Inclusive design: bridging theory and practice

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Abstract. Large groups in society lack the necessary skills to be sufficiently self-reliant and are in need of personal assistance. These groups could be supported by information and information technology (ICT), but only if this technology is designed to fit their (cognitive) abilities. Inclusive design theory and methods have already been developed in research contexts, but there is still a gap between theory and practice. There is a need for a practical aid, that helps to create awareness of inclusive design among ICT developers, and offers easy-to-use information and tools to actually apply the methods for diverse target groups. This paper describes the first steps taken towards an inclusive design toolbox for developing ICT applications that offer cognitive support for self-reliance. Dutch ICT companies were interviewed and participated in a co-design workshop, leading to a number of initial needs, user requirements, and an on-line community, that form input for further development of the toolbox.

Keywords. Cognitive abilities, toolbox, design patterns, personas, inclusive design methods, ICT, self-reliance, SME, co-design.

1 Introduction

Information and communication technology (ICT) has a large impact on personal and social lives of people. More and more, in order to access, request or provide information (e.g. to make personal choices in health care), and to participate actively in society (e.g. to use social media to maintain contacts with peers), people need to be able to make use of this technology. Also, the government expects citizens to become more self-reliant. Large groups in society, however, lack the necessary skills to be sufficiently self-reliant and are in need of personal assistance. These groups could be supported by information and information technology, but only if this technology is designed to fit their abilities. In that way, technology is not another barrier, but would instead serve as a means to achieve self-reliance.

Diverse groups exhibiting limited self-reliance include people with specific physical and cognitive limitations, ageing people and people with a low education and/or a low socioeconomic status, all of whom adhere to specific values in life. Self-reliance is relevant in many areas of society, but in particular in social security (absence of threats as a result of criminal acts, offenses, serious nuisances of other citizens), health care and well-being (make personal choices, life style, adherence to therapy), and participation (education, work, social engagement). An important determinant for

self-reliance is self-efficacy: the ability and belief to act adequately and efficiently in a given situation (Bandura, 1997), which should also be present for ICT use. Problems with using ICT to support self-reliance mainly apply to people with suboptimal cognitive abilities, such as elderly persons, people of low literacy and non-natives, but also children.

In order to make ICT accessible to a large diversity of user groups with specific abilities and values, inclusive design methods should be applied. Inclusive design is defined as the design of mainstream products and/or services that are accessible to, and usable by, as many people as reasonably possible, without the need for special adaptation or specialized design (British Standards Institute, 2005; Langdon & Thimbleby, 2010). However, developers of ICT products and services are generally not aware of the existence of inclusive design theory and methods. Also, theory and methods have been developed in research contexts and are often hard to apply in real life. In short, there is a gap between theory and practice of inclusive design. There is a need for a practical aid, that helps to create awareness of inclusive design among ICT developers, and offers easy-to-use information and tools to actually apply the methods for diverse target groups. Such a toolbox should reflect state of the art knowledge on inclusive design and should easily be connectable to already existing tools.

This paper describes the first steps taken towards an inclusive design toolbox for developing ICT applications that offer cognitive support for self-reliance. First, a brief state of the art of inclusive design standards, guidelines, design patterns and methods is provided. Then, current practices of inclusive design are presented, in the form of existing toolboxes and an inventory of the use of inclusive design methods in Dutch ICT small and medium enterprises (SMEs). Finally, a first step towards co-design of the toolbox together with SMEs is described, resulting in initial use requirements of the toolbox. The paper ends with initial conclusions and directions for further steps in the co-design process.

2 Inclusive design theory and methods

2.1 Standards and guidelines

The term ‘inclusive design’ stands in the tradition of the terms ‘design for all’, ‘universal design’ and ‘(universal) accessibility’. Up till now a number of sets of ‘Universal Accessibility’ guidelines have been developed for people with a variety of limitations. These guidelines are an important source of information for inclusive user interface design and evaluation. Examples of guidelines that have been issued by official bodies are the “Web Content Accessibility Guidelines” and the “User Agent Accessibility Guidelines” of the World Wide Web Consortium (W3C) and the “Guidelines for ICT products and services; ‘‘Design for All’’ of the European Telecommunications Standards Institute (ETSI). W3C aims specifically at people with visual disorders who want to use the internet (World Wide Web Consortium). ETSI has written

guidelines for various disorders, but focuses more on products than on user interfaces (ETSI, 2009).

For other target groups and applications no official guidelines or standards exist. Although a lot of research has been carried out into various target groups and applications, which has often resulted in lists of design recommendations or guidelines. There are design principles for elderly people (Fisk et al., 2009), for children (Hourcade, 2008), and design 'considerations' for persons with a cognitive disability (WebAIM, Van der Pijl et al., 2005) and for people of low literacy (Cremers et al., 2012).

2.2 Human values into design patterns

Value Sensitive Design (VSD) is a theoretically grounded approach to the design of technology that accounts for *human values* in a principled and comprehensive manner throughout the design process (Friedman et al., 2006). Values concern "principles or standards of a person or society, and personal or societal judgments of what is valuable and important in life" (Oxford English Dictionary) on personal, cultural or ethical issues (Cheng and Fleischmann, 2010). The values that should be addressed in inclusive design practices, such as access to information and services, can be investigated via three complementary approaches (cf. Friedman et al., 2006). First, a conceptual investigation starts with an analysis of the direct (e.g. frail elderly) and the indirect stakeholders (e.g. caregivers). Such an analysis conveys theoretical-founded values like dignity, autonomy, independence, safety, trust, and privacy. Second, an empirical investigation, encompassing different techniques like focus groups, observations, interviews and surveys, can provide additional or elaborated "situated values" like freedom from discriminatory bias. Third, a technical investigation (e.g., domotics) acquires the values that relate to technical constraints and opportunities, such as comfort and affordability.

Friedman et al. (2008) used VSD to enhance the public participation and value advocacy in a simulation-supported city design environment, aiming at mutual understandings (without manipulative or strategic actions) and freedom from bias (the absence of systematic and unfair discrimination). To achieve these value-driven goals, a *design pattern* was formulated that clearly demarcates a more factual presentation of information from opinion (in order to avoid misperceptions). This example shows that interaction design patterns provide a practical and sound method to establish best practices of inclusive design, incorporating the relevant human values. Interaction design patterns are structured descriptions of an invariant solution to a recurrent problem within a context (Dearden and Finlay, 2006). They are used *both* to record and communicate design knowledge *and* to support the design process. We aim at an incremental development of an inclusive design pattern library (cf. http://www.welie.com/patterns).

2.3 Situated inclusive design

Both the standards and guidelines (section 2.1) *and* the Value Sensitive Design and Interaction Design Pattern (section 2.2) approaches, have to be integrated into a coherent user-centered design rationale to establish an effective and efficient engineering process. The design rationale 'situated Cognitive Engineering' (sCE) has been developed to channel this human-centered, iterative process of deriving, refining, shaping and validating *user requirements* (Neerincx & Lindenberg, 2008). Values, standards and guidelines explicitly feed into the requirements, combined with the identification of specific accessibility-related user characteristics or technological preconditions (Neerincx et al., 2009; Lindenberg & Neerincx, 2001). Use case analyses drive this specification and refinement process, integrated with claims analyses that provide the justification (i.e. the expected outcome of the interaction). The use cases and user requirements with an appropriate justification are shaped into interaction design patterns. However, if appropriate design patterns are already available, these practices can be selected and re-used. The set of patterns can be implemented in a prototype for evaluation.

For inclusive design, it is essential to involve all relevant user groups in the process. Evaluation should include aspects that can be perceived objectively (performance) as well as subjective factors (affect, privacy, trust) and be executed in a realistic use context. Examples of this 'situated inclusive design process' are applications for people of low-literacy (Cremers et al., 2008), cognitively disabled (Pijl et al, 2005) and elderly (Blanson Henkemans et al., 2008; Bojic et al., 2009). Such examples show a large variety of methods and solutions with specifications on different levels of abstraction. Currently, we are developing a situated Cognitive Engineering Tool (sCET) that supports both (1) the analytical and empirical activities to acquire and assess information and (2) the recording and sharing of this information in a concise and coherent format (cf., Neerincx, 2011, and see http://www.scetool.nl).

3 Practices of inclusive design

3.1 Existing design toolboxes

A large collection of design methods is currently available, applicable in various phases of the design process, for both specification and evaluation. A number of practical on-line design toolboxes already exist that try to bridge the gap between theory and practice. For each toolbox, the aimed users, the target groups, the method description, method organization and selection, and the presentation/visualization are described.

- **Inclusive design toolkit.** The toolkit contains an introduction on inclusive design and the need for doing it. Aimed users of the toolbox are not specified; it focusses on both designers and businesses. The focus lies on descriptions of all possible target groups and their capabilities, including a model of interaction between the dif-

ferent user capabilities and design guidance for each capability. The toolkit contains a limited number of method descriptions: design process checklist, integrated design log, business case materials, exclusion calculator, Cambridge simulation gloves, Cambridge simulation glasses, impairment simulator software, example set of personas. The descriptions consist of definitions, case studies, and guidelines. The information presentation employs short text sections, and lots of icons, graphics, pictures and charts (http://www.inclusivedesigntoolkit.com/).

- **55plus toolbox.** The toolbox (in Dutch) focuses on topics that change the innovation process as a result of the choice of a target group (in this case: of 55plus people). Aimed users of the toolbox are entrepreneurs, focusing on both product development and marketing and sales. There is a phasing for product design consisting of: exploration, product development, production and marketing. In each phase the user can choose from a number of guiding questions to obtain information on the target group, useful tools and cases. Suitable tools for the particular phase and target group are suggested and illustrated in factsheets containing step by step guidance, visualizations, relevant links and references (http://www.55plustoolbox.nl).
- **UCD toolbox.** This toolbox (only a private beta-version) presents some benefits of applying user-centered design. Aimed users of the toolbox are not specified. It contains an overview of 35 design methods, which can be pre-selected by criteria: type of product, design goal, resources, participants and method characteristics. Also, a pre-selection of methods can be made for various target groups: elderly, children, physically challenged, visual/hearing impaired or cognitively challenged. However, no background information on specific target groups is offered and it does not become clear why the methods are suitable for the target groups. Method descriptions contain: overview (visuals, possible outcomes, benefits, limitations, written by and reviewed by), description, tweaks (optimization), instructions (preparation, execution, analysis) and literature (http://www.ucdtoolbox.com).
- **HCD toolkit.** The toolkit shows the theory on HCD with visualizations and models. Aimed users of the toolbox are people, nonprofits, and social enterprises that work with low-income communities throughout the world (target group). The HCD Toolkit walks users through the human-centered design process and supports them in activities such as building observation and empathy skills, prototyping, leading workshops, and implementing ideas. This HCD process identifies 3 phases: Hear, Create, Deliver. Per phase a number of methods are presented. After selecting a method, you see detailed information on the method containing instructions and tips and indications of time, difficulty, materials and participants. Each method ends with one or more related stories (cases) which are submitted by users of the toolbox, creating a large involvement and experience sharing of these users (http://www.hcdconnect.org/methods).

The collection of current toolboxes already contains extensive information on target groups and (the added value of using) inclusive design methods. However, there is no toolbox yet that makes an explicit connection between (cognitive) characteristics of target groups and suitable methods. Also, current toolboxes do not contain many de-

sign guidelines yet; best practices are offered but not as design patterns. Finally, toolboxes could benefit from a better description of the commercial interest of using inclusive design for (ICT) companies.

3.2 Actual use of methods in The Netherlands

Interviews. A selection of Dutch SMEs who are involved in the development of products or services for end-users was made. All companies were approached by telephone to make an inventory of end-user activities they were already employing. The following questions were asked:

- What kinds of products or services do you develop?
- Who are your end-users?
- Do you involve end-users in your product or service development processes?
- Which methods do you use when involving end-users?
- What questions and needs do you have with respect to involving end-users?

Results. An inventory of a total of 56 Dutch companies was made. Of all companies, 13 (23%) were finally interviewed. The remaining 43 companies did not participate for various reasons: they did not react to requests via email or voice mail, it was hard to find the right point of contact, they turned out not to produce products or services for end-users, or they were not interested in being interviewed.

These companies produced a variety of products and services: applications of agent technology, help artists from a concept to a concrete product, virtual environments, training simulation, television apps, mobile services, health care robots, sensor technology, document management, web sites, and mobile apps. End user groups are diverse: children, people with multiple disabilities, general public, police, fire brigade, military, consumers, elderly, chronically ill, professional users.

Of the 13 companies that were interviewed, 4 indicated they never consulted end-users during their development process. One indicated they had not selected their own methods yet, but sometimes hired students industrial design to do end-user research. Another said that they sometimes used ‘AB’-testing: two versions of a design, e.g. a banner, are used and the number of clicks on the banners are counted to see which one is preferred. Reasons why companies did not involve end-users is that creative persons want to pursue their own ideas, speed is very important there is no time to wait for a report, client keeps in touch with end-user, sometimes aware of adjustment of method to specific target group. Nine companies indicated they sometimes involved end-users. Various methods were mentioned: set up user evaluation in cooperation with the client, place a camera in a test setup, recruit employees from a certain application domain who bring in background knowledge, own engineers act as end-users, observations of use in context, test sessions of use in context, scenarios of future use, interviews, round table sessions, get a feeling with the market (clients) and new technology (conferences, exhibitions), review off-line (form filling), play scenarios in the lab, interview stakeholders, acquaintances of end-users, ‘undercover’ observation,

contextual design, observation in lab, observe clients making use of products, workshops with stakeholders, customer journeys, service blue prints, concept evaluation, visit/talk to clients. However, the number of methods mentioned varied a lot between companies: larger companies and design companies employ far more methods than ICT companies.

Companies indicated some questions and needs, which a toolbox could possibly address:

- How do you know whether you have done enough research?
- How do you know you have sold the real problem with your product?
- Who do you recruit to contact the end-users?
- Who do you select as test persons if the target group is large and varied?
- How do you behave towards the end-user? What is the right attitude?
- How do you avoid politically correct answers from users?
- How can you test with end-users if the product concept is still confidential?
- What is a structured way to handle requirements?
- The need for a platform to find other companies, share information and tips & tricks.

4 Co-design of an inclusive design toolbox

4.1 Toolbox considerations

Descriptions of relevant methods, target groups and aspects of self-reliance, examples of applications of these methods and lessons learned will be collected in an inclusive design toolbox. The toolbox will be made available to SMEs who develop ICT products and services for end-users with suboptimal cognitive abilities, and who want to involve these end-users in their development processes. In order to develop a toolbox, the following aspects need to be considered:

- Who are the users of the toolbox?
  - Expert vs. non-expert users (with respect to inclusive design)
  - Designing for all vs. designing for special target groups
  - Knowledge of the target group vs. unknown target group
- What are the goals of the toolbox?
  - Offering help with choosing a method in general
    - Choice criteria (design phase, budget, time, etc.)
    - Short description and visualization of the method
  - Offering help with executing the method in general
    - (Extensive) description of the method and procedure
    - Guidelines, design patterns, best practices
    - Tips & tricks, do’s & don’ts
  - Offering help with executing methods for specific target groups
    - Which methods are suited for specific target groups?
    - How to adjust methods to a specific target group?

    - Guidelines, design patterns, best practices per target group
    - Tips & tricks, do's & don'ts
- Offering help with designing for specific target groups in general
    - Descriptions of target group characteristics
    - Personas, scenarios, storyboards of target groups
- Offering help with designing for self-reliance
    - Definition aspects of self-reliance (social security, social engagement, self-efficacy)
    - Tips & tricks, do's & don'ts

4.2 Workshop with SMEs

Method. In order to be able to develop an inclusive design toolbox that is useful for developers of products and services, requirements for functionality and design of the toolbox should be collected from the prospective users of the toolbox. In order to get input from these users, a workshop was organized with a selection of the companies, to delve deeper into requirements for the toolbox and create a Dutch inclusive design ('design for diversity') community. The goal of the workshop was to:

- Gather knowledge on special target groups such as elderly, people of low-literacy, immigrants and children
- Gather knowledge on different methods and techniques for developing and evaluating products and services for the target groups
- Inspiring best practices of peer companies of involving end users
- Exchange experiences and build up a network with companies and knowledge institutions with respect to designing for a diversity of target groups.
- Gather first requirements for the toolbox.

Participants were 14 representatives of ICT and design companies (SMEs). The workshop started with introductions on the commercial interest of designing with end-users for SMEs and the societal relevance of the inclusive design toolbox. Then, three presentations of best practices of inclusive design methods (context mapping, focus group, questionnaire) with, respectively, children, low-literate and elderly persons were given by three companies. In interactive sessions, three groups discussed how the best practices could be applied in their own companies and how a toolbox could help. Finally, a 'design for diversity' social media group was launched.

Results. Some requirements for the toolbox came up during the workshop:

- Availability of personas, to create an image of standard end-users
- Examples (best practices) of products and processes, success/failure factors
- Preconditions for the use of methods and solutions
- SME-proof: simple, not scientific (but rooted in scientific knowledge)
- Available methods within a certain time period and budget
- First present solutions (best practices), then method on how to get there

- Possibility to shop and snitch from toolbox
- Possibility to share information (open source)

5 Discussion, conclusions and future work

This study confirms our assumption that there is a substantial gap between theory and practice of inclusive design.

From a theoretical point of view, there is still a lot of work to be done in the selection of appropriate inclusive design methods, standards, guidelines and design patterns for diverse target groups, as well as the validation, description and disclosure of this knowledge base. Moreover, inclusive design theory and methods should form input to the situated cognitive engineering process, to become 'situated inclusive design'.

From a practical perspective, it can be concluded that awareness of inclusive design is still lacking. It has proven to be hard to find Dutch ICT companies that produce end-user products and are willing or able to discuss methods for end-user involvement. Unfamiliarity with inclusive design seems to be a barrier for participation in interviews or a workshop. However, we found that some companies already involve end-users in their development processes, in less or more structured ways. Also, we have been able to derive some initial needs and requirements for an inclusive design toolbox, in particular the need for concrete personas (target groups) and design patterns (best practices). Finally, the creation of a social media group 'design for diversity' should ensure more awareness and involvement of companies.

In the future, next steps in the co-design process of the inclusive design toolbox should be taken, with regular involvement of ICT companies. The inclusive design research community has a strong responsibility to guarantee the quality of this toolbox. Ultimately, the toolbox should lead to ICT solutions that match cognitive abilities and reflect values of diverse target groups, in order to empower these citizens to become self-reliant in society.

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