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EXPLORATION OF USER-TECHNICAL PROCESS SCENARIO TECHNIQUE IN PRACTICE

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ABSTRACT
The objective of the research described in this paper is to investigate a scenario technique based on a user-technical process. This means that the scenario is built with the aid of three processes in parallel: the mental activities of the user, the user actions and the technical functions. Four product development teams have tested the technique on products that were under development. The results from the explorations have shown that the technique assists in understanding design problems, prompts discussion within the group, presents no great problems in usage, elicits new thoughts about the design problem and serves a useful purpose in comparing different product concepts with each other.

Keywords: Communication, conceptual design, design method, evaluation, scenario technique, user behaviour

1 INTRODUCTION
Users' demands on a wide range of technical products are continuously increasing. Besides good functionality and usability, they desire pleasure from product use and ownership [1]. The product developer's awareness of and focus on the users and their use situation have become crucial for creating good design. This paper takes departure in the product developer's impact on fulfilling the user needs.

There is a need for design methods that support the activity of considering user aspects during the design process [2], [3]. Buur and Nielsen [4] state that traditional design models are too static for describing user-product interaction, and that these models concentrate on the technical artefact and neglect the user's interaction with it. They call for new dynamic techniques, such as scenarios, for modelling user-product interactions. A front-end process requires consideration of the user aspects in early design stages. Many methods are aimed at analysing an existing physical prototype. If investigations of the concepts are carried out before prototypes are built, product development costs may be reduced. Consequently, there is a need for design methods for user product interaction, which can be applied in early design stages.

Scenario building is a useful technique for forecasting the usability of a product design [4]. Moreover, it supports communication between different design parties [2], [4], [5], [6], [7], which is an important factor for winning products/projects [8], [9].

A scenario technique based on a user-technical process [10] has been developed – the User-Technical Process Scenario (UTPS) technique. The aim of the research work presented in this paper is to investigate whether the technique is of value and is easy to use. This paper also contains a short introduction to the investigated technique and to the scenario technique in general.

2 SCENARIO TECHNIQUE IN GENERAL
Scenarios are stories – stories about people and their activities [11]. Every scenario comprises at least one agent or actor, who has specific goals or objectives, and a sequence of actions and events, i.e. things that the actor does. In order to demonstrate the user activities, the scenarios may take many different forms, such as textual narratives, annotated cartoon panels or video sequences [2].

According to Fulton Suri and Marsh [12], scenario building consists of three elements:

1. *A set of specific individual users*. The users' nature, lifestyle and incentives are defined.
2. *The individual characters' goals, tasks, and situations*.
3. *The product to be developed,* which may be a precise design proposition or a vaguely defined concept.

A situation is built up comprising these three elements, where the intended product is seen in the context of its environment and user, and the interaction between user and product may be studied.

Scenarios unite concreteness and flexibility as they can clarify a design situation and moreover present a specific solution, while being easy to modify and expand [11]. The scenarios' ability to give a concrete form to rough descriptions derives from people's way of creating and understanding stories. Building scenarios may stimulate imagination and support the design team in being creative. By using extreme or distinctive scenarios, or characters in the scenarios, the designer is encouraged to see things from another perspective and is directed in new ways of designing [13], [14], [15].

An essential role for scenarios is to mediate the thinking and support communication between designers in a team, as well as with other stakeholders outside the group, such as people in the organisation and the users [2], [5], [6], [7]. The scenarios make it easier to focus the discussions on the user activities and may support the design team in concentrating on the product's future use. One of the advantages is that all the members in a design team can participate in scenario building.

The low accuracy of scenarios makes them easy to create, expand, but also to reject [6]. Their roughness and ambiguity trigger people to be critical, as it is easier to form opinions about things that are not completed [7]. On the other hand, the stories are specific in certain respects, since they are directed at a specific situation. Sutcliffe [16] implies that scenarios may cause people to concentrate on unnecessary details in the design issue and to lose the general view of the design problem.

Another risk in using the scenario technique is that people tend to seek evidence that confirms their decisions, beliefs and hypotheses [17]. Therefore, scenarios are better used for identifying problems, forming new ideas or rejecting a product concept than for verifying product proposals. Hence, it is important that scenario building be seen as a complement to other methods.

3 USER-TECHNICAL PROCESS SCENARIO – UTPS

The investigated scenario technique, the User-Technical Process Scenario (UTPS) is based on the technical process in the theory of technical systems, which is a descriptive theory of the machine system or artefact [18], [19]. The technical process transforms an operand from its in-state to its out-state (Figure 1). There are four basic varieties of transformation, namely changes of structure, form, location and time. Humans and an active environment influence the technical process.

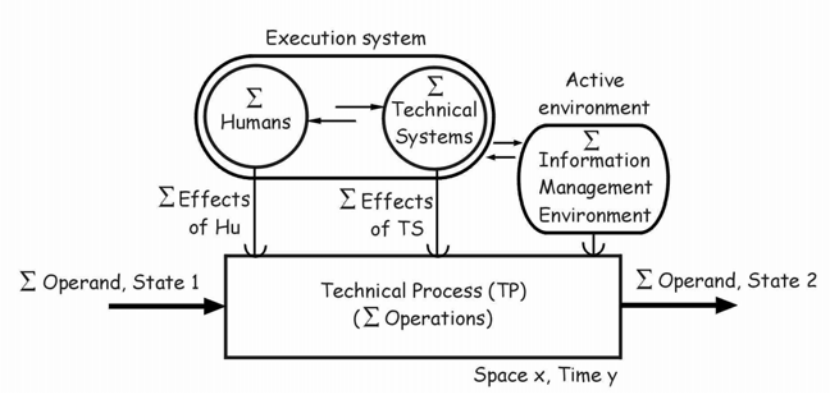

Figure 1. A general model of a transformation system [18]

Since many products do not obtain their entire functionality without assistance from the users, the technical process has been supplemented with user actions and mental activities. Together, they constitute a user-technical process [10] (Figure 2).

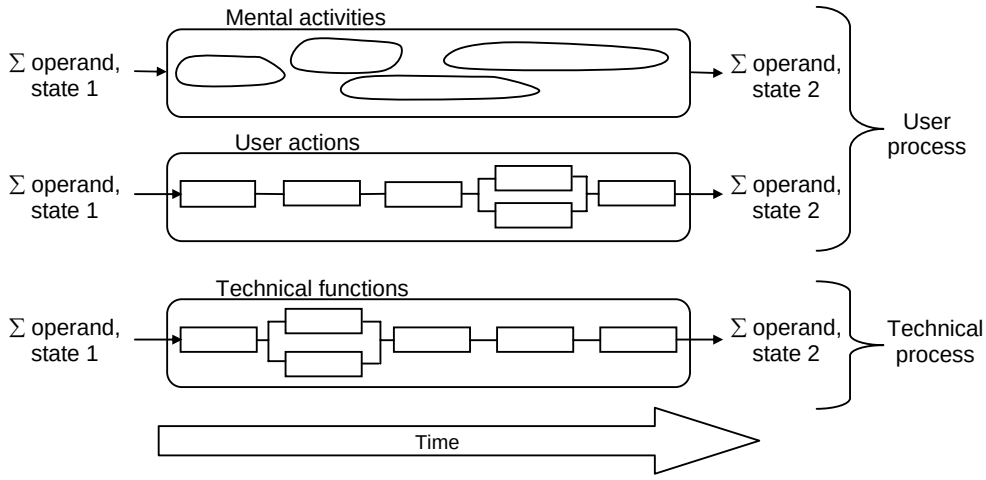

Figure 2. The user-technical process consists of a user process constituted of mental activities and user actions, and a technical process which comprises technical functions

In the *mental activities*, the user's expected or desired feelings and thoughts are illustrated. The *user actions* describe what the users are intended to perform when using the product. A *technical function* is what an element (system, part, component, module, organ, feature, etc.) of a technical system actively or passively does in order to contribute to a certain purpose [19]. A time axis extends along the processes, being parallel to the actions, activities and functions.

The foundation of the scenario consists of the product and a set of individual users with their aims, tasks, situation and use environment. By using the user-technical process as a base, a structured scenario can be built up, i.e. a User-Technical Process Scenario (UTPS). This technique differs from other scenario techniques by clearly presenting the concurrence between a user action and the corresponding technical function, i.e. the method shows manifestly what the user and the technical system perform simultaneously. At the same time, it is possible to segregate a process and investigate it in isolation to see what either the user or the technical system does. Moreover, the user's action and mental activity are visibly separated. Compared to other scenario techniques, the UTPS gives more attention to the user's thoughts and feelings, as well as the product's functions. For example, it is clear what the product is doing throughout the use sequence.

4 PURPOSE OF THE STUDY

The UTPS is intended to provide support in analysing problems and improving product concepts in early design stages, i.e. before a prototype is built. In order to investigate this, four product development teams have tested the technique. Many authors state that scenarios stimulate communication [2], [5], [6], [7]. It was necessary to investigate whether the statement is true also for this more detailed scenario technique. Moreover, the technique ought to be uncomplicated and effortless in use; otherwise, it will not be utilised by product developers [20].

By using the UTPS it is possible to replace combinations of actions or functions with other actions and functions. This is believed to support the comparison of different design solutions by keeping the same use situation and adapting the scenario for the different concepts. This comparison technique is also investigated.

To summarise, the aim of the study is to investigate whether the UTPS technique:

- is valuable for understanding the design issue
- supports communication
- is easy to work with
- can support designers in finding defects in the product to be developed and whether it can elicit new solutions and requirements for the product
- can be used for comparing design solutions

5 THE EXPLORATION

Four exploration groups from various companies working with product development (BT Industries AB, Husqvarna, Electrolux and Volvo Construction Equipment) have tried out the UTPS technique. Each exploration group consisted of four to seven persons with different competences, such as mechanical engineers and market personnel (Table 1). The exploration participants tested the UTPS on products that they were developing, which were at varying stages of completion from concept ideas to finished products (Table 1).

BT Industries AB worked with two different kinds of "very narrow aisle trucks" already introduced on the market - VR trucks and C15 trucks. A difference between these two trucks is that the VR truck has a fixed cabin, while the cabin on the C15 truck rises together with the forks up to a certain level.

Husqvarna tried out the starting sequence for a petrol-powered chainsaw and a new solution for tightening the chain, for which it had developed a prototype.

Electrolux was working on a new concept for an air cleaner and compared it with the old one. The concept was at the idea stage and no drawings or prototypes existed.

Volvo Construction Equipment investigated two different concepts for accessing the cabin of a mobile drilling rig. They had CAD drawings and animations of the two prototypes. The rig is being developed by Atlas Copco, which is a customer of Volvo Construction Equipment.

Table 1. The participating companies and their investigated products

Company	Tested products/concepts	Degree of completion	Number of exploration persons	Competences of exploration persons
BT Industries AB	Very narrow aisle trucks	Complete product on the market	4	Engineering design Marketing
Husqvarna	Petrol powered chainsaw	Physical prototype	7	Engineering design Marketing Service
Electrolux	Air cleaner	Concept ideas	6	Engineering design Marketing Service
Volvo Construction Equipment	Access to cabin	CAD drawings and animations	6	Engineering design A customer and an internal contact person for the customer Three students

The author acted as exploration leader and introduced each exploration with a description of the scenario technique and an example of its application. After this, the members of the exploration groups described two products or product concepts that were going to be investigated using the UTPS technique. The exploration leader then asked the group to create two user characters; each of which was given a personality, experiences and the circumstances for the use situation.

Self-adhesive paper slips in three different colours, one for each process (mental activities, user actions and technical functions), were handed out to the exploration participants, who were asked to write down the events on the slips and stick them on a large sheet of paper, which was also handed to them. In this way, it was possible to move the slips around easily and change their order. For each

scenario, the exploration participants were encouraged to find quite extreme use sequences, i.e. not an ordinary intended use sequence or a "sunshine story". In each exploration group three scenarios were performed.

Scenario 1: The group members chose one of the products/concepts and one of the created users with a use situation and built a scenario from the initial situation comprising the mental activities, the user actions and the technical functions to a suitable closing stage. Finally, the exploration participants were asked to think about important aspects of the product, such as product requirements resulting from this use sequence.

Scenario 2: The second scenario was founded on the other user and on one of the products/concepts. Each participant individually suggested approximately ten user actions, mental activities or technical functions. After this, the group members together combined the actions, the activities and the functions into a complete scenario. The exploration group investigated whether they had found hitherto unconsidered aspects of the product.

Scenario 3: In the last scenario, the idea was to compare the two products/concepts by adapting one of the previously built scenarios to the other product/concept, i.e. the product not treated in the scenario. The exploration participants used the first scenario as a base and simply changed the actions, functions and activities that had changed due to the other product/concept. Differences in the two products or concepts were investigated and product requirements were identified.

After the three scenarios were carried out, the exploration participants answered a questionnaire concerning the benefits and ease of use of the UTPS technique. After the questionnaire was completed, a group discussion was held in order to cover viewpoints concerning the methods included or excluded from treatment in the questionnaire. The whole session was videotaped.

It is a complex process to perform this kind of exploration since the exploration leader has two roles, being both instructor and observer of the explorations. This leads to at least two problems:

- *The influence problem*, which appears when the observer is present during the observations, leading to the risk that he/she will influence the results.
- *The interpretation problem*, which is enhanced by the fact that the observer is also the developer of the method being studied. Thus, the subconscious expectation effects may be greater than usual.

The exploration leader has tried to reduce interference in the process of building the scenarios. However, in some circumstances it was necessary to support the group. A second person, who had not been involved in the development of the method, also observed the explorations in order to reduce the misinterpretations. The group compositions, the investigated products and the participants' experience of and attitude to this kind of method may also have affected the results. With an awareness of the above-mentioned difficulties, the following results were acquired.

6 RESULTS

6.1 Scenarios of the exploration groups

BT Industries AB – Very narrow aisle trucks: In these scenarios, the driver was to move a package from a storage rack to a loading bay. Two user characters were created and scenarios 1 and 2 were performed on the VR truck. In the third scenario, the exploration participants compared the VR truck with the C15 truck by adapting the C15 truck to the first scenario.

Husqvarna – Petrol powered chainsaw: In the exploration at Husqvarna, the exploration group tried out a starting sequence of their existing product but with a new type of user - amateur users who purchase the saw in a supermarket. This group of inexperienced users is growing and the company does not have the same control over the information given to the users by sellers in a supermarket (Figure 3). In the second scenario, a new solution for tightening the chain was tried on a more

experienced user and this new concept was compared with the existing solution in the third scenario. A fragment of the first scenario built by the group at Husqvarna is shown as an example in Figure 4.

Electrolux – Air cleaner: The exploration team investigated the existing air cleaner in scenarios 1 and 2 with two different types of user - a design and health-conscious young man and a middle-aged lady with allergy problems. In the third scenario, a new concept of the air cleaner was tested with scenario 1. The sequences concerned changing the filter in the air cleaner.

Volvo Construction Equipment – Entrance design solution for a mobile oil rig cabin: This group tried out two different concepts of entrance design for an oil rig cabin. The actor in the first scenario was a driver located in a very hot climate in Australia and the second scenario was built with the alternative concept and a driver working in a strip mine in northern Sweden at a temperature of –28°C. The first scenario was adapted for the second concept in the last part of the exploration.

User 1	**User 2**
Tom - 42 years old	Geir – 38 years old
American	Norwegian
Novice	Semi-professional
Weak, “office drip”	Cheerful and talkative
Impatient	Handy and creative
Not technically interested	He knows that the chain has to be tightened
Houseowner – needs to burn wood	He is well acquainted with the old solution for tightening the chain
Thinks the saw has a macho factor	
Situation	**Situation**
Just bought the saw at the supermarket; there was insufficient information on its use	He has just bought a new saw, which is much more powerful and is of better quality than the old one
Stressful situation	He is going to tighten the chain on this saw for the first time
Inquisitive children	He is alone in the wood
Tom is worried that the children might be injured by the saw	It is spring and the air is cold
Inquisitive neighbour	The chain is in the right place
Tom is standing by the garage	

Figure 3. The two users created by the group at Husqvarna

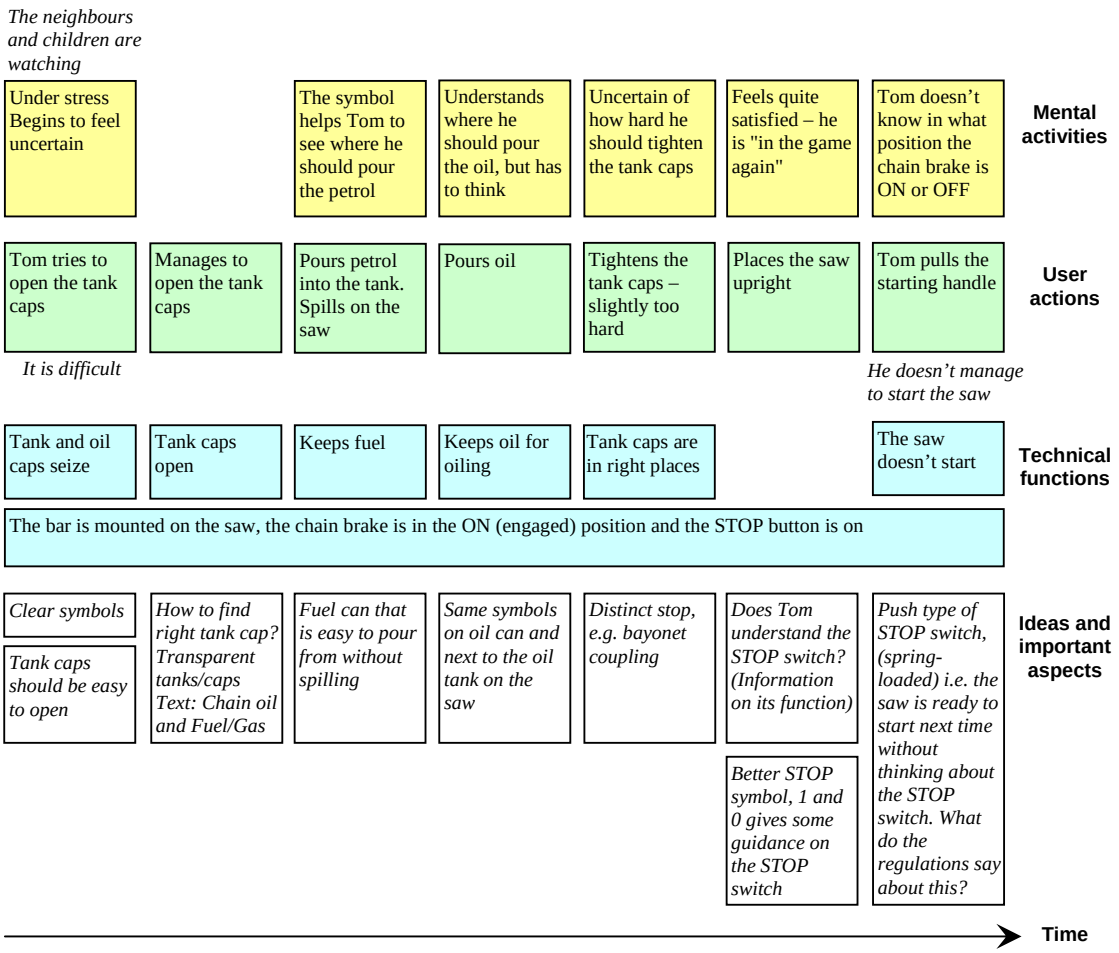

Figure 4. A fragment of the first scenario for the starting sequence of a chainsaw. The scenario was completed with various important aspects and requirements acquired during the building process.

6.2 Results from the observations

All groups needed support at the beginning in creating the two user characters and their use situations. However, when building the first scenario, the exploration participants' ability to perform the scenario by themselves varied. Two groups were self-governing. Despite the fact that the participants in only one of these two groups had previously worked in a similar way, they understood how they should proceed and managed to apply the method to their product with only limited assistance from the exploration leader. In one group, the project leader drove the process forwards and took all the notes. Since the discussion was lively, she seemed to have difficulties in writing everything down while trying to take part in the discussions to the same extent as her fellow participants.

The other two groups had difficulties in starting to build the first scenario and needed the exploration leader's support. She asked them questions such as "What happens in the next step?" in order to drive the scenario forwards and she also took all the notes. After a while, in one of these groups, the participants were carrying on the discussion by themselves, but the exploration leader continued to write the slips for the scenario. The other team needed support throughout the first scenario.

The individual work in scenario 2 was completed satisfactorily. With some support from the exploration leader the groups managed to handle the combining and completion to create a whole sequence.

In the last scenario, the adaptation of a product to another scenario for comparing the two concepts functioned well. Both the advantages and disadvantages of the concepts were detected or highlighted, and new ideas for design solutions were elicited. In one case, there was a major conceptual difference between the two concepts, so the comparison could not be made very detailed and was mainly beneficial for detecting some advantages and disadvantages of the new concept. These were discussed.

During scenario building, the main focus was on the user actions, while the secondary focus was on the mental activities. The participants needed to be encouraged to work also with the technical process.

It was noticed that the scenarios, especially at the beginning, were not especially unexpected or accidental, and that the user character could in many cases have had a greater influence on the scenarios. In most of the groups, the first scenario resembled a detailed description of an intended use sequence. The exploration leader had to encourage the groups to find unusual or accidental sequences. Many problems were discussed that were never included in the scenarios. The accidents were mostly of the character of user mistakes, but also included incidents concerning the product, e.g. a broken component or low battery charge.

It was also possible to see a tendency for detailed questions to be investigated while the major issues were neglected. The exploration participants did not open their eyes wide enough to see how a problem might be solved in a completely different way. However, scenarios in another situation than the close user-product interaction situation, such as obtaining petrol for the chainsaw, might lead to proposals for appliances for handling the product.

It was observed that the UTPS technique could be used for many different purposes. The following use areas were utilised by the group members during the explorations:

- Learning and knowledge transfer concerning the product and its intended use sequences
- Highlighting questions and problems, and giving a concrete form to them in order to simplify the discussions
- Giving concrete form to user needs and finding new product requirements
- Finding problems, gaps and possibilities in early product concepts
- Further developing the concepts, finding new design solutions and generating new ideas for the product
- Making the use situation and the functions of the product clearer and closer to completion
- Comparing different concepts
- Investigating the different use situations, depending on the user's lifestyle, personality and experiences

Moreover, the feasibility of using the technique to find ways of marketing and selling the product was discussed.

6.3 Results from the questionnaire

None of the 24 exploration participants thought that it was difficult to understand how the UTPS technique should be used. They considered it slightly more difficult to apply the technique than to understand how it should be used. The third scenario supports the comparison between the two products/concepts and none of the participants had difficulties in adapting a product to another scenario. Most of the participants thought that it was rewarding to use the technique. The greater part thought that the scenarios stimulated new thoughts and supported communication between the team members, and that the scenario technique is valuable for understanding the design issue. Only one person did not agree.

The exploration participants who had previously tried out other scenario techniques commented that the UTPS had certain advantages compared with other techniques, such as separating actions from technical functions and paying attention to mental activities. Moreover, they thought that this presentation was lucid and more detailed than other scenario techniques they had tried. It was also

stated that the technique is fast and cost-effective, and that the focus on a narrow part of the use makes for a deeper understanding.

Other comments from the questionnaire were that the strength of the method lies in the focus on the user, which is useful for the product developers. The opportunity to really analyse the whole use sequence and also what may happen with the product was stated by one participant as being very useful. Another person from the same group thought that the benefits from separating the user aspects from the technical functions were not clarified. Participants in the two groups which needed most support in handling scenario building stated that the method was useful and easily learnt, and that everyone in the group was able to participate. The participants from one group seemed to be very positive. They thought that the technique is rewarding and fun to use, and that they would use it in future product development projects. The technique is good for predicting problems the user might come across during use. They also stated that the technique is useful for detecting problems and defects early in product development work, which provides better products faster and may save money since unnecessary prototype construction can be avoided.

6.4 Results from the group discussion

None of the exploration participants had previously worked in this structured and detailed way with use sequences. All the groups considered it a good way to work. They also thought it was useful to have different disciplines in the group and one person also called for additional disciplines in the group, such as after-sale.

One participant thought that it was important for the group to include an expert on the product. They stated that the method is valuable at the beginning of a project in order to form a common picture of the design issue and for a newcomer to the design group to learn about the product. However, the importance of going out and meeting the users in reality was also emphasised. The opportunity for marketing representatives to use the method in their selling arguments was also pointed out.

One participant commented that it was good to be focused on a single aspect so quickly. The need for a facilitator was also stated. Another participant liked the separate presentation of technical functions, user actions and mental activities. It was also mentioned that it was a good thing that the participants had the opportunity to work individually and could thereby present all their ideas.

It was stated in one group that the technique is valuable for investigating early concepts in order to arrive more quickly at a product closer to completion as well as a functional solution. They thought that the mental process was the most important contribution since the other two parts are treated in other ways, such as with FMEA.

7 DISCUSSION

7.1 The need for a facilitator

In the questionnaire, the participants stated that it was easy to understand how the methods should be used. Nevertheless, two groups experienced various problems in applying it. The main reason is probably a lack of practice in working with scenarios. Another problem was that the persons who wrote the scenarios had difficulties in joining the discussion. Thus, every group, inexperienced or experienced, may need a facilitator, who supports the group in building the scenarios. Possibly, the facilitator should be an external person who can ask “stupid questions” and who is not biased in regard to any particular opinion. There is always a risk that the person who writes the scenarios consciously or unconsciously neglects proposals that he/she dislikes and focuses attention on personally favoured proposals.

7.2 Few accidents in the scenarios

The reason for not creating accidental events in the scenario may be that the participants tried to find positive evidence to support their products [17] or that they did not think that the problems could appear. Probably it is easier for a non-expert to find things that the user could do wrong than for the experts who know how the product works. This could also be due to the exploration participants

feeling uneasy about suggesting extraordinary accidents. Possibly they were anxious that the other participants would think they were naïve or unprofessional. The presence of the two observers and the video camera may also have inhibited the group activity.

Moreover, the reason for creating use sequences with few accidental events might be that not everyone in the groups knew the ordinary intended use sequence and needed to learn that first in order to be brought up to date. Consequently, the scenarios can be used for transferring knowledge [7]. A helpful approach may be to start creating an ordinary intended use sequence before making the scenarios, especially the first time they perform scenario building for a given problem.

7.3 Getting buried in detail or focusing on broader issues

The focus on detailed solutions instead of looking at the major issue is probably an effect of the technique, as posed by Sutcliffe [16]. On the other hand, the participants emphasised that many of the details they discussed during scenario building were things they would easily forget when concentrating on the main issues and that these details are important for the users. This scenario technique is of the character that it encourages the group to work in detail. The consequence is naturally that details are discussed, which is not a disadvantage.

7.4 Product completion

A correlation between the products' completion and their benefit from the scenarios was discerned. The newer the product ideas the product development team worked with, the more they gained from the scenarios. They also utilised the scenarios in a greater variety of ways, i.e. use areas. Besides the fact that more matters were unsettled in the incomplete products and therefore gained from the scenarios, the low accuracy of not only the technique [7] but also the treated products triggered criticism and discussion.

8 CONCLUSIONS

Since the exploration material is rather limited, the findings are not completely valid. However, the results from the questionnaires, interviews and observations have pointed in the same direction in all the explorations, i.e. the UTPS technique

- is valuable for understanding the design issue
- supports discussion between the group members
- is quite easy to work with
- may elicit new thoughts about the design task, such as problems, requirements and design solutions
- is useful for comparing products or concepts for a particular use sequence

The technique seemed to be most valuable in early design stages when trying out a product idea or a concept. Perhaps it is necessary to formulate an ordinary intended use sequence to start with, especially if the sequence is not clear. A facilitator may also be useful in order to lead and document scenario building. Under the right circumstances, the UTPS technique is rewarding as well as stimulating for the participants.

The UTPS technique is very detailed and is not suited for exploring major issues. Moreover, it is hazardous to use the technique for verifying concepts. The technique needs to be supplemented with other methods. Naturally, it is also vital to have contact with the users and learn about their needs through, for example, interviews, observations and discussion groups [21], [22] and also, if possible, to involve the users in scenario building.

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