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Designing Computer Systems from a Human Perspective: The Use of Narratives

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Abstract

From the assumption that we need techniques and tools, which support designers making descriptions of human living people during the design process, I propose that we use narratives as a form of expression. I present a model, which illustrates how the designer can work with narratives, and the model is explained referring to experiences derived from different kinds of student reports and activities carried out in the years 1990- 92.

Most computer systems are developed with the purpose of supporting people fulfilling some kind of activities and it is expected that this purpose should be achieved through some kind of interaction between human beings and the computer system. In this way system designers have always been aware of human beings when they develop computer systems. This statement is underlined by the fact that the term 'user'—which to most system designers are a pseudonym for 'human beings', always have had a central positions in the development process. The many activities within the fields of HCI and CSCW underline the growing awareness among designers on the importance of making considerations about human beings in the development process.

Even though nearly anybody agrees in the importance of the users, and al-

though computer applications in almost any form are spread throughout the society in these years, it is still a hard job for the system designers to make users visible throughout the design process. The most common strategy for the development and implementation of computer applications still seems to be a 'trial and error' strategy. The system designers do there job the best they can, the system is implemented whereupon the designers learn from their mistakes and make adjustments to the system. As time passes the designers come up with a system, which is acceptable to the users, and in some cases the designers have constructed an application that furthermore could be used by other people.

In this way the technological development seems to be an accidentally never-ending process where the users often are confronted with poor and unsatisfactory systems and furthermore forced to constantly shift to new versions of the systems, as the older versions would not get any support from the technical specialists. The users seem to be a helpless prey to the technological evolution, which are developing ever faster with no time for reflections about the benefits and drawbacks we get from using all these different applications. In this situation it seems increasingly important to come up with methods and techniques that could help the designers and the users to discuss and reflect upon the usefulness of a planned computer application at a very early stage of the development process. If this could be achieved there will be a chance, that the development of new applications could be planned and steered in a consciousness way instead of being an almost accidentally affair.

1. Focusing on human beings

In the end computer applications should contribute to better the situation of human beings, whether we are talking about a work situation, situation as citizens or private situations. Consequently we have to set focus on these situations. We have to take human beings into account, when we wish to develop new computer applications. This is not done in most of today's development projects. Surely designers are taking about users and sometimes also with the users, but they do not communicate about users as human beings even though the designers may think they do so.

Designers are focusing on the system they are going to develop, which means that they are talking about human beings as 'users' a term which is only meaningful when people are seen in coherence with the system. People are most often seen as objects that retrieve, process and send information and they are described on a par with other resources which form part of the system. The reason the designers choose this simplified and naive perspective on human beings is due to the effort of making a unified overarching description of the technical part of the system and the people who are going to interact with the system. But descriptions—made up of simple figures as circles, triangles or squares connected with lines and supplemented with some chosen and limited set of data elements—are far from being descriptions from which we could discuss and evaluate how the system is going to contribute to better the situation in which people are living and acting.

If we wish to take users serious, we have to see users as human beings, who

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are social beings with emotions and a will, beings who wish to be active using their intellectual and physical capacities, who are not functioning in a rational rule-following way, but are creative and demanding beings. Of course system designers know—at least from themselves—that people are this kind of creature, but they are not capable of dealing with these facts during the development process. Consequently we have to develop techniques and tools that support descriptions, which could inspire people to form images of living human beings thereby being able to take a stand towards the usefulness of the proposed system. Using narratives in the system development process seems to be a way in which designers will be able to come up with the kind of descriptions that is asked for. In the following I will present a model, which is a proposal to how the system designer could work with and use narratives in the development process.

2. Assumptions about the designer

Within the computer world, "designer" is used as a general description for people who develop new computer systems. In the following the term will be used in a more specific way as I make some assumptions on who the designers are, what kind of job they are going to do, and the qualifications the designers should possess.

2.1. Who is the designer?
The designer is an individual who is acting actively; is creative and through his activities expresses a will to influence and change into the better some existing situations by developing a computer sys-

tem. With this precision of the designer's role I wish to give an impression of the designer as a man of action, who are working within practise, which he wishes to change according to his own conceptions and attitudes. The designer distinguishes essentially from the ideal of a scientific person, who aims at an objective understanding and solution to the phenomenon studied. However this does not mean that the designer does not use methods and tools that are founded on a scientific basis.

2.2. What is the designer's tasks?
The designer is aiming at implementing a computer system as part of a larger whole, in which the interplay between human beings and the computer system are of importance. He has a vision about changing the situation to some people and it is his task to formulate and express his vision in such a way that it could be understood, discussed and evaluated by other people. Moreover the designer should account for how it will be possible to realise the proposed computer system, he should not necessarily be able to construct the system himself, but make descriptions, from which technical experts are able to construct the system.

2.3. The qualifications of the designers.
The designer should be able to decide, which part of his vision can be realised. This means that he should have a theoretical as well as a practical knowledge about the computer technology. Moreover he should be competent in analysing, hereby extracting the system from the situation studied. These qualifications can be seen as the more technical part of the designer's capacity. Just as important is that the designer hold a design capaci-

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FIGURE 1. Different approaches to communication in system development
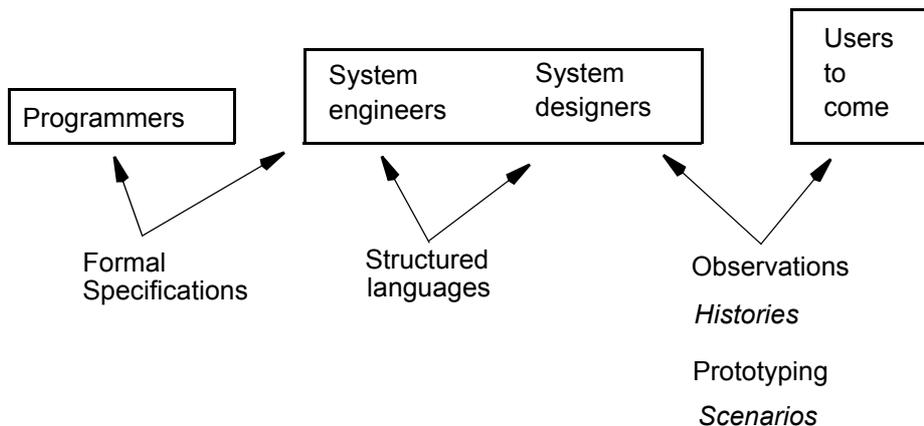
ty, by which I mean an ability not only to formulate and express his own visions, but also an ability to grasp, formulate and express visions of other people. The ethics of the designer is important in the sense that he has a conception that something is better than something else. A conception that will guide him to take a stand towards, which kind of qualities should be weighted constructing the system. These more soft qualifications could to a certain degree be supported by some techniques, but is just as well a question of more general life experiences.

2.4. How the designers communicate with other people.

Many people are involved in the system development process and it is important how the involved persons communicate with each other. The designer should use different form of languages through the development process dependent on what he is communicating about and with whom he is communicating. In figure 1 I distinguish among four different

groups—programmers, system engineers, system designers and users to come, and I point out to whom some of the most widespread approaches are suitable when people communicate about the system to come.

System engineers communicate with the craftsmen — the programmers — about the construction of the system. This is a technical domain and the communication should be accurate, consequently a certain kind of formalism is appropriate. When the designer and the engineers communicate about the system, its structure, components and technical functions it can be suitable to use some kind of structured languages or notations[1].

Anyway, none of these means of expressions are suitable when the designer should communicate with the users to come. When the designer communicates with users, he either wishes to learn something from the users about the domain or get the users reaction on the system to come. Even though some system engineers still hold the opinion, that

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structured languages and formal specifications could be understood by the users, experience has shown that other approaches are necessary. Observations, different forms of interviewing techniques and user-participation are some of the most widespread approaches used by system designers, when they wish to learn from the users[2], while prototyping is the only real alternative when designers wish to get reactions from the users.

In this picture the use of narratives is a supplementary approach which support the communications between system designers and other people.

3. The narrative

As the designer is focusing on the situation of human beings, he has to come up with a kind of description, which expresses human beings as living people. Narratives are such kind of descriptions that has been used through centuries by almost everybody. We are custom with narratives in many genres—adventures, historical narratives, tragedies and in many forms—novels, comics, spectacles and so on.

Narratives in all its forms are being used to give people an orientation in their lives. We are told what is good and bad, right and wrong, beautiful and ugly, and we communicate with other people (across borders and time) about good and bad aspects of human existence.

The question is if we can say something reasonable about using narratives in the system development process. Should we use some special genre or expression? Could we come up with some guidelines, which could support the design activities?

3.1. Narratives and interpretations

When we use narratives we are far from simply communicating facts. We are formulating and/or expressing our conceptions about often very complex wholes. We interpret the narratives. Our attitudes, experiences and evaluations are important aspects doing so, which means that the messages given or taken are a very personal matter. We are far from the ideal of an objective description, but we can—within the spirit of C. W. Churchman[3]—aim at this ideal by letting people interpret and discuss the phenomenon studied. To get some structure on how people uses narratives communicating with each other, D. Polkinghorne[4] distinguished between three different kind of story presentation referring to the "narrative representation". The first is the representation of the story to personal awareness and it appears as a personal experience of a unified venture composed of a variety of events. The second kind is the representation of an experience in a language message directed to others, it could be the communication of a personally experienced story, a constructed story about the past (a historical narrative) or a imaginatively story (a novel). The third kind of story is involved with the reception of a story when people interpreted and understand a story by hearing or reading a story.

Important to notice is, that people constantly interpreted the stories told, which means that there is no guarantee, that the storyteller and the listener hold the same conceptions about the story told. This is just a commonplace fact, which holds whenever people are communicating with each other whether they are talking about daily events or discussing some formal system descriptions.

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My point with introducing narratives in the system development process is simply to emphasise the importance of interpretations.

3.2. Two different kinds of narratives— he history and the scenario

In the proposed model for design activities, narratives are used in two different connections namely when designers build up conceptions about the existing situation of the users and when the designers aim at composing conceptions about the future situation.

When the designer is going to formulate narratives about the existing situation, he has to grasp the conceptions about the situation from several people. Consequently he must get the users to express their conceptions, e.g., by using the technique known from making "qualitative interview"[5]. In this case the users are the storytellers and the designer is the listener. He interprets the stories told by the users thereby building his own conception about the situation, which he then presents by formulating his history about the situation studied. Even though the designer interprets the stories told he can not compose freely when he formulates his own version, as it is a demand that the history told should reflect reality and it is possible to control the designer's version comparing it with the stories told by the users. In this way the designer work as a historian, who performs his work by interpreting stories told by others.

When the designer is formulating narratives about the future he works with scenarios and consequently he shifts from working with empirical narratives to fictional narratives. He works like a composer aiming at creating a narrative, which communicates his vision including his messages. In this case other people can not control the scenario presented but only evaluate the future situation by making their own judgements. Anyway the designer has to take into consideration that he only will get in a dialogue with other people if they evaluate the scenario as being a realistic possibility.

3.3. A framework to the system designers narratives

Whether the system designer is working with histories or scenarios he has to come up with a description that make people perceive the users as living beings. This means that the narratives should illustrate and express the variation and manifold, which characterise the human existence. The designer has to choose, which sides of the situation studied he wishes to threat as he is forced to constraint his descriptions. To support the designer making this kind of decision I have set up a framework consisting of nine aspects that all seems to be important when people should evaluate the quality of their life situation. These aspects do not originate from a theory but are simply chosen from a mere pragmatic consideration. An aspect is included if only it could be argued that some people are effected on the aspect by some computer systems. This means that not all users are effected on all aspects by every computer system. It is the designer's task to consider which aspects are of importance to the situation studied and thereby decide which aspects should be included in the narratives. The single aspect is intentionally characterised by an equivocal term since I am aiming at a framework that should inspire people to express all

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TABLE 1. Aspects to be considered in formulating narratives

Aspects	Hints
Social	togetherness, acceptence, respectability
Emotional	safety, confidence, care
Creative	fantasy, creations, vision
Aesthetic	pleasure, beauty, enjoyment
Intellectual	insight, understanding, thinking

Aspects	Hints
Activity-allowing	competence, mastering, acting
Health	well-being, physical, psychical
Economic	time-saving, rational, effectiveness
Functional	ready-to-hand, adjustment

possible matters relevant in evaluating a computer system.

To get an impression on the meaning of the different aspects you have to think on specific situations with concrete persons using specific systems, e.g., how work routines are change introducing new production systems; how communication patterns are changed when people are using e-mail systems; how relations between citizens and authorities are affected establishing public registration systems; banking customer's dependence on finance institutions using banking systems; how children's playing are changed thanks to the many computer games. Reflecting on these different situations it is important to notice, that people have different opinions about the quality of the single system, not only because they are affected differently but also because they are weighting different aspects.

4. A model to the system designers activities

The following model is a proposal to how the system designer could work

with the more fundamental ideas of the system he is going to develop. Compared to a more traditional model it will fit into the very early phases of the system development process.

However the model is build on some assumptions about the system designer and it is only meaningful to carry through the listed activities if these assumptions are fulfilled. Firstly the designer shall see himself as an active creative person, who acts in an artistic and analytical way striving at using the computer technology to better the situation to some people. Consequently the designer is focusing on people and their situation, while the computer only is seen as a mean to help people. Secondly the designer has an ethic that enables him not only to take a stand towards what is good and bad about the situation studied, but also to explain to and argue with other people about the reason he wishes to change the situation. Thirdly it is expected that the designer has defined a problem, which he tries to solve totally or partly by developing a computer system.

The task of the designer is to define the computer system at a principal level in such a way that the users are able to

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decide if they wish to get the system and the technical experts are able to construct the system. From these demands it follows that the proposed activities should result in two different kinds of documents:

A. One or more narratives from which it will be possible for other people to decide if they want the proposed system

B. One or more drafts of the system from which it will be possible to outline system descriptions that can function as a fundament to the following work of construction.

4.1. The model

The proposed activities listed in Table 2 should not necessarily be accomplished in a strict sequential way even though the order reflects a certain dependence between the different activities. Furthermore a time estimate is given to the single activity, to get an idea about the total time needed. From this estimate it can be seen, that the total amount of time needed is not less than 3 months, which indicate the size of the project to which this model could be used.

Table 2 illustrates how the field of work changes throughout the design process. The designer has to work with different approaches and different methods during the design process as the field worked with are very different, e.g., composing narratives are much different from analysing the problems.

When the designer formulates the problem he has to come up with a theme, which must be related to some people. The theme expresses how the designer constraints his field of actions as he only cares about aspects that can be related to
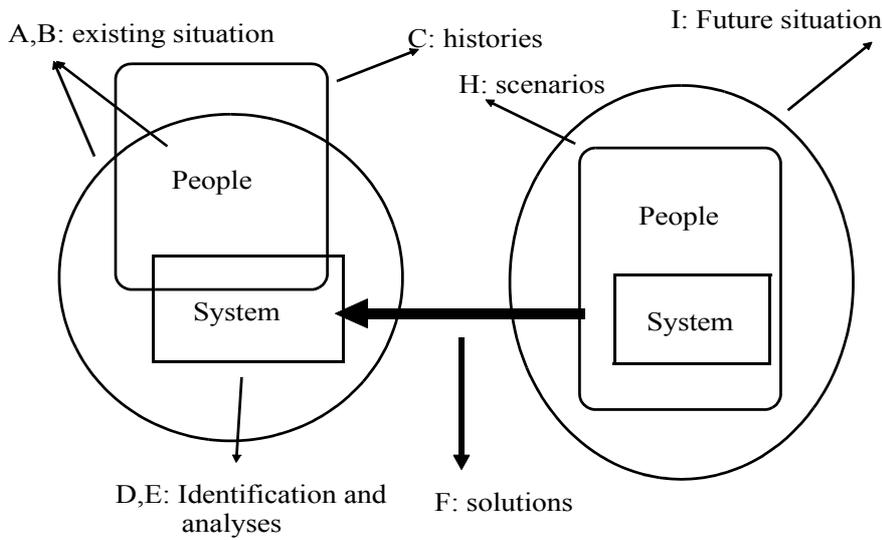
the theme. In the same sense the designer has to be very clear about which people he expects to help by introducing the new system. The designer can not simply speak about users, since this term is ambiguous and therefore would not give the designer any orientation about which people he actually wishes to help. This is a well-known problem within the field of system development and designers normally try to differentiate people by talking about different kinds of users. One of the most popular group of users that the

TABLE 2. Activities in the design process

Activity	Time
A. Formulating the problem	1 day
B. Identification of users and choosing representatives	1 week
C. Formulating conceptions about the existing situation	
C1. Qualitative interviews	2 weeks
C2. Composing empirical narratives (histories)	1 week
D. Identification of problems	2 days
E. Analysing problems	1 week
F. Proposal to solutions	2 weeks
G. Choosing solutions	1 week
H. Composing fictional narratives (scenarios)	2 weeks
I. Presenting scenarios	1 week

designers are told to take into consideration is "end-users", which refer to people who are going to operate with the system. However—most often it is not this group of people the designer has in mind when he thinks about better the situation

FIGURE 3. Fields of work in the design process

A,B: existing situation

C: histories

I: Future situation

H: scenarios

People

People

System

System

D,E: Identification and analyses

F: solutions

of some people and consequently it is not this group of people the designer has to concentrate on when he is designing the system, e.g., if we are going to design a production planning system, we try to better the situation to the people in the planning department or the shareholders, but not necessarily to the workers in the production line. Anyway this does not mean that the designer should not care about the end-users, which could be relevant from other viewpoints, e.g., that the system as such will not function if either the technical system or the users are out of function.

So it is important to clarify which people we are going to help as it is among this group of people we have to choose the representatives we are going to interview and compose histories about. Composing histories we should concentrate on the situation that is outlined in the theme, but it could be relevant to make histories broader thereby

ensuring that we communicate descriptions about living human beings. Moreover it will be appropriate to compose different kinds of histories, hereby reflecting and expressing the variations and complexity of the situation studied. Doing this it is allowable to combine information from different interviews as the composed history should not be seen as a true reflection of the persons interviewed but as stories, which the listeners find reliable and in which they can recognise themselves.

All the histories together will communicate a rather unstructured and complex picture of the situation studied from which it is not at all clear how a computer system can be constructed. This is not surprising as we so far only have tried to unfold the situation studied. After this the designer has to seek for problems, which he finds is common to the different histories moreover he has to analyse and describe the problems from a struc-

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tural analytical approach. Through the analyses the designer builds a model of the phenomenon studied from which he will be able to decide if it is possible to construct a computer system that will meet the problems. It is a requirement to the system described, that it fulfil the following conditions:

1. The system shall be delimited according to its surroundings.

2. It should be possible to describe the system in a set of observable and exact data.

3. It should be possible to lay down any possible state the system could be in.

4. It should be possible to set up a set of rules, which expresses the functioning of the system.[6]

In this way the designer—at a principal level—determines whether it is possible to come up with a computer based solution to the chosen problems. From this point the designer has to investigate how it will be possible to come up with a concrete practical system. He must use his knowledge about the state of the art within the computer industry, hereby making a draft that clarifies how the different parts of the system can be constructed and especially he has to point out the more uncertain and difficult elements. Evaluating which of the different solutions he expects to be realisable, the designer must not only reflect on technical hindrance but also think of economical, organisational and political aspects, even if these aspects are going to be exposed in the following discussions about the scenarios.

The scenarios composed by the designer should communicate the designer's vision about the future situation. The designer must come up with a story that seems realistic and relevant to the people who are going to evaluate the proposed system. He must describe people as real living people, but in contradistinction to the histories he has to include descriptions of the functioning of the system. The listeners should be able to form realistic pictures of how the system can be used and how it is going to affect their future situation only then the designer can expect to get into a dialogue with the users.[7]

It is important to notice that the designer is not responsible to the realisation of the scenario he presents, he is only responsible to the realisation of the proposed system. The designer creates computer systems not situations. When the system is implemented it is the users, who create their future situation. The use of narratives in the design process is only a mean to make people more conscious about which kind of system they expect to be useful doing their tasks.

5. Some experiences from working with narratives in system development

Even though the proposed model has not yet been used in connection with a real practical project, we have some experiences about the different activities derived from a number of student projects and a course at DIKU.

5.1. Using the Framework of Qualitative Aspects

To clarify whether it is even possible to communicate with people about the aspects mentioned in the framework, students in the process of writing their mas-

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ter's thesis for the Department of Computer Science at the University of Copenhagen in 1990-92 carried out a series of studies with the intention, on the basis of qualitative interviews, of capturing the users' evaluation of concrete systems. Our experiences from these studies were that users easily and frankly could talk about the quality of the systems related to the different aspects and, even if the numbers of interviewed persons are limited[8], a relevant hypothesis seems to be that users attach importance to the activity-allowing, intellectual and creative aspects while aspects like economic, social and aspects to do with health play a minor role. Moreover it seems clear that the system is perceived and valued by users as an integrated part of their total working situation.

It has not been easy to work with the aspects, difficulties did not arise during the interview, nor analysing the interviews but adopting the ideas of the project. The students, all studying within the discipline of computer science and thereby educated in the traditions of science, are used to definitions and strongly believe in methods and theories as guidelines to their activities. None of these ideals were fulfilled within this project. Whenever, the students tried to define and describe the different aspects on an abstract level, they failed. Working with one aspect constantly involved some other aspects—the aspects were totally intertwined. I do not believe it is possible to understand the single aspect by isolating them from each other on a theoretical and abstract level. They should be seen as a whole and when it comes to a concrete situation—with concrete persons and a specific system—we would only

have minor difficulties classing different evaluations with different aspects.

The results from the studies have shown that the aspects chosen seem to be usable catching people's valuation of the qualities of computer systems and thereby constitute a possible framework for the designer working with narratives. Moreover it has been underlined that the designer should take a stand towards the situation he is going to change, which were illustrated by the fact that when two students had accomplished the study together—made interview together and thereby had access to the same information—they did not hold the same conception about the situation studied.

5.2. An example using the model

To get an idea on how narratives could be worked with in the design process I decided to give a course, "Writing narratives in system development," during the autumn 1992. Thirteen students participated and twelve of these got through with most of the activities in the proposed model. Even if the course cannot be taken as a real example of a practical design process it was a good illustration on how the design process could pass off and we got many experiences, which could be drawn on in the ongoing work.

The problem and theme were formulated by the teachers and were formulated as follows—"The system to be developed shall be a computer system, which support economical 'illiterates', as it is assumed to be a good idea to develop a system that supports ordinary people to get a survey over and hold on their finances."

The students should interpret this formulated problem and themselves decide, which kind of people and situations they

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were going to present a history about. The qualitative aspects were presented to the students, but as the students did not have the time to carry out series of qualitative interviews they were recommended to base their histories on people whom they knew. All the students came up with a history and of course they differed in quality, but more remarkable were that the histories were about many different people and situations, which illustrates that people's conceptions about a general problem are very different even if they hold a common professional background. Several students had difficulties fabricating the histories as they did not allow themselves to compose freely as they steadily asked themselves if the persons they had in mind really would act in the way they described. This is a real dilemma, which are founded in the difference between the researcher's and the artist's way of working to which the designer may pay special attention fabricating the histories during the design process.

Thanks to the many different histories we got a varied and manifold illustration of how people can misconduct their financial means. From the stories we were able to identify three more common problems—the dependency-problem; the budget-problem and the credit card-problem, which all can be included in the original formulated problem. Further discussions lead to the conclusions that the dependency-problem were a psychological problem that we hardly could solve by developing a computer system, whereas it seems promising to develop computer systems that could help people handling the two other problems.

Regarding the limited time we got at our disposal we choose to concentrate on the credit card-problem and the next step was to express the problem in a structural analytical way thereby determine if we could come up with a satisfactory solution. From an analysis of the meaning of money when people are handling financial circumstances we found that replacing physical money with 'information'-money, as it is done with credit cards, do not make any significant differences to banking people, professional economist's or other people who are operating in an abstract economical universe, but to ordinary people acting in reality there is a problem. It is no longer possible to handle physical money—sense them, count them, destroy or make them, instead people should be able to handle information, which is quite another matter. Consequently the solutions we should aim at should re-establish the physical moneys.

The students came up with several solutions to the problem, most of which were based on the use of an intelligent credit card and ranging from a simple display that shows the balance to more complex systems that involves new systems and routines delivered by the credit card issuer. We did not have the time to discuss the different solutions but the students ended up composing a scenario that describes the future situation when people are using their proposed system.

5.3. Composing narratives

Just as there is no right way to make a system description there is no formula how to compose narratives but some knowledge, techniques and practical advises are available to the system designer.

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Firstly the system designer must comprehend the differences on using a scientific language and an intermediate language. The scientific language is applied to analyse, define and systematise and so it is static, general, abstract, logic-reasoning, impersonal and non-pictorial. On the contrary the intermediate language is applied to tell, interpret and explain and therefore dynamic, specific, concrete, narrative, personally and rich in pictures[9].

The purpose of using narratives is to help the reader to grasp the situations described. From the concrete descriptions the reader should build his own pictures thereby forming his own opinion about the users, their situation and the usefulness of the system to come. In short narratives can be seen as a tool that help people to move from a concrete to an abstract level of understanding. Consequently the writer should describe situations from different angles, use redundancy and make references to concrete well-known persons, places and situations.

It is not appropriate in this article to give more detailed descriptions of the many different techniques, that can be useful composing the single narrative, but from an overall point of view the writer should be aware of the following:

The narrative should be a story with a point. The narrative should hold a motor that drives the reader through the narrative thereby making him experience the many different situations described. Which kind of story and points the narrative is build on may be a personal choice to the single writer.

The persons in the narrative are used to express different kinds of values and it is important that the single character is credible. The reader should actually see the characters as real persons which values should be taken seriously.

The writer should carefully consider the purpose with the single situations which constitutes the narrative. Is it applied to express some evaluations done by a person or is the purpose simply to give a description of the system? Anyway it is of most importance that the many different situations constitutes a coherent whole.

From the course we have learned that it is possible to compose and work with narratives during a design process and one great benefit was that the narratives forced us to focus on and talk about the people we were going to help. Any proposed problem or solution was constantly related to and evaluated according to our conceptions about people and their situation. The experiment has shown that narratives are useful internal to a design group but it still remains to be shown that they also can be useful communicating with people outside the design group. Furthermore we have learned that it is difficult to shift between the different modes of working—artistic when we are composing narratives and scientific when we are performing analysis, but it can be done and I am convinced that it will be much easier as we get more experienced using the model.

6. Future activities

It still has to be shown whether narratives can be used by system designers in real life. The projects carried out at the university have shown that ordinary users are able to evaluate computer system referring to more soft aspects and stu-

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dents with a background in computer science are able to compose and work with narratives. We do not know if and how narratives can be used by designers to get into a dialogue with people outside the design group. To get an idea of the usefulness of narratives in practical system development work we have to carry through practical projects.

Notes

[1] High level programming languages and structured methods like Yourdon Object-oriented Analysis or ISAC are examples which could be useful.

[2] Some examples of this kind of studies are presented in part 1: Reflecting on Work Practice in (greenbaum & Kyng 1991).

[3] Churchman is advocating this viewpoint in his book "The System Approach", Dell Publishing Co., 1968.

[4] Polkinghorne is working both as an academic researcher and a practical psychotherapist. In his book (Polkinghorne 1988) he argues that narrative is a scheme by means of which human beings give meaning to their experience of temporality and personal actions.

[5] "Qualitative interview" refers to different kind of methods, which are used by different professional groups e.g., journalists and psychotherapists, but in recent years similar methods are used by researchers within the field of System Development. The use of the method is closely related to a hermeneutic approach, which in many ways is in opposition to a scientific approach. This viewpoint is stated by Steiner Kvale in the article (Kvale 1987).

[6] If we are going to construct a computer system we have to take a structured analytical approach, and this approach is valid if these four conditions are fulfilled. This is argued in (Clausen 1985).

[7] The use of prototyping can be seen as an alternative way of making people able to form realistic pictures of the future situation.

[8] Roughly 50 persons have been interviewed in five projects.

[9] This distinction is made by Jensen in his book (Jensen 1987).

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