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A Method-Independent Process Model of User-Centred Design

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Abstract: We propose a method-independent process model of user-centred design (UCD). It is based on recognised sources and its structure was developed in a set of assessments in industrial settings. The result is a process model that identifies six main processes of UCD. Each of these is defined through a set of outcomes. The model makes tangible the interface between the usability engineering and design processes. The model has provided a practical basis for the assessment of UCD processes, which was the original scope of the model. In addition, we have found the model as a useful asset in training UCD and in planning UCD activities in projects.

Key words: user-centred design, UCD, usability methods, usability engineering, process model, assessments, training

1. INTRODUCTION

We propose a method-independent process model of user-centred design (UCD). The background of the model is in the assessment of UCD processes where a process model is a key asset. We also have found the model effective in other uses, such as training and project planning.

The purpose of an assessment is to identify the strengths and weaknesses of UCD in a product or software development organisation, for the purpose of providing a basis for process improvement. During an assessment, the existing UCD practices of a development organisation are mapped against a process model of UCD. The process model should represent an ideal UCD process. It also should be method-independent: it should state 'what', not 'how'. For example, a process model may state that 'current user tasks should be analysed' but should not insist a specific method (e.g. 'contextual

inquiry') to be used for that. The assessment result is typically a quantitative statement about the extent to which the development practices meet the requirements of a process model.

There exist a number of methods for the assessment of UCD processes. During the 1990's, methods such as Trillium (Coallier et al., 1994), IBM (Flanagan, 1995), Philips (Taylor et al., 1998), and INUSE (Earthy, 1998), (Earthy, 1997) were proposed. The most recent developments are ISO 18529 (ISO/IEC, 2000) and Human-System Life Cycle Processes (ISO/IEC, 2001).

We carried out a set of assessments of UCD processes. We used ISO (International Organization for Standardization) 18529 as a hypothesis process model. Throughout the experiments, we tried to understand what kind of process model makes sense and is effective. For that, we gathered data about how the development staff perceived the models presented using questionnaires and interviews. In addition, each member of the assessment team made observations, which were shared and discussed jointly in sessions after the assessments. Step by step, the structure of the UCD process model evolved. The scope of this paper is to describe the evolvement and the main features of the model. Also the assessment approach as a whole changed to a one that we call *KESSU*, as described in Jokela et al. (2001).

In the next section, we justify the selection of our hypothesis model and our experiments with it. Thereafter, we describe how the process model evolved during the subsequent experiments. We then describe the new process model, and finally in the last section summarise the results and examine limitations, implications and further research topic.

2. THE EXPERIMENTS WITH THE HYPOTHESIS MODEL

UCD principles, activities and methods are described in many books. The main reference is the book *Usability Engineering* by Nielsen (Nielsen, 1993). Later books have been published, such as *Developing User Interfaces: Ensuring Usability Through Product & Process* (Hix and Hartson, 1993), *Contextual Design* by (Beyer and Holtzblatt, 1998), *The UCD Lifecycle* (Mayhew, 1999), *Software for Use* (Constantine and Lockwood, 1999). All of these describe well the UCD processes. They, however, are all more or less method-oriented (at least partially they propose 'how-to-do' rather than 'what-to-do'), and thereby cannot be used as reference models in assessments.

We regard ISO 13407, *Human-Centred Design Processes for Interactive Systems*, (ISO/IEC, 1999) as an appropriate general reference model of UCD. It contains the core substance of UCD in a concise and understandable

way. The four key UCD activities (processes) of ISO 13407 are illustrated in Figure 1. The processes are described in an informal way, with 1 to 2 pages of text for each process. The processes can be briefly described as follows:

- *Understand and Specify Context of Use.* Know the user, the environment of use, and for what tasks he or she uses the product.
- *Specify the User and Organisational Requirements.* Determine the success criteria of usability for the product in terms of user tasks, e.g. how quickly a typical user should be able to complete a task with the product. Determine the design guidelines and constraints.
- *Produce Design Solutions.* Develop design solutions incorporating HCI (human-computer interaction) knowledge, including visual design, interaction design, and usability.
- *Evaluate Designs against Requirements.* The usability of designs is evaluated against requirements.

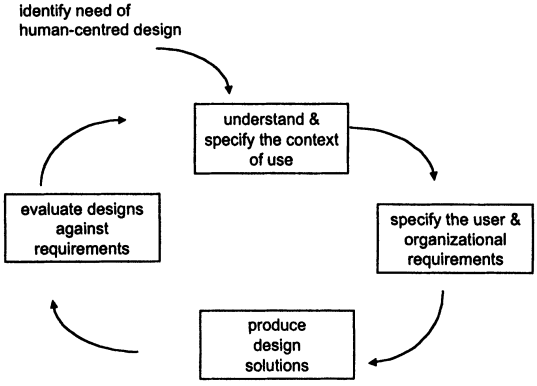

Figure 1. Processes of UCD as defined in ISO 13407

2.1 ISO 18529 - Human-Centred Lifecycle Process Descriptions

A subsequent activity following on from ISO 13407 was the creation of ISO 18529 (ISO/IEC, 2000), which defines the processes more precisely than does ISO 13407. The objective was to meet the formality of process definitions required by the process assessment standard ISO 15504 (ISO/IEC, 1998). ISO 18529 identifies the same core processes of UCD, as does ISO 13407, Figure 1. One can say that the essential substance in these two sources is the same – the difference is in the format of presentation.

Our rather natural selection for the hypothesis model for the assessments was ISO 18529. It is developed for assessment purposes, and its background is in a recognised UCD standard.

In ISO 18529, each process is defined with a *purpose statement* and a set of *base practices*. The purpose of the process is 'typically achieved' by implementing the base practices. Assessments are normally carried out through analysing the extent to which the base practices are implemented. The purpose statement is 2 to 3 lines of text, and a list of outcomes. The number of base practices per process varies between 5 and 8. For example, the process *Specify The User and Organisational Requirements* is defined as follows:

"The purpose of the process is to establish the requirements of the organisation and other interested parties for the system. This process takes full account of the needs, competencies and working environment of each relevant stakeholder in the system. As a result of successful implementation of the process, the following will be defined:

- Required performance of new system against operational and functional objectives
- Relevant statutory or legislative requirements
- Co-operation and communication between users and other relevant parties
- The users' jobs (including the allocation of tasks, users' comfort, safety, health and motivation)
- Task performance of the user when supported by the system
- Work design, and organisational practices and structure
- Feasibility of operation and maintenance
- Objectives for the operation and/or use of the software and hardware components of the system.

The purpose is typically achieved by the performance of the following practices:

- Clarify and document system goals
- Analyse stakeholders
- Assess risk to stakeholders
- Define the use of the system
- Generate the stakeholder and organisational requirements
- Set quality in use objectives."

The definitions of base practices include some further notes. The other three processes are defined in an analogous way.

2.2 The experiments with ISO 18529

We used the ISO 18529 model as the process reference model in the first two assessments. In the first assessment the customer representatives - most of whom were neither usability nor process assessment professionals - encountered difficulties in understanding the process model. For example, the usability specialist for the company reported afterwards in an interview "the model was not understood here". Some of the staff had a perception that the assessment was "academic stuff driven by the interests of the university". In addition, the assessment team found it difficult to agree on the ratings of the capability of the processes. Specifically, it was difficult to determine whether the base practices (see the example in the previous section) were truly performed or not.

Our conclusion from the assessment was that the basic process structure of ISO 18529 seems to make sense to people but we need more precise and unambiguous interpretations of the process definitions. This was rather a surprise: ISO 18529 was chosen as our hypothesis model because its definitions are formalised.

Even if we met some problems with ISO 18529, the reference model was the same for the second assessment in another company. In the latter case, the main reason for this was that the lead assessor was from a different organisation. The feedback from this assessment indicated similar problems as we had in the previous assessment. The staff perceived the models of the assessment difficult to understand, and the results not concrete enough. Another problem was – again - in the interpretation of the process definitions. The interpretations caused even more disputes within the assessment team than in the earlier case because now there were members from two organisations in the team.

An example will illustrate our interpretation problem. The process *Specify The User and Organisational Requirements* (see previous section) has a base practice 'Analyse stakeholders'. In an assessment, one should determine the extent to which this base practice is performed using the scale 'none, partially, largely, fully'. First, we found it difficult to determine what kind of activities the 'analysis of stakeholders' should incorporate. A second problem was related to the quality of performing a practice: what does it mean if a practice is performed but in an inappropriate way? A third problem was in the exploitation of the results of a practice: what does it mean if a practice is performed but its results are ignored in the development process?

Our main conclusion from these experiments was that we need to have a precise and understandable interpretation of ISO 18529 for the following assessment.

3. ITERATION STEPS

We distinguish two major steps in the evolvement of the process model. In the first step, we changed the way of defining processes and split the 'Produce design solutions' process into two separate processes. In the second one, we added one new process and did some changes to the contents of processes.

3.1 The first iteration step

We decided to try a modified process model in the third assessment. It had two different characteristics compared with ISO 18529: (1) definition of processes through outcomes, and (2) structuring the UCD activities into five processes (rather than four).

(1) We decided to define the processes through concrete *outcomes* of processes. In the previous assessments, we had problems with the interpretation of the base practices. We first tried to create 'unambiguous interpretations' of those practices but found it difficult. Therefore we decided to try an alternative approach: defining processes through outcomes. In contrast with the outcome definitions of processes in ISO 18529 (the purpose definitions contain also outcomes, see the example in the last section), we limited the outcomes to *concrete deliverables*.

For example, we defined the process *Specify The User and Organisational Requirements* with two outcomes: *Usability Requirements*, and *UI Design Requirements*, *Figure 2* (compare with the definition shown in the previous section). We also gave a simpler name to the process: *User Requirements*. We worked analogously with other processes, and identified the relevant outcomes of each of the processes.

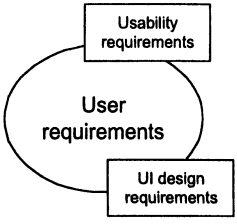

Figure 2. Illustrating the outcomes: User requirements process

(2) We split the *Produce Design Solutions* process into two processes. We found this solution sensible because we find two different scopes in

design: user task design, and user interaction design. These two scopes are significantly different from the viewpoint of UCD. User task design is a characteristic activity of UCD while user interaction design is always performed as user-interface elements are developed – even if there is no user-centredness in the development process. In summary, we now had five main processes: *Context of Use* process, *User Requirements* process, *User Tasks Design* process, *Produce User Interaction Designs* process, and *Usability Evaluation* process. The processes with outcomes are illustrated in *Figure 3*.

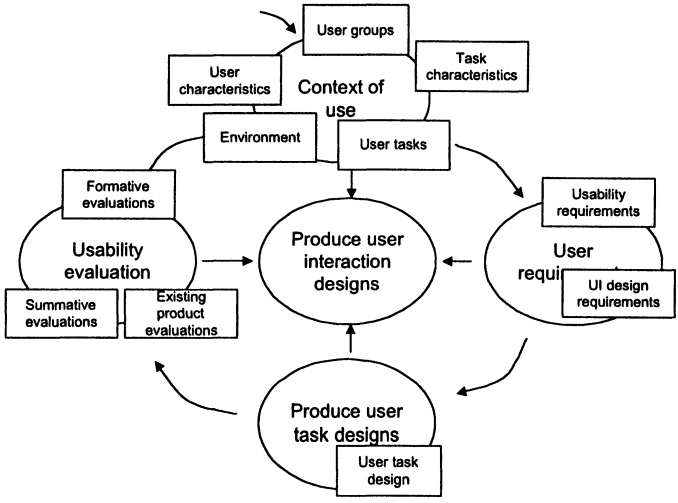

Figure 3. The modified UCD process model: the first iteration

We got better responses from this model than from the one we used earlier. One project manager stated immediately after an assessment workshop that she "already started to challenge herself on how to implement improvements in user requirements". The development staff reported that the revised UCD process model made a lot of sense: "The process model pointed out many issues to consider in the following projects"; "Now we know that task analysis is important. We also need to work on usability requirements". The usability specialists of the company received the process model as a useful reference on how UCD processes should be developed.

All those members of the assessment team who had attended the previous assessments found this assessment more successful and sensible than the earlier ones. One illustrative comment from an assistant assessor was, "Interview by interview, the model became clearer. This is the way we

should have done from the beginning: to make a clear interpretation of our own about the process models".

Our clear feeling after the assessment was that we wanted to try this kind of process model again.

3.2 The second iteration step

In the next assessment, we found that the process model generally worked well but not in all respects. We faced challenges especially with the *Context of Use* (CoU) process. The product that was under development is a new product type. Our earlier interpretation of the CoU process was 'to know the user and his/her work and work environment as it is now'. In this case, however, the environment where the new product is used is partly very different from the earlier environment: a mobile environment ('anywhere') instead of office or home environment. A new product also means some new user tasks.

Our conclusion was that one should discuss separately the outcomes related to the user tasks already in use and user tasks of the future (with the new product that is to be developed). Our solution was to define two different parts: *Context of Use of Old System*, and *Context of Use of Future System* in the CoU process, *Figure 4*.

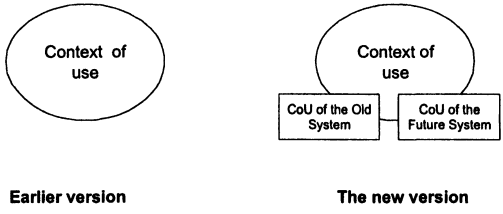

Figure 4. Changes in the Context of Use process

Another challenge during the assessment was that we wanted to elegantly describe and rate a situation where the product under development obviously has several user groups but the project team has identified and analysed only one user group. Our solution was to split the *Context of Use* process into two processes: *Identification of User Groups* and *Context of Use of User Group 'N'*. We found that with this kind of structure we were able to explain the situation more concretely and elegantly.

Another refinement of the model was about the *Usability Evaluation* process. We removed the sub-process *Existing Products Evaluation*. The reason was that we started to consider this activity as a *method* that actually

should belong to the User requirements process: existing products are evaluated in order to know where to set the usability goals with the future product. Because our goal was a method-independent model, we removed this activity.

As a result, we identified a total of six processes of UCD as illustrated in Figure 5. One should note that *Context of Use* process has more than one instance, one for each user group.

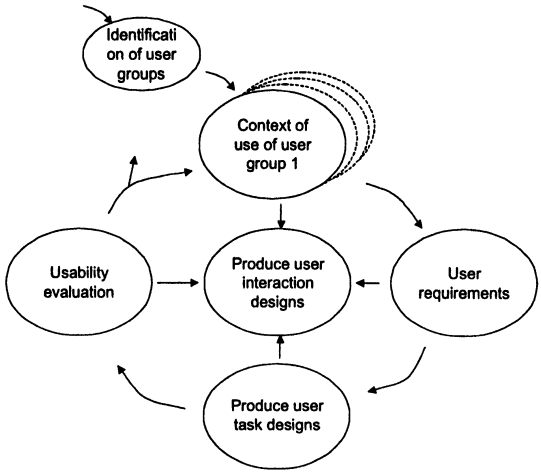

Figure 5. The six processes of UCD after the second step

4. THE PROPOSED PROCESS MODEL

After the experiments described above, we have a UCD process model of six processes. In the following, we give the definitions of each of the processes. The model is illustrated in *Figure 6*.

4.1 Process: Identification of User Groups

The purpose of the Identification of User Groups process is to identify the different user groups: who are potential users of the product or system. The substance of this process is not explicitly included in ISO 13407 or ISO 18529.

The outcomes of the process are:

- *User Groups Definitions*. The intended user groups of the system are identified. Typically a characteristic name is given to each user group, and the sizes (how many users) of the groups are also determined.

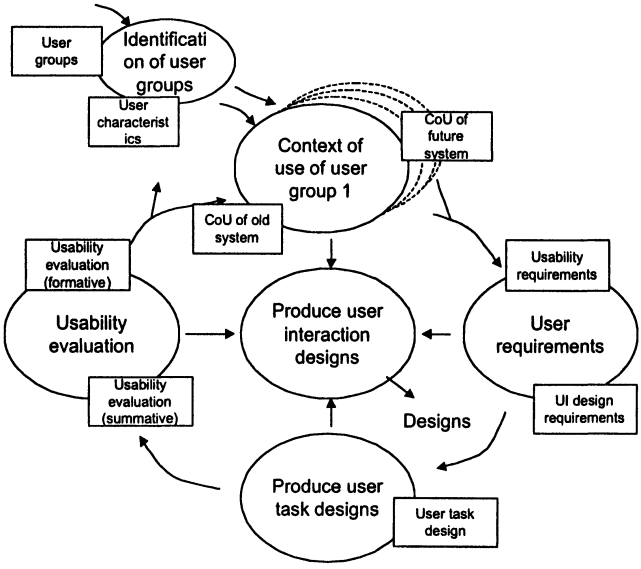

Figure 6. Outcomes of the latest version of the process model

- *User Characteristics*: The characteristics of the users of the user group are documented. These may include knowledge, language, physical capabilities, anthropometrics, psychosocial issues, motivations in using the system, priorities, etc.

4.2 Process: Context of Use of User Group 'N'

The purpose of the Context of Use of User Group 'N' process is to identify the characteristics of the users, their tasks and the technical, organisational and the physical environment in which the product system will operate.

A new product or system will always replace an existing one. The existing product may be close to the new one, e.g. a new version of a product will replace an old one. The new product may also be very different from the old one. For example, a fixed location application may be replaced with a mobile one.

This process needs to have an instance for each user group identified by the *Identification of Users Groups* process.

The outcomes of the process are:

- *Context of Use of the Old System:* The context of use of the old system is about describing the use of the existing system as relevant for designing the new one. The outcome has the following parts:

a) The user accomplishments related to the old product are identified and documented. The accomplishments should be described in terms of user and organisational activities, not in terms of equipment functions or features of the product

b) The user tasks that users perform to achieve the accomplishments are described and documented.

c) The real operational environment of the product, including the factors that affect the performance of users, is described.

d) The non-functional attributes of tasks should be identified and documented. The attributes may be for example: frequency, duration of performance, criticality for errors, identification of problems and risks that users meet when performing their tasks.

- *Context of Use of the Future System:* The context of use of the future system is about describing the context of use of the product under development. It is described to the extent that the context of use is different contrasted with current context of use. The outcome has the following parts:

a) The user accomplishments related to the product are identified and documented. Especially the differences compared with the existing context of use are identified.

b) The real operational environment of the product, including the factors that affect the performance of users, is described.

c) The non-functional attributes of tasks should be identified and documented. The attributes may be for example: frequency, duration of performance, criticality for errors, identification of problems and risks that users meet when performing their tasks.

NOTE. This sub-process is essential for systems that are 'totally' new.

4.3 Process: User Requirements

The purpose of the user requirements process is to define usability and user interface design requirements for the product. The main input for this process is the context of use information and business goals of the project. While business goals should drive all the processes of the UCD capability area, they especially should drive the user requirements process.

One should understand that usability requirements may contradict with other requirements. Resolution between conflicting requirements should be performed in this process.

The outcomes of the process are:

- *Usability Requirements:* The usability requirements are determined and documented. With usability requirements, we mean the required performance of the product *against the context of use*. Usability requirements typically are given in terms of effectiveness, efficiency, and satisfaction in the specific context of use (ISO/IEC, 1999).

NOTE. The requirements should integrate requirements of things that have impact on the total user-experience: not software only but also user documentation, user training, and in packaging the product.

- *UI Design Requirements:* The guidelines and restrictions that should be considered when the UI is designed should be identified and documented. Typically these include general user interface design heuristics, style guides, or company or project standards.

4.4 Process: User Task Design

The purpose of the user task design process is to design how users would carry out their tasks with the new product being developed.

This is the design phase where 'the work of the users' is designed: what are the accomplishments that their product will support, and what are the scenarios of steps for how these accomplishments are to be reached. This phase is not yet design of user interface elements.

The outcomes of the process are:

- *User Task Descriptions:* The tasks relating to how a user plans to use the product to achieve the goals are described and documented. The tasks should also be designed in relation to such tasks as user documentation and user training,

NOTE. Special emphasis should be paid to the tasks on which explicit requirements are set in the User requirements process.

4.5 Process: Produce User Interaction Designs

The purpose of the produce user interaction design process is to design those elements of the product that users interact with. These elements include interaction and graphical design of user interfaces, user documentation, user training and user support.

This process has a specific role among all the processes: this process produces the concrete designs while all other processes have a supporting role. Another specific feature of this process is that the different outcomes

should be produced in parallel. People from different departments (user interface development, user documentation, customer training) typically work together.

The outcomes of the process are:

- *User Interface:* The user interface (interactions, visual design) is produced.
- *User Documentation:* The user documentation is produced.
- *User Training:* The user training material and concepts are produced.
- *Other relevant outputs:* Other relevant outputs are generated, for example packaging, user support procedures etc.

4.6 Process: Usability Evaluation

The purpose of this process is to evaluate the product (including user documentation, user training etc.) against the requirements in terms of the context of use.

This process addresses on usability only from the task performance aspect. Those activities that evaluate the generic, non-task driven issues (for example, heuristic evaluations, or adherence to style guides etc.) are activities relating to the produce user interaction solutions process.

The outcomes of the process are:

- *Formative Usability Evaluation Results:* The purpose of the Formative usability evaluation process is to collect qualitative feedback on the usability of the product under development.

NOTE. The outcome of this process is typically an iterative set of evaluation results. The outcome is extensively produced if the designs are evaluated against all major user tasks.

- *Summative Usability Evaluation Results:* The purpose of the Summative usability evaluation process is to evaluate to what extent the product meets the defined usability requirements. The outcome of this process is typically an evaluation result report. The outcome is extensively produced if the designs are evaluated against all major user tasks defined in by the user requirements process.

5. SUMMARISING THE RESULTS

Our target was to create a method-independent process model that clearly describes the essentials of UCD. We started with a recognised model, and ended up with a structure that contains six UCD processes and definition of the processes through outcomes.

The model makes clear the integration challenge between usability processes and the design processes. Product designs are produced by visual, software and hardware designers. Others but usability specialists typically produce interaction designs. The challenge of usability specialists is to integrate their work to the central process carried out by the designers. As widely recognised, this is a true challenge in many cases.

The model does not require the use of any specific methods. However, in order to produce valid outcomes, one should use valid methods in a professional way. Therefore, it is in an assessment one should examine not only whether outcomes are produced but also the validity of the methods used. This is done by the professional judgement of the assessors.

Although our main use for the process model has been the assessments, we have identified other uses for it, too. When communicating the assessment model and results to the development staff, our observation has been that the model seems to be an effective asset in training the essence of UCD. Feedback from the experiments indicate that focusing on 'what needs to be produced' rather than on methods seems to communicate well (especially in assessment situations where the past practice of the staff is mapped against the model). We have seen that many practitioners have learned UCD only through methods. People have reported that discussing UCD without methods has 'opened their eyes'.

The model also seems to be a useful teamwork asset when planning UCD activities for a development project. At the first stage, one discusses at the level of outcomes: what usability deliverables are essential, and where to put efforts. This discussion can be carried out together with development staff. The method issues (how the outcomes are produced) are a separate issue that is discussed later within the usability group.

6. DISCUSSION AND CONCLUSIONS

We propose a method-independent process model of UCD. It is based on recognised sources and its structure was developed in a set of assessments in industrial settings. The result is a process model that identifies six main processes of UCD. Each of these is defined through a set of outcomes. The model makes tangible the interface between usability engineering and design processes. The model has provided a practical basis for the assessment of UCD processes, which was the original scope of the model. In addition, we have found the model as a useful asset in training UCD and in planning UCD activities in projects.

One should understand that the model has evolved from one experiment to another, and is still subject to refinements. Our goal is to have a

communicative and elegant model. New experiments and situations may reveal need for further refinements.

While the key thing in the model is its structure, we have been forced to make some interpretations of the substance of UCD. It may well be that all do not agree with us about all those interpretations.

We want to emphasise that the process model is a complementary one to our starting point, ISO 13407 and ISO 18529. If formal process assessment is desired, it is important that the process model is a recognised and widely approved one, such as ISO 18529.

This kind of process model could possibly be used for other purposes, too. The research focus in UCD methods is still generally usability evaluation method focused. A process model like these may help identifying other areas where new effective methods are required. For example, our experience is that definition of usability requirements is perceived difficult. New methods in this area are required.

In our future research, we will carry out further experiments where we plan and implement improvements in UCD together with our partner companies. In these different efforts – whether they are assessments, training, or planning and implementation of usability activities – we will further evaluate the model and make refinements as needed.

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