Classifying Scenarios in a Product Design Process: a study towards semi-automated scenario generation

I. Anggreeni[1], M.C. van der Voort[1]
[1]Laboratory of Design, Production and Management, Faculty of Engineering Technology,
University of Twente, Enschede, The Netherlands

Abstract
This paper explains the possible uses of scenarios in product design. A scenario classification is proposed as a framework to create, use and reuse different types of scenarios in a product design process. Our aims are three-fold: (1) to obtain a better view on the extent to which scenarios can be useful to a product design process, (2) to identify in which specific areas of scenario-based design a support in scenario generation is needed in practice and (3) to build a foundation for the succeeding framework of scenario generation research.

Keywords:
Scenario, scenario classification, scenario based product design, product design

1 INTRODUCTION

Designing consumer products has nowadays become more challenging. Motivated by the competitive market, design companies want to add innovations and unique selling points in their products. Innovations in design techniques and methods are taking place to answer this need. Nevertheless, the way to design a marketable product is still often achieved by bringing several functions into one single product, to actually convince potential buyers that the product is the best value for money. Overall, consumer products increasingly become multi-purpose, multi-user or having a dynamic contexts of use [1]. To adapt a solution into many users, purposes or contexts of use all at once, some design aspects could become compromised and therefore, the design process requires tough and iterative verifications to make sure all aspects are met. On top of this, the product design must also meet the initial demands of the stakeholders (i.e. the clients – who gives the design assignment) as well as standards or regulations from relevant authorities (e.g. ISO, Arbowet). A product design project often has complexities that can only be tackled by a multi-disciplinary team. Designers, engineers, ethnographers, marketers, managers, customers, end-users etc would compile a design team where team building and communication could potentially become problems.

Product design has recently turned to scenario based design to answer these challenges. Scenario based design, arising from computer system development, uses concrete descriptions of people using such technology to discuss and analyze how the technology could fit in into their activities [2]. These concrete descriptions are called scenarios. They serve well as a communication tool because the concreteness forces the authors to explicitly tell about their assumptions. Scenarios are inexpensive. They could highlight key issues on the problems or solutions before any design specification is built, and therefore guide the direction of designing. Despite all the benefits, scenario based design in its original form is mainly a heuristic method. A design team indeed has to define its own strategy to benefit from using scenarios. What has been mostly neglected is the actual work of generating the scenarios. Scenario authors will face doubts whether they have identified, created and communicated the scenarios in an optimal way. Without adequate support to these backbone activities, scenario based design could turn into a sporadic use of scenarios without any significant benefit to the design process.

Our hypothesis is that a support by means of a semi-automated scenario generation tool will 'jump-start' designers into adapting a structured scenario based approach. The framework that is implemented in the tool could as well give method guidance for creating and managing scenarios as an integral part of designing. Important to take into account is that scenarios can be used for dedicated purposes and under different circumstances. To create an awareness of the types of scenarios as the target of the generation, the first part of our research is therefore to classify scenario usages and identify their key characteristics. Using this scenario use classification to find intersections with design practice, we will be able to identify, consider and determine the form of scenario generation support required by design companies in their practice.

2 SCENARIO AND SCENARIO BASED DESIGN

There exist many different definitions of 'scenario', which are mainly proposed from the computer system development discipline, e.g. [2-4]. Despite all the different formulations, scenarios used in computer system development share some common features. *Firstly*, scenarios always describe a process or a sequence of acts, never a single act. *Secondly*, the unfolding is from the viewpoint of an actor, which corresponds to a stakeholder. *Thirdly*, the scope of a scenario ranges from 'narrow' (describing what a product does) to 'rich' (describing a larger context of use). These different scopes of scenarios are essential to capture the complete design information [5]. Without the intention to make a stand in defining 'scenario' for product design, we would like to share our practical definition of 'scenario' in this

paper. Scenarios are *explicit descriptions of the hypothetical use of a product*.

As mentioned earlier, scenarios as a communication tool have beneficial characteristics. They are easy to use because they use natural language. Scenarios are also at once concrete and flexible because they can be changed readily and inexpensively in terms of time and money. The effort to create the narratives is far less than say a prototype. Depending on which information to highlight, the purpose and the audience, scenarios can take different forms of representation. A few examples of scenario representation are illustrated in Figure 1.

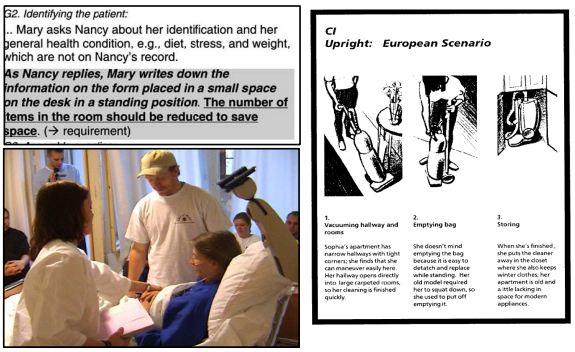

Figure 1 In clockwise direction, a scenario describing a phlebotomist's current practice in narrative form [6], a scenario introducing a new idea of vacuum cleaner for European market in a storyboard with text [7], and a scenario for finding future solutions acted in a role play [8].

Designing involves communication in many directions: between users and designers, designers and other stakeholders, and among designers internally. Designers get insights about current use situations from users and stakeholders. The challenging part is to elicit or discover what the users and stakeholders consider to be their needs, wishes and problems. Using scenarios could make explicit any assumption which in turn reveals the deep-down needs of the users and stakeholders. During the exploration of design directions as well as in the design process, the design team needs users' and stakeholders' feedback on its proposed solutions from time to time. Scenarios could again be the tool for the design team to describe the solutions in the users' context, with or without sketches or models visualizing the solutions. Accordingly, the users and stakeholders have the liberty to come up with scenarios, based on their experiences, which may discover weaknesses of the proposed solutions early. Within the design team itself, the concreteness of scenarios informs everyone explicitly about the context of use of the product or the way the product is intended to work, which is especially crucial in a multi-disciplinary design team.

In addition to the benefits of using scenarios for improving communication in design, Carroll [2] also motivates the use of scenarios to address technical challenges in information system design. In reality, designers need to combine various design techniques to identify, create and use scenarios effectively and efficiently. The resulting design strategy is therefore dedicated for the specific design project, which attributes to a successful design process. Thereby, there exists no single template for scenario based design methodology. We rather define scenario based design as a *common denominator* for *techniques that apply scenarios* to bring *products, environments* and their *interactions* into harmony.

3 SCENARIO CLASSIFICATION

3.1 Motivation

A scenario based approach to product design is still in its early stage and currently develops through adapting scenario-based approaches by other disciplines. The closest discipline where we could learn most about scenarios for product design is the scenario uses in computer system development. In this discipline, scenarios have many roles each of which is related to a purpose [2]. The scenario roles in computer system development are clustered in specific domains, e.g. information system [2-4], usability in the human-computer interaction [9, 10] and requirements engineering [11, 12]. Although we can learn from this knowledge, we need to be aware of an underlying difference between a computer system and a *tangible* product. This difference hinders a direct translation of the available scenario use frameworks in computer system development into the product design domain. Unlike a computer system whose information is handled through a determined set of user interfaces, the 'information' in tangible products could be represented through a larger set of interaction means, involving the five human senses. Therefore, scenarios for product design need to comprise the larger scope of use situations as well as the smaller scope of interaction details. Relevantly, Lim and Sato [6] propose a product design framework that combines multiple aspects of use situations for a holistic problem viewing. This framework helps the generation of current use scenarios based on empirical observations.

Our approach starts by looking at a complete account of designing, which reveals that the potentials of scenario based product design are not equally addressed in all stages of design. Figure 2 incorporates the high-level view of design as a cycle of analysis, synthesis and evaluation steps and the design phases that represent each step. Throughout these design phases, scenarios could make the process more effective by supporting communication, nurturing creativity and providing concrete situations to evaluate solutions. We will therefore anchor the discussion on each scenario type to its corresponding design phase.

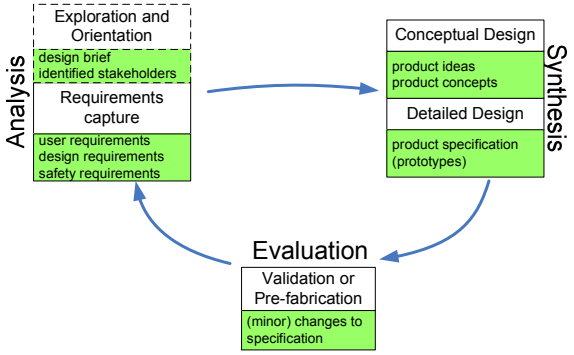

Figure 2 A representation of the design phases within a process loop of *analysis*, *synthesis* and *evaluation*; the green boxes show the outputs of the relevant phase.

3.2 Our scenario classification

In Figure 2 we have presented our simplified model of a product design process. The design phases are formed as a synthesis of existing engineering design models. Although design practice would most likely be more complicated than this simplified model, we need to emphasize that the model is only to illustrate our assumptions of the role of each design phase. Henceforth, the model becomes a foundation to our proposal of scenario uses.

Phase 1. Exploration and Orientation

Design problems in any design project are often ill-defined. However, despite the uncertainties in the phase, the design team must dare to create tentative solutions and understand the problem boundaries. To make sound decisions in this early phase amid the uncertainties, the design team members inform themselves well on the subjects relevant to the design problem. *Stories from potential stakeholders* often reveal important aspects of their professional or personal lives, parts of which will be affected by the design. Adopting scenario planning for decision making [13], the knowledge from stakeholders and other sources could be synthesized into a small number of focused explorative scenarios. *Explorative scenarios* describe some versions of the future which are all equally plausible; yet they also accentuate the most important and uncertain elements within a world of certain and predictable elements. As a result, the design team gains awareness of the possible consequences of their design in the plausible futures. For example, designing a bicycle for a market of 5-10 years in the future requires designers' understandings of the plausible situations in which people use bicycles. How is commuting like within 5 to 10 years? Could it be that the use of bicycles is triggered due to government imposing environment policies? Is there any new traffic regulation or infrastructure to be implemented within 5 to 10 years? The answers could lead to a broad range of design directions where exploration is necessary.

Scenario Types

- (Potential) stakeholder stories serve as an initial study into the domain where the product is going to be used. These stories reveal what matters to the (potential) stakeholders, which aspects of life or work they want to improve, etc. Interviews, surveys and ethnography are among the techniques than can be used as input.
- Explorative scenarios help the design team to reflect on their design strategy, creating awareness of the threats and opportunities along their decisions. Creating sound explorative scenarios requires knowledge that can be informed by literature studies, survey results and experts in the related domain. In practice, designers might not be actively involved in the creation of these scenarios. When the design project is still being defined, other members of the design team (e.g. managers or marketing) have a more active role to create a business case together with the stakeholders. The explorative scenarios could improve their communications in the process.

Phase 2. Requirements Capture

A set of requirements is an elaboration of problem and solution definitions. In practice, problems and solutions evolve together throughout the design process: every proposed solution affects the problems, whereas problem redefinition reveals possible solutions that lie outside the boundaries of what was assumed to be possible [14]. Therefore, one approach could begin from the actual situation to identify requirements. The *actual practice scenarios* capture the current (problematic) situations and based on them, draw requirements. Another approach could start from solution ideas that, by designers' intuition, *might* work. The designers could then envision more requirements from the imagined future practice. *Future practice scenarios* describe imagined futures with the solution ideas: '*would people use the product?', 'how might people perform their activities if such product were available?', 'how would the product affect their life?'*. Both approaches propel each other into a more detailed set of requirements.

Scenario Types

- Actual practice scenarios describe users' problems, dissatisfactions, needs and wishes in their current practice in a concrete manner. The concreteness is achieved by completing each scenario with all relevant information, so that there is no room for misinterpretation. Interviews, ethnography and contextual inquiry with users (and possibly other stakeholders) inform the creation of these scenarios.
- Future practice scenarios exploit designers' intuition, but do not completely rely on it. These scenarios are projections of how the early product ideas would change the use practice, and could be accompanied with mock-ups or demonstrators. By keeping a firm connection with the empirical requirements, the ideas are directed to fulfil the user needs. By using future scenarios instead of prematurely building prototypes, there is only minimum risk in case the ideas turn out to be unsuitable. The stakeholders can be more actively involved in the shaping of the solutions because the future scenarios can be easily moulded with their views on the futures.

Phase 3. Design (conceptual and detailed)

The design phase requires both creativity and criticism to mingle. Developing product concepts is a cycle on its own: the design team thinks of a product concept using information from stakeholders, evaluates it in different use situations and makes modifications to the concept. In this phase, the designers produce many sketches depicting their ideas to bring on the solutions. The *interaction scenarios* could regulate this activity. They are detailed accounts of the future practice scenarios, thus formulating answers to the question *"How does the user interact with the product to make future practice scenarios happen?"*. Therefore, the interaction scenarios are actually an inseparable part to the sketches (i.e. product ideas/concepts), though sometimes they are not made explicit. The interaction scenarios could belong to different levels of interactions. In the beginning when the designers are still refining the product concept, the interaction scenarios can represent it as a 'black-box' product with a set of behaviours. Having concrete scenarios to work with, it is easier for the designers to fit a concept into different use situations iteratively, making sense of the proposed solution in the real life. Inviting users' opinions, for example in a 'scenario walkthrough' session, could assist in determining the concept details. The interaction scenarios could then be refined by adding more details to the interactions and interfaces.

Possible problem scenarios expose weaknesses of the product concept, especially in extreme and critical situations. The initial requirements capture might not discover all extreme and critical situations, which could be remediated by a close and continuous contact with users and stakeholders. Possible problem scenarios could also describe unanticipated problems that may rise due to the proposed solutions, thus requiring criticism which is less biased when it comes from stakeholders. In conclusion, both scenario types are more effective when created, discussed and criticized together with the stakeholders.

Scenario Types

- Interaction scenarios describe the interactions between users and the product concept to actualize the futures as claimed in future practice scenarios. The interaction scenarios undergo transformation from abstract to detailed, and eventually function as rationales to the resulting design specification. The opinions of users are most valued, and therefore their

involvement through participatory design is important (e.g. [8, 15]).

- Possible problem scenarios describe problematic events or situations against which the product concept should be tested. These events or situations could be left unnoticed during the requirements capture using interview and ethnography (observation). Complementally, designers and stakeholders could conduct a brainstorm session to identify critical, extreme or dangerous events or situations that could happen during product usage. Probing technique [16] could also be used to invite users to share their personal experiences which they think relevant to the product being designed.

Phase 4. Validation or Pre-fabrication

The design phase aims to generate solutions which fulfil the design requirements with as minimum compromise as possible. To avoid overlooking any requirement ('*I really did think of that, but I forgot…*') or more subtle criteria ('*Did the user say he likes it this or that way?*'), the design team needs to evaluate the solution or solutions by means of validation scenarios. *Validation scenarios* take inspiration from all other previous scenarios. The validation process itself could cover several design aspects (e.g. *functionality, usability, safety* and *branding profile)* or specific product parts (e.g. lock mechanism, steering mechanism or motor). For each of these design aspects or specific product parts, validation scenarios can be composed by combining scenario elements of existing scenarios to give a good coverage of all possible use situations. Figure 4 provides an overview of the scenario elements.

Scenario Types

- Validation scenarios, especially the ones intended for usability testing must be complete, i.e. comprise a complete set of scenario elements. As defined in ISO 9241-11, the usability of a product applies to specified users (element: *actors*) with specified goals (actor's sub-element: *goals*) in a specified context of use (element: *context*). This phase must detect any remaining deficiency before the product design is manufactured and marketed. Therefore, a rigorous participation from all stakeholders within the validation phase is requisite. Any change to the product specification should be only to streamline or fine-tune it.

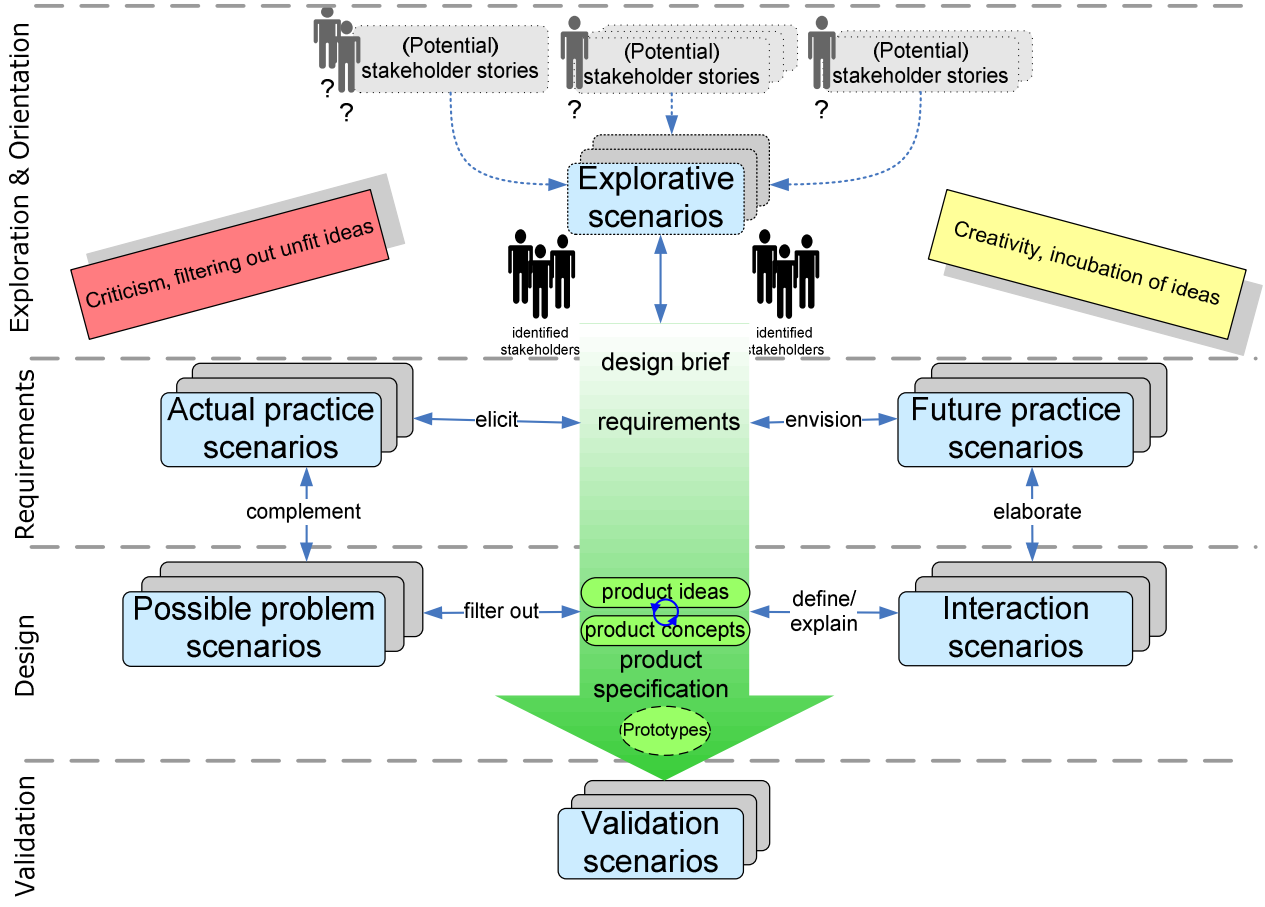

Figure 3 A roadmap for possible scenario usages in a design process, showing how scenarios are related to one another and to other in-between design results.

3.3 Summary

Figure 3 summarizes the discussed scenario types and shows their connection with one another and with the design deliveries. These scenario usages are not meant to be exclusive for the designer role. As an example, the explorative scenarios could be more useful when used by the design team managers during a project definition with the clients. We always need to remember that the stakeholders have different interests, backgrounds and assumptions, which all count into the design directions. Defining a design project is therefore a tough process to make a compromise for the interests of all stakeholders. The explorative scenarios then become the manifestations of the possible design directions that give clear indications where a design project could be going next. As the result, one design direction can be passed on

to the next phase with supporting information that is more concrete, focused and detailed.

Most designers and engineers who perform the practical designing work would find the scenario uses from the requirements phase and later to be more useful in their activities. Scenarios that capture problems (i.e. *actual practice* and *possible problem scenarios*) as well as scenarios that describe solutions (i.e. *future practice* and *interaction scenarios*) are the frames of reference for designers to every little decision that they have to make during the design process. Obviously, with experience designers develop the ability to always be aware of what implications they create with their design by running through "scenarios" in their mind. If we look into our definition of "scenarios", scenarios need to be explicitly communicated, meaning that they must be expressed no matter in which form of representation. Above all reasons, the explicitness aims to guide designers in remembering their rationales and therefore reducing the risk of overlooking design aspects. When designers can be made aware of all possible problem scenarios while they are designing, most design mistakes can be avoided, detected and anticipated early.

Product designers often have to deal with many subtle design components such as their intuitions that a solution might just work, users' tastes and likeness, or what users regard as "comfortable" or "trendy" in a product. Scenarios can hold these subtle design components. Nevertheless, the scenarios need a framework of use to get the best out of them. The structure of this framework should take into account the practice of designing, and adjusts to it. Our roadmap of scenario uses is pertinent to the underlying design activities, which is a cycle of analysis, synthesis and evaluation. By putting forward this convergence, we aim to invite product designers to reflect on and share their experiences of using scenarios, which is currently our ongoing work.

4 SCENARIO ELEMENTS

In the discussion on scenario types, we have indicated that scenarios need to be concrete. The concreteness of a scenario depends on how well the scenario elements are described. Every scenario needs a certain set of elements to be a coherent narrative. Depending on the purposes and the audience of scenarios, some elements can be given more emphasis than others. For example, explorative scenarios could focus on the plausible future contexts that the design team envisions to be a strategic business case, without yet exposing any product concept. These scenarios make explicit the information that the managers need to deliver to the stakeholders in order to convince them. Another design case would probably need a large set of actual practice scenarios. For example, designing a product for the disabled or the elderly requires a lot of information on the current practice as well as extensive and intensive descriptions of the users. The designers might have no idea at all about the lives of these users. For that reason, the process of creating actual practice scenarios could compensate this lack of knowledge.

Scenarios elements that source from the present time can also be altered to create a specific type of scenario. For example, actual practice scenarios could undergo major changes in contexts, actors or practices. The resulting future practice scenarios could illustrate brand new situations that the designers think could be the ideal solutions for the current problematic situations. We present in Figure 4 a mapping of scenario elements to illustrate the relationship between them.

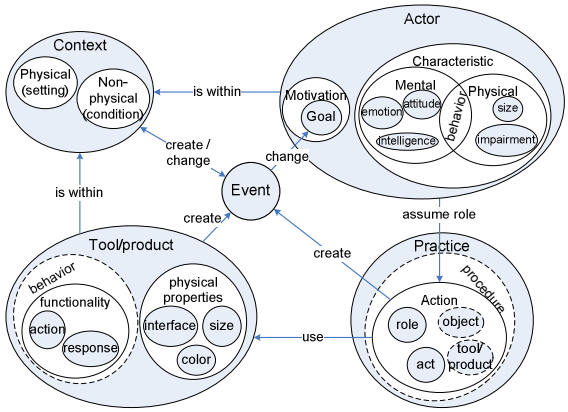

Figure 4 An overview of scenario elements.

5 CONCLUSIONS AND FUTURE WORKS

A scenario classification has been proposed to explain the possible scenario uses in a design process. The classification framework also serves as a heuristic guidance for a scenario generation process, which is our next step in this research. Being generic, practical and convergent to the underlying steps of designing (see Figure 2), we aim to use the classification framework as a basis to locate challenges in implementing scenarios and to deduce a form of support to address these challenges. Our future work specifically aims to support scenario generation by means of a software tool that guides and automates parts of the generation process. A variety of approaches have been proposed to address this problem (e.g. [11, 12]). Nevertheless, they are aimed unanimously at extracting empirical requirements. Therefore, we have looked into supporting scenario generation on a larger scope.

The scenario generation support tool is aimed to confront designers with scenarios that capture relevant design aspects; especially the ones that usually slip the mind of designers. As an illustration, the explorative scenarios could reveal what threats and opportunities lay ahead so that the design team can make decisions strategically. Furthermore, consider the complexity of dynamic use situations that is introduced by intelligent consumer products nowadays. A single product can have multiple functions, be operated by multiple users, undergo different situations, or a combination of those. Designing for dynamic use situations requires the design team to deal with an enormous amount of relevant, yet not uncommonly contradicting design aspects at once [1]. Future practice scenarios that explicitly place these aspects in proper contexts could assist the design team to structure the design activities and state priorities. Aforementioned examples are among many design situations in which our scenario generation support tool could be of use in practice.

6 REFERENCES

[1] Brouwer, M., van der Voort, M.C. (2006). Design for Dynamic Use Situations. In Proceedings of Wonderground 2006 Design Research Society International Conference. Lisbon, Portugal: CEIADE.

[2] Carroll, J.M. (2000). Making Use: Scenario-Based Design of Human-Computer Interactions. London, UK: MIT Press.

[3] Carroll, J.M. (ed.) (1995). Scenario-based Design: Envisioning Work and Technology in System Development. New York, USA: John Wiley and Sons.

[4] Alexander, I.F., Maiden, N. (eds) (2004). Scenarios, Stories, Use Cases: Through the Systems Development Life-Cycle. New York, USA: John Wiley & Sons.

[5] Kuutti, K. (1995). Work Processes: Scenario as a Preliminary Vocabulary. In: J.M. Carroll (ed.). Scenario-based Design. New York, USA: John Wiley & Sons.

[6] Lim, Y., Sato, K. (2006). Describing Multiple Aspects of Use Situation: Applications of Design Information Framework to Scenario Development. *Design Studies*, 27/1, p. 57-76.

[7] Suri, J.F., Marsh, M. (2000). Scenario building as an ergonomics method in consumer product design. *Applied Ergonomics*, 31/2, p. 151-157.

[8] Svanaes, D., Seland, G. (2004). Putting the Users Center Stage: Role Playing and Low-fi Prototyping Enable End Users to Design Mobile Systems. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. Vienna, Austria: ACM Press.

[9] Nielsen, J. (1990). Paper versus computer implementations as mockup scenarios for heuristic evaluation. In Proceedings of the IFIP TC13 Third International Conference on Human-Computer Interaction. Amsterdam, The Netherlands: North-Holland Publishing Co., p. 315-320.

[10] Cooper, A., Reimann, R. (2003). About Face 2.0: The Essentials of Interaction Design. New York, USA: John Wiley & Sons.

[11] Maiden, N., Minocha, S., Manning, K., Ryan, M. (1998). CREWS-SAVRE: Systematic Scenario Generation and Use. In Proceedings of the Third International Conference on Requirements Engineering. Colorado Springs, USA: IEEE Computer Society, p. 148-155.

[12] Rolland, C., Souveyet, C., Achour, C.B. (1998). Guiding goal modelling using scenarios. *IEEE Transactions on Software Engineering, Special Issue on Scenario Management*, 24/12, p. 1055-1071.

[13] Schwartz, P. (1996). The Art of the Long View: Planning for the Future in an Uncertain World. New York, USA: Currency.

[14] Cross, N. (1994). Engineering design methods: strategies for product design. New York, USA: John Wiley & Sons.

[15] Muller, M.J., Kuhn, S. (1993). Participatory design. *Communications of the ACM*, 36/6, p. 24-28.

[16] Wensveen, S.A.G. (1999). Probing experiences. In Proceedings of the First International Conference on Design and Emotion. Delft, The Netherlands: Delft University of Technology, p. 23-29.