'.

If the user can't use it, it doesn't work

Susan Dray

design evaluation experiment experimental group heuristic information interaction interface number problems subjects system task techniques testing usability user variables wizard

Chapter 5

Evaluation and usability assessment techniques

Introduction » Informal techniques » Heuristic Evaluation » Cognitive Walkthrough » Formal techniques » WoZ » Experimental evaluation » Choosing a technique » Professional input » Summary

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- describe specific usability evaluation techniques
- undertake simple assessments and interface design evaluations
- describe how to choose between evaluation methods and techniques.

Essential reading

Note: Further reading and websites are listed at the end of the chapter.

HCI textbooks

Shneiderman, B., et al. *Designing the user interface*. (2009) Chapter 4.

Sharp, H., Y. Rogers and J. Preece *Interaction design*. (2007) Chapters 8, 12 and 15.

Dix, A., et al. *Human-computer interaction*. (2003) Chapter 9.

Introduction

Usability evaluation is concerned with evaluating how well a design or implemented system meets its requirements. The process is central to User-Centred Design and major aims are to identify specific problems and to assess and test both design and implementation in terms of:

- the usability of a system
- the extent of system functionality
- the effect of the interface on the user.

Specifically, it can:

- identify the problems users have
- highlight design inadequacies
- provide suggestions for improving prototypes or recommendations for redesign
- determine if the system meets statutory safety requirements
- investigate productivity, usability and safety
- test a system against a competitor's products.

Analytical evaluation involves testing the design or implemented system against the specified user requirements and usability principles. Empirical evaluation involves carrying out experiments or empirical studies where data is collected and analysed. Early evaluation (also called 'formative') means undertaking an evaluative study before a runnable programme of any sort exists. This is carried out by the use of storyboards or mock-ups, or using pencil and paper prototypes. Late evaluation (also called 'summative') means testing when a fully implemented system or a runnable prototype is available. This can be carried out by both analytical and empirical means. Such techniques can also be divided by levels of formality and informality (also called 'discount' or cheap techniques). Yet another way of breaking the techniques down is to regard them as either expert-based where usability experts review a system and diagnose different problems or as user-based evaluation where users themselves test out an interface or system. For all, prototypes form the basis for evaluation of interfaces and designs.

5.1 Informal techniques

Informal evaluation involves evaluators working individually with a group of users looking either at the different parts of a prototype in a structured way, or using the system themselves to perform specific tasks in a step-by-step fashion. There are many techniques, the most well-known being the following.

5.1.1 Heuristic Evaluation

Heuristic Evaluation is a highly informal team-oriented discount usability method for discovering usability problems in a user interface design. It is one of a number of methods where end-users are not involved in evaluating the interface. The procedure is for a number of expert evaluators (a team of at least three to five HCI specialists)[1] to examine a given interface (a design or a prototype) and '…judge its compliance with recognised usability principles'[2] (i.e. a set of heuristics). Most of the heuristics originally come from Smith and Mosier's exhaustive guidelines,[3] severely pruned by Nielsen to a mere ten.

It is important that each evaluator examines the product individually – in order to remain independent and unbiased and because different evaluators will find different problems – before sharing findings and aggregating results. A typical evaluation session might involve an evaluator taking several passes through the interface, comparing the interaction activities against a list of heuristics which describe common properties of usable

[1] *For a discussion on evaluator numbers, see Nielsen, J. 'How to Conduct a Heuristic Evaluation': http://www.useit.com/papers/heuristic/*

[2] *Nielsen, J. 'Heuristic evaluation', in Nielsen, J. and R.L. Mack (eds)* Usability inspection methods. *(Wiley, 1994), p.26.*

[3] *Smith, S.L. and J.N. Mosier 'Guidelines for designing user interface software', Report ESD-TR-86-278 (The MITRE Corporation, 1986).*

interfaces (of course, other usability principles or heuristics can also be considered). The first pass is to allow the evaluator to get a '*...feel for the flow of interaction and general scope of the system. The second pass then allows the evaluator to focus on specific interface elements while knowing how they fit into the larger whole*'.[4] The specific procedure for a typical session length of 1–2 hours is to:

[4] *Nielsen, J. (1994) op. cit. p.29.*

- Look at the interface, inspecting the flow.
- Inspect each screen and its components (dialogue box, messages, etc.) one at a time.
- List any problems encountered.
- Repeat for two or more passes.
- Aggregate lists of problems from different evaluators/observers.
- Determine how severe each problem is and give a severity rating.
- Carry out a debrief and discuss the outcome with the design team.

What is produced is a checklist and associated severity ratings and may be a written or a verbal report. This list will identify areas in the design where usability heuristics have been violated, each problem being separately noted to lessen the risk of repeating the same design error. Such problems may be found within the overall structure of the interface, in a single location or in two or more locations that need to be compared, or there may be something that is missing. Severity ratings are used to allocate resources to fix problems and are a combination of frequency, impact and persistence. Calculated after all evaluations are completed (first individually and independently, and then as a group) severity ratings can be listed as:

0 = I don't agree that this is a usability problem at all.

1 = Cosmetic problem only: need not be fixed unless extra time is available on project.

2 = Minor usability problem: fixing this should be given low priority.

3 = Major usability problem: important to fix, so should be given high priority.

4 = Usability catastrophe: imperative to fix this before product can be released.

The outcome can then be used to redesign the interface and to fix as many problems as possible, bearing in mind that not all problems can be 'fixed'. The set of heuristics has been extended from the original set[5] to a more detailed set:[6]

[5] *Nielsen, J., and R. Molich 'Heuristic evaluation of user interfaces', Proceedings of ACM CHI'90 Conference (Seattle, WA, 1–5 April 1990), pp.249–56.*

[6] *Nielsen, J. (1994) op. cit.*

Simple and natural dialogue	Speak the users' language	Minimize the users' memory load	Consistency	Feedback
Clearly marked exits	Shortcuts	Precise, constructive error messages	Prevent errors	Help and documentation

Visibility of system status

- The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

Match between system and the real world

- The system should speak the users' language, with words, phrases and concepts familiar to the user rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

User control and freedom

- Users often choose system functions by mistake and will need a clearly marked 'emergency exit' to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

Consistency and standards

- Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

Error prevention

- Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

Recognition rather than recall

- Minimize the user's memory load by making objects, actions and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

Flexibility and efficiency of use

- Accelerators – unseen by the novice user – may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

Aesthetic and minimalist design

- Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

Help users recognize, diagnose and recover from errors

- Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

Help and documentation

- Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

The benefits of Heuristic Evaluation are that it is cheap (in that no special equipment is needed), fast (it can take only a day to apply) and easy-to-use (it can be taught in 2–4 hours). Multiple passes and teams of evaluators mean that, since every evaluator will not find every problem, numbers of good evaluators should find both simple and hard problems.

When compared to testing an interface or a design with users, Heuristic Evaluation is much faster and does not need the evaluator to interpret users' actions. On the other hand, user testing is much more accurate, taking into account real users and tasks. To be exhaustive, the two can be alternated since they find different problems and have different foci. A useful discussion on the benefit–cost ratio of discount usability techniques can be found in one of Jakob Nielsen's web columns.[7]

[7] *Nielsen, J. (1994) 'Guerrilla HCI: Using Discount Usability Engineering to Penetrate the Intimidation Barrier': http://www.useit.com/papers/guerrilla_hci.html*

5.1.2 Cognitive Walkthrough

The Cognitive Walkthrough technique was developed by Clayton Lewis, Peter Polson and John Rieman – and further modified by Cathleen Wharton – in the early 1990s as one of a number of discount or economical usability methods where end-users are not involved in evaluating the interface.[8] Based on requirements or code walkthroughs, the procedure is for an HCI specialist/expert to 'walk through' the design to identify potential ease-of-learning problems. The expert carries out a range of representative tasks in order of increasing complexity and notes all the problems ('design errors') encountered, showing where mismatches occur between the designer's and user's conceptualisations of tasks, lack of feedback for actions, and poor choices in terminology and labelling. Evaluation of the steps necessary to perform a task identifies the difficulties for users trying to learn an interface by exploration and can be performed on low-or high-fidelity prototypes. The goal is to improve the design, not to defend or explain the errors made.

[8] *Wharton, C., J. Rieman, C. Lewis and P. Polson 'The cognitive walkthrough method: A practitioner's guide', in Nielsen, J. and R. Mack (eds)* Usability inspection methods*. (Wiley, 1994).*

Preparation involves addressing these questions first:

- How is the interface defined?
- Who will be the users of the system?
- What task (or tasks) will be analysed?
- What is the correct action sequence for each task, and how is it described?

Given the design description of the user interface, answering those questions means:

- Making explicit assumptions about the user population and the context of use
- Determining a task scenario
- Identifying the task flow of a successful interaction.

Important information that must be captured is:

- What the user **must know** prior to performing the task
- What the user **should learn** while performing the task.

During the evaluation or analysis phase, each task and its component potential user actions are highlighted and a 'success' or 'failure' story told of why the user will perform that action based on his/her knowledge and skills. By imagining the user's experience and evaluating the particular choice-points in the interface, action-by-action and testing how the user accomplishes tasks, it is possible to detect confusing labels or options and likely user navigation errors. Those features important to explaining user behaviour are '*those that provide links between the user's task description and the correct action, and those that provide feedback indicating that the previous action advanced the user's progress.*'[9]

[9] *Wharton, C., et al. (1994) op. cit. p.112.*

Several questions can be asked of the user's choices to help focus on problems:

- Will the users try to achieve the right effect? They may know, 'What effect to achieve':
  - because it is part of their original task
  - because they have experience using a system
  - because the system tells them to do it.
- Will the user notice that the correct action is available? They may know, 'An action is available':
  - by experience
  - by seeing some control device (such as a button)
  - by seeing a representation of an action (such as a menu entry).
- Will the user associate the correct action with the desired effect, or see what produces that effect? They may know, 'An action is appropriate':
  - by experience
  - because the interface provides a prompt or label that connects the action to what they are trying to do
  - because all other actions look wrong.
- If the correct action is performed, will the user see that progress is being made toward a solution for the task? They may know, 'Things are going OK':
  - by experience
  - by recognising a connection between a system response and what they were trying to do.
- If an incorrect action is performed, will the user select a different control instead? Will the user understand the feedback to proceed correctly? What is the feedback for self-correction?

How could Cognitive Walkthrough be improved?

Although it can be a useful tool when used in conjunction with others, the technique is limited by its very nature. It is biased towards correct action sequences and is limited in implementation. Even experts will not find every problem and, moreover, it is hard for evaluators to realistically act as naive users.

Improvements may be possible (based on the original definitions) by:

- using experts familiar with the application domain as well as being usability experts
- making tedious form-filling less laborious (e.g. by asking less ambiguous questions and thus lessening the evaluator's load)
- allowing macros of actions – rather than every individual one – to be documented
- allowing the evaluator to document their goal structure to minimise task confusion.

5.2 Formal techniques

In a formal evaluation, a user will be given a series of tasks to perform in a controlled or laboratory environment. User performance and opinions will be recorded via observations and video, and by interviews, answering questions or expressing their attitude using a set of rating scales.

5.2.1 Wizard of Oz

'Wizard of Oz' evaluation involves a user interacting with a computer system which is actually operated by a hidden developer – referred to as the 'Wizard' after the hidden Wizard of Oz in the film and book of that name. This method is a specific type of observational evaluation, known as interactive observation. The wizard takes input from a user and simulates system output, during which process the user is led to believe that they are interacting with and directly controlling a computer system or real application – in reality usually a software prototype.

This type of assessment can be beneficial early in the design cycle and helps to identify user expectations and usability requirements. Because WoZ provides a way of evaluating prototypes without the need for full implementation, it is especially suited to exploring design possibilities in systems which are expensive or hard to implement and go beyond readily available technology – such as 'intelligent interfaces' which feature agents, advisors or intelligent assistants, and which use natural language.

Generic uses are in allowing early stage evaluation and providing real insight into a user's actions, gained from the simulated interaction. Specific benefits can be seen in providing information on which to base future designs:

- gathering information about the nature of the interaction
- testing which input techniques and sensing mechanisms best represent the proposed interaction
- testing the interaction of a physical device before building a functional model
- finding out the kinds of problems users might have with both devices and techniques.

Limitations include:

- The person playing the role of the wizard must appreciate the functionality of the proposed system in order to provide a convincing representation.
- The approach requires a high commitment of resources (people, staging, equipment, software tools, and task designs: the minimum required is the system under evaluation, a system to control the evaluation, two evaluators – wizard and recorder).
- Evaluators need intimate knowledge of the operation of the system in order to ensure a convincing representation.
- It can be problematic to evaluate systems with a large graphical interface element.

Carrying out a Wizard of Oz evaluation

The evaluation requires two evaluators: one to control the system, the other to monitor the user's actions. The wizard sits in a back room, observes the user's actions, and simulates the system's responses in real-time. For input device testing, the wizard will typically watch live video feeds from cameras trained on the participant's hand(s), and simulate the effects of the observed manipulations. Often users are unaware until after the experiment that the system was not real. The wizard has to be able to quickly and accurately discern the user's input, which is easiest for simple voice input or hand movements. The output must also be sufficiently simple that the wizard can simulate or create it in real time. The RESPECT[10] European Usability Support Centre project lists these general steps to conducting an evaluation:

[10] RESPECT, Wizard of Oz Prototyping: http://www.ucc.ie/hfrg/projects/respect/urmethods/wizard.htm

- Develop the Wizard of Oz prototype, design the tasks, and recruit the users.
- Allocate the role of wizard and the role of facilitator to the relevant staff.
- Assemble the necessary equipment and interconnecting software.
- Select appropriate users to test the prototype, and try to cover the range of users within the target population.
- Prepare realistic task scenarios for the evaluation.
- Pilot the evaluation procedure and ensure the wizard is well practised in playing the role of the computer.
- Ensure recording facilities are available and functioning.
- Conduct each session. The facilitator instructs the user to work through the allocated tasks interacting and responding to the system as appropriate.
- Conduct post-session interviews with the users, drawing upon pre-set questions and issues raised during the use of the prototype.
- Debrief the users and thank them for their co-operation.
- Analyse information obtained, summarise observations and user evaluations. Consider the themes and severity of the problems identified.
- Summarise design implications and recommendations for improvements, and give feedback to the design team. Video recordings can support this.
- Where necessary, refine the prototype and repeat the above process.

5.2.2 Experimental evaluation

Empirical evaluation means carrying out a study or experiment on a number of participants (or subjects, or users) to establish whether or not a system meets specific, testable user requirements. It involves users in assessing an interface for usability in order to demonstrate factors such as ease of use or ease of learning. It specifically provides metrics to test whether usability requirements are met. Approaches cover a range of subjective data collection activities (such as surveys, interviews and Protocol Analysis) to get users' opinions and identify preferences. These have all been discussed earlier (see Chapter 3).

Much research in the behavioural sciences, from which HCI procedures derive, is carried out in the form of an experiment which systematically manipulates one or more variables. The purpose is to gain more knowledge about some factor or variable that is of interest. In HCI this can be to gain knowledge about the user with the lowest cost to system development. Before committing to an interface style, it would be useful to know whether users prefer, say, pointing to typing on mobile device screens. Instead of a designer arbitrarily choosing one style, an experiment could identify which is the preferred user style.

Definitions

The most widely used empirical method for usability evaluation is an experiment where the assessor or experimenter tests a usability hypothesis under controlled conditions and where factors are manipulated.

a) Experiment
For an activity to be classed as an experiment it must meet three conditions:

- The person carrying out the experiment must manipulate (i.e. vary or systematically change) some feature of the situation.
- The manipulation must be made under controlled conditions. Any other variables which could potentially affect the subject's (i.e. the user's) behaviour are controlled by some means.
- The experimenter must observe the effects of the manipulation and must collect the data.

b) Variables
A variable is something that varies. It is a general – but measurable – characteristic property or an event, an object, or a person that can take on different values at different times depending on circumstances. It is important to be able to specify how any particular variable can be measured since the nature of the variable is intimately related to the operations by which it is measured. In the context of an experiment, variables are classified into 'dependent' and 'independent' variables.

c) Independent variables
An independent variable is one that is systematically varied by the experimenter. So if a researcher wishes to find out if there are different rates of learning by users of three different types of interface, then 'type of interface' would be the independent variable, of which there are three levels.

d) Dependent variables
The dependent variable is that on which a subject's performance is measured. So, if a researcher is interested in how subjects learn to use three different interfaces, then the variables that are assumed to reflect learning would be the dependent measures. For example, the number of attempts taken or the number of errors made in learning how to carry out a task would be the dependent variables. Dependent variables must have the following qualities. They must be:

- readily observable
- easily transformed into numbers and be economically feasible
- stable and reliable so that they do not vary under constant experimental conditions
- measure the behaviour they are intended to measure.

e) Data

Dependent variables can differ in their scale of measurement and so different types of data will be obtained. Some are qualitative ('soft'), others quantitative ('hard'). Soft measures correspond to classification groupings, subject rankings, impressions and attitude scales, whilst hard measures correspond to interval scales which measure time to complete a task, time to recover from errors, keystroke times, etc. Both types are used to measure, say, in a usability test, the time taken to complete a task and the number of errors made, but must also take into account if the user preferred one interface style over another.

f) Subjects

A subject is the person (or user) who participates in the experiment. Designers themselves should not act as subjects since generalising experimental results to a target population means that a random, representative sample of that population must be the subjects. As seen in Chapter 3, potential users will carry out tasks in a different way from that of the designer so an appropriate population should be sampled (i.e. subjects should be chosen from that population of users). Many factors must be considered in subject selection, some being:

- age, gender, handedness, etc.
- personality and attitudinal factors
- degree of skill and experience
- past history.

If factors are not systematically manipulated (i.e. treated as independent variables) then they must be controlled by making subjects as representative of the target population as possible. The number of subjects is a matter of choice but there must be enough subjects to provide 'sensitivity' in the research hypothesis (i.e. the ability to detect differences when they are present) since significant statistical results rely on the treatment variance being greater than expected by chance. It is felt that the minimum number of subjects in a controlled experiment should be no less than five or six but ten or more subjects is better.

g) Hypotheses testing

An experiment is carried out to:

- provide empirical support/evidence for a theory
- test hypotheses which arise from the theory
- validate results from previous experiences and experiments.

Experimental outcomes establish the cause-and-effect relationships between what is manipulated and the observed effects of that manipulation on what is measured. If at least two groups of subjects are treated exactly alike in all ways except one – the experimental treatment – then any differences observed in the behaviour of the groups can be attributed to the difference in the specific experimental treatment conditions.

The 'research hypothesis' is a statement of the purpose of the experiment. The null hypothesis is that the results are no better, on average, than the current situation. An experiment set up to manipulate independent variables and observe their effects on dependent variables will either confirm or reject the experimental hypotheses. So, a research hypothesis might be that users learn faster with a structured rather than free-form interface. The independent variable is the type of interface; the dependent variables might be the number of errors made and the length of time taken to complete the task and the users' preference ratings for each type of interface. The choice of dependent variable is directly related to the null and alternative hypotheses.

h) Experimental design
Experimental designs can differ in a number of ways:

- in the type of subjects, and the number that participate in the experiment
- in the number of independent variables to be manipulated
- in how subjects are assigned to different treatment conditions, these designs being named:
  - 'between measures' – in independent groups
  - 'repeated measures' – within the same group
  - 'mixed factorial' – an element of both.

The complexities of experimental design and the later data analyses with parametric and non-parametric statistics are not covered here but more information can be found in the Further reading given at the end of this chapter.

i) Procedure
The way in which an experiment is carried out is called the 'procedure' and must be described in full in any write-up so that it can be replicated by another investigator. The 'experimental design' is the specific plan for conducting an experiment.

- A basic requirement is that an 'artefact' exists to be tested.
  - For experimental evaluation this can be a prototype or simulation and can be based on a Usability Specification Table (i.e. the observed results from defined features with actual values filled in after the evaluation sessions).
- There must be objective benchmark tests to measure typically representative tasks, e.g.:
  - throughput (a measure of productivity)
  - execution time (time taken to perform operations)
  - accuracy (a measure of precision).
- There must be a controlled investigation of a specific aspect of an interface with manipulation of one or two independent variables, for example:
  - user experience, interaction style.

Carrying out an experimental evaluation

The process is to:

- formulate hypotheses about the different interfaces
- list all the variables which might affect the results of the experiment
  - decide on the independent variables (and their levels), the dependent variables and which variables need to be controlled by some means
- decide on the experimental design, or data collection method

  - select subjects or users
  - devise a set of tasks that will enable the hypotheses to be tested
  - decide on the appropriate statistical or other analysis
- measure dependent variables
- collect quantitative data from users
- analyse data using statistical tests
- derive metrics and draw comparative conclusions
- write up the study and describe what was found.

5.3 Choosing a technique

Evaluation methods range from formal to informal. The selection of method/s will depend on goals at particular stages of the design process. So, for example:

- to meet a specific requirement one could use Heuristic Evaluation
- to meet specific usability targets one could use benchmark tests
- to choose from alternative designs one could use laboratory experiments
- to inform the early stages of design one could use scenarios or field studies.

Different strategies can also be delineated based on activity classifications:

- Observing users, carried out through:
  - Observation, as an outsider or insider; in a controlled laboratory environment (or taking think-aloud recordings) versus in a natural environment, examining the people, places, and things involved in the task.
  - Indirect observation via interaction logging; user diaries or journals.
  - Interpretation through grouping together of qualitative notes, or by statistical analysis of quantitative data to find incidents of note, patterns, or groupings.
- Asking users, to obtain facts, behaviour, beliefs and attitudes through:
  - Interviews – open or unstructured; structured; semi-structured; individual; group; focus group.
  - Questionnaires – specific/structured questions for large samples.
- Testing users – but note that there are differences between user testing and experiments.
  - An experiment is about searching for new knowledge and has independent and dependent variables. Issues of control and repeatability are important.
  - Testing requires that goals be determined, questions decided upon, users selected, tasks developed, and the test itself run. Issues to be focused on will be task-based questions, the navigation trail made by users and feedback on user satisfaction through a post-test questionnaire.

- Modelling users:
  - Design inspections by an expert evaluator, rather than a user, such as Heuristic Evaluation and Cognitive Walkthrough.
  - Predictive models such as GOMS, KLM, and Fitt's law. These formal analytic methods are described in detail in HCI textbooks. They assess the cognitive skill and knowledge required to use an interface based on psychological models of the user. They can be used to predict performance times to carry out certain tasks but have some problems in usage, such as scalability and dealing with errors and complex behaviour.

It can be hard to finally decide on which factors to concentrate when choosing a technique. The authors of HCI textbooks give some guidance based on factors such as goals, resources and immediacy of response.[11] More precise and tailored guidance is given by Usability Professionals (companies, consultancies or individuals) in the many websites and blogs available (see Preface for a suitable list, and Further reading texts for relevant books). The actual choice will depend on specific contexts. In a real-work situation, however, there will be a company process to follow, the choice of technique will be a team decision and formal costings will be taken into account. In terms of the choice of technique for a student project, the decision is a simpler one and should factor in realistic timings, the number of potential test users, statistical expertise, availability of resources and match to the domain being investigated.

[11] *See Sharp, H., Y. Rogers and J. Preece* Interaction design*. (2007); and Dix, A., et al.* Human-computer interaction*. (2003).*

5.4 Professional input

As a usability specialist or Interaction Designer, it is critical to understand the potential users and scenarios. Those domain experts must be partners in the evaluation and throughout the planning, design and development phases. Usability specialists tend to focus on issues of effectiveness, efficiency, and satisfaction, but they also work with specialists who consider as paramount: utility, collaboration, creativity and innovation, interaction, iteration, and situation awareness. Evaluations ideally should not be carried out simply by being passed from one specialist to another but in teamwork, as a collaborative endeavour.

Summary

Evaluation occurs at different stages of the design process and assesses different aspects of design. At the early design specification stage, it is **formative**, before implementation is finalised. At the later design implementation stage, after a runnable program has been produced, with a full prototype or the final system, it is **summative**. By its very nature, however, all evaluation is highly iterative. Evaluation paradigms for testing systems and interfaces can be informally classified:

- 'quick and dirty' – fast, informal data
- concerned with usability testing – carefully controlled
- field studies – situated in natural conditions
- predictive – actual users not required.

A reminder of your learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- describe specific usability evaluation techniques
- undertake simple assessments and interface design evaluations
- describe how to choose between evaluation methods and techniques.

Exercises

1. Compare and contrast the main evaluation methods used in User-Centred Design.
2. In a table format, draw up the benefits and drawbacks of:
   a) formal
   b) informal evaluation.
3. What is the difference between formative and summative evaluation? Classify all the HCI evaluation techniques you know about as formative or summative.
4. Describe some situations in which you would use lists of heuristics.
   ◦ Which do you think are most intuitive?
   ◦ Which do you think you might find easiest to assess?
   ◦ Which do you think you might find hardest to assess?
5. Design separate experiments to assess the problems novices and experts might have in learning to use a new interface design to an existing application.
6. Which of the following four competing interface designs might be the best for novices and which for experts:
   i. has no help facility
   ii. has a paper-based manual only
   iii. has an online help index
   iv. has an online context-sensitive assistant?
7. What are the outcomes of an experimental and video laboratory usability evaluation? How might you best persuade management to take note of the findings of such a study?
8. Give two reasons why formative evaluation must be low cost.

Sample examination question

Describe in full two informal usability evaluation techniques. What are the differences between the two, and for which types of interface might you employ each?

Further reading

There is a very large range of methods, stemming from long-standing psychological experimentation, that can be used to test and evaluate interfaces. The basics have been presented above but, when carrying out such experiments as part of project work or in a future job, greater information and expertise is required.

For explicit detail concerning issues such as participant/subject choice; ethical considerations; design; and how to carry out procedures in experimental design

Cairns, P. and A. Cox *Research methods for human-computer interaction*. (2008) Chapter 1.

Lazar, J., et al. *Research methods in human computer interaction*. (2009) Chapters 2, 3, 10, 14 and 15.

Norman, K. *Cyberpsychology*. (2008) Chapter 4.

Lindgaard, G. *Usability testing and system evaluation*. (1994) Chapter 6.

STC (2001) *Topics in usability*: www.stcsig.org/usability/topics/ethics.html

For statistical analysis and detail on how to use statistical methods in usability research

Cairns, P. and A. Cox *Research methods for human-computer interaction*. (2008) Chapter 6.

Lazar, J. et al. *Research methods in human computer interaction*. (2009) Chapters 4 and 11.

Lindgaard, G. *Usability testing and system evaluation*. (1994) Chapter 3.

For questionnaire design and methodology, and for details on survey techniques

Cairns, P. and A. Cox *Research methods for human-computer interaction*. (2008) Chapter 2.

Lazar, J., et al. *Research methods in human computer interaction*. (2009) Chapter 13.

Lindgaard, G. *Usability testing and system evaluation*. (1994) Chapter 5.

Online questionnaire design

User Interface Usability Evaluation with web-based questionnaires available from Gary Perlman's hcibib.org: http://oldwww.acm.org/perlman/question.html

Kirakowski, J. (2000). Questionnaires in Usability Engineering: A List of Frequently Asked Questions: www.ucc.ie/hfrg/resources/qfaq1.html

For interview techniques and strategies; and for information on focus groups

Cairns, P. and A. Cox *Research methods for human-computer interaction*. (2008) Chapter 2.

Lazar, J. et al. *Research methods in human computer interaction*. (2009) Chapter 8.

Lindgaard, G. *Usability testing and system evaluation*. (1994) Chapter 5.

Jones, M. and G. Marsden *Mobile interaction design*. (2006) Chapter 5.

For the use of video-based techniques

Heath, C., J. Hindmarsh and P. Luff *Video in qualitative research*. (2010).

For newer techniques such as eye-tracking and physiological research in HCI, evaluation of VR and VE systems, evaluation of mobile technologies

Cairns, P. and A. Cox *Research methods for human-computer interaction*. (2008) Chapter 3.

Jones, M. and G. Marsden *Mobile interaction design*. (2006) Chapters 4 and 5.

Lazar, J. et al. *Research methods in human computer interaction*. (2009) Chapter 13.

Sutcliffe, A. *Multimedia and virtual reality*. (2003) Chapter 6.

For guidance and explanation of the practicalities of usability assessment and evaluating interactive products, these published books are useful:

Albert, B., T. Tullis and D. Tedesco *Beyond the usability lab*. (2010).

Cooper, A., R. Reimann and D. Cronin *About face 3*. (2007).

Goodwin, K. *Designing for the digital age*. (2009).

Tullis, T. and B. Albert *Measuring the user experience*. (2009).

Wilson, C. *User experience re-mastered*. (2009).

The real issue is understanding: things we understand are no longer complicated, no longer confusing.

Donald Norman

accessibility children computer cultural design disabilities interaction interface issues mobile needs older people population requirements technologies universal usability user web

Chapter 6
Designing for different users

Introduction » Culture and universal usability » Inclusive interaction » Accessibility » Summary

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- understand and be able to describe the concepts of Universal Usability and Universal Design
- describe the needs and physical requirements of differing user populations
- discuss how changes in user populations can impact on Interaction Design.

Essential reading

Note: Further reading and websites are listed at the end of the chapter.

HCI textbooks

Shneiderman, B., et al. *Designing the user interface*. (2009) Chapter 1.

Sharp, H., Y. Rogers and J. Preece *Interaction design*. (2007) Chapter 4.

Dix, A., et al. *Human-computer interaction*. (2003) Chapter 10.

Introduction

Designing interactions, interfaces and applications for new technologies is not just about designing for a set of given users, or for generic populations. As the use of the internet and technology mediated communication increases exponentially across the world, Interaction Designers and developers – as well as HCI researchers – are faced with new challenges. Users now vary along numerous dimensions but certain classifications can be identified to help define design boundaries:

- culture – mobile communication and web interactions especially by those in non-Western and non-English-speaking cultures
- age – computer usage by children and teenagers, by the very young and by an older generation

- impairment – widespread technology use by those with varying levels of cognitive and physical disabilities.

This classification provides a dimension of cultural diversity and accessibility on the one hand but also means that some boundaries are crossed; that between certain physical impairments and the older user is one such. It is not an easy task to achieve 'Design For All' since requirements in one area can affect requirements in another. When designing for a broad range of abilities (also variously called Accessible Design, Universal Design, and Inclusive Design) there are many factors to consider. We shall look at these, one by one, under three general headings.

6.1 Culture and Universal Usability

The World Wide Web is truly a world-wide phenomenon that has swiftly brought about global distribution of products and services. Appealing to and catering for a culturally-diverse international audience is now both a business and design necessity. The growth rate of mobile phone ownership and usage in Africa and India now bears comparison with that of Europe and the Americas – soon it can be envisaged that there will be very few people left on the planet who do not have access to a mobile phone. To achieve work, home and mobile-product success, developers of user interfaces for the web, information appliances and mobile devices must reach across culturally diverse user communities. The pertinent concept is not the specific ownership numbers (statistics change) but what this means in terms of design issues and specific cultural associations.

> '*In 2007, 77% of Africans had a mobile phone, while only 11% had computer access. So, many of the people who have been acquiring mobiles in Africa are not computer-literate. Some are also unfamiliar with the concept of information hierarchies, making it hard for them to understand hierarchical menus. Concepts more familiar to their culture and the local ways of doing things may instead become more common-place.*'[1]

[1] *Harper, R., et al.* Being Human: HCI in the Year 2020 *(Microsoft Research, 2008): http://research.microsoft.com/en-us/um/cambridge/projects/hci2020/download.html*

Whilst we concentrate on the design issues in this guide, there are many current movements and international initiatives towards creating a more equal worldwide information society with less Western bias and more widespread opportunity for digital connectivity. These are generally described as 'Bridging the Global Digital Divide' and are endorsed by many in the HCI field through initiatives such as 'One Computer per Child' but are beyond the scope of this Study Guide.

Cross-cultural design

Interface designers, as we have seen in previous chapters, should not rely on intuition or personal experience when designing multiple sites for culturally different user groups, but should consider their own cultural orientation and attempt to understand the preferred structures and processes of other cultures. In practice, it can be most useful to adopt the simple approaches of:

- focusing on, say, website characteristics which are sensitive to demographic differences within the user base
- determining to what extent international or universal approaches might be better than localised, customised designs.

If the user-interface design process acknowledges user diversity, practical questions arise:

- How can the differences between cultures be understood?
- What impact might these cultures have on the understanding and use of web-based communication of content and tools?
- What are the needs, wishes, preferences, and expectations of different cultures?

There have been many investigations of cross-cultural design or cultural diversity. Guidelines have been developed and research published (see Further reading list). The basis is often the work of Geert Hofstede[2] who applied some of his well-known Cultural Dimensions to web user interfaces to illustrate his concepts. He originally conceptualised culture as 'programming of the mind' in the sense that certain reactions were more likely in certain cultures than in others, based on differences between base values of the members of different cultures. He proposed that all cultures could be defined through three – and then later another two – dimensions:

[2] *Hofstede, G.* A Summary of my ideas about national culture differences. *(2006): http://www.uigarden.net/english/national_culture_differences*

- Power distance (the degree of emotional dependence between leader and subordinate)
- Collectivism/Individualism (integration into cohesive groups versus being expected to look after oneself)
- Femininity/masculinity (which could be interpreted as 'toughness' versus 'tenderness')
- Uncertainty avoidance (in Western cultures)
- Confucian orientation (in Eastern cultures).

This categorisation can effectively deal with some basic differences and misunderstandings but it is still very much the case, as stated by Aaron Marcus, a long-time advocate for cross-cultural usability, that:

> '*Current design is based on psychological and social models drawn from European and American research traditions. Cultural anthropologists and designers are reconsidering the applicability of psychological and social models by identifying cultural preferences and value orientations more prevalent in Asia, Latin America, the Islamic world and Africa. Their theories complement, and sometimes revise, current principles, including the design of metaphors, mental models, navigation, interaction and appearance.*'[3]

[3] *Marcus, A.* Globalization of user-interface design for the web. *Proceedings of the 5th Human Factors and the Web conference (3 June 1999, Gaithersburg, MD) (1999): http://www.amanda.com/resources/HFWEB99/HFWEB99.Marcus.html*

These are the building blocks of cross-cultural design but the problem still lies in obtaining usability requirements. There have been some reported ethnographic studies of the cultural impacts of new technologies in remote rural locations in India or Africa but relatively few successful real implementations so far. One is described in the Case Study recommendation at the end of this chapter. In addition to the generic design approaches discussed in earlier chapters, or predictively applying Hofstede's model when proposing designs, one recommended approach is to undertake local website audits to identify the elements that are indigenous to the target culture.[4]

[4] *Smith, A., L. Dunckley, et al. 'A process model for developing usable cross-cultural websites',* Interacting with Computers *Vol. 16(1) 2004, pp.63–91.*

Major problems which arise in multi-cultural design and development are often to do with evaluation. Possible solutions are to:

- Test with real users in the target culture – although there is often limited access to representative users for usability testing in laboratories and there can be serious logistical problems.
- Evaluate against cross-cultural heuristics – although existing guidelines must be checked for cultural bias.

The situation is constantly changing as advances in technology make remote user testing across cultures and remote geographical locations both feasible and lower in cost. The more recent expansion of usability consultancies in Asia and India (often local and geographical outposts of larger organisations) is overcoming existing biases and providing professional services. There is a newly published guide on the topic of usability evaluation in the field by a respected practitioner.[5] The growth of mobile applications is also strongly pushing culturally-sensitive design to become a necessary part of the whole Interaction Design process as a matter of course.

[5] *Schumacher, R.* The handbook of global user research. *(Morgan Kaufmann, 2009).*

6.1.2 Globalisation and Localisation

There are design features which can effectively be dealt with in terms of Globalisation and Localisation. 'Internationalisation' refers to the geographic, political, and linguistic or typographic issues of nations/groups of nations and is most evident in shared standards endorsed by ISO or W3C.

What is more relevant for ID is 'Globalisation', which refers to the worldwide production and consumption of products and includes issues at international, intercultural, and local levels. It can be thought of as a process for enabling different national versions of a product – making that same product fit many international markets – by creating a base design that can be adapted for different markets.

Localisation is the process of adapting a product to a particular language or culture, using 'local' interface elements to create the desired design. Making different versions of the same product for different international markets can be cost-effective if only a small number of different countries are involved and is, in theory, less difficult to achieve. The adaptations will be at the technical, national and cultural levels but are not regulated in the same way as are international standards and recommendations.

Some features of cultural and national diversity which can be easily addressed and suitably amended include aspects such as language and verbal style, format conventions, the use of colour, and layout and orientation. These can be specific to some or all of:

- characters, numerals, special characters, and diacriticals
- capitalisation and punctuation, pluralisation, grammar and spelling
- left-to-right versus right-to-left and vertical input and reading
- names, titles and honorifics
- date and time, numeric and currency formats, weights and measures, telephone numbers and addresses
- social security, national identification, and passport numbers
- icons, buttons, symbols

- colours and aesthetics
- etiquette, policies, tone, formality, metaphors.

6.2 Inclusive Interaction

Inclusive Interaction Design means understanding the needs of all potential users and exploring the difficult design problems in providing enabling technology for users with special needs. The aim of such 'Design for All' or 'Universal Design' is to make working and living with IT easier for everyone by making products, communications, and the built environment more usable by as many people as possible at minimal cost. Creating accessible interfaces and applications for those with physical or cognitive impairments brings a number of basic human–computer interface design issues to the fore but results in benefits for people of all ages and abilities. Research into accessibility requirements has long been a part of HCI (stemming mainly from engineering and rehabilitation psychology) but it is now seen as a multi-disciplinary area of practically-oriented approaches, such as how to measure inclusion and new techniques for rehabilitative and assistive technologies. The prime motivator is by necessity and historical precedent the field of healthcare and 'wellness management' and the overriding aim is to reduce exclusion and interaction difficulties.

The commonly used definition for what we shall now refer to as Inclusive Design is:

> '*The design of mainstream products and/or services that are accessible to, and usable by, as many people as reasonably possible on a global basis, in a wide variety of situations and to the greatest extent possible without the need for special adaptation or specialised design.*'[6]

[6] RNIB Digital Accessibility Team, Tiresias.org, Making ICT accessible. http://www.tiresias.org/index.htm

The growth of Inclusive Design approaches can be attributed to factors such as:

- technology and communication growth, especially in telemedicine and healthcare
- an increase in the older population
- adoption of new technology by elders
- expanding consumer expectations
- new legislation and updated governmental procurement policies
- new legislation such as the UK Disability Discrimination Act or the US Americans with Disabilities Act.

It is generally considered that the number of people with special needs is larger than the number of people with disabilities (about 10 per cent of the UK population) since it includes children (about 20 per cent), older people (about 15 per cent) and people who are left-handed (about 10 per cent).[7]

[7] The percentages are indicative figures produced by the UK RNIB.

We shall first briefly look at the first category ('children') then deal in more detail with the second ('the elderly') and in the next section with the third (accessibility issues for the 'less abled'). We shall not look at requirements for left-handed users.

6.2.1 Children as users

The majority of work into children as users of computer technology comes from educational technology and game-based learning (so-called 'serious games'). There is such a wealth of information and research that it is not possible to cover the area adequately in this Study Guide; Further reading is provided for those interested in this topic.

Child–computer interaction and design for children is about understanding the specialised needs of children (not just children in junior schools but also toddlers and teenagers), and how to design for them as a diverse group (i.e. young people of different gender and ages, with or without special needs, from different cultures or ethnic groups). The main focus is on design requirement methods and suitable evaluation approaches. Areas of investigation range from applications in emerging technologies to the impact that such technologies can have on children's lives and personalities in schools, at home, in hospitals or in public spaces.

Potential applications include:

- innovative educational simulations and interactive games
- mobile communication devices, wireless embedded technologies and robots
- accessible fabrication devices and 'smart' materials
- authoring tools and programming languages such as Scratch[8]
- interactive playgrounds and intelligent environments.

[8] *MIT, Scratch. http://scratch.mit.edu/*

A particular feature is that there are many social, ethical and cultural issues to be considered. This research area requires quite a different design approach in that spending time with children and attempting to see the world through their eyes is an essential part of the design process when assessing what is possible and important for children. Since interpretive products designed for children are increasingly embedded in their lives and school experiences, the need to ensure that such products are safe as well as being effective – and entertaining – requires different methodologies for determining both how children use interactive products and how good that interaction and that technology is for a child.

6.2.2 Older users

The number of older people using the World Wide Web as part of their daily social lives is now large and fast-growing. These discretionary users have very different life experiences and interaction strategies from those who have been brought up in an interactive, always-on internet world. It is not that older people use different applications, or have vastly different requirements; it is more that the levels of skill, the underlying assumptions of requisite knowledge and the physical dexterity needed can be very different. There are also elderly people who are not discretionary users: they have to accept assistive technologies as part of growing older, or as part of a necessary healthcare regime. Novel technologies designed for older people do not necessarily fully take into account their needs and wants and incorrect assumptions can easily be made. Many older users are also naïve computer users and find unexpected difficulties in interacting with everyday technologies.

One way in which these problems are brought effectively to life comes from the Utopia Trilogy work of the research group at Dundee University. As leaders in 'Extra-ordinary HCI' they pioneered a new form of educational and research resource, namely live theatre and video. Theatrical techniques can capture attention, change attitudes and convey information in an engaging and powerful manner. They have been effectively used to raise awareness of Inclusive Design issues through facilitating discussion on the challenges faced by older people. Live theatre has been demonstrated as part of requirements gathering exercises and for raising awareness at international conferences.[9] The Utopia Trilogy produced professional narrative videos with actors playing the part of users, dramatising stories of older people's experiences with technology to illustrate some of the problems older people are confronted with as they become part of the digital world. The videos can be accessed online and demonstrate practical and cognitive difficulties as described below:

[9] Presented at the 2008 CHI conference, Florence, Italy. http://www.chi2008.org/program.pdf

Peter and Jane buy a Webcam
Jane feels confident in using her son's old computer for email and word processing, but has decided to buy a web cam so she can talk to her daughter and grandchildren in Australia. She has some interesting experiences with trying to install this equipment and the associated 'help line'.

Sandy's Mobile Adventure
Sandy never uses the mobile phone his daughter has given him until he is locked out of the house – following this experience he develops a crib sheet [i.e. a set of instructions he has written down], but he still remains less than confident in the use of mobile phones.

Email Experience
Peter is jealous of his wife's confidence in using a computer, and, while she is out, tries to use it with little success. He signs up to a computer class, but still finds great difficulties. He finally succeeds when using a piece of software which has been specially designed for simplicity, clarity and ease of use.

Relative Confusion
When Jack and Tommy decided to surprise their sister Maureen with a digital TV system, the one thing they didn't reckon with was the minefield of bewildering new technology they were about to enter. One thing it won't be is… 'A PIECE OF CAKE'.

Relatively PC
What are the challenges the Digital Economy presents to older people? How do you personalise your computer when you cannot even switch it on? What are the perils of online banking? And just what are you going to do with all that spam? Tommy, Jack and Maureen attempt to enter the digital age … with a little help from Skippy!

Newell, A. Educational videos: 'Examining the issues older people have in using modern technology', *Interfaces 80*, Autumn 2009, pp.18–19: http://bcs-hci.org.uk/files/usermedia/file/interfaces_69on/interfaces80.pdf

The issues illustrated in clips from the video can be divided into: issues arising from the design itself; the things people themselves worry about; other factors which can be regarded as age-specific.

- Interaction design issues:
  complex interaction methods; disastrous functions; user feedback; highlighting of information; labelling and colour coding; icon design; language; metaphors; modal errors and the effect of cognitive load; patronising design; standardisation of interaction metaphors and methods; the usability of manuals; visual distractions.
- Things people worry about:
  dangers in the digital world; identity theft; remembering PIN numbers; the consequences of jargon; too much choice; undo methods and operational anxiety; user confusion; warning messages; what is the ‘internet’?; why have a computer?
- Age specific:
  computer classes; inter-generational differences; lack of understanding; reasons for technophobia; the effects of poor eyesight and manual dexterity; the interaction of poor eyesight and memory; the rate of learning new functionality; visual problems.

Dealing with each of these types of issue requires different approaches. Some problems arise simply from bad design and a lack of appropriate sensitivity to the needs of this user population; some can be the result of thoughtlessness, carelessness and incorrect assumptions about the knowledge and abilities of all of the user population. The impacts of poor memory, poor vision and/or less dexterity are not restricted to the elderly and it is these physical attributes which can be most easily corrected by concentrating on design for accessibility.

6.3 Accessibility

ID has been traditionally concerned with the design and development of interfaces which will be usable by the average person. An implicit assumption is that the user resembles the designer but Universal Usability means that we can no longer identify an average user – there are so many different physical abilities and now so many interaction locations given the ubiquity of mobile technologies. A compromise must be made or multiple versions of applications or systems must be built. For about 90 per cent of the population, standards for interface issues associated with physical workstations in offices (where a great many users still spend much of their time), are available. But physical anthropometric data about humans (as is used in ergonomics and upon which standards are based) is not enough; we must also deal with dynamic measures such as reach, strength or speed. There is wide variance in any user population’s senses:

- Vision: Depth, contrast, colour blindness, and motion sensitivity
- Touch: Keyboard and touchscreen sensitivity
- Hearing: Audio and sound.

Those with wider variations than the norm are deemed to have impairments at various levels of severity – in mobility and manual dexterity, visually, in speech and hearing.

6.3.1 Designing for special needs

A widely used definition of Universal Design is that it means designing products which can be effectively and efficiently used by people with a wide range of abilities or in a wide range of situations. Allowing for maximum variability on the range of abilities and characteristics, but still maintaining efficiency in use, underlines the relationship between universal design requirements and the cost–benefit ratio of producing a product. Increasing accessibility will usually make a product more usable for all but extra development costs may not always be justified by that increased accessibility. There are several advantages to designing for a broader range of abilities, rather than for more limited user groups:

- products can have a broader market and application area
- the legal and ethical rights of the user/consumer are upheld and legislation adhered to
- it can contribute to a more 'open' society, with fewer disability products, reducing stigmatisation and discrimination.

The Web Accessibility Initiative (WAI) was one of many developing guidelines for overall accessibility of websites and associated software applications to make it easier for people with disabilities to use the internet. As they and the UK's Royal National Institute for the Blind (RNIB) state:

> '*Given the Web's increasingly important role in society, access to the Web is vital for people with disabilities. Many of the accessibility solutions described in WAI materials also benefit Web users who do not have disabilities.*[10]
>
> *… people with for example a sensory handicap may have the same requirements to a product as other people working in a specific environment, or with a specific task. This calls for an understanding of human-computer interaction as depending on a set of human abilities which will vary across the total population. A better understanding of this interaction requires an analysis of human characteristics rather than developing a typology of people. So, then instead of finding the requirements that say blind people may have to a specific product, one should assess the functional characteristics of vision during interaction with the product.*'[11]

6.3.2 Guidelines

One of the simplest ways in which designers can successfully cater for disability and impairment can be by using software such as 'aDesigner', a disability simulator that helps web designers ensure that their pages are accessible and usable by the visually impaired.[12] The W3C initiative, 'How People with Disabilities Use the Web', has a set of descriptive scenarios which illustrate how disabled people with impairments of various kinds might use web-based facilities and the amendments which might be made to help them.[13] The more common, and recommended approach, is to adhere to developed standards.[14]

- The Web Content Accessibility Guidelines (WCAG) is a guide for making websites accessible to people with disabilities.
- The Mobile Web Best Practices (MWBP) is a guide for making websites usable from a mobile device.

[10] W3C. How People with Disabilities Use the Web: http://www.w3.org/WAI/EO/Drafts/PWD-Use-Web/#shopper

[11] RNIB Digital Accessibility Team, Tiresias.org, 'Making ICT accessible': http://www.tiresias.org/index.htm

[12] 'aDesigner': http://www.alphaworks.ibm.com/tech/adesigner/

[13] W3C. 'How People with Disabilities Use the Web': http://www.w3.org/WAI/EO/Drafts/PWD-Use-Web/#shopper

[14] RERC-AMI: D2.2: Universal Design Guidelines: http://www.rerc-ami.org/ami/projects/d/2/udg/

- The amended US Rehabilitation Act Section 508 requires federal agencies to make their electronic and information technology accessible to people with disabilities.[15]

[15] *Section 508 Tools and Resources: http://www.section508.gov/*

The WCAG explain how to make content accessible to people with disabilities and website evaluation tools are offered. These guidelines provide 65 website checkpoints for web accessibility, prioritised in three levels. Websites must comply with the first 16 (Priority 1) checkpoints to ensure the minimum level of web accessibility and obtain A-grade certification. The second level (Double A certification) has 35 checkpoints at Priority 1 and 2 while the last level (Triple A certification) has 24 checkpoints of the more difficult to achieve features at Priority 1, 2 and 3.

W3C WAI-A WCAG 2.0 | W3C WAI-AA WCAG 2.0 | W3C WAI-AAA WCAG 2.0

Figure 6.1 W3C Web Content Accessibility Guidelines (WCAG) 2.0 conformance logos[16]

[16] *http://www.w3.org/WAI/WCAG2-Conformance.html*

Many companies and commercial usability firms provide web accessibility checking services and a number of online tools and checklists can be used. These will evolve over time – one example is that provided by the consultancy, Webcredible[17] who advocate the more advanced design techniques for webpages.

[17] *Webcredible. 'Beyond guidelines: Advanced accessibility techniques': http://www.webcredible.co.uk/user-friendly-resources/web-accessibility/beyond-guidelines.shtml*

6.3.3 Assistive Technologies

Assistive Technologies are those which support individuals with disabilities to allow equitable access to information technology. They include any technologies or devices designed to help disabled people adapt to their work and living environments. Some of the best known are speech-to-text translators, screen magnifiers or readers, and eye-gaze technology; both Apple and Microsoft provide in-built accessibility features to standard software. However, these technologies are somewhat specialised and not yet in the mainstream of Interaction Design. As people in the West who grew up with computers and expect to stay online become older, there is likely to be an increasing demand for products to help them do that. The increasing population of older people who will use medical assistive technologies in their homes may also make a significant impact.

Summary

Designing interactions, interfaces and applications for new technologies is not just about designing for a set of given users or for generic populations. When designing for a broad range of abilities many factors must be taken into account to enable Universal Usability and appropriate cross-cultural designs to cater for cultural diversity. Inclusive Interaction requires a good understanding of the needs of all potential users – children, the elderly and those with special needs and impairments or disabilities. Enabling technology for accessibility leads to Assistive Technologies. Mobile and website design must increasingly conform to legal accessibility requirements and guidelines.

A reminder of your learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- understand and be able to describe the concepts of Universal Usability and Universal Design
- describe the needs and physical requirements of differing user populations
- discuss how changes in user populations can impact on Interaction Design.

Exercises

1. Discuss the principle of Universal Design.
2. Do children have special requirements for interaction and interface design? How can you effectively evaluate applications designed to be used by children?
3. What do you think the most important accessibility design requirements are? What are the advantages of designing for a broader range of abilities? How can designers cater for conflicting requirements?
4. How might you carry out field tests of a new mobile device to be used by remote rural communities?
5. What do you understand by cross-cultural usability? What might be the most effective design and evaluation strategies to address cross-cultural issues in Interaction Design?
6. Define – and explain the differences between – ‘Localisation’ and ‘Globalisation’.
7. Define – and explain the differences between – ‘customisation’ and ‘adaptivity’ in an interface.
8. A company is developing a hand-held device that recognises handwriting and speech input and has full internet connectivity. One of the targeted user groups is disabled students. Imagine you are part of the team assigned to evaluate the new product. How would you go about it?

Sample examination question

Exchanging information with the public is an increasingly common activity.

a) How would you identify a user population?

b) How would you define the user requirements of such systems?

c) Justify which usability design principles might be appropriate.

d) Explain how you would test whether the needs of special groups of users are being met.

Further reading

Universal Usability

Jones, M. and G. Marsden *Mobile interaction design*. (2006) Chapter 11.

Lazar, J. *Universal usability.* Especially Preece, J. 'Making universal access truly universal' (2007) Chapter 19.

Lazar, J. et al. *Research methods in human computer interaction*. (2009) Chapter 15.

Preece, J. *Online communities: designing usability and supporting sociability.* (2001) Chapter 4.

Internationalisation and different cultures

Aykin, N. (ed.) *Internationalization, design and global development*. (2009).

Hofstede, G. *Cultures and organizations: software of the mind.* (2010).

Marcus, A. 'International and intercultural user interfaces', in Stephanidis, C. (ed.) *User interfaces for all*. (2001) Chapter 3.

Nielsen, J. (ed.) *Designing user interfaces for international use*. (1990).

Trenner, L. and J. Bawa *The politics of usability*. (1998) Part 4 'The politics of expansion: how to work effectively on an international multicultural level'.

Webliography 'Intercultural/International/Multilingual Issues': www.hcibib.org/intercultural/

Special needs and accessibility motivators and infrastructure; assistive technologies; Inclusive Interaction

ACM Special Interest Group on Accessible Computing, SIGACCESS: www.sigaccess.org/

Accessibility Resources: www.hcibib.org/accessibility/

Emiliani, P.L. 'Special needs and enabling technology', in Stephanidis, C. (ed.) *User interfaces for all*. (2001) Chapter 6.

Langdon, P., P.J. Clarkson and P. Robinson (eds) *Designing inclusive interactions: inclusive interactions between people and products in their contexts of use*. (Springer, 2010) [ISBN 1849961654]: www.springer.com/engineering/mechanical+eng/book/978-1-84996-165-3?changeHeader

Norman, K. *Cyberpsychology*. (2008) Chapter 14.

Pernice, K. and J. Nielsen *Beyond ALT text: making the web easy to use for users with disabilities: design guidelines for websites and intranets based on usability studies with people using assistive technology* (2001): www.nngroup.com/reports/accessibility/ (free download).

RNIB Digital Accessibility Team (Tiresias.org) *Making ICT accessible*: www.tiresias.org/index.htm

Stephanidis, C. (ed.) *User interfaces for all.* (2001) part VII: support measures.

Web Accessibility Initiative: www.w3.org/WAI/

Children and computers

Coverage of all aspects of children using new mobile technology with many intercultural and internationalisation issues; resources in the area; recent research publications.

Druin, A. (ed.) *Mobile technology for children*. (2009).

IFIP SIG TC 13.2 (IDC SIG) on Children and HCI: www.idc-sig.org/

Kids and Computers: www.hcibib.org/kids/

Cheok, A., H. Ishii, et al. (guest eds) 'Interactive play and learning for children', *Advances in Human-Computer Interaction (AHCI)*, Volume 2008 (2008) [an open access journal]: www.hindawi.com/journals/ahci/2008/si.1.html

Video material

Inclusive Digital Economy Network: www.iden.org.uk/videoplayer.asp

UTOPIA Project (Usable Technology for Older People: Inclusive and Appropriate): www.computing.dundee.ac.uk/projects/utopia/utopiavideo.asp

Druin, A. *Mobile technologies for children*. (2009).

Case study

A useful case study into bridging the digital divide has been run as a network of four academic projects. The common objective is to explore ways of enabling access to those currently excluded from world telecommunications and digital networks.

Storybank: sharing stories across digital divides: http://gow.epsrc.ac.uk/ViewGrant.aspx?GrantRef=EP/E007090/1

Rural e-services: participatory co-design of sustainable software and business systems in rural co-operatives: http://gow.epsrc.ac.uk/ViewGrant.aspx?GrantRef=EP/E026052/1

VESEL: village e-science for Life: http://gow.epsrc.ac.uk/ViewGrant.aspx?GrantRef=EP/E007198/1. The mobile resource kit part of the project is working with two rural communities in Kenya to test a variety of mobile devices for delivering and recording agricultural information.

Fair tracing: empowering producers and consumers by providing enriched information about the roots of goods and services: http://gow.epsrc.ac.uk/ViewGrant.aspx?GrantRef=EP/E009018/1

See the Newsletters at: www.bgdd.org/Wiki.jsp?page=BgddAnnounce5 and the article by Kevin Walker in ICT Update, Issue 51: http://ictupdate.cta.int/en/Feature-Articles/The-mobile-resource-kit

Notes

'Intuitive' interfaces are easier to build when designers have a deep understanding of the users.

Jared M. Spool

case-study children design development digital experience human information interaction interfaces number online project prototyping research resources system technology usability users

Chapter 7
Design case studies

Introduction » hcibook » ID2 » HFRG » Equator » UPA » GATECH » Summary

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- demonstrate an understanding of what a case study in HCI and ID is, and what it entails
- demonstrate knowledge from reading about and studying the selected and recommended case studies
- obtain practice and experience in carrying out small prototyping, design and test exercises.

Essential reading

Note: Further reading and websites are listed at the end of the chapter.

HCI textbooks

Shneiderman, B., et al. *Designing the user interface*. (2009) Parts 3 and 4.

Sharp, H., Y. Rogers and J. Preece *Interaction design*. (2007) Chapter 5 and the downloadable pdf of Chapter 15, 'Design and evaluation in the real world', from the first edition of this textbook: www.id-book.com/downloads/ID_ch15.pdf

Dix, A., et al. *Human-computer interaction*. (2003) Chapters 2, 3, 4 and 5.

Introduction

This chapter presents some formal case studies, and both real-life and constructed examples of design scenarios and situations, which illustrate HCI and ID design challenges – and their solutions. It directs you to write-ups and descriptions from existing sources such as textbooks, HCI resource sites and research projects.

A selection of case studies

Many useful case studies are available online, some more coherent and appropriate for this course unit than others. An exhaustive list is impossible but large numbers may be found by targeted searches and by reference to recent conference papers, especially those from small, specialised conferences. Those may be more useful as source material for final year projects. Those selected below from five reliable sources deal with the whole spectrum of designing interfaces and interactive experiences for people and provide more general information and knowledge.

7.1 hcibook[1]

[1] *© Alan Dix, 2004.*

The textbook, *Human-computer interaction*, contains a number of short 'Design Focus' highlights in many chapters throughout the whole book. Some of the most useful look at how chunking and closure mechanisms associated with human memory have impacted on the design of ATMs (Automated Teller Machines); how humans adapt to different numeric keypad layouts; requirements for industrial interfaces; navigation aids for 3D interfaces; button size on touch screens; historical prototyping for the Olympic Messaging System; guidelines for reading text on a screen and for speech instructions; environmental cues and workflow implementations in the Lotus Notes database; the use of avatars contrasted with a presentation view in an online conference; applications of augmented reality.

Those which are linked to full case studies on the textbook website are recommended. Some case studies and examples are rather outdated now in terms of technologies but still include useful insights into design and development issues.

- **Hermes, electronic doorplates** (www.hcibook.com/e3/casestudy/hermes/). As quoted: 'The Hermes system is a network of electronic displays mounted on the door frames of offices. The door owner can leave messages for people visiting the office and visitors can leave messages for the door owner.'
- **Crackers, virtual Christmas crackers** (www.hcibook.com/e3/casestudy/crackers/). An entertaining description of the design rationale behind the creation of web simulations of party crackers, a form of electronic greetings card.
- **Digitising the hospital in Trofa: tomorrow's hospital – using Participatory Design** (www.hcibook.com/e3/casestudy/trofa/). As quoted: 'Hospital da Trofa is a small privately-run hospital in Portugal. It was one of the partners in a European Commission-funded project, Team-HOS. The Team-HOS project developed a participatory methodology aimed at the health sector and piloted in hospitals in three countries. The methodology focused on the stages prior to implementation which was contracted.'
- **SPAM: coordination in residential care using SMS – SMS in action** (www.hcibook.com/e3/casestudy/spam/). As quoted: 'Studying and designing (in a hostel for former psychiatric patients) is hard and cultural probes were used alongside more traditional methods such as focus groups. A recurrent problem for staff at the hostel was keeping in touch with one another as they are often away at meetings, on trips with patients, etc. After seeing a demonstration of the Hermes system the staff expressed a wish to have something using some of the same technology, in particular to allow them to use SMS messaging to keep in touch.'

- **Ambient wood – augmenting the physical** (www.hcibook.com/e3/casestudy/ambient-wood/). As quoted: '… an innovative educational experience exploring how biological ideas can be learnt in a real environment augmented by technology'.
- **Excel mode error** – an example of modes and closure (www.hcibook.com/e3/casestudy/excel-mode/).

[2] © John Wiley and Sons, Inc. 2007.

7.2 Interaction Design (ID2)[2]

The textbook, *Interaction design*, contains short summaries of case studies which are detailed further in the book's supporting website (www.id-book.com/casestudy_index.htm). Each case study includes a downloadable pdf file, and a screen-readable version to be browsed online. Again, some are not absolutely up to the minute but they are well described and enlightening.

The following are especially recommended.

- **The 'Technology as Experience' framework** (www.id-book.com/casestudy_5-1.htm). Uses the framework presented in Chapter 5 to show how to guide initial ideas for the design of two websites: an online fundraising site and a site that reviews men's clothing, intended to appeal to men who do not enjoy shopping.
- **Blind users experience the internet** (www.id-book.com/casestudy_6-1.htm). As quoted: 'The redesign of a website's information architecture to provide audio navigation to assist blind users'.
- **Using ethnographic data to understand Indian ATM usage** (www.id-book.com/casestudy_8-1.htm). As quoted: 'This case study focuses on an investigation into the use of ATMs (Automated Teller Machines) in India. It illustrates the use of ethnographic data to answer questions such as, "What is the general attitude towards ATM use?" and "What problems do people face when using ATMs?"'.
- **Universal Usability: web fun for individuals with Down's Syndrome** (www.id-book.com/casestudy_10-1.htm). A development team worked with individuals with Down's Syndrome to understand and analyse their needs in learning and practising the basic skills required to use the internet. They collaboratively designed, evaluated and refined prototypes resulting in the final product development of a set of online tools.
- **Establishing requirements for a mobile learning system** (www.id-book.com/casestudy_10-2.htm). As quoted: 'MobiLearn was a European-funded research and development project that explored new ways of using mobile environments to meet the needs of learners working by themselves and with others.'
- **Paper prototyping in the design of mobile phone interfaces** (www.id-book.com/casestudy_11-2_paper.htm). As quoted: 'This case study describes the benefits of using paper prototyping from a designer's viewpoint while considering the bigger picture of its impact across the entire project lifecycle.'
- **Developing cross-cultural children's book communities** (www.id-book.com/casestudy_14-2.htm). As quoted: 'The "International Children's Digital Library" (ICDL) (www.icdlbooks.org) is an online library for the world's children. Research is being conducted on how children access and use digital books to explore diverse cultures.'

[3] © Jurek Kirakowski, Human Factors Research Group, Cork, Ireland, 2000.

7.3 HFRG[3]

Jurek Kirakowski of the Human Factors Research Group at University College Cork maintains a webpage of useful resources for HCI evaluation (www.ucc.ie/hfrg/resources/index.html) with links to a set of case studies resulting from the group's long involvement in many European research projects (www.ucc.ie/hfrg/resources/index.html#cases).

Those identified below are worth looking at for the level of detail on formal usability evaluation and the use of metrics and usability methodologies.

- **EMMUS project** (www.ucc.ie/hfrg/emmus/). A highly interactive hypertext document about usability methods in the development of multimedia products, presenting a number of different views of the process. A variety of case studies in the use of guidelines and usability principles for multimedia are described.
- **Case studies in usability evaluation** (www.ucc.ie/hfrg/resources/index.html#cases). As quoted: 'This is a collection of documents from the MAPI (MUSiC Assisted Process Improvement) project, giving public domain information about the case studies carried out during this project, as well as some background information on the MUSiC toolset.'

[4] © EPSRC, UK. 2002.

7.4 Equator[4]

Equator was a six-year Interdisciplinary Research Collaboration in the UK, which studied the integration of physical and digital interaction with different user communities. It aimed to develop new combinations of physical and digital worlds and explore how such integration could enhance the quality of everyday life. The project resulted in a large number of experience projects leading to outcomes such as research publications; spin-off companies developing devices and tools; significant input to the Microsoft book, *Being human*; and a number of publicly available case studies on the project website (www.equator.ac.uk/). As quoted: 'A series of research challenges explored (a) new classes of device which link the physical and the digital, (b) adaptive software architectures and (c) new design and evaluation methods, which draw together approaches from social science, cognitive science and art and design. Equator involved over 60 researchers, with a range of expertise encompassing computer science, psychology, sociology, design and the arts.'

The experience projects are available to view as videos and demonstrations under the headings of:

Playing & Learning, The Curious Home and City & Seamful Games (www.equator.ac.uk/index.php/articles/c159/).

Some of the most pertinent for this course unit are listed below:

- **Hunting of the Snark** (www.equator.ac.uk/index.php/articles/625). An application to allow groups of children to discover and reflect on new kinds of mixed reality spaces.
- **Chawton House** (www.equator.ac.uk/index.php/articles/1218). As quoted: 'The aim of the project is to enable curators and teachers to create their own context to provide an interactive experience for visiting schoolchildren.'
- **Drift Table** (www.equator.ac.uk/index.php/articles/1026). As quoted:

'An interactive table controlled by weight to take the spectator drifting across a landscape provided by Google Earth.'

- **Ubiquitous technologies** (www.equator.ac.uk/index.php/articles/c65). A description of the research techniques used to design ubiquitous technologies for the domestic environment.

A selection of videos describing interactive performances as part of the Citywide experience projects is available and is worth viewing: www.equator.ac.uk/index.php/articles/c163/.

7.5 UPA

The Usability Professionals' Association (UPA) has a webpage under the heading, 'Usability in the Real World: Usability Case Studies'.[5] As quoted: 'This page contains short case studies of the impact of usability. Some are success stories, showing how usability improved a project and company bottom line. Others are examples of situations where a little usability might have salvaged a project.' They make interesting reading and demonstrate many of the commercial impacts of considering usability in the design process – or not.

[5] *http://www.upassoc.org/usability_resources/usability_in_the_real_world/case_studies.html. © Usability Professionals' Association, 2000.*

7.6 Other case studies

Case studies on specific topics (the elderly and computers and the digital divide) are specifically referenced in Chapters 6 and 8. Many other case studies are available in various online course notes accessible via the internet and many more in other HCI textbooks. It is worth looking at some others you may come across but an exhaustive and recommended list cannot be compiled. (It may be possible to provide updates from time to time via the VLE.)

Summary

A list of case studies has been provided and short descriptions, indicating the area of investigation and the design issues and techniques applied as solutions, have been given.

A reminder of your learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- demonstrate an understanding of what a case study in HCI and ID is, and what it entails
- demonstrate knowledge from reading about and studying the selected and recommended case studies
- obtain practice and experience in carrying out small prototyping, design and test exercises.

Exercises

Look at the Project Resources web pages of the textbook at: http://wps.aw.com/aw_shneiderman_dtui_5/110/28382/7265974.cw/index.html (**Note**: students need to log in to access. The access code is given with textbook purchase.)

1. Three assignments cover Rapid Prototyping (Designing a New Hybrid Product; Designing a Teaching Theatre Control Panel; Designing a Symptom Assessment Interface). As quoted: 'The following projects are designed to get you oriented with a graphical programming environment, such as Visual Basic. These assignments focus strictly on the visual layout of an interface, with little emphasis on the interactions.'
2. Five assignments cover Serving the Users' Needs (Future Fast Food Drive-through Ordering; Diabetes Monitoring System; Classroom Locator; Simplifying an Airline Reservation System; Visitor Information System). As quoted: 'The following projects are designed to get you to think about solving the needs of users in creative ways. You will build full applications which include designing the layout of the programme as well as implementing the interactions.'
3. Two assignments cover information visualisation (Examining the Nation's Health; Visualising Flight Information). As quoted: 'The following projects will give you experience presenting information in meaningful ways to the user.'
4. Two assignments cover HCI Theory (Designing and Analysing a Digital Clock; Measuring Fitts' Law Using a Mouse). As quoted: 'The following projects focus on giving you experience in understanding important theories of human-computer interaction.'
5. Additional exercises can be found in the textbook, *Research methods in human computer interaction*, at the end of each chapter. Those for Chapters 6, 7 and 9 are especially relevant. The edited collection of readings in the book, *The politics of usability*, has descriptions of commercial case studies and usability evaluations. Those in Chapters 5, 6 and 9 are relevant.
6. This case study is based on an interactive panel session presented at the CHI 2003 Conference and has been used for a class-based exercise at Georgia Institute of Technology in the USA. It is worth looking at for a better insight into introducing usability issues into organisations. See: Rolf Molich, Kara Coyne, Ron Perkins and Deborah Mayhew, 'A Usability Business Case: The Politics of Usability' (http://hcc.cc.gatech.edu/documents/201_Molich_chi2003politics.pdf).[6]

[6] *Molich, R., K.P. Coyne, R. Perkins and D.J. Mayhew 'Politics and usability: test your skills against the experts',* Conference on Human Factors in Computing Systems, *Ft. Lauderdale, Florida, USA, CHI 2003 Extended Abstracts.*

Further reading

Harper, R., et al. *Being human*. (2008).

Lazar, J. et al. *Research methods in human computer interaction*. (2009) Chapters 6, 7 and 9.

Trenner, L. and J. Bawa *The politics of usability*. (1998) Chapters 5, 6 and 9.

The inventors will invent, for that is what inventors do. The technology will come first, the products second, and then the needs will slowly appear, as new applications become luxuries, then "needs," and finally, essential.

Donald Norman

affective applications augmented computers design emotions human immersive interaction interfaces physical real reality sense systems tangible technologies user virtual world

Chapter 8
Interaction Design and new technologies

Introduction » Tangible Interaction » Affective Interaction » Virtual Environments » Summary

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- describe some of the new and emerging technologies that will impact on Interaction Design
- discuss what some new user requirements might be
- decribe how to design for new technologies, needs and applications.

Essential reading

Note: Further reading and websites are listed at the end of the chapter.

HCI textbooks

Shneiderman, B., et al. *Designing the user interface*. (2009) Chapters 5, 8, 14 and Afterword.

Sharp, H., Y. Rogers and J. Preece *Interaction design*. (2007) Chapter 5.

Dix, A., et al. *Human-computer interaction*. (2003) Chapters 18, 20 and 21.

Introduction

Amongst the many new technologies current in our digital world are a set that deal with the human haptic (touch) and kinaesthetic (orientation in space) senses of touch and orientation in space. The former of these areas of work and investigation have become known as 'tangibles', and the latter as Virtual Reality or Immersive Interaction. We will discuss a specific technology of some potential, known as 'Smart Clothing' or 'wearables', and consider how Affective Interaction is becoming a key feature of new UX paradigms. 'Affective' is the psychological term for ' emotional' responses or 'to do with the feelings and emotions'. Finally, we shall take a look at what the future might hold for Augmented Humans making use of such technologies.

8.1 Tangible Interaction

Tangible Interaction describes user interfaces and interaction approaches that focus on the haptic sense with touch feedback from the physical material of an interface ('tangibility'). It is associated with interfaces or systems that are materially embodied in some fashion, whether as physical artefacts or in Virtual Environments. The interface and users' interaction is embedded in 'real spaces' and contexts. It has fast become a growing research and commercially viable area within HCI. From its beginnings in 'Tangible User Interfaces' championed by Hiroshi Ishii and his group at the Massachusetts Institute of Technology (MIT) Media Lab since 1997,[1] current application areas are widespread:

[1] Tangible Media Group, http://tangible.media.mit.edu/

- supporting learning and education in sensory environments
- new interactive musical instruments
- tools to support planning and decision-making
- museum and interactive spatial art installations.

Numerous associated areas can be delineated:

- Whole-Body Interaction and/or Movement Interaction is bodily interaction or movement, such as gestures or regulated dance movements, which can be related to physical objects. Instead of interacting with small objects that can be grabbed and moved around within arm's reach, the interaction is with large objects within a large space and there is a need to move around a space using the whole body.
- Interactive intelligent products based on RFID technology as discussed under the heading of Ambient Intelligence in Chapter 9.
- Interactive Spaces which embed an interface and users' interactions in real spaces and contexts. Many are interactive arts installations using sensors to track users' behaviour with physical artefacts and to integrate tangible objects into the installation. Whole-body movement is used to interact within these environments.
- Tangible Augmented Reality uses the principles of tangible input in an Augmented Reality context.
- Interactive tabletops are surfaces which respond to touch and pressure and can have tangible input elements, often used in educational contexts.
- Embodied Interfaces, the physical embodiment of data.
- Exertion Interfaces and Embodied Interaction, the use of intelligent computational technologies and the supporting device technologies to build interactive entertainment systems and games (such as movement-based sports video games). Exertion Interfaces are the user interfaces which provide, elicit and stimulate bodily activity for recreational or for health purposes.

TUIs were seen originally as an alternative to graphical displays and traditional screen-based interfaces. Unlike in the early VR systems, designers attempted to embody some of the 'richness of interaction' humans have with physical devices into interaction with digital content. The earliest work was in Graspable User Interfaces where data states could be represented by physical interaction with tangible artefacts which essentially allowed users to 'grasp data with their hands' and to perform actions by simulated manipulation. TUI now focuses more on the design of the interaction instead of the visible interface. It brings to the fore the quality of interaction, requiring designers to think about what people actually physically 'do' with the system.

As with Affective Interaction, contributing enabling technologies from the worlds of robotics, mechanics and psychophysics led to the development of prototypes. Technological innovations such as actuation, complex sensor-based data-collection, conductive fabrics and 3D printers enabled these to be built and further developed in a more inclusive way. Originally, specialised hardware and expertise was required to build a prototype with comparatively simple functionality – nowadays it has become easier and cheaper to build working prototypes and functioning systems which can be tried out with, and tested on, potential users.

8.1.1 Smart clothing/wearables

Intelligent textiles (of which phase-change, shape memory, chromic/colour-change and conductive materials form the basis of the newest technologies) have many potential future applications. Integrating intelligent textiles into clothing through electronic advancements is beginning to be a discipline in its own right. It results in complex systems embedded unobtrusively into everyday clothing to create wearables ('wearable technologies'). Some uses will obviously be in fashion – digitally printed fabrics are now commonplace in commercial products – and in the art world, but many will also be for applications in information, healthcare, medicine, manufacturing, training, and recreation/entertainment. Users might be textile, electrical, or biomedical engineers. Many prototypes already exist; some in the context of the 'smart home' and others in rehabilitation, healthcare and Assistive Technologies.

In addition to the Smart Clothing technology (the physical interface, communications, energy supply, processors, and actuators) and software issues of data management, there are inherent usability aspects relevant to the manufacture, sale and use of such products. As textile-based keypads, transmission lines, sensors, and actuators become embedded in clothing and accessories, interface design issues associated with wearable computers and AR displays will come to the forefront of attention. Wearable computers allow a much closer association between user and embedded information and the ways in which this interchange will work have yet to be understood and fully commercialised. Current easily accessible work is being carried out at a number of research establishments, notably the Georgia Institute of Technology[2] and the *Eidgenössische Technische Hochschule* (ETH) Zürich in Switzerland.[3] A slightly different, but related area of application and research is into mobile and wearable projection,[4] notably personal projection via mobile and wearable pico projectors (i.e. handheld pocket projectors).

[2] *See* Contextual computing group*: https://wiki.cc.gatech.edu/ccg/start*

[3] *See* Wearable computing lab*: http://www.wearable.ethz.ch/*

[4] *See* Ubiprojection 2010*: http://eis.comp.lancs.ac.uk/workshops/ubiproject2010/*

8.2 Affective Interaction

A vital element of human communication is emotional expression – that is, understanding how the other participant in a dialogue or conversation 'feels' and reacts by means of communication channels such as facial expressions, non-verbal aspects of speech, posture and gestures. Recognising facial and bodily expressions is crucial to building trust and friendliness in social interactions. Awareness of these aspects is a process both continuous (monitoring movements and positioning) and unconscious (responding to minute movements and eye-gaze) – part of a complex and rich communication system. Affective aspects are those which produce an emotional response, i.e. recognising emotions in others and responding accordingly. Such a response can impact on how humans think, and results in a physiological and behavioural reaction by an individual. This reaction can be measured and calibrated in a reliable manner.

Computing devices are now also able to make use of Affective Interaction: machines can recognise, sense, analyse and express emotions, leading to an improvement in both human–computer and human–human communications. This was an early goal of many AI researchers and forms the basis of research on Intelligent Agents and Human-Robot Interaction work. A major proponent of Affective Interaction is Rosalind Picard of the MIT Affective Computing Group[5] who observed in 2000 that emotions play an essential role in rational decision-making, perception, learning and a variety of other cognitive emotions. Believing that the most effective communication with computers also requires emotional intelligence, Picard determined that computers ought to also have the ability to recognise and express emotions. Affective Interaction computes emotions both through psychophysics and a synthesis of psychological research and computation techniques based on the ways in which humans recognise emotion. Machine sensing and recognition of emotions creates technology that helps people sense, regulate and communicate affect, focusing particularly on autonomic nervous system arousal. Nowadays affect-measuring technologies exist and it is possible to use models and simple, wearable sensors, mobile biosensors and automated facial expression analysis to recognise human emotional or affective reactions. It is leading to new technologies with applications in commerce, education, entertainment, security, therapy and healthcare.

[5] Affective computing*: http:// affect.media.mit.edu/*

The simplest of interaction designs may convey or elicit both positive and negative emotions. We can use icons or animation:

- to express emotion
- to provide pleasing aesthetics
- as helpful interface agents
- as basic emoticons.

An often overlooked emotion in human–technology interactions is that of negative emotions, especially that of frustration. This may be the result of poor usability and can be overcome by good design, helpful feedback and contextually relevant help – through an anthropomorphic animated agent or an embodied conversational agent which is ‘believable’ in its appearance and behaviour. Avatars and robots in immersive VR environments can manipulate their appearance and can copy and simulate human behaviours – it is these which are known as ‘embodied conversational agents’. Human reactions to robots are quite different from those to humans so developing social robots or agents that can produce affective reactions in humans helps to understand the role of embodiment in social cognition. Studying physiological responses helps in understanding the interplay between everyday experiences and physiology for the many potential users of Assistive Technologies.

The future prospects for Affective Interaction are wide-ranging, especially in the area of human–robot interaction and in immersive virtual realities of all kinds. There still exist, though, as with many other aspects of modern HCI and ID, important issues of privacy and personal expression.

8.3 Virtual Environments

The history of Virtual Reality is an interesting one with, according to some, roots in 1950s cinema technology. The more accepted founders are generally recognised as being Ivan Sutherland[6] (creator of the head-mounted display) and Myron Krueger[7] (creator of Videoplace, an application that allowed users to interact with virtual objects for the first time). Both the naming of the area as 'Virtual Reality' (by Jaron Lanier) and 'Augmented Reality' (by Tom Caudell) and the first research prototypes from the interactive graphics community took place between 1992 and 2000. The concept of 'immersion' is common to all.

[6] *Sutherland, I. 'The ultimate display',* Proceedings of the IFIP Congress *(1965).*

[7] *Krueger, M.* Artificial reality 2. *(Addison-Wesley, 1991) [ISBN 0201522608].*

Immersive Virtual Reality systems present users with a projected image, often viewed through head-mounted displays which cover the eyes with shutter glasses so that the left and right eyes receive different views. This enables 3-D depth simulation and can be a very compelling experience. A strong sense of 'presence' enables a suspension of belief that the real world can be overlaid with another, which seems more or less real. Computer technology creates a simulated, realistic-seeming world that users can manipulate and explore with that sense of presence (the feeling of being inside and a part of that world). Immersive experiences suffer if users become aware of the surrounding real world and so input methods must be natural. If a user is aware of the interaction device, then he or she cannot be truly immersed. The combination of a sense of immersion and interactivity is called 'telepresence'. If a user can easily direct his or her own movements, that becomes an 'interactive experience' which can draw in the user, making the interaction interesting and absorbing and creating a sense of 'engagement' (see Section 9.2). If the surrounding Virtual Environment can be easily modified and is responsive to the user's actions in a way that makes sense (even if only in that Virtual Environment) that will enhance a user's sense of telepresence.

Basic elements that must be incorporated are:

- Three-dimensional images appear, from the user's perspective, to be life-sized.
- The ability to track the user's movements (especially eye and head motion) and to adjust the images in the user's simulated sight to seamlessly reflect the change in perspective.
- The ability to interact with that environment in meaningful ways thus becoming unaware of the real surroundings and focusing instead on an existence within the Virtual Environment.

The mechanisms and technologies of Virtual Environments are beyond the scope of this Study Guide – we are more interested in how to create successful interactions. This can be achieved partly because of the primacy of human visual and auditory senses and the concentration on getting these components right, making them consistent and naturalistic with no latency delays. Other senses, such as the sense of touch and force feedback, are increasingly being exploited in haptic systems – 'passive haptics' are real objects in a physical space mapped onto virtual objects in a virtual space.

The uses of VE are myriad and it has become a very successful technology in the world of media and entertainment and, most especially, in gaming and film. There are many military uses (the US Defence Research Agency has long been a prime mover in VR research) but there are also serious industrial applications in architecture, engineering and the earth sciences. Major investigations into and production of educational material, training of various kinds and medical applications also figure prominently.

8.3.1 Augmented Humans

The 'Augmented Human' is the newest term for the integration of various scientific contributions (some of which we have discussed in this Study Guide) towards augmenting human capabilities through technology. AH research is not well-developed as yet but is likely to be an umbrella term covering many technologies, techniques and inventions. As well as considering the hardware side of Interaction Design (the sensors and RFIDs mentioned earlier; bionics and biomechanical additions such as exoskeletons) and the technologies which already exist (Augmented and Mixed Realities; Ubiquitous Computing; smart artefacts, wearables and tangibles), uses can be widely identified. These may be in entertainment (augmented sport, games and tourism) and in health (augmented wellbeing, technology for training and rehabilitation) and smart artefacts but also in new methods of interaction (brain computer interfaces and augmented context-awareness). Again, as noted before, safety, ethics, legal, security and privacy aspects must all be seriously addressed.

Summary

Tangible Interaction concentrates on the haptic sense and tangibility – interaction is embedded in real spaces – whilst Whole-Body Interaction involves physical bodily interaction or movement related to physical objects. This type of interaction tries to embody some of the richness of interaction we have with physical devices into interaction with digital content. One way in which to achieve this is by tangible devices, or by embedding electronic sensors in everyday items such as clothing. Affective Interaction can improve both human-to-computer and human-to-human communications. Social robots or agents that can demonstrate affective reactions will be a feature of future applications, some in Immersive Virtual Environments. Designing VEs means understanding the concepts of immersion, engagement, context-awareness and presence to allow users to fully participate in a virtual world. Augmented interaction has myriad future uses which will give rise to new ways of interacting with computers and technology.

A reminder of your learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- describe some of the new and emerging technologies that will impact on Interaction Design
- discuss what some new user requirements might be
- decribe how to design for new technologies, needs and applications.

Exercises

1. Discuss how the concept of 'the interface' has changed over the last 20 years.
2. Augmented Reality Systems, with all-round see-through head-mounted displays, allow users to visualise 3-D computer-generated representations superimposed on real world objects.
   i. Describe the application areas where this kind of integration of virtual and physical worlds would benefit different user groups.
   ii. Discuss the problems that these user groups currently have with the way they carry out their tasks, and how this new mode of interaction could overcome such problems.
3. What can tabletop displays be used for?
   i. Describe suitable applications in education and tourism.
   ii. What specific user requirements should be taken into account in the design of such interfaces?
4. Define the terms below, identify the applications you know associated with these technologies and make a list of critical design principles applicable to each:
   i. Virtual Reality
   ii. intelligent and affective agents
   iii. mobiles and handheld devices
   iv. Assistive Technologies
   v. online communities
   vi. Tactile User Interaction and wearables.
5. What can the experience of interactive games and gameplay bring to Interaction Design?

Sample examination question

'The only certain trend on the internet and the world wide web is that there are no trends on the internet. It changes so fast that it is impossible to predict what will happen, and new trends may bloom and die overnight.'

What do you see as the critical user-centred requirements for the next generation of web tools?

Further reading

Introduction to technologies and usability issues in VR and TUI; design of VE; and evaluation issues specific to VR. Evaluation issues specific to games and an introduction to the concepts that enhance the overall user experience in games.

Sutcliffe, A. *Multimedia and virtual reality*. (2003) Chapters 1 and 5, and Appendix A.

Bernhardt, R. (ed.) *Evaluating user experience in games: concepts and methods*. (2010).

Issues in emotion in HCI

Norman, K. *Cyberpsychology*. (2008) Chapter 10.

Karpouzis, K., E. Andre and A. Batliner (guest eds) 'Emotion-aware natural

interaction', *Advances in Human-Computer Interaction (AHCI)*, Volume 2010 (2010): www.hindawi.com/journals/ahci/si/eani.html [an open access journal].

Smart clothing and new modes of interaction

Barfield, W. (ed.) *Fundamentals of wearable computers and augmented reality*. (2001).

Cho, G. (ed.) *Smart clothing: technology and applications*. (2009).

Mattila, H.R. (ed.) *Intelligent textiles and clothing*. (2006).

Video material

Picard, R. *Emotional intelligence, technology and autism*. Women in HCI Lecture Series, 2009: www.hci.iastate.edu/media/News/Announce/womeninhci.php#picard

Klatzky, R. *Entering the human in virtual and augmented reality: the role of psychophysics*. Women in HCI Lecture Series, 2008: www.hci.iastate.edu/media/News/Announce/womeninhci.php#klatzky

The first Augmented Human (AH) International Conference in March 2011 will have papers in the ACM Digital Library in due course. In the meantime, the promotional video by the Fluid Interactions Group at MIT Media Lab is available to view: www.augmented-human.com/

The good news is that computing, once seen as alienating and antihuman, is becoming a socially respectable and interpersonally positive force

Ben Shneiderman

ambient computing design devices embedded impacts individuals information intelligence interfaces internet issues networks personal privacy social technologies ubiquitous user world

Chapter 9
Real world interactions

Introduction » Ubiquitous Computing » Seductive Interfaces and Flow » Ambient Intelligence » The Internet of Things » Impacts » Relevance to ID and HCI » Summary

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- demonstrate an understanding of social aspects and societal impacts of new computer technologies
- understand and be able to define the concepts of Ubiquitous Computing, Ambient Intelligence and The Internet of Things
- discuss issues such as personal privacy and online trust in human-computer interactions
- describe the design challenges posed by new interaction paradigms.

Essential reading

Note: Further reading and websites are listed at the end of the chapter.

HCI textbooks

Shneiderman, B., et al. *Designing the user interface*. (2009) Chapter 1 and Afterword.

Sharp, H., Y. Rogers and J. Preece *Interaction design*. (2007) Chapter 5.

Dix, A., et al. *Human-computer interaction*. (2003) Chapter 1.

Introduction

'Ambient Intelligence' is the phrase used by the European Commission, first coined by Philips Research Laboratories in the Netherlands to describe a world in which 'intelligence' is embedded in almost everything in the physical world around us. In Europe the 'Disappearing Computer Initiative' envisaged people as surrounded by computers embedded in everyday objects in their environment. These would recognise and respond to individuals in a seamless, unobtrusive and invisible fashion. This is a world of the convergence of technology and communication (much as multimedia was during the last decade), which will be embodied by intelligent software and adaptive agents that cater to predicted and observed human needs and wants. It is a world, however, also fraught with potential problems for humans.

9.1 Ubiquitous Computing

The term 'Ubiquitous Computing' was first used by Mark Weiser in the early 1990s[1] to describe a future with technologies that would be widespread and in use all the time. Instead of having a desktop or laptop computer, that technology and functionality would exist everywhere (i.e. be 'ubiquitous') in our environment. Since then such technology has become wireless, mobile, and networked, making its users increasingly connected to the world around them and to others in that world. These technologies are also highly pervasive and 'invisible 'in that we tend to use them without thinking about it, and without noticing the physical tools themselves. We, as users, focus on the task at hand, making the technology effectively hidden as discussed in Don Norman's views on design (see Chapter 2 and below, Section 9.2). Designers have now started to address issues relevant to the most useful and appropriate techniques for designing Ubiquitous Computing user experiences and identifying best practices.[2] Much more information and online assistance is likely to become available in the near future.

[1] *Weiser, M. 'The computer for the 21st century',* Scientific American*, September 1991, pp.94–104.*

[2] *See, Kuniavsky, M.* Smart things: Ubiquitous Computing User Experience Design. *(2010).*

Terminology is somewhat looser now with many descriptors referring to very similar developments and applications in use, or to specific aspects of more general technological improvements. Those most in use currently include:

- Ambient Intelligence – a term adopted by the European Commission and major European research companies. It emphasises human-centred computing and recognises the convergence of innovations in key technologies.
- Ubiquitous or Pervasive Computing – or simply 'UbiComp' – the more common usage in the USA.
- The Internet of Things – this refers to networks.

9.2 Seductive Interfaces and Flow

'Seductive Interfaces' are highly interactive interfaces which 'draw in' a user and make the interaction 'fulfilling' in some sense through mental and emotional engagement. A level of engagement is an inherent feature of entertainment applications, games and VEs. It is now being applied in e-commerce and to education, leading to the development of 'edutainment' and 'serious games'. Many such applications are aimed at interactions with children, or as an entry point for healthcare in the community. The concepts involved are those of initially attracting user attention, and maintaining it, by engaging both the mind and the emotions of users.

[3] *Csíkszentmihályi, Mihály* Flow: the psychology of optimal experience*. (Harper and Row, 1990).*

The underlying principle is the theory of 'Flow' (identified by Mihály Csíkszentmihályi in an influential book of the same name).[3] The condition is an 'optimal experience' that is 'intrinsically enjoyable.' People become immersed, lose track both of time and of the sense of self, feel playful and are willing to experiment with novelty. This sensation can occur with many physical activities but also seems to be evident in interacting with computers. A design approach – known as 'funology' – has grown up around the creation of such Seductive Interfaces, which incorporate a strong sense of fun. Web designers, especially, have taken this psychological concept on board, simplifying a theoretical stance into simple guidelines and approaches such as:

- enhancing the speed of interaction and response
- providing excellent and responsive feedback
- enabling an adaptable/customisable interface that can be adjusted to a user's skill level
- making things simple and usable but still fun.

9.3 Ambient Intelligence

A European-funded research project – the SWAMI consortium under the EC's 6th Framework Programme 'Disappearing Computer' initiative – produced a report on what the implications of such technologies might be, based on an overriding vision of '… greater user friendliness, more efficient services support, user empowerment and support for human interactions. People are surrounded by easy-to-use interfaces that are embedded in all kinds of objects and by an everyday environment that is capable of recognising and responding to individuals in a seamless, unobtrusive, and invisible way.' An enticing and descriptive vision of what such a future world might be is quoted below:

> '*The brave new world of ambient intelligence is almost upon us. Ambient Intelligence is the phrase coined in a world in which 'intelligence' is embedded in virtually everything around us. It has been called an Internet of Things, where radio frequency identification (RFID) tags are attached to all products. It is a world of smart dust with networked sensors and actuators so small as to be virtually invisible, where the clothes you wear, the paint on your walls, the carpets on your floor, and the paper money in your pocket have a computer communications capability. It is a 4G world where today's mobile phone is transformed into a terminal capable of receiving television, accessing the internet, downloading music, reading RFIDs, taking pictures, enabling interactive video telephony, and much more. It is a world of convergence, where heterogeneous devices are able to communicate seamlessly across today's disparate networks, a world of machine learning and intelligent software, where computers monitor our activities, routines and behaviours to predict what we will do or want next. In the brave new world of ambient intelligence, we will never have to worry about losing track of our children because they will have a location device implanted under the skin or, if they are squeamish about that, then at least they will have one in their wristwatch.*'[4]

[4] *Wright, D., et al. (eds)* The international library of ethics, law and technology: safeguards in a world of ambient intelligence*. (Springer, 2008): http://www.springerlink.com/content/j23468h304310755/fulltext.pdf*

9.4 The Internet of Things

The practicalities of implementing this vision are being addressed by a number of commercial companies which sell internet-enabled devices and RFID-tagged devices and, in research terms, by international laboratories such as the MIT Media Lab in the US, Philips Research in Europe, and Nokia and Microsoft Research in India and the Far East. The longer-term legislative issues are being seriously considered at a European level. In a recent report,[5] those which seem to be the most pertinent areas which need to be addressed before the reality can be achieved are:

[5] *DG INFSO and EPOSS* Internet of Things in 2020: a roadmap for the future *(2008): http://www.smart-systems-integration.org/public/internet-of-things*

- governance, standardisation and interoperability
- environmental sustainability and resource efficiency
- trust, privacy and security.

Areas in which the Internet of Things will become common are thought to be:

- applications for 'things on the move' – the replacement of bar-codes, and tracking the provenance of and anti-counterfeiting of food and pharmaceuticals
- ubiquitous intelligent devices in the 'Intelligent Home'
- ambient and assisted living support, especially of health and personal medical equipment
- transportation, both private cars and public transport.

9.5 Impacts

The growth of Pervasive Computing is not just at a personal, or purely social, level; it is also expanding fast at both local and global, political and economic levels. The report quoted at the beginning of this Study Guide[6] has views on this, claiming that governments and authorities are using computers and the internet in more ways than ever before, both to inform a populace in what has come to be known as Exchanging Information with the Public or 'e-government', but also to gather and embed in digital artefacts increasing amounts of personal information. Some, but not all, of the worries that people have about new technologies and their personal privacy are:

[6] *Harper, R., et al.* Being human: HCI in the year 2020. *(Microsoft Research, 2008).*

- anonymity, reputation and identity
- user authentication and verification
- social engineering
- information flow, security and trust issues
- malware, botnets, spam, scams and phishing.

All of this has potential impacts, to quote:

> '*Opinions about what information governments and authorities need and ought to have, and what citizens should reasonably be expected to provide are changing, making the relationship between government and individual more complex, not least because it is difficult to know how much information is being collected, how and when it is being used, and who has control of it.*'[7]

[7] *Harper, R., et al.* Being human: HCI in the year 2020. *(Microsoft Research, 2008).*

'What happens on the world wide stage is now affecting what happens locally. Global communications mean that the fate of individuals subject to one form of governance can have an effect, in real time, elsewhere, on individuals subject to very different political circumstances. One consequence of this is that internal and foreign affairs are subjected more to the media glare. Computers increasingly span the globe and are being used by many differing cultures. This broadening may bring us together, but it may simply highlight our differences.

Hence the trade-off or balance between security and privacy, between the individual and society. There are no simple solutions to striking the right balance, just as there are no simple solutions to making sure that AmI benefits citizens and consumers as well as industry and government. Unfortunately, many safeguards are necessary because there are many threats and vulnerabilities, some of which are known today, others of which will only emerge in the years to come... When every product is embedded with intelligence, everyone must (or should) be involved in safeguarding his or her privacy, identity, trust, security and inclusiveness in a world of ambient intelligence.'[8]

[8] *Wright, D., et al. (eds.)* The international library of ethics, law and technology: safeguards in a world of ambient intelligence. *(Springer, 2008): http://www.springerlink.com/content/j23468h304310755/fulltext.pdf*

Shneiderman and his co-authors discuss this issue in their textbook and identify a set of serious legal issues and concerns.[9]

[9] *Shneiderman, et al.* Designing the user interface. *(2009) Chapter 3.9, 'Legal Issues'.*

- **Privacy**
  Medical, legal, financial data; privacy protection; identity checking and data access
- **Safety and reliability**
  Medical equipment, military and safety-critical systems
- **Software copyright protection**
  Illegal copying; open source software; Creative Commons™
- **Online information copyright protection**
  Digital libraries; electronic copying and 'fair use'
- **Freedom of speech**
  Electronic environments; social networking; data protection; network providers' policies
- **Equal access**
  Legal adherence; online services

They also have a number of well-considered concerns about recent modern technologies and the growing manipulation of personal information. This is somewhat prescient – this text was written well before the 2010 Facebook privacy settings uproar.

'…the loss of individual privacy because of rapid search capabilities is a dramatic change that is disturbing to many people…the detailed tracking of personal behaviours undermines traditional expectations. Credit databases … are a centralised collection of personal information that could be used by criminals or oppressive political groups … data mining strategies have been challenged as ineffective and potentially invasive of personal privacy … Even social networking and user-generated content web sites raise concerns as individuals put personal information and photos in public spaces where they could be maliciously misused.'[10]

[10] *Shneiderman, et al.* Designing the User Interface. *(2009) Afterword, p.577.*

It is not only researchers who are concerned about privacy issues – commercial organisations take the threat of cybercrime very seriously indeed. An internet security company states the case well:

> '*The first decade of the 21st century saw a dramatic change in the nature of cybercrime. Once the province of teenage boys spreading graffiti for kicks and notoriety, hackers today are organized, financially motivated gangs. In the past, virus writers displayed offensive images and bragged about the malware they had written; now hackers target companies to steal intellectual property, build complex networks of compromised PCs and rob individuals of their identities. 2009 saw Facebook, Twitter and other social networking sites solidify their position at the heart of many users' daily internet activities, and saw these websites become a primary target for hackers. Because of this, social networks have become one of the most significant vectors for data loss and identity theft.*'[11]

[11] *© Sophos Group (2010). http://www.sophos.com/security/topic/security-report-2010.html*

One of the reasons for taking this so seriously is the sheer commercial impact and the changes that social networking sites have made to marketing, advertising and customer-facing organisations:

> '*Companies now commonly use blogs to disseminate and share information. Forums serve as a form of technical support where professionals can troubleshoot with peers and colleagues. Meanwhile, many companies embrace Facebook and MySpace because the sites present a great way to connect with customers and spread the latest company news or product offerings to the public*'.[12]

[12] *© Sophos Group (2010). http://www.sophos.com/security/topic/security-report-2010.html*

9.6 Relevance to ID and HCI

As designers and professionals in IT, we should be aware of the implications of our work, not just in terms of making life easier and more productive for users, but in terms of also making it safer and in ensuring privacy and trustworthiness. This is not solely a designers' problem but design issues can no longer be divorced from the reality of computers and interactive devices across the whole of ordinary life. Ambient Intelligence and Ubiquitous Computing have produced the applications which govern much of our everyday activities and the computer has all but disappeared, leaving traces of its presence in its wake. It is this trace and the ever-widening circles of influence that indicate social inclusion that we must be aware of in order to operate in an ethical manner.

Summary

Various trends have emerged which envisage people surrounded by computers embedded in everyday objects which would recognise and respond to individuals in a seamless, unobtrusive and invisible fashion. Ambient Intelligence emphasises human-centred computing in the convergence of innovations in three key technologies. Implementation is being carried out by commercial companies developing internet-enabled devices whilst research by international laboratories and longer-term legislative issues are being considered by governments. It is, however, a world of potential problems in identity, trust and social engineering.

A reminder of your learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- demonstrate an understanding of social aspects and societal impacts of new computer technologies
- understand and be able to define the concepts of Ubiquitous Computing, Ambient Intelligence and The Internet of Things
- discuss issues such as personal privacy and online trust in human-computer interactions
- describe the design challenges posed by new interaction paradigms.

Exercises

1. Investigate current and anticipated developments in:
   i) e-government
   ii) e-health
   iii) e-commerce.
2. What are the design issues in e-banking applications?
3. How can your knowledge of the software and technical aspects of e-commerce systems help you to design better interfaces for such systems?
4. What might the impact of the 'smart home' be on family life?
5. What do you understand by the term, 'user empowerment'?
6. Define 'Ambient Intelligence' and describe the new paradigm for home computing and entertainment that it promises.
7. Discuss 'cybercrime'. How can Interaction Designers help alleviate it?
8. How do you think both children and the elderly will be affected by new health technologies?

Sample examination question

Discuss how concerns relating to identity, privacy, security, trust, social inclusion and other issues are beginning to have an impact on the internet for developments in e-commerce, e-government, e-health and universal computing.

Further reading

Harper, R., et al. *Being human*. (2008).

Kuniavsky, M. *Smart things: ubiquitous computing user experience design*. (2010).

Excellent textbook on all aspects of community computing

Preece, J. *Online communities: designing usability and supporting sociability*. (2001).

Recent publications on social and ethical consideration of new technologies

Baase, S. *Gift of fire: social, legal, and ethical issues for computing and the internet*. (2008).

Kizza, J. *Ethical and social issues in the information age*. (2010).

Quinn, M.J. *Ethics for the information age*. (2009).

Tavani, H.T. *Ethics and technology: controversies, questions, and strategies for ethical computing*. (2010).

Public policy monitoring, carried out by various worldwide organisations and coalitions; news, blogs and comments by interested parties

NetCoalition: www.netcoalition.com/index.asp?Type=NONE&SEC={1B56510B-4051-403E-8AF5-6CC89CE899E7}

Google's Public Policy Blog: http://googlepublicpolicy.blogspot.com/

Electronic Frontier Foundation: www.eff.org/

Computer Professionals for Social Responsibility: http://cpsr.org/

Privacy International: www.privacyinternational.org/

Future of Privacy Forum: www.futureofprivacy.org/

Appendix 1
Sample examination paper

Duration: 2 hours 15 minutes

There are five questions in this paper. Candidates should answer **THREE** questions. All questions carry equal marks and full marks can be obtained for complete answers to **THREE** questions.

Question 1: Design concepts

Part a

i) Explain what you understand by the term, 'Usability Engineering'.

(4 marks)

ii) Why is an iterative design approach important?

(4 marks)

iii) How does an emphasis on user requirements affect systems design?

(4 marks)

iv) Why should user needs be considered early in interface design?

(4 marks)

Part b

Describe in detail a design approach used in HCI and Interaction Design.

(9 marks)

Question 2: Prototyping

Part a

i) Fully describe three different types of prototyping.

(6 marks)

ii) Identify some of the benefits of early prototyping.

(3 marks)

iii) What problems might you encounter when using prototyping tools for developing new styles of interface?

(4 marks)

Part b

Which prototyping tools might be most suitable for developing mobile technology applications? Provide an outline design and prototype for such an application.

(12 marks)

Question 3: Usability evaluation

Part a

Consider a Usability Evaluation Laboratory:

i) What evaluation methods would you normally use in the Laboratory?
(6 marks)

ii) Draw up a table showing the advantages and disadvantages of formal and informal evaluation procedures.
(4 marks)

Part b

i) Design a 7-item questionnaire to find out what experienced users think about using a simple database application, such as Microsoft Access.
(8 marks)

ii) Clearly identify and describe the usability features you are investigating in every question.
(7 marks)

Question 4: Design practice

Imagine that you are required to design both the interface and physical components of a public access interactive kiosk for exchanging local government information for the general public.

Part a

i) What factors might you consider when designing such a systems if it is to be used by people with a range of physical abilities?
(7 marks)

ii) How would you investigate and test such user requirements?
(6 marks)

iii) What sources of information might you consult to help you?
(2 marks)

Part b

Show your design and prototype for the system described.
(10 marks)

Question 5: Essay

Computers are all-pervasive, ubiquitous, and invisible. Discuss.
(25 marks)

Appendix 2
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Notes

Appendix 3
Chapter summaries

Preface

About this course unit » Course aims, learning objectives and outcomes » The Study Guide » Recommended texts and supporting resources » Sources of further information » Acronyms

Learning outcomes

By the end of this half unit, and having completed the relevant readings and activities, you should be able to:

- gain a historical perspective of the field of HCI and its relationship with software engineering, psychology and ergonomics
- understand what Interaction Design is and be able to think critically about design
- appreciate HCI theory, practice and a set of design approaches
- understand the concept of usability and techniques of usability evaluation
- make use of usability concepts in appreciating, using and building interactive solutions for a range of applications
- criticise and improve poor interface designs, and so develop the skills to design and evaluate interfaces
- demonstrate awareness of new application areas and up-and-coming advanced technologies in order to better understand the potential of new technologies and techniques in the design of future interactive systems and applications.

Chapter 1: Introduction to HCI and Interaction Design

Introduction » Definitions » Why study user interaction » Early HCI » Why it changed » HCI in the 1970s and 1980s » The situation today » Summary

Summary

The scope of HCI has progressed from ergonomics/human factors to human cognition and psychology; from effects on workflow and communication to effects on culture and society. We now investigate the relationships between people that computers and computer networks enable, such as patterns of behaviour between people and within social groups, and study the digital artefacts which shape aspects of our everyday lives.

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- understand the definitions of HCI and ID and associated terminology
- demonstrate knowledge of the historical development of the discipline
- define and describe common HCI terms
- describe how future developments in interaction, design and technology link to the history of the study of ID and HCI.

Chapter 2: Interaction and design approaches

Introduction » What is design? » Some principles of design » Problem space and design space » Design methodologies and approaches » The design activity » Idea generation » Summary

Summary

The goal of Interaction Design is to create products which are useable, useful and desirable. ID attempts to manage the complexity of interaction without losing the feel of a craft when creating ‘great user experiences’. The design approach is one of focusing on users and their needs, and is derived both from design theory and from existing SE and HCI User-Centred Design models.

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- demonstrate a realistic appreciation of ID processes and activities
- discuss the variety of approaches to ID and the range of design techniques and methodologies
- describe how and when such methods are used in a design activity
- describe what a metaphor is, and identify its importance
- demonstrate practice in drawing, sketching and designing paper prototypes.

Chapter 3: Techniques for Interaction Design Requirements

Introduction* » *Task Analysis* » *Data collection* » *Qualitative data* » *User narratives and prototyping* » *Requirements gathering* » *Summary

Summary

Interaction Design is about understanding user needs, taking into account what people are good and bad at, and what can help them best in the way they currently do things. Determining user needs and translating them into system requirements is achieved primarily in user-centred methods by listening to what people want and getting them involved in the design activity. Different data gathering techniques are used to capture and discover user needs, but data interpretation and analysis requires expertise and often an appreciation of the embedded social aspects of work. Task Analysis identifies and describes tasks and user activities, and their inter-relationships; task scenarios, user narratives and prototypes can all be used both to generate designs and to see how users might interact with proposed design alternatives.

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- describe a range of user-focused requirements elicitation techniques
- use a number of techniques for obtaining design input from an end-user population
- understand different types of data (qualitative and quantitative)
- describe which techniques to use in which situations
- demonstrate knowledge of the use of prototyping techniques and distinctions between those techniques.

Chapter 4: Usability

Introduction » Usability » International standards » The Usability Profession » Summary

Summary

Quantifiable elements of usability can be defined through the measurement of efficiency, effectiveness and satisfaction factors. Such usability metrics can be used for comparative testing of systems or interfaces through the definition of usability goals. Standardisation of terminology, approach and techniques have had a great impact within the field of usability testing, on usability design and engineering approaches and on the Usability Profession itself.

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- define and describe usability and usability goals
- discuss how to assess usability and know what usability evaluation entails
- describe the business benefits of usability
- demonstrate a good appreciation of international standards concerned with usability
- describe what a Usability Practitioner does.

Chapter 5: Evaluation and usability assessment techniques

Introduction » Informal techniques » Heuristic Evaluation » Cognitive Walkthrough » Formal techniques » WoZ » Experimental evaluation » Choosing a technique » Professional input » Summary

Summary

Evaluation occurs at different stages of the design process and assesses different aspects of design. At the early design specification stage, it is **formative**, before implementation is finalised. At the later design implementation stage, after a runnable program has been produced, with a full prototype or the final system, it is **summative**. By its very nature, however, all evaluation is highly iterative. Evaluation paradigms for testing systems and interfaces can be informally classified:

- 'quick and dirty' – fast, informal data
- concerned with usability testing – carefully controlled
- field studies – situated in natural conditions
- predictive – actual users not required.

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- describe specific usability evaluation techniques
- undertake simple assessments and interface design evaluations
- describe how to choose between evaluation methods and techniques.

Chapter 6: Designing for different users

Introduction » Culture and universal usability » Inclusive interaction » Accessibility » Summary

Summary

Designing interactions, interfaces and applications for new technologies is not just about designing for a set of given users or for generic populations. When designing for a broad range of abilities many factors must be taken into account to enable Universal Usability and appropriate cross-cultural designs to cater for cultural diversity. Inclusive Interaction requires a good understanding of the needs of all potential users – children, the elderly and those with special needs and impairments or disabilities. Enabling technology for accessibility leads to Assistive Technologies. Mobile and website design must increasingly conform to legal accessibility requirements and guidelines.

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- understand and be able to describe the concepts of Universal Usability and Universal Design
- describe the needs and physical requirements of differing user populations
- discuss how changes in user populations can impact on Interaction Design.

Chapter 7: Design case studies

Introduction » hcibook » ID2 » HFRG » Equator » UPA » GATECH » Summary

Summary

A list of case studies has been provided and short descriptions, indicating the area of investigation and the design issues and techniques applied as solutions, have been given.

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- demonstrate an understanding of what a case study in HCI and ID is, and what it entails
- demonstrate knowledge from reading about and studying the selected and recommended case studies
- obtain practice and experience in carrying out small prototyping, design and test exercises.

Chapter 8: Interaction Design and new technologies

Introduction » Tangible Interaction » Affective Interaction » Virtual Environments » Summary

Summary

Tangible Interaction concentrates on the haptic sense and tangibility – interaction is embedded in real spaces – whilst Whole-Body Interaction involves physical bodily interaction or movement related to physical objects. This type of interaction tries to embody some of the richness of interaction we have with physical devices into interaction with digital content. One way in which to achieve this is by tangible devices, or by embedding electronic sensors in everyday items such as clothing. Affective Interaction can improve both human-to-computer and human-to-human communications. Social robots or agents that can demonstrate affective reactions will be a feature of future applications, some in Immersive Virtual Environments. Designing VEs means understanding the concepts of immersion, engagement, context-awareness and presence to allow users to fully participate in a virtual world. Augmented interaction has myriad future uses which will give rise to new ways of interacting with computers and technology.

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- describe some of the new and emerging technologies that will impact on Interaction Design
- discuss what some new user requirements might be
- decribe how to design for new technologies, needs and applications.

Chapter 9: Real world interactions

Introduction » Ubiquitous Computing » Seductive Interfaces and Flow » Ambient Intelligence » The Internet of Things » Impacts » Relevance to ID and HCI » Summary

Summary

Various trends have emerged which envisage people surrounded by computers embedded in everyday objects which would recognise and respond to individuals in a seamless, unobtrusive and invisible fashion. Ambient Intelligence emphasises human-centred computing in the convergence of innovations in three key technologies. Implementation is being carried out by commercial companies developing internet-enabled devices whilst research by international laboratories and longer-term legislative issues are being considered by governments. It is, however, a world of potential problems in identity, trust and social engineering.

Learning outcomes

By the end of this chapter, and having completed the relevant readings and activities, you should be able to:

- demonstrate an understanding of social aspects and societal impacts of new computer technologies
- understand and be able to define the concepts of Ubiquitous Computing, Ambient Intelligence and The Internet of Things
- discuss issues such as personal privacy and online trust in human-computer interactions
- describe the design challenges posed by new interaction paradigms.

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If you have any comments about this guide, either general or specific (including corrections, non-availability of Essential readings, etc.), please take the time to complete and return this form.

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