

Designing Technology for People

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Introduction

Designing Technology for People

We cannot live without technology today. It's a disaster if there is a power failure, or if the Internet connection is down. From starting with nothing, except our bare hands, we invented tools to accomplish tasks and from that day and on, we have refined these tools with the help of the discovery of new technology. Each new step in the development of technology, resting on some previously discovered technology. But the invention of technology and new tools are not a development, which is separated from the development of human society. When new technology is released, it's going to be used by people, and in most cases these people are not the designers, but ordinary people. This seems to be a fact, which many designers have forgotten during the industrial revolution. Previously, a carpenter would cut a chair for Mr. Jensen, which he normally knew very well and therefore was able to customize the product to exactly Mr. Jensen's needs.

With the industrial revolution came mass production and Ford T's came rolling of the transportation band. Now everyone was offered a black Ford T, whenever they liked it or not. The main philosophy was, that if the product was good enough (according to the designers) people would buy it. This resulted in the eighties, in the downfall of American automobile industry on behalf of the Japanese, which were better at customizing there production to the marked with new technology (for instance Just in time production, Total Quality Management)¹.

This was the first step towards adapting technology to people's needs, but this was only the beginning. Another area where researchers were approaching user influence in the design process was in Scandinavia with the participatory design tradition. In this area companies were experimenting with involving users in every part of the design process, from brainstorming to final product. In this way, users were not isolated to comment on bugs in the final prototype, but users were actually able to influence the design from the beginning².

These were two approaches to designing technology to people, but if we focus our search for technology for people, the area of human computer (machine) interaction and computer supported cooperative work seems to play a most central role. This area focuses on analysing the interaction between humans and machines, and to investigate how machines or computers support the working practices of humans, and humans doing cooperative work.

¹ Porter

² Greenbaum, Kyng

The goal of this paper

It's the area of human computer interaction (HCI) and computer supported cooperative work (CSCW), which will be the focus of this paper. The purpose of the paper is not to specify a specific piece of technology, and even though I'll come with an example proposing a new information technology, this is not the main purpose of the paper either. The purpose of this paper is instead, through a reframing of the question about which human values and needs should form the basis of new information technology, to focus on how designers can design technology, which provides an as good as possible fit with the coming human users. I have made this reframing, because I do not believe that a specific human value or a specific human need can generally be identified, which I also will argue for in the beginning of the paper. Instead, I believe that the central aspect in

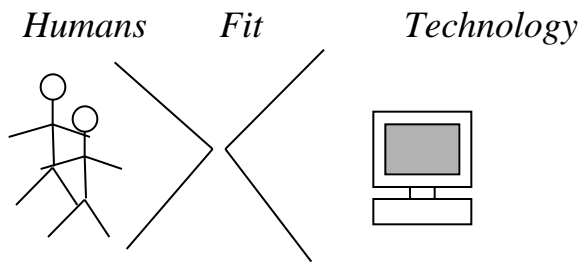


Fig. 1.1

designing technology for people, instead of just designing technology, is to provide a good fit or pattern between the designed form of the technology and the coming users.

This paper will therefore contain six essays about five important factors and an example, which I'll argue play an important role in the fit or pattern, and which are important to consider in the design of new technology. This is far from going to be a complete checklist in the designing of user-friendly systems, but rather some aspects, which will, when considered by the designer, help in the production of new user-friendly technology.

Since I have chosen to focus on this fit or pattern, there are other aspects in designing technology to people, which I only sparsely will touch. This will for instance be different moral and ethic considerations, about how technology will change people and society, and hereby whether new technology is to be considered as improving our society or undermining it. In this paper I'll assume that we always will have technology and that we always will develop new tools and machines based on this technology, and this paper will focus on how to make this technology based on human values.

It's important to underline that the purpose of this paper is not to academically discuss or propose some new theories, but to cover and discuss a broad line of aspects a designer has to focus on when developing technology for people. Besides that, I'll try to suggest different known and new suggestions to how this concrete is done by the designer. The chosen writing style is therefore semi-academic. In each essay I'll discuss how to design technology, and I'll try to base each discussion in well-known theories, often very complex theory, which I'll mention briefly, but not discuss or set out in completeness and details. I've chosen the parts of the theories, which I have found most relevant for this area and these parts are mostly very simplified. To give a deeper understanding I'll suggest reading the books and articles I'll refer to.

Structure

This paper consists of six essays. In the first five essays I'll be presenting five different areas in the design of technology for people, which I'll argue play an important role in developing new technology for people. In the last, sixth essay I'll further underline these areas through a concrete example.

In the first essay the need for new technology is investigated. I'll discuss different techniques to investigate the coming users motives, values and needs will be discussed, and how the user can be let in on the design process. Afterward some of the problems about determining the users needs and reactions will be discussed, and I'll look at how technology might be altered after it's released.

The discussion on human needs leads to the second essay in which the focus is on how to shape technology in a way that makes humans feel confident with the technology. How can we for instance make people feel safe and comfortable with e-commerce or how can we make technology attractive instead of scarring? I'll look at how badly designed technology can lead to a kind of learned helplessness, and I'll propose a new metaphor for how confidence in a technology can be obtained at a virtual playground based on Donald Schöns theory about a reflexive practicum.

Some of the points about how to make people confident with technology are closely connected to the third essay, which will discuss usability and how to make technology easy to use. I'll look at principles like, how to provide a good conceptual model, the importance of keeping things visible, how to provide good feedback, and the importance of a good mapping, which will be based on Donald Normans famous book about "The Design of Everyday Things". I'll also try to look at another principle from the human computer interaction called direct manipulation and try to suggest a broader appliance. I'll use these theories to point out the importance of user-friendly designs in designing for humans.

In the fourth essay, the point from the discussion about different people having different needs will be pursued, by asking how to make technology flexible and able to adjust to different needs. This essay will focus on how to make dynamic technologies, which adapt to different users instead of accepting standardized products. I'll start by looking at some of the areas where people might differ

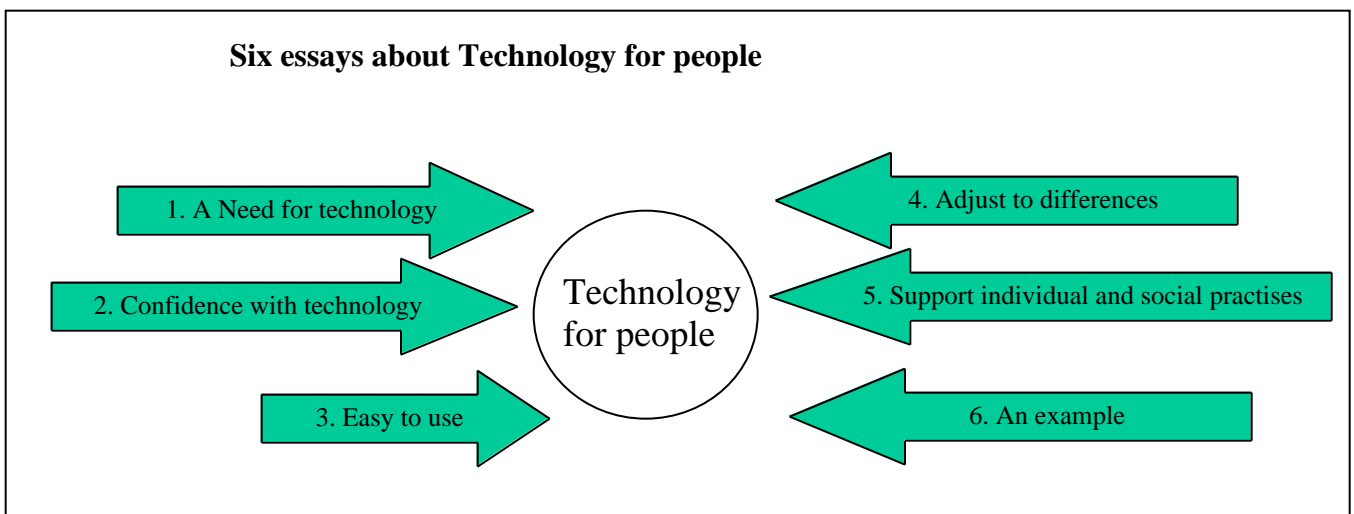
and discuss how providing redundant paths can help customizing products. I take this discussion further and introduce a new idea about dynamical interfaces.

In the last essay the discussion is on how to develop technology, which support work practices. The discussion will touch not only how technology can support individual work practices, but also how technology can support social practices, and how it sometimes can destroy valuable social practices. I'll try to discuss how technology tools can be designed to obtain a transparent effect in the interaction. Next I'll discuss how augmented and virtual reality provides two different roads for new technology that are going to support different working practices. In the last section I'll try to analyse social work practices based on the idea of seeing a social work practices as an information ecology.

The aim is, that these five essays clarify some of the aspects, which are important to consider when designing information technology based on human values.

In the sixth essay I'll try to give a concrete example on how to build technology based on some of the points I've stated in the discussions in the five essays. The example I'll use is from a training project, which I participated in, where we tried to develop a new kind of principle for remote controls based on human values and needs.

The purpose of letting this paper consist of six essays is to present the many important aspects a designer has to consider when designing technology for people in an intuitive and manageable way.



First Essay

A need for new technology

“The elderly woman walks up to the Liberian and asks how the computer works, because she wants to send an email to her grandchild in the States”

Introduction

One of the most obvious, but often forgotten things when somebody designs and invents things is, that there has to be a demand or need for the new technology before the technology is going to be a success.

The Danish company “The Martin Group”, which produces intelligent light for use in clubs and concerts, launched an application for professional photographers around 1997, which aim it was to help automatically setting the light when using digital cameras. The problem was, that in 1997 digital cameras were rare, too expensive and not yet competitive with the traditional cameras, which resulted in a very low sale, because, at the current time there was no need or demand for that kind of technology³.

There are a lot of examples of how the demand or need for a particular service or technology has been miscalculated and overestimated. Many e-commerce businesses are closed at the moment and one of the reasons for this, is that they have overestimated the need for e-commerce.

On the other hand, some technologies hit just the right needs at just the right time. One example is the SMS-technology. With cheap mobile phones, parents often buy mobile phones for their teenagers. In this way the parents can call their children if they are worried, and the other way around. The only problem is, that talking in mobile phones can be pretty expensive especially for a teenager. A way to solve this problem is to send small, cheap messages to each other, and in this way the SMS hits just right and has become a major success.

Another example is the use of emails, which has proven to be a killer application for the Internet. Last year, we made a project at the public library, where we investigated how new technology influenced the way librarians worked and how the library was used. During this project we interviewed a librarian about how people used the around 25 computers with an Internet connection. The librarian told us, that sometimes –“elderly people come here, who have never touched a computer and ask how to send emails”. Some of their grandchildren have moved abroad, to for instance the States, and now they want to keep in touch by email. This is an example where there is a good fit between the need and the technology. The elderly person has a wish of keeping in touch with her grandchild and the technology fulfils this need⁴.

The above were some examples of technologies, which did or did not fulfil the needs of the users, which it was designed to help. But it’s always easy to find examples in the history

³ Report on the Martin Group

of things going well or things falling. Another and much harder problem is to design technology for current or future needs. To help in the process of evaluating whether or not there indeed is a demand for a design, I'll propose several different approaches. The first approach is analysing the working practices of the coming users. This discussion will lead to a second approach, where I'll make some suggestions on how to involve the user in different parts of the design process. I'll end this essay with a discussion on some of the problems designers might run into when trying to anticipate the outcome of a design process.

A User Centred Approach

One approach to making technology, which increases the probability that the new technology corresponds with human needs, is to let the user in on the design process.

The first step in this process is to identify, which users the technology is minded towards and their working practices. An approach suggested by researchers at Danfoss is to put up user characters. A user character is a concrete stereotype character, which the design is minded toward. An example of a user character to a new mobile phone could be "Peter James, 39 years old, live in small town, work at the local police office, married with 2 children, values nature and music, uses only technology when necessary etc.". With these kinds of user characters the designer will always be able to take the design and hold it up against one of the concrete characters instead of some abstract ideas about potential users.

Getting to know your users and their working practices is another important feature in this first step. You'll definitely fail in producing a new technology if you have no knowledge about the coming users. Observing the users and interviewing the users can help in getting to know the coming users and their working practices. Observing users in a working situation can give valuable clues to new dimensions in the product, which might first have been caught late in the design process or not at all. A good idea is to videotape as much as possible. It can be cumbersome during the observation, but many important details are first revealed after watching the scene repeatedly⁵.

But observation is not enough alone. Often observation cannot explain the motives for people acting in a specific manner or their prior knowledge of the situation. It's therefore necessary to do some interviewing. Generally there are two major kinds of interview forms. One is doing quantitative interviews where a lot of people are asked the same question often in the

⁴ Report on the public library

form of a questionnaire. These give broad answers to some specific questions and are normally easy to handle. The problems with these kinds of questionnaires are: Does the interviewer know what kind of questions to ask, and does the broad public know how to answer. I wouldn't know what to answer if someone asked me, if I wanted a talking computer. Maybe I would answer yes because it could be cool to have a talking computer, but if someone then developed it and gave it to me, I would turn off the speaker because it was annoying to listen to. The point here is, that questionnaires sometimes are able to show some trends in society, but when it comes to interviewing about new technology this approach often fails, mainly because people cannot relate to the not yet existing technology.

The suggestion here is to make qualitative interviews instead of quantitative. With qualitative interviews some key users are chosen and interviewed about their current work practices, possible problems, and hopes for the future. This gives a lot of material, which will have to be transcribed and compressed in order to give a rich picture of some of the users' needs. Combining the material from observation with the compressed material from qualitative interviews, the designer has a valuable insight into some of the aspects he will have to consider if he wants to develop technology for the users, for people⁶.

The picture can be further clarified by using interaction styles. Interaction styles are a technique in which you look at the history of a product. Which similar technology or product has failed or succeeded in the past. If you are designing a new Internet television system you'll have to look at the history of television and the Internet, and literally learn from history. Combining observation, interviews and interaction styles the designer will have an even better chance of producing something people actually needs and wants⁷.

User involvement in the design process

In the tradition known as the Scandinavian design tradition the user centred design approach has been pursued even further. In this tradition users are encouraged to take part in the whole design process. Some of the suggestions from this tradition is brainstorming, future workshops, design games and cooperative mock up building. The basic idea is to invite some users to be co-designers on the project. An example is the future workshop, where some users are invited to a 3-stage session with the designers. In the first stage the users are encouraged to criticize the

⁵ Blomberg

⁶ Silverman

⁷ Øritsland & Buur

current technology or work practices. In the second stage the users are allowed to fantasize about how it could be in the future if there were no constraints, and in the final phase, the users are asked to come up with concrete ideas about which technology or which changes are needed to move toward the future vision. There are a lot of other suggestions from this tradition about how to involve the users in especially the creative phase of the design⁸.

There has been some discussion about this approach. Some critique of this approach can be stated: Can users actually design better than some designers who have spend there hole life designing, and do the users really know better what they want than the designers? The answers to these questions are not strait forward. The best suggestion would probably be, to train designers with as many design tools as possible and letting the experienced designer know when it would be beneficial to invite users and when to close the doors and let the designers do their work by themselves. A heuristic rule would be to have a lot of user involvement, if the design is minded for work practices very unfamiliar to the designer. For instance when designing for people with disabilities, or for people with another cultural background. But even when the designers are familiar with the context, some degree of usability will probably be able to reveal hidden connections or needs among the users.

It's not easy to design

Anticipating whenever a new technology corresponds to the need of the people is an almost impossible job for a designer. I will in this part look at two of the problems of being a designer. The first problem is figuring out which needs and values people actually have. Using the work of Edgar Schein and his theories on organizational cultures, light can be shed on this problem. He divides culture into three groups: Artefacts and creations, values, and basic assumptions⁹.

Artefacts and creations are at the top of the iceberg in a culture. It's what you see when you observe for instance an organisation. That is the written and spoken language, the social and physical environment, the overt behaviour etc. These things are easy to observe, but the hard part is to figure out what deeper pattern they reflect.

The middle layer is called values, and it's this layer that normally guides people's behaviour at the artifactual level. Some of the values are at a conscious level and can be articulated in an interview, and others can be obtained by analysing observation and interviews. But many of the values articulated in the interviews, will be contradictory and incongruent with

⁸ Greenbaum and Kyng

observed behaviour. To explain these irregularities Schein introduces another level called basic assumptions.

Basic assumptions are largely unconscious and normally pretty homogeneous within a given group. Basic assumptions are normally values, which have proven their strength over and over again, and have in a dynamic process transformed to basic assumptions. Because basic assumptions normally works at an unconscious level, these can lead to deviations from models which are based on conscious values, and these deviations can sometimes explain the difference between a successful technology and a failing one. One example of this mechanism can be observed when transferring technology to foreign cultures. Even though their values might look pretty much the same, the technology does sometimes need a totally different form to adjust to other cultures.

These underlying unconscious assumptions are almost impossible to identify, and even longer observation or extensive interviews will not reveal much. However, one way to challenge some of the unconscious assumptions from the designer's point of view is to force breakdowns, for instance in a scenario. A breakdown is an abbreviation from the expected outcome of an action. If a breakdown occurs, our normal rational behaviour is challenged, and we are forced to come up with another new kind of solution to the suddenly rising problem. In this process the user will sometimes fall back on unconscious assumption and raise a hypotheses about the cause of the abbreviation. These experiments can give valuable insight into how users react in different, special cases and give a clue about some lower level assumptions. An experiment could be to give some users a new telephone with a flat battery. How will the user react? Will he phone a support hotline? Will he experiment? Will he look in the manual? Will he turn to a friend he knows is an expert on mobile phones? The answer is not clear and will probably vary depending on different users, and this illustrates another aspect of the design process.

Releasing technology into the real world

Designing for real use differs almost always very much from the proper use. No one uses for instance a cellular phone exactly the way the designer had planed. In real life a cellular phone is dropped, used with dirty hands, gets wet in the rain, used to secure a newspaper on a garden table a windy summer day, stolen, borrowed by a friend, used to impress a friend etc. The point here is, that designing a mobile phone is much more than just designing a telephone. Another theoretic, who mentions these points, is Bruno Latour in his Actor-Network theory. One of his points from this

⁹ Schein

theory is, that the technology which is going to be black boxed or stable in a given group or subculture is not “the world inscribed in the object”, but “the world described by it’s displacement” which finally is going to be black boxed. This means that a designer cannot determine the actual use of a given technology. When a technology is released into society, users will transform and displace the technology, and it’s the displacement, that is going to be the technology people actually use¹⁰.

A proposal to the designer on this point is to forget the thought about controlling the use of the technology. It’s in almost any case not possible. Instead the designer should make a robust design, which will be able to survive the displacement made by the users. The designer can however build in prescriptions in the technology, which prevent or encourage a special kind of use. An example is the microwave oven. When someone opens the door to the oven, the microwave automatically stops. That is a simple prescription or constraint, which prevent the users from exposing themselves to microwaves, and there are many other examples.

One last example to illustrate some of the points. An instruction manual from a home video game set (1986). If a child wants to play a game he can insert a game pack, but he has to be cautious, because this is only allowed if the game set is turned off (it’s even written with capital letters)¹¹. This is an example of the world inscribed in the object by the design. In real life when kids (and grown ups) get excited, they forget everything about turning the machine off before changing games. This would be “the world described by its displacement”, and this is going to be the actual use of the video game set. One way of solving the problem is to prescribe a behaviour where pressing the release button to the game pack automatically turns off the game system.

Conclusion

In this essay, the focus was on how to design technology, which actually in some degree corresponds to the needs, demands, and wishes of the humans, who are going to use this technology in their everyday lives. In the first section the focus was on getting information about the users and their needs. Three techniques were suggested: The use of video observation, qualitative interviews and interaction styles. The observation would capture important aspects of the ways users normally work. The interviews were introduced to examine the motivation and previous experience of the users and the term interaction styles was introduced to bring in the history of the technology.

The participatory design tradition was introduced to present a tradition, which further involved the users in the design process. Several techniques were mentioned as tools, which would

¹⁰ Latour

prove as valuable for a professional designer. The degree of user involvement depended on the situation and the experience obtained by the designer, but a certain degree of user involvement seems to be a valuable investment.

With the help of Edgar Schein's analysis the important influence unconscious assumptions can have on peoples values was discussed, and the approach of forcing breakdowns were proposed to reveal some of the unconscious parts of our behaviour. At the same time, the importance of designing for unintended use was pointed out.

This lead to the final discussion where the dynamic changes of a given technology after it was released to the public was examined. The conclusion in this section was to produce a robust design and to inscribe prescriptions in the technology, which prevented or forced the users to a specific use.

The purpose of this essay was to give an overview of some approaches to designing new technology based on human needs and thereby closing the gab between humans, computers, and technology. In the other four essays other important aspects of this fit will be discussed.

¹¹ Norman p. 139

Second Essay

Confidence in technology

“I’ll never touch a computer. It’s way too complicated and I’m probably just going to break something”

Introduction

Generally most people want to use technology, because it normally helps people solve their problems and opens up for new possibilities. However, in many cases people don't use the technology even if it's available and able to solve many of their problems. How is that so? In many cases this might be due to a good technology wrapped in a bad design and one of the properties of bad design is, that it makes people feel uncomfortable and stupid.

For instance, look at a video recorder. I've studied technology for three years and I'm still having a hard time whenever I try to record something. In some way this makes me feel stupid and scares me away from recording anything, unless it's very important. Another example is my mobile phone, which is able of sending messages to an email account. The only problem is, that in order to send an email you'll have to send a text message to a three-digit number. I use this service infrequently, which leads me to forgetting this number, and it's not in the manual. This means, that every time I wish to send an email, I'm forced to call a support line. Does this make me feel stupid or comfortable with the technology? It's a good technology, but the design makes it uncomfortable to use, and in this fashion alienates the technology from human wishes and needs. This is the main topic of this essay, which is closely connected with the next essay about usability.

In the first part, the aspect about feeling uneasy with a technology is examined, and in the second part, the focus will be on how to design artefacts, which are easy to learn, and enables playing and experimenting.

Learned helplessness

Donald Norman has used the psychological term "learned helplessness", which describes what happens in situation where people feel uneasy or stupid when dealing with technology¹². Learned helplessness occurs, when people try to use a technology and fails repeatable. If a person tries to use a video recorder, and the video recorder tapes the wrong channel the first time, and maybe nothing at all the second time. The user sometimes gives up and accepts the fact, that the task of recording a program is simply too hard for him. He has learned helplessness towards the given technology. Again, it's not because it's a bad technology to be able to record programs, but a bad design prevents it from being minded towards the needs and values of people.

In our remote control project we interviewed a girl (mid twenties) about how she used remote controls. She had three remote controls in her room: One that controlled the TV, one that

¹² Norman

controlled the VCR, and one that controlled the stereo. During our interview she revealed, that she only used the top half of the buttons on the remote control for the television. When we asked her why she didn't use the remaining two remotes and the bottom part of the first one, she explained, that it was possible they contained some valuable features, but she didn't know which ones, and she was afraid of experimenting because she didn't want to mess up for instance the channel setting on the TV.

However, this is not the way it has to be. Instead of learned helplessness one could talk about learned comfortableness. One possible option for improving comfortableness and overcome the fear of new technology is to improve the usability of the design, which I'll discuss in the next essay. I'll in this essay instead discuss another approach of making technology comfortable for the users, by introducing a virtual playground metaphor.

Virtual Playground

In Donald Schön's book "The reflective practitioner"¹³ he states, that if someone wishes to be competent at a task (in our case competent using a technology) it's not enough to read or hear about how to do it. To be competent one has to try it out in practice. The only problem is, that trying something out in real life might not always be possible, and might have some irreversible consequences, which are unintended as long as it's only practicing and learning.

To solve this problem Schön suggest a place called a reflective practicum, which simulate the real practices, but without the consequences. In a reflective practicum student can experience and learn for instance new technology by trying it out, without having any consequences. The learning will normally be supervised by a coach, who helps the student in his learning tasks.

What I suggest here is a similar mechanism when learning new technology. Instead of assuming that people learn a new design by reading manuals, I suggest incorporating some kind of playing mechanism in the design, based on the ideas from the reflective practicum.

One approach to designing playgrounds into artefacts is by making as many actions as possible reversible. Take the tale from the ancient Greece, where a young warrior is challenged to defeat the minotaur in his maze. To prevent getting lost the young warrior ties a string to the entrance, and as he moves, he unwinds the string. After killing the beast he follows the string back to the entrance and survives. Providing an "undo" or "back" facility in a design provides the same

¹³ Schön

safety string, which always enables the users to get back to safe ground. This mechanism encourages experimentation, because the users always know that they can get back to safe ground, just by following the string (pressing “back” or “undo”).

Another approach is to make a playground version or learning mode of a given design. A very successful appliance is tutorials in computer application. Take for instance the example with computer games. Kids younger than ten can learn and be very skilled in complicated computer games, which sometimes possess more than a hundred different interaction possibilities and complicated relationships between the elements. One of the secrets is the use of tutorials and increasing complexity in missions. By starting at point zero, the games increasingly build up the player’s ability by adding more complexity at each step or iteration. The process is normally guided by a virtual instructor in terms of mission briefings and hints, and combined with the practical exercises the player has to solve this approach very much resembles the reflective practicum suggested by Schön.

The tutorial approach has, together with online help function, proved very successful in many software cases and almost removed the need for manuals (there are however still produced a lot of user frightening software). The question is: Is it possible to translate the playground approach from software to generally based designs.

One possible solution is to simulate the real technology on a computer. An example is the Lego Mindstorms homepage¹⁴. On this page it’s possible to program and simulate a virtual legorobot in the same manner you’ll program it if you owned the product. This is an example of making people comfortable with a technology before it has any consequences, in this case you would have to buy it. In the same manner, one could imagine a simulated mobile phone playground, a simulated washing machine playground etc., where people could learn their technology with the help of an instructor and where mixing red and white clothes doesn’t imply having to wear a pink shirt. With the advance in areas like pervasive computing, one might even imagine these playgrounds being incorporated in the design itself.

Conclusion

In this essay I have examined another important aspect of designing technology for people. It was how a good technology can appear frightening because of a bad design. The area was discussed with the help of the term “learned helplessness”, which means, that a bad design learns the users to

¹⁴ Robot Academy (<http://mindstorms.lego.com/bookmarks/3dsimulator.asp> checked 15-03-01)

be helpless, which makes the users insecure about a given technology. On the other hand, good designed technology, which is easy to use, makes the users comfortable and secure with the technology, and it is this latter situation we wish to achieve, if we want to design technology for people.

Two approaches of making comfortable design were mentioned. The first, which I'll discuss further in the next essay, was to make the design easy to use, and the second one, which I discussed in this essay, was to make the approach and learning phase to a new design as easy and intuitive as possible.

The ability to get back on safe ground was mentioned as being very important for a comfortable design, because whatever the user tries, he will always be able to go back to a safe starting point, where everything works. A common way to do this is by providing the design with as many possibilities for undoing and unwinding.

Learning technology by playing was introduced to suggest an easy way to get people acquainted and comfortable with a new technology. Computer games were mentioned as being successful in facilitating learning by playing. It was suggested that designers in other areas than software, ought to use some of these ideas, for instance by simulating the design on a computer or incorporating a learning facility or mode in the product.

Third Essay

Easy to use

“When you have finally learnt how to drive, you’ll be comfortable driving almost any type of car, and even if you haven’t driven a car for several years you’ll still be able to drive almost any car with ease. Just imagine the same situation with a VCR. Once you learned to program a VCR you’ll be able to program any VCR, even after years of not programming you’ll be able to program any VCR”.

Introduction

A lot of good technologies are developed every year, which really can help people in their everyday lives. However, the access to a given core technology is almost always mediated through a given artefact. When someone uses a technology, like the possibility to send information in a copper wire, it's through the artefact a telephone the technology is presented etc. The technology is always presented wrapped in a concrete design.

Earlier, the main focus was on physicists and engineers developing the new technology, and concerns about how it was presented towards users were not an issue, or merely a question of some aesthetics designers. This is not strange, because much of the developed technology was conceptually easy to understand, mainly because all major parts were visible. However, during the last fifty years these things have changed. With the upcoming of for example miniaturization, it's now possible to produce designs, which leaves absolutely no visible clues about what's going on, or which action that is possible at the given moment.

This has led to a situation, where a lot of people actually wants to get access to a given technology, but the technology's interface is just too complicated, which makes people feel alienated and insecure about the technology (essay two). How many very intelligent engineers do you think know how to use all useful functions of a TV, VCR, stereo, mobile phone, heating system etc? My guess is very few, so the point here is to reframe the problem. Instead of concluding from a failed interaction with a technology that "I'm not smart enough to use this technology", one has to conclude the other way around: "I'm a normal person, and the reason I failed is not because I'm stupid, but because the design is bad and unintuitive".

It's a beginning trend to blame the bad and unintuitive designs, and leading companies have noticed this trend, and hereby found an area where they can gain competitive advances. The increasing demand for usable products (and other aspects described in these essays) has changed the environment of the developing departments. Instead of consisting purely of employees from natural science, it's now compounded of people from many different traditions, for instance from humanities in an interdisciplinary way. Engineers and physicists now have to cooperate with for instance artists, usability specialists, philosophers and psychologists towards the common goal: Producing technology for the people instead of to the people.

I'll in this essay focus on how to design usable artefacts. First, four main principles in designing easy to use interfaces will be discussed with suggestions to the designers. Secondly, these principles will be further discussed grounded in the idea of direct manipulation.

Four usability principles

One of the most famous books about designing for usability is Donald Normans book about "The Design of Everyday Things". I will outline four of Norman's main principles in this section¹⁵.

Conceptual model

The first principle I'll discuss is the importance of providing a good conceptual model. Another way of phrasing it is to make things logical. When using artefacts, people build up a model of how different interactions with a technology are wired to different kinds of sensory output or actions. It's easy to make a conceptual model of how the pedals on a bicycle are connected to the rear wheel by following the chain. It's however not always easy to see how the hidden gear works inside the rear wheel. I once saw a bike with 5 gears and two switches that controlled them. One of the switches had two possible positions and the other one had three. It leaved six possible lever positions, and to me the connection between the state of the switches and the current gear configuration seemed pretty arbitrary. I lacked the conceptual model between the two systems, and as compensation, five small drawings were placed on the handlebars to explain the connection. A general rule is, that if it's necessary to write a meta text to explain how a function works, it's probably not a good design solution.

One way of providing a good conceptual model as a designer, is to build the design on models the users are comfortable with, or by providing metaphors. For instance, the use of menus on mobile phones provides a conceptual model of how functions are structured, based on the menu system many computer users are comfortable with. The computer menus are then again metaphors based on a menu known from for instance a restaurant (this metaphor has however developed as a conceptual model for the computer into a new form¹⁶).

Visible

The second principle is to make things visible. This principle states, that usable design is a design where all possibilities for interaction are visible to the user. One of the typical violations is to make

¹⁵ Norman

the interaction with a given artefact combinatorial. For instance, to set the time on a digital watch, I found that one has to press button 2 two times and then button 1 and 3 at the same time. When setting the time, button 1 added on to the time and button 2 moved on to the next digit. Not easy to remember. Take the telephone system at the university. To activate the automatic answering machine, one has to press # 55. Not easy to remember either. The problem with combinatorial interface is, that the buttons often present hundreds of possible combinations and no clues about which is the right one. Either you remember the combination (in your head or on a piece of paper), or else you're not able to use the technology before you have found the manual.

The main design principle is to avoid combinatorial interfaces and other interfaces where some of the interaction possibilities are hidden. It's however, sometimes necessary to comprise because of production costs, aesthetics etc., but even then, it might be possible to redesign and incorporate some clues about which combinations are possible and their effects.

Feedback

The third principle is to provide feedback. Feedback is a very central aspect of interacting with a technology. Feedbacks are a way of breaking the user's monolog, and turn it into a dialog where the machine uses feedback as a kind of response. Try for instance during a conversation to be quiet - no nodding or agreeing - and watch how the other person gets confused. "Why isn't he saying anything? Does he understand what I'm saying?" etc. It's impossible for the other person to know whether or not you understand him, because he lacks access to your thoughts. It's the same problem with any advanced electronic technologic device. Without a certain degree of feedback, the users are unaware of whether the device has understood his wishes, and of what it expects from him.

Take for instance my multi-device remote control. On the top there is six buttons, which allow me to choose the device I wish to manipulate. If I for instance choose CD, put the remote down, turn off the CD, and instead turn on the turner directly on the device. The next time I try to change station with the remote control, nothing happens no matter how hard I push the buttons. How is that so? The remote control has an internal state saying: "Now I'm manipulating the CD". There is a discrepancy between my wishes, which are to switch station, and the remote control's. This discrepancy is due to lack of feedback.

The advice for the designer is to provide the users with as much feedback as possible, as long as it's relevant for the interaction.

¹⁶ Report on Transparency and remote controls

Mapping

The fourth principle is the need for a good mapping. A good mapping means the existence of an intuitive relationship between the user interface and the correspondent action in the world. An example of a good mapping, is the mapping between the computer mouse and the corresponding cursor. When I move my hand to the right, I move the cursor the same way, and if I move the mouse fast, the cursor moves fast. An example of bad mapping is for instance the previous example with the digital watch with four anonymous looking buttons. There is no clear mapping between button 1 and increasing the time by a unit.

Designing good mapping means placing and choosing the controls of the user interface in a fashion that resembles the logic of the action: Activating a function should be modelled as a push button, setting the state of a given function should be a switch, time can be simulated with a wheel etc. Another example of providing mapping to a design is to place the control in correspondence with the natural physical or logical arrangement of the function. For instance, placing the switch controlling the left lamp to the left, or placing the low temperature program for the washing machine left of the high temperature program.

Just by noticing and considering these four principles in the design process will produce much more user-friendly designs, and eliminate the worst cases of unintuitive interfaces. An area where usability is advancing fast is at the web. On the web people normally travel alone, and they are extremely mobile. This means that badly designed web pages will be left within seconds. I will therefore in the next section look at the term from the computer software usability tradition called direct manipulation, and examine whether this term can be generalized to other areas.

Direct manipulation

In making computer applications, the complexity of an interface can be simplified by letting the interaction happen through a number of steps of direct manipulation on objects¹⁷. By translating known facts from the real world to the virtual world, a lot of the possible interactions are given just by making analogies. One of the best examples is the trashcan metaphor. You can take a document, drag it into the trashcan, you can open the trashcan, you can recover a document from the trashcan, but after you have taken out the trash the document is gone forever, that is exactly as in the real

¹⁷ The term is taken from Ben Schneidermann

world. Using already know practices from the real world or metaphors provides the user with a good conceptual model, which can explain some of the success, the interfaces providing direct manipulation have had (Windows, MacOS), simply because they are intuitively easy to use (compared to other systems).

I have in another paper discussed the process of going from real world objects to virtual interface objects. After a given analogy or metaphor has been provided, the metaphor (or analogy) gets a life on it's own. The metaphor is extended, manipulated, and formed in a way, which weakens the original metaphor. The metaphor for a desktop window establishes a connection with the physical window that transport meanings like: You can close or open a desktop window, or you can look through a given window with borders framing your vision. The metaphor has however, through a life of its own, developed new properties not found corresponding in the real world. It's for instance possible to move a desktop window or resize it, which is not possible with a physical window. Through this process, metaphors and analogies might evolve away from their original representation and find grounding for new representations based on this new form¹⁸.

As in the real world, we do not always manipulate the world directly with our bare hands. We have developed tools that we use to mediate our actions. The same approach has been suggested on software applications¹⁹. A typical example is drawing programs, where tools like a pencil, a brush, a robber etc mediate the interaction when the drawing.

Applying direct manipulation

These topics are mainly directed towards computer applications, and many of these principles have been obeyed in the major software programs because the high complexity of these programs demands easy to use interface, if they are to be used by other people than experts. On the Internet and in technical devices these principles are more often violated. On the Internet, it's my opinion that it's due to a lot of small, inexperienced players, and the Internet's relatively young age. In technical devices, factors like hardware requirement, costs and relatively small screens are important parameters, which at the moment prevent the wide use of direct manipulation on small electronic devices.

I see another important area for direct manipulation in the interaction between different technical devices. A concrete example could for instance be buying a cola from a machine. A solution not supporting these principles would be to read a number of the machine. Sending an

¹⁸ Report on Transparency and remote controls

SMS to the number, with a credit card number, and the number of desired beverage. On the other hand, moving the mobile phone or a kind of electronic wallet over a sensor, in the same way as one would use a credit card, and pressing accept, would be a much more user friendly approach (and probably more expensive too), because it supports direct manipulation. The mobile phone is used as a tool for directly manipulating the object - the cola machine.

Conclusion

With the constant development of more complex technology and increasing density of technological devices in our everyday life, the importance of usable interfaces now plays a more and more essential role in the design of new technology. This fact was the focus of this essay, where I, grounded in the principles from Donald Norman about providing a good conceptual model, keeping things visible, providing feedback and providing a good mapping, suggested different aspects that the designer has to consider.

I suggested the use of metaphors and analogies as a possible way of providing a good conceptual model. Keeping the principle about visibility in mind was pointed out as being important in the interaction with engineers and aesthetics designers and generally avoiding combinatorial interfaces was suggested. Feedback was pointed out as being important for turning steps of action on an artefact into an interaction, and it was suggested to provide the users with as much relevant feedback about the artefacts, wishes, and states for further interaction, as possible. Using logical controls and arranging them according to physical or logical grouping of actions, was suggested as effects that could provide a good mapping.

These principles were further discussed with the notion of direct manipulation in software usability, where it has proven to be an important grounding for most successful application. The dynamics of the represented objects were discussed along with the use of virtual tools in direct manipulation. It was suggested that these principles probably would spread to Internet sites as well, but constraints like hardware, costs and screen space might at the moment prevent the wide spread application in small electronic devices. At last, direct manipulation was mentioned as a principle worth considering when designing for interaction among different electronic devices.

Fourth Essay

Adjust to differences

“When looking at a hologram, people situated on different locations can watch totally different images by looking at the same hologram.

Can the same effect be obtained by looking at for instance a mobile phone?”

Introduction

People are different and possess different values and needs. Providing the same technology to all people in the same shape will provide a perfect fit with some people's values and needs (for instance the designers or the engineers), and a lousy fit with other people's (normally not considered when designing the product). Some techniques for determining the values and needs of the users were mentioned in the first essay. The focus in this essay will therefore instead be on how to develop technologies and interfaces which try to adapt to people's differences.

The problem of when to standardize and when to support mutable adjustments is an old discussion in for instance organizational theories, but it's a rather new discussion in the production of artefacts and software. It's expensive and requires advanced production techniques to produce a lot of personally specialized products, and it has proven to be very difficult to produce software products that actually know its users. Besides, specialized products will prevent different people from using the same technology and prevent cooperation. On the other hand, too standardized products will generally only provide average fits. My main focus in this essay will not be on how to build production systems that produce specialized products.

I will instead in this essay first point out some aspects in which people might differ from each other. Secondly, I'll try to propose two principles, which will encourage mutual adjustments while still providing a degree of standardization.

People are different

I will in this section, based on some axes suggested by Schneidermann²⁰, look at how people might differ from each other, and in the end, connect it to user characters as mentioned in the first essay.

First of all, people have different physical abilities: Some are strong, others weak, some have supple small fingers, and others have big, rough thumbs, some are tall, others small etc. Secondly, people have different cognitive and perceptual abilities, again some are fast and bright, others are unskilled in foreign language, others are good at remembering etc, and all these abilities can then again be affected by factors like fatigue, boredom, drugs etc. Thirdly, people have different personal preferences. Some prefer rational approaches, others value feeling and emotional approaches better etc.

Fourthly, people in different cultures and countries have different backgrounds, which influences their needs and values. There are for instance very different working practices between

²⁰ Schneidermann

Japan and the States etc. Fifthly, some users have different disabilities. Some are deaf, some are blind, others have problems walking, and some uses glasses. For instance, when designing portable head displays it's important to consider persons with glasses, otherwise around one fifth of the population will be unable to use the design. Sixthly, some users are elderly and may therefore lack some of the abilities of younger people, and posses others.

The reason why I just briefly mentioned some of the axis on which people might differ, was to give an impression of how people might be different in many ways. A research project could be to extensively describe the different properties people possess in different countries and at different periods of time in their lives. Even though the list would be incomplete, I would still consider such a list as being a valuable tool for a designer. Each time a designer wishes to design a new artefact, he would be able to run through the list and consider what properties are supported in the artefact. I suggest this process leading to a number of user characters with different properties, to which the designer wishes the product to provide a fairly good match. The designer will then have to further examine these suggested user characters, with the different techniques described in the first essay.

Providing different access

When looking at a hologram, people situated on different locations can watch totally different images by looking at same hologram. I'll in this section try to point out the value of incorporating redundant paths in an artefact, and how this simple principle can help in the design of an artefact that supports differences in the users, to obtain a similar effect as with the hologram. Some people see one side of the technology and others will see a totally different shape.

One way of obtaining this effect is by making redundancy in the design. This means, that instead of having just one way of for instance accessing a function, several paths should be available. For instance, if I want to copy a piece of text in a text editor, several approaches are available: I can mark the text and find the command in the menus, or mark it and click on the tool bar, or mark it and press the right mouse button, or pressing a short cut on the keyboard. All four paths access the same function, so why make four different approaches? One of the reasons is that it supports different users' needs. A newcomer will probably find the function in the menu, an intermediate user will probably prefer the icon in the tool bar because it's faster, and the expert will then again prefer the short cut because it's the fastest way and allows him to keep his hands on the

keyboard. In this way, different users will see the program in different ways, and the program will support, in this case, the user's experience level.

An observed connection is that the different paths form a kind of hierarchic pyramid, where the easiest path to follow are the longest and safest one, and the shortest is a path which requires training and memory to follow. Another property is that it's always possible to alter among the paths, which enables a novice to advance, and helps an expert who has forgotten his short cuts.

But not only in the designing of access paths can this principle be used, it can also be used in providing feedback or information to the users. Skilled users will only need a single clue, for instance a blinking lamp, to know the source of a problem, where as unskilled users will need more information. Being able to provide the users with information on a suitable information depth or level will also help customizing a product to different users.

Not only in designing for novice and expert users can the principle about redundancy be used, it can also be used to support many other differences. For instance, a remote control can help the user operate his device at a distance, but most devices also allows the user to turn off the devices directly in case the remote control is lost, flat on battery etc. A vibrator on a mobile phone allows the user to get different kinds of feedback when the telephone rings, he can choose the mode according to the different contexts he moves in. The point is, that providing redundancy allows people to see a different artefact depending on their personal differences, which might support individual differences and help closing the gap between technology and people.

Dynamical interfaces

Even though redundancy might narrow the gap between technology and people, I still see some problems in the static approach. For instance, take the previous example of copying in a text editor. Suppose the novice users keep taking the long way through the menu, time over and over again. How are the users supposed to learn about the shorter paths, which will ease the users' work? To further illuminate the problem, I'll draw an analogy with shoes. The previous approach about redundancy can be seen as providing different shoes sizes instead of a fixed ones. This will greatly support different sizes of feet, but still a new shoe does not fit perfectly until it has been worn for some time and has adapted exactly to the foot. Can this effect be obtained in the design of technology?

My answer would be yes, but it's not going to be easy. As I see it, the process is combined in two steps. The first is to make the technology identify the user, and the second is to get

information about the identified user, which will allow you to dynamically customize your interface.

Until recently the technology had no clues at all about, which users actually used it. It provided the same possibilities to all users, because it simply didn't know better. With the Internet, a lot of customized services have evolved, where the user reveals himself by typing a password, and then the given site provides different information depending on the user.

This is the approach I'm suggesting, but I still see two problems with the approach on the Internet. First of all, the identifying process where the users type a password is way too cumbersome. As mentioned in essay three, this kind of user name/password is an example of a combinatorial interface, and even though it might be necessary in some places due to security, people tend to forget these combinations. Especially when you have to remember one combination for each site with different user name and password, and with a lot of restrictions on your passwords (need to have 8 characters, minimum 2 digit, need to be changed every month, may not be something connected to the rest of your life like your birthday etc). What happens is, that people forget their passwords and are forced to spend a lot of time getting access or just moves on to another service. A solution might be a kind of standardized solution or locally stored information. The other problem as I see it, is the secrecy about the registered information. What I want from an intelligent computer or Internet agent is a helping companion – not a spy. The registered or collected information about my person should be viewable and modifiable at all time, and I wish to be able to refuse registration at any given time.

Identifying the users is a necessary step in dynamically customizing technology. It can be obtained by providing some kind of clues (password, electronic card, fingerprint etc), but it has to be done easier than on the Internet. With other devices, like for instance a remote control, typing a password would be awkward, and an identifying mechanism based on the user's behaviour might be enough and more suitable.

After the user has been identified, the second process is to analyse the user's behaviour and try dynamically to support him in a cooperative way. This is an area where especially research in artificial intelligence would be important. For instance, repeatable use of a long access path would trigger a behaviour, which asked the user if it was okay, that the computer placed a short cut to that specific function, or another example would be a TV, which noticed a bad relationship between colour, brightness and contrast and asked the user if the TV might launch a tutorial on how

to adjust the settings. I see more of these things coming in the future, but it's a subtle matter. Too much interference from a given device at the wrong time can be very annoying.

Conclusion

People are different and providing the technology in one form will only match a fraction of the users and possibly only an average match. What I have analysed is not how to produce a lot of different products for different people, but how to make flexible products that support different people.

In the first part, I looked at some of the areas where people differ. I suggested a design tool consisting of a list of areas in which people might differ. A list the designer could use, when considering which people the design should support and to what degree. I suggested the designer to make user characters based on these considerations, which is further described in the first essay.

Secondly, I pointed out the importance of providing redundant paths in the design of an artefact, and showed how it could be used in, for instance, supporting different levels of experience of the user and different contexts. I extended this discussion further by introducing the term of dynamical interfaces. Dynamical interfaces were shown to greatly support the fit between a given artefact and the users, but new identifying technology have to be developed, and research in artificial intelligence would have to be applied in this area. Some of the points stated were, that the identifying process should be extremely user friendly, the information gathered should be accessible and easy modifiable, and finally, the interruptions from the artefact should be subtle, adjusted to prevent irritating the user.

Producing specialised products, allowing different possible accesses and being able to dynamically adjust to the users, will, as I see it, in the future greatly minimize the gap between technology and the human users, but it's still only one dimension in the fit, and the other aspects discussed in the other essays have to be considered as well.

Fifth Essay

Support individual and social practises

“The best place to get updated news, is in the line in front of the coffee machine”

Introduction

I once talked with a consultant working on a project at a textile factory. The factory wanted a system that controlled their inventory. The first approach was to place a computer terminal in the store building, and each time an employee removed something from the store, he had to update it on the computer. The consultant, however, noticed by observations and interviews that many of the employees working at the store had very little education and some were illiterate. She judged that the first approach about a central computer would lead to great trouble and distortion in the working practises. Instead, a system was implemented in which each employee had a portable bar code reader. When removing something from the store, the employees simply had to use their bar code reader on a bar code at the shelf, and the computer would do the rest of the calculation.

This is an example that illustrates supporting individual working practices, where the use of the first approach would have proved a maybe catastrophically fit. This also shows aspects discussed in the first and forth essay about designing for different people and their needs.

I will in this essay first examine different aspects in designing technology which supports a given work situation. The term about to what degree an artefact has to be transparent will be discussed, and following will augmentation and virtual reality, two future approaches for technological devices, be discussed. In the second part, the focus will not be as much on how technology supports individual working practices, but instead on how technology affects and changes the social practices, and which consequences this aspect has on the design of technology.

Transparency

According to a theory call the activity theory all human activity is hierarchically structured. At the top level are activities, which are undertaken in order to fulfil a motive. To fulfil the motive is on the second level a number of actions, which have to be fulfilled in order to perform the given activities. A given action is then again composed by a number of unconscious operations. For instance an activity could be to relax by watching TV, the actions would then be to grab the remote control, turn on the TV, find a good channel, and the corresponding operations would be to look with your eyes for the remote control, moving your arm towards it, grapping it with your fingers etc. Another important statement in the activity theory is the point that mediating tools play an important role in achieving motives²¹.

²¹ Kaptelilnin and Nardi

These points from the activity theory can help us in analysing new technology. The main point is to analyse the motive of the users when using a given technology. Is the technological artefact the goal the activity is directed towards, or is it a tool, which helps and mediates the users actions towards another object. If the artefact is used as a tool, I suggest as much transparency in the interaction with the tool.

With transparency I mean that the tool should be able to be manipulated, without the focus being removed from the object in focus. The focus is on the nail not on the hammer when a carpenter is working, and the focus is on the ball, not the racket when a tennis player is playing. The tool seems to become an invisible extension of the users physical or cognitive abilities. The same effect should be obtained when designing other mediating technical tools.

Transparent artefacts can be designed in many ways, but the following rules are central. First of all, the interaction with the tool should not rely on visual feedback. It's only the focus object, which is allowed to give visual feedback. The visual feedback should for instance in the situation with remote controls not be given on the remote control, but on the device it's controlling. Giving visual clues on the remote control will force the user to a repeatable change in focus between the mediating tool and the focus object, and lead to an unsupportive interaction. Secondly, the tool should provide as much guidance and feedback as possible using non-visual feedback techniques. With non-visual I mean feedback techniques minded at the hearing or feeling sense. Buttons, wheels, and fixed positioned switches are good examples. Take for example the buttons on a remote control. Well placed, these buttons are able to guide the user's hand and at the same time providing a good feedback when they are pressed. This is a reason why I believe digital remote controls have had little success. They lack the physical feedback and rely on visual interaction techniques²².

The last example I'll mention is the voice controlled call technique, which is provided in some normal and mobile phones. The mobile phone has a special status, because in some situations it will act as the focus object (for example when playing games), but in the situation with placing a call it takes the role as a tool. By using voice controlled call, the user is not forced to focus on the tool, but can instead focus at the activity calling someone. Again, the feedback from the phone is a steady ringing tone instead of some visual clues.

The main design principle is to provide as much non-visual feedback from the device when designing tools, and letting the focus object be the only one allowed visual feedback.

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Augmented reality

I will in this section discuss two different roads the technology of the future might take, which will support working practices in different ways. The first one is augmentation and the second is the idea about virtual reality, and the chosen approach will greatly influence the way technology is shaped in the future. Which one to choose is a highly philosophical question, which I will only sparsely discuss. Instead, my main focus will be on looking at some of the properties of the two approaches.

Augmented reality is a technique, which main philosophy is, that people live in the real world consisting of physical objects (a new term which covers some of the same aspects as pervasive computing). The role of the technology in the future with this approach, is to augment the function of the physical objects. At an introduction course to this area, I briefly worked with the idea about how to design a calendar, not based on small portable palms, but on an old fashion spiral time manager. It should look like a normal time manager and have pages, the only difference were that they should be digital instead of regular pages of paper (not invented yet in a commercial forms, but that's not the issue). The user could use his time manager as normally, but it was augmented with functions like synchronizing and searching.

Another example of augmented reality is from a research project conducted at a French airport. The purpose was to augment the flight strips used in the control room at the airport. Extensive studies showed, that the controllers liked the flight strips: They were reliable and gave a physical feeling about each plane. Therefore the controllers mistrusted total digitalizing of the flight strips. Instead, an augmented path was suggested where the flight strip was kept, but a chip was incorporated that cooperated with a computer²³.

These are examples on how to augment the physical world. The advantage is, that augmented artefacts are easy to use, because the users already know how to use the not augmented artefact. At the same time augmented objects can use the information already available in the world. When augmenting the world, it's only necessary to provide the augmentation layer and not necessary to simulate the rest of the world. The only problem is, that augmented artefacts are constrained by the physical laws, which constrains all other physical things.

²³ Mackay and Médini

Virtual reality

The main philosophy in virtual reality is, that the world we will be interacting with is a simulated version of reality with some extra properties. These extra properties are, that no physical laws exist in a virtual reality, which are the main advantages. There are not the same masses, distances, time properties etc. as in the physical world. It's worth noticing, that I'll use the term virtual reality on everything that's going on inside a computer, and I'll define the degree of virtual reality feeling to be how real an experience of the translation from the digital to the real world are.

There are a lot of examples of virtual reality systems according to the current definition: Net banking, Internet shops, virtual communities and virtual reality games (for instance everquest and Ultima Online). All still with a relatively small degree of reality feeling, but still providing a virtual copy of for instance a bank.

I'll not pursue the idea of augmented or virtual reality further, but suggest that designers consider to what degree, existing artefacts can be augmented with new technology to prevent dramatic changes in the individuals working practices. When a given technology needs to violate physical constraints like distance, a virtual reality approach would be suitable and even a combination might be possible. The question is however, a very philosophical question, which I'm not going to try to answer. Are we going to live our life in the future in virtual reality, or will we be living in a physical, but augmented reality?

Information ecologies

In this last section I'll examine the social impact on new technology in a given practise. I'll be grounding my argumentation in the term Information Ecologies²⁴. An information ecology is a relatively closed system evolved around a given work situation, and it's, like an ecological system in nature, a balanced adaptive system, and like a real ecology, a healthy information ecology may contain redundancy, key species and a rich diversity.

This idea can be used when analysing the impact new technology might have on social systems. This leads to two spontaneity reactions by the system. The system and the technology can either adapt to each other and the system may be enriched, or the technology can destroy some healthy mechanism, be repelled by the system, or change the system in an unintended way. To know which effect the technology may have on a system requires a good idea about different properties in the system (can be obtained by observation, interviews and working in the given place

²⁴ Nardi and O'Day

for a while) and experiences with the social impact on technology. Take for instance the example with a company that introduces email as the main communication. Previously, the employees had to collect their messages at a central place, which evolved to be a meeting place where people talked and got updated about projects initiated by the colleagues. With email, this meeting place died out and the internal communication lacked. This is just to show some side effects the introduction of new technology might have.

Another example is virtual meetings. Communication normally consists of digital communication, which is what we actually say, and analogue communication, which is how we react when we are communicating. The main point is, that digital communication only is half the part of the conversation and even though net meetings might reduce costs, they greatly reduce the details of the conversation. For instance, the small talk in breaks, the eager with which a colleague states a proposal, and how another colleague reacts very sceptical towards a new idea.

The proposal for the designer is to pay attention to the information ecology for which the design is minded, and examine the bias the new technology might have on this ecology. Another proposal would be to encourage social interaction either within the technology or coexisting along with the technology.

Conclusion

Supporting individual and social working practices can be an important factor in determining to what degree a new technology will fit the needs of people. First, technology which main principle it was to act as mediating tool in an interaction was discussed, and it was suggested that the designer provided as much non-visual feedback at the device, and kept the visual feedback at the focus object to prevent changing focus.

Augmentation and virtual reality were mentioned as two further directions for technology, and it was examined how each of these two technologies supported different working practices. A philosophical question concerning the future role of technology was also mentioned.

In the last part, I looked at how the introduction of new technology influences the social practices. The metaphor information ecology was used to point out the important connection that exists between people, and between people and technology, and how changing or adding new technology might disturb the balance in either a positive or negative way. The designer was asked to consider which biases the introduction of new technology might have on a given ecology, and how these biases could be compensated for when designing new technology.

I discussed the technological impact on social systems, because using technology is not only a matter of the interaction between technology and a person, but the technology is going to be used in a world consisting of social practices and not only individual. I therefore see the importance in bringing the social dimension into the design process when designing for people.

Sixth Essay

An Example: The flexible remote control

“Is it possible to make a remote control based on human values?”

Introduction

There is a gap between just talking about some principles and giving good advices, and then using these principles in a concrete project. I participated together with two other students in a learning project, in the fall of 2000²⁵, which main purpose it was to design technology



for people. The idea behind the project was to find another way to design a remote control based on user involvement, but without technical restrictions. I'll in this last essay discuss how we did use or didn't use some of the principles I have outlined in the other five essays.

A need for technology

Even though we had some experience with remote controls, we were somehow blinded by our own focus on technology and wanted to design a remote control, which would be based on other peoples needs. We therefore identified different user characters, which we would consider during the design process, and those values, and needs we would try to match as well as possible. We chose four characters.

- The young son in the family, who is very confident with technology.
- The young girl, who dislikes technology and only uses it when necessary
- The elderly woman, with some disabilities
- The grown up man, who normally is responsible for configuring the technology, but besides that haven't any given interest in technology.



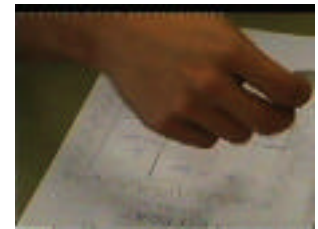
We videotaped some of the user characters at their home using remote controls and followed up by interviewing them. We would have liked to have observed and interviewed all the user characters, and several different in each category, but in real life, time schedules forced us to limit our initial investigations. Some of the main points we observed was, that our users in many cases had two or three remote controls, which easily got lost, and the great number annoyed the users. We also observed that people had confidence in the use of the most common function (like zapping on the TV), but a large part of the buttons were never used and their functions were a mystery to the users.

²⁵ Report on flexible remote controls.

We looked at interaction styles and the history of the remote control and traced its root to radio controlled motorboats during the First World War. One trend we observed was the direction towards more user specific and customized products. Combining the observations of our user characters and interaction styles, we were able to draw a picture of some of the important aspects about what was working and what didn't prove a good fit in the use of remote controls.



We following used a large amount of user centred design in our remote control project. An example was a design game called feature function puzzle. The purpose of the game was to force the users to choose among different features the coming remote control might have. Each feature was represented by a rectangular piece, where the space consuming or expensive features were represented on large pieces and small or inexpensive features were places on the small pieces. The goal of the game was to place the feature pieces in an area around half the size of the total area occupied by the pieces. This game forced the users to choose which features they found most important, and indirectly considering cost. If they chose expensive features, they could only have a couple, in contrast to choosing inexpensive features. The game was repeated, but the second time the game area was only fourth the size of the total area.



We ended up with a design idea about creating a remote control, where the buttons should be mobile, and the users should be able to remove and add new buttons when needed. A locking mechanism will prevent unintended modifying of the remote control. On the picture to the left is our first attempt to build a mock up. We tested our design in two usability tests and ended up with a possible suggestion for a new future kind of remote control. However, to determine if the design idea had a real success would have required advanced technology and better possibilities for prototyping, which we didn't have at our disposal.

We therefore didn't consider the possible displacement the release of the product could bring, because we didn't go that far in the design process.



Confidence in the technology

We tried to build a technology with which people would be confident because they had designed the product themselves. We ran into trouble producing a good prototype, which allowed the users to design their personal remote control and move the buttons while still keeping it relatively robust.

We tried to compromise this by making a virtual simulation of the remote control, where the users were able to design their personal remote control. We then made a physical remote control based on the user's design, which we tested in the user's home environment.



The digital part of the prototype inspired the idea about a virtual play ground, as introduced in the second essay. In this design playground, the users were able to drag buttons from the bottom of the screen to the remote control. When the remote control had been designed, the user was able to try it out in the virtual living room by using it to manipulate the TV, the CD, and the VCR.

This provided an area where the users could play with different ideas and turned out to be an excellent way to communicate our design to third party people.

Easy to use

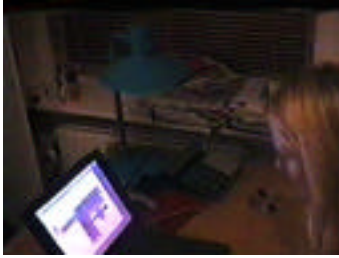
We tried to make our design as easy to use as possible. One of our design ideas were, that if the user designed his remote control by himself, it would be easy to use, because the user himself had chosen the given conceptual model and mapping. To further support this, we gave each button a logical initial function but allowed the user to override this function to provide his personal



mapping. We also tried to make non-standardized symbols to see when the user found these symbols to provide a better mapping. We supported direct

manipulation to some degree, because the user was able to directly move the button to the desired location and didn't have to specify some coordinates etc.

One of our main problems in the design process was, whether the user was able to design his personal remote control at all, or if he actually preferred an experienced designer's work. We didn't have time or resources to investigate this problem in depth, but came to the temporary conclusion, that many people actually would be able to design their own remote control if it was relatively easy.



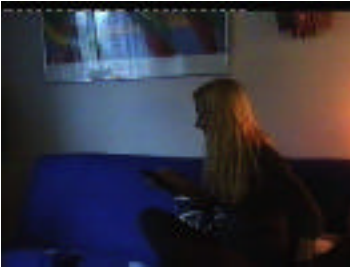
Adjust to differences

We imagined the product would be customized to different persons needs by allowing them to alter the expression of the device. Based on the user characters, we, however, did build in the possibility for expert users to modify the mapping between a given button and the corresponding function. In the same fashion, we provided large and simple buttons minded at our elder user characters with a bad vision and eye - hand coordination problems. We didn't discuss the possibility for dynamical interfaces, because the whole idea is new, and because we lacked an appropriate way of providing the feedback from the interface.



Support individual and social practices

One of our main observations was, how the remote control almost always was being used as a tool. The focus was almost always at the controlled device, and only on the remote control when we asked the user to use a button that was unfamiliar. We used two analytical terms to analyse the degree of transparency. Lean backward was when the user was comfortable with the technology and leaned backward while focusing on the controlling device. Lean forward was on the contrary when the user was unfamiliar with the project, and leaned forward while changing focus constantly from the controlled device to the remote control.



Because we wanted to support transparency and provide the users with non-visual feedback techniques, we insisted on keeping the physical buttons instead of making the remote control a touch sensitive LCD display or similar, which depends on visual interaction techniques to identify the different buttons.

When we looked at the social practices and information ecology, we ran into the problem about how different users would respond to a highly customized remote control. For example when the mother, father, and the kids have to agree on the same design, or when visitors are going to use the remote control. We considered providing each of the members in the family with their own customized remote control, but found this approach to be overkill, and an approach that lead to other kinds of problems. We concluded that it would be possible for a family to agree in

one design, and found that situations in which a visitor uses the remote control were so rare that this incident wouldn't affect the eventual success of our design idea.

Conclusion

The purpose of this last essay was to provide an example of how to apply some of the techniques described in the other five essays. The project was a training project in designing for human values,



and I doubt seeing any flexible remote controls with these properties within the first coming years (this is also due to technological problems, which we didn't consider in the project). However, important conclusions were drawn from the project, which as I see it supports the points proposed in the first five essays.

Conclusion

Providing the fit

I have not specified a specific piece of technology, and even though the flexible remote control example in essay six might be seen as a proposal for a new information technology, this is not the main purpose of the paper either. I have instead reframed the question about which human values and needs should form the basis of new information technology, into, how can designers design technology, which provides as good as possible fits with the coming human users. I have made this reframing because I do not believe that a specific human value or a specific human need can generally be identified. Instead I believe that the central aspect in designing technology for people, instead of just designing technology, is to provide a good fit between the designed form of the technology and the coming users.

I have in the first five essays discussed this fit based on different themes, which I have found important in the design of technology for people. I have discussed how to determine if there exists a need for technology in the first essay. In the second essay, I examined how to make the user confident in using technology, and in the third essay, I looked at how to make designs easy to use. In the fourth essay, the focus was on how to adjust to differences, and in the fifth essay, the main focus was how to support individual and social practices. I found that these five essays and the examples in the sixth essay cover many of the most important aspects in providing a good fit between human and technology. I have with these essays tried to give the designers of the future technology an extensive overview of the variety of aspects the designer has to consider and be skilled in, when designing for human beings, and I have tried to give my concrete suggestions on how this can be done. The conclusions on each aspect can be read in the conclusive section at the end of each essay.

I have tried to ground my discussion in each chapter in well-founded theory from interdisciplinary areas like the humanity, social science, natural science, and psychology, and own experiences. I have chosen this approach to give my statement validity instead of just dreaming and guessing. Further the references will also serve to provide a deeper knowledge about the different areas. I have, when presenting this paper, had to choose between providing a detailed discussion of a narrow technique or providing this broad picture. I found it most important to give a broad overview of the area, and used the different references to provide the depth, and I hope the collection, discussion, and suggestions will help future designers in their mission to design technology for people. Finally, I have chosen theories from many different disciplines, because I see the future designers to come from both technical, social and humanity traditions.

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