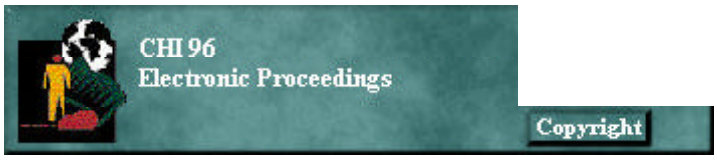

Interaction design and human factors support in the development of a personal communicator for children

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ABSTRACT

Today's computer games for children are primarily focused on boys. Two years ago Philips started the development of a new 'personal communication' product that addresses the needs of young children and especially the needs of young girls. This article is focused on the interaction design and human factors support provided throughout the development of this product. It illustrates the involvement of the interaction design discipline, ranging from the initial generation and visualization of interface ideas to the final transfer to the software engineering team of detailed user interface specifications. The article also describes how human factors support ensured that potential users were involved on continuously in the design process, as well as how this involvement influenced the development of the final product. The article concludes with a discussion of the lessons learned in designing products for children.

Keywords

Children, communicator, user interface, interaction, design, development process, qualitative research, methods and techniques.

INTRODUCTION

Market studies indicated that within the electronic games industry, there is a potentially uncovered market niche for feminine-based functionality, especially in the teenage range. It appears that the video games of today do not attract girls, because of the nature of the games; where boys are focused on rules and winning, girls will use rules creatively or change them.

By focusing on this very particular target group, it was possible to develop new directions. However, we feel that the characteristics of the final product will address a much larger audience, including boys.

Philips Corporate Design contributed in all phases of the project with a multi-disciplinary team covering product design, interaction design, human factors support and graphic communication design.

PRODUCT DESCRIPTION

The product consists of a small handheld device that features a touch-sensitive liquid crystal display, pen input, infrared communication, and audio output (Figure 1). It has built-in software as well as external software available on separate cards. The functionality and interface of the product focuses on fun, creative, communicative, personal, and magical applications.

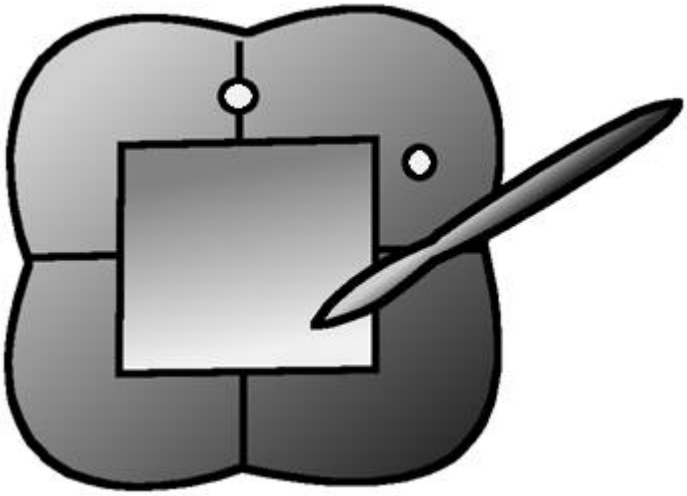


Figure 1: the communicator with pen

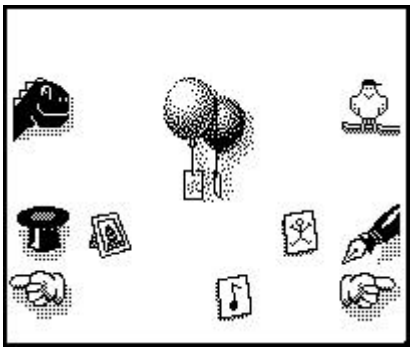


Figure 2: the product display showing the 'world '. The world allows for navigation, access to specific applications, basic functions, and storage (footnote 1)

Interaction between child and product primarily takes place through pen and display. The interface uses the metaphor of a 'living world' in which the user can freely move around (Figure 2).

The user can enter all kinds of 'applications' such as a weekly calendar/alarm clock, a photo album, a fortune teller, a communicator, as well as many others (Figure 3).

The user can use her product to create letters, tunes and drawings that can be stored within the product, onto cards or be sent by infra-red to another product.

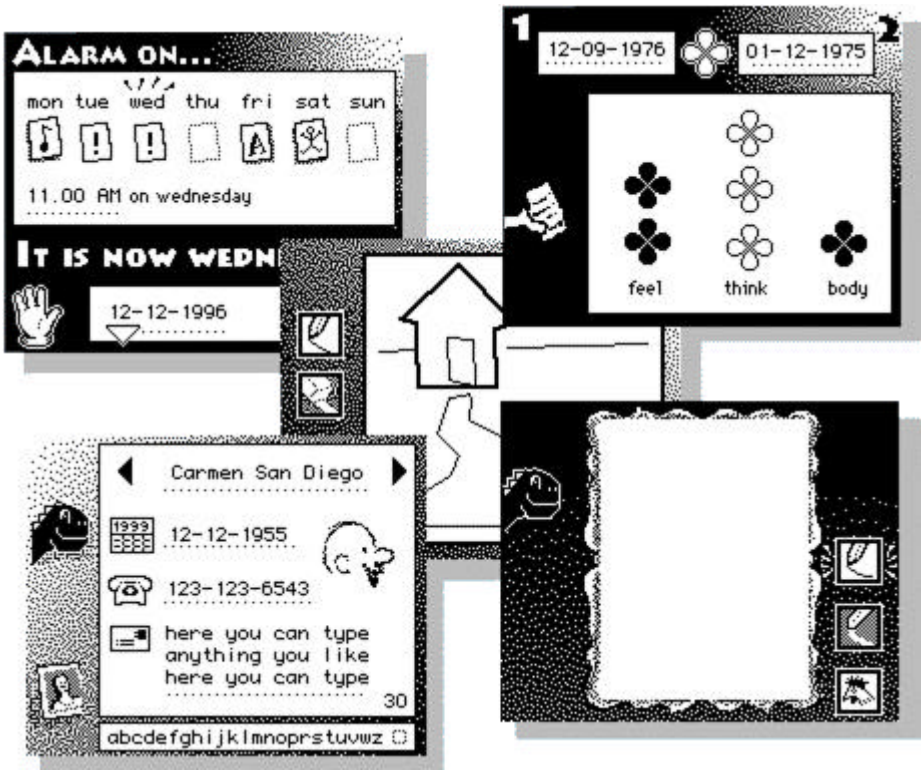


Figure 3: Some of the built-in applications: weekly alarm, matchmaker, communicator, photo album, and painter.

DEVELOPING THE PRODUCT

The following phases are used as a framework for describing the product development process: *initiation, concept creation, specification, and finalisation.*

INITIATION

The goal of the initiation phase was to translate an idea into a sensible combination of market opportunity, feasible technology and design direction determined by the target user needs; in other words 'the opportunity definition'.

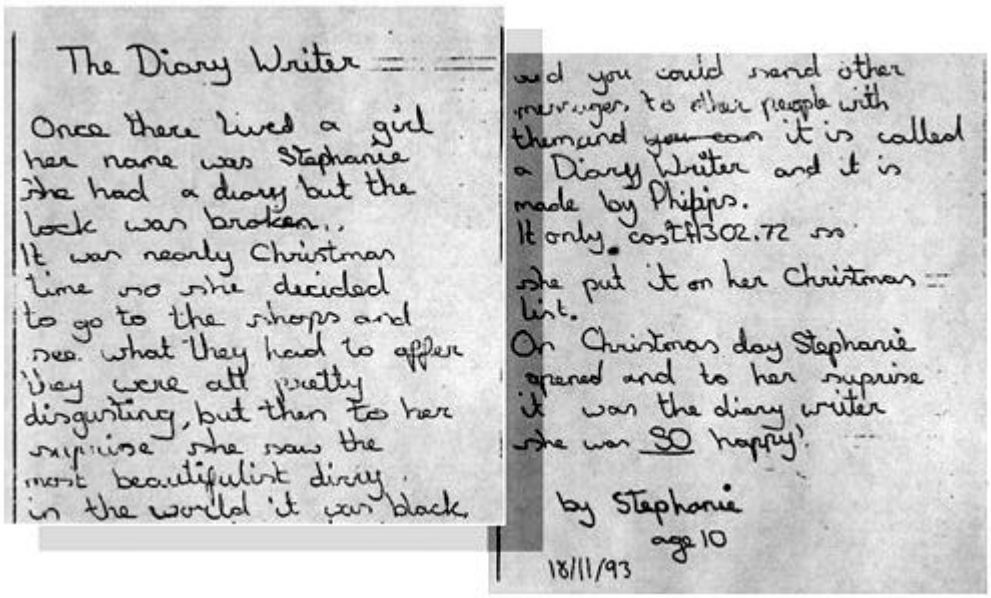
The project started within 'Philips New Business Creation', a structure within the Philips organization dedicated to fast exploration of the viability of new product ideas. The idea in this case being a 'communicator for young girls'.

Co-design at an international primary school The goals of the first co-design workshop held at an international primary school, were to get insight into the personal and social aspects of a 7 - 12 year old girl's daily life, and to obtain design directions by actively involving the youngsters in participatory design sessions.

Representatives of the whole design team were present at the sessions.

Children were visited at school where there is a familiar environment of peer interaction. We invited groups of 8 to 12 children at one time to avoid discomfort they would experience if interviewed alone. Group discussions were held, round-robin questionnaires were used and children were asked to make sketches of their 'ideal' product. During these sessions we gradually focused and revealed the intent of the product idea.

In order to obtain information about the actual setting in which the product would be used the children were also given photo cameras and asked to take pictures of, for example, computers they use, diaries they have, their room, etc. Furthermore, one group of children was asked to write a story in which the product would play a role (Figure 4).


The Diary Writer

Once there lived a girl her name was Stephanie She had a diary but the lock was broken.. It was nearly Christmas time so she decided to go to the shops and see what they had to offer they were all pretty disgusting, but then to her surprise she saw the most beautifulest diary in the world it was black.

and you could send other messages to other people with them and you can it is called a Diary Writer and it is made by Philips. It only cost £302.72 pp

She put it on her Christmas list.

On Christmas day Stephanie opened and to her suprise it was the diary writer she was SO happy!

by Stephanie age 10

18/11/93

Figure 4: Example of child's story

Results of the Co-Design Workshop.
Results of the workshop indicated that communication, the pen based interface and the multi-functionality were appreciated. The majority of youngsters was very positive about the concept.

Important differences were identified between boys and girls, both with respect to the games they are interested in and in the functionality of the device. Boys were interested in a device with a broader range of functionality, while girls were more interested in communication. Girls liked other type of games (e.g. Marioland[a]) than boys and mentioned frequently that they did not like fighting games.

Personalisation was also found to be important. Youngsters mentioned for example, that they would like the product to warn them about an incoming message differently, dependent on the circumstance one is in. For instance one girl mentioned that the product should 'cough' when a message was received so that the teacher would not notice that she was using her product.

Evaluation of First Set of Product Models

A second session at the same school provided feedback on the first set of product models (Figure 5).

The children were asked what they thought about several aspects of the models such as the colour, the shape, the styles, robustness, etc. Group discussion took place at the end of each session to assess and evaluate the details of the models.

Results of the Evaluation of the Models.
Results of the evaluation indicated that children liked the possibility to protect the screen when carrying the product. Different bags and cases for carrying the product should be provided. The stylus should be stored within the device to avoid loosing it. The pen should not be stored in the bottom of the device because that created the impression that it can fall out.

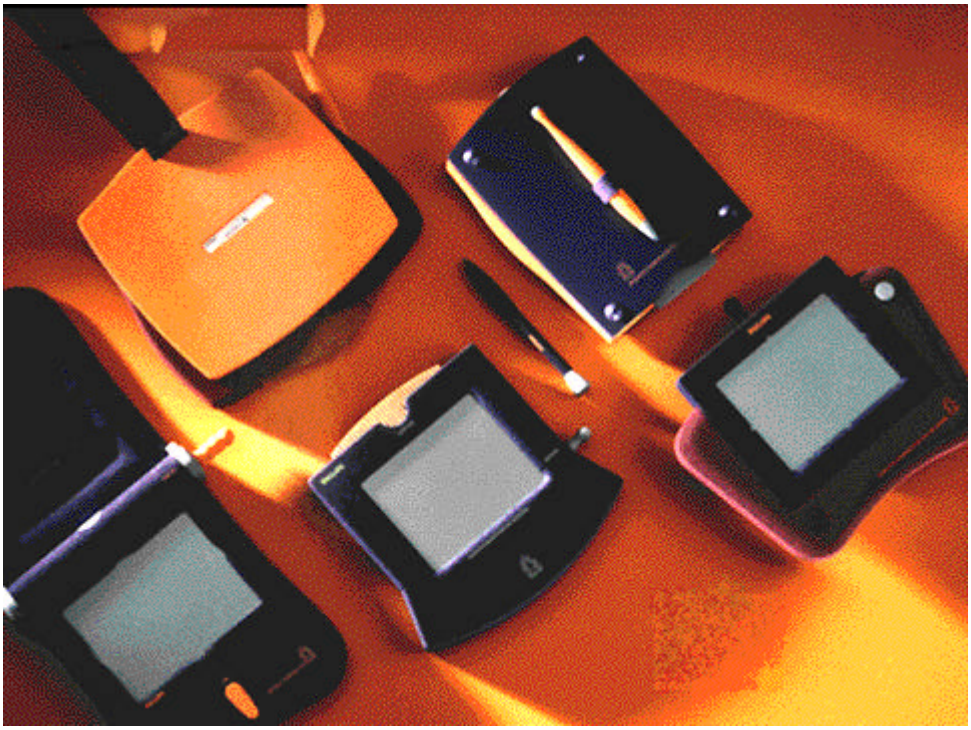


Figure 5: Set of product models

The children perceived the product as a personal product that should not be easily to access by others without their permission. The hardware should reflect therefor privacy and security.

The most negative aspect of the models was the colour. Most children suggested that the product should be dark just like their parents' hi-fi equipment. We interpreted and translated this finding as: the product is relatively expensive and therefore should communicate sophistication and quality which associated with the dark colours of hi-fi equipment.

Although the children were evaluating foam models that did not incorporate any functionality, they were capable of assessing a lot of aspects of the product directly related to the usability of the device. The participation of designers in the sessions showed clear benefits. The designers and human factors specialists could discuss the reasoning behind the concepts. An advantage hereby was that the designers got the opportunity to explain why they made certain decisions to which the participants could then respond.

The first user interface sketch

The first user involvement sessions provided not only feedback on models but also input for a first 'dynamic sketch' illustrating a possible user interface (Figure 6).

Using an animation tool, issues such as navigational metaphor, consequences of a pen-based dialogue, types of applications, and visual style were explored.

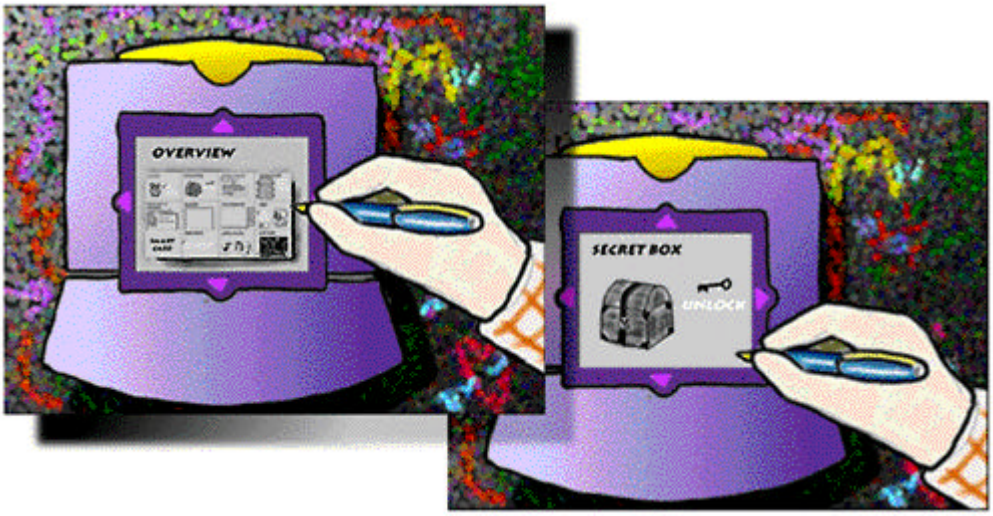


Figure 6: Some shots from the first visualization of the product idea using a computer animation tool.

CONCEPT CREATION

The goal of the concept creation phase was to come towards the definition of a clear concept with regard to the product design and user interface.

Children's Workshop on Product Metaphor

As input for this phase, workshops on product metaphors were conducted to provide input for possible interface concepts.

At this time it became clear that the product had to have a distinct set of values - in product as well as interface design. Those values were:

- to support communication by stimulating social interaction between children.
- to evoke creativity - instead of achieving 'hi-scores', the product had to stimulate the children's fantasy.
- to be alive - unexpected fun things should happen, surprising and pleasurable to the user that give the product more character.
- intimacy - the product is a personal asset, containing personal information.

Based on these values the design team created five different metaphors. Each metaphor was represented by a story (Figure 7). The girls were asked to 'translate' the metaphor into a collage, using a combination of drawings, essays and existing pictures.

The goal of the workshop was to get insight into how the girls appreciated the different metaphors, using collage techniques to visualize their ideas about the different metaphors.

Figure 7: Illustration explaining one of the metaphors: the wizard.

Results of the metaphor workshop.
Results indicated that girls preferred to have an interface and functionality where they were able to create, communicate and organize personal 'things'. The creativity of the girls showed different levels of abstraction, that made it impossible to compare the collages and therefor the metaphors with each other. The fact that the girls became so creative was a general positive feedback on the metaphors.

Designers' Workshop On Product Metaphor

The children's workshop was followed by another session with interaction designers in order to explore concepts of interaction and functionality (Figure 8).


Figure 8: Designers' workshop

Scenarios were used to describe the children's environment and the context of use of the product. This resulted in first sketches for the interface.

Interaction Prototyping

With the use of computer-based prototyping tools, a number of ideas from the workshop were illustrated dynamically (Figure 9) and an initial document was written that defined the product's

interface and functionality.

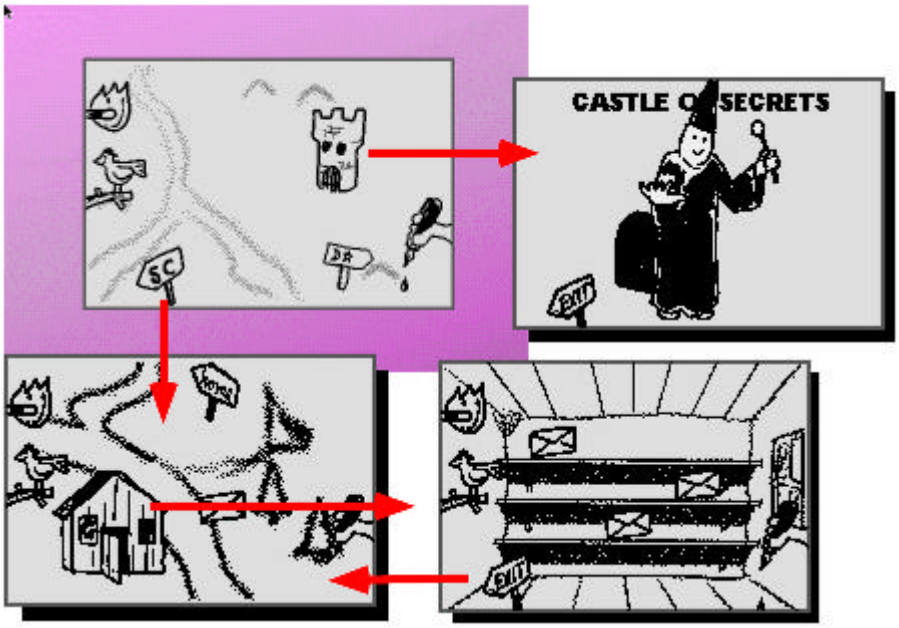


Figure 9: Illustrations from the first dynamic visualizations

SPECIFICATION

The goal of the specification phase was to produce a first draft of functional and user interface specifications agreed upon by the team, and to focus on one or two concepts for hardware design.

Display Workshop

A study was performed to investigate requirements for the size and resolution of the display. The children should be able to write or type messages on the touch screen using a pen.

We wanted to find an optimum between writability and portability, taking into account left & right handed writers and the motor & cognitive skills of children.

Foam models and Apple Newtons[a] were used for this study. The foam models (Figure 10) were used to simulate different display formats, get feedback on how children would handle the product, and to test the writability of the product while users were standing. The validity of using the foam models to investigate children's writing behaviour was tested by comparing the children's writing capabilities while using the foam models and while using an Apple Newton[a] (Figure 11).

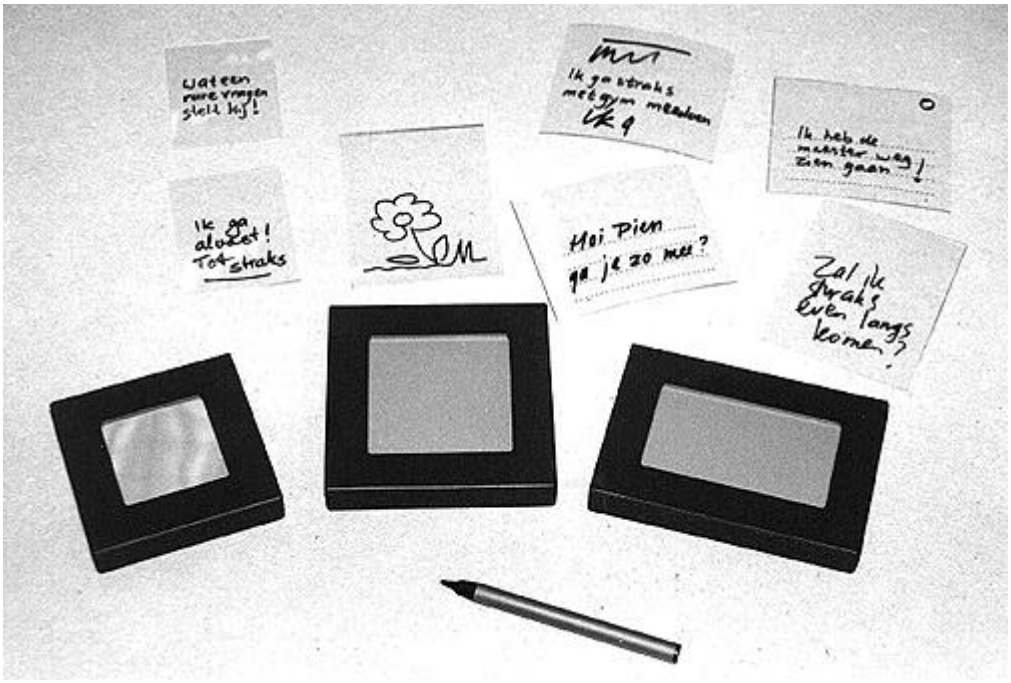


Figure 10: Foam models used in the workshop including children's writing examples.

Results of the Display Workshop.
No important differences between writing performance on the foam models and on the Apple Newtons[a] were observed. The foam models were concluded to be useful tools to assess the writability and portability of different screens sizes.

Left handed children used the upper left part of the product as leaning place while writing, whereas the right handed children used the lower right part of the product. Based on this finding it was concluded that the top right and low left corner around the screen had to offer hand resting space to support both left and right handed users.

All the children chose writability over portability. Portability was not such an important issue because all children mentioned they would put the product in their backpacks.


Figure 11: Writing on the Display of a Foam Model

As expected, there were large differences between writing performance of children aged 7 and 12 years old. Therefor it was decided to build an optimal product for children of 10-12 year old.

User Interface Evaluation
The goal of the user interface evaluation was to obtain feedback on ideas and directions developed by the user interface design team. Two user interface concepts were presented to users at a fair for

youngsters.

Both concepts contained exactly the same functions and shared the same hardware. They differed in the directness of accessing functions and the visual explicitness of their metaphors. Also the concept of storing information (the archiving function) was different for both concepts.

Concept A. This concept had one 'home screen' (Figure 12) that displayed almost all available functions of the device. The visual presentation and size of each function was limited to be able to fit all functions within one screen. The amount of objects that could be stored was limited to the space available on this screen.

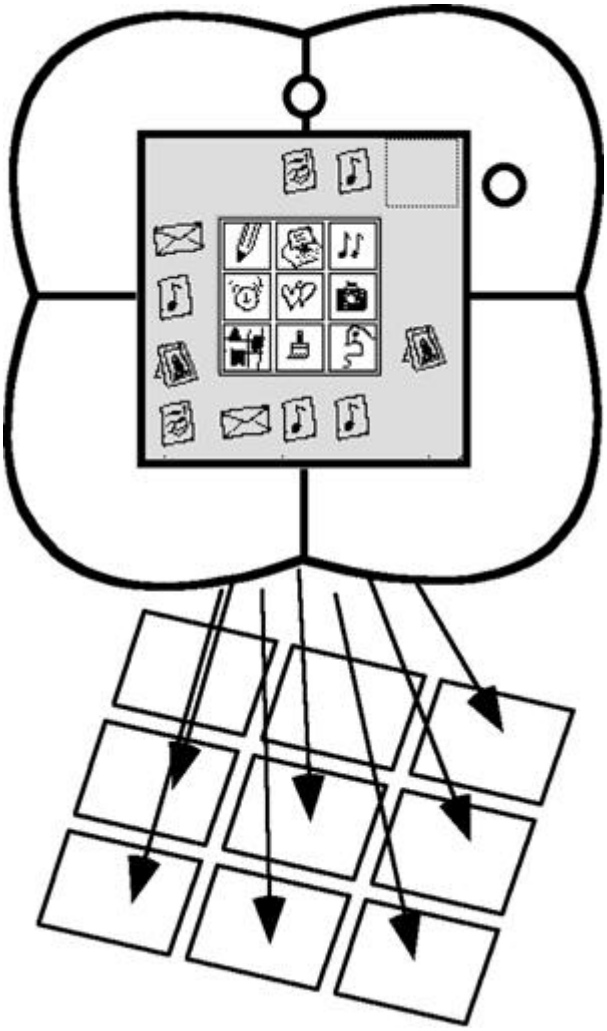


Figure 12: Concept A, direct access to all functions using a top-level overview screen.

Concept B. The second concept featured a 'world' that consisted of several screens (Figure 13). Applications were distributed over the screens and thus not always directly accessible. Applications were visualized by a large icon in the center of the screen. A number of basic tools were represented by detailed animated figures that were always present at the sides of the screen.

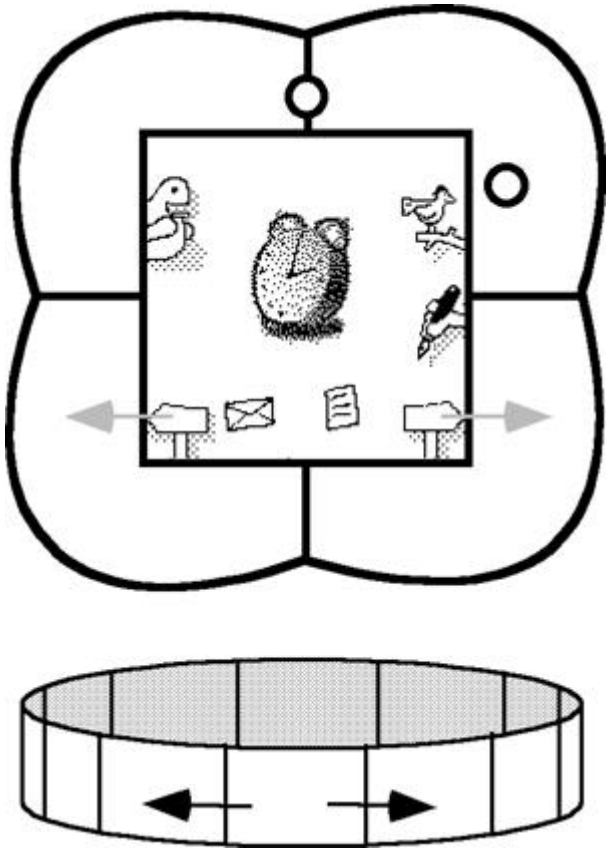


Figure 13: Concept B, indirect access through a 'linked list' navigational model

All participants were shown both concepts. The order in which they were was randomized. After they had been shown both concepts, a number of questions were asked about the interaction.

Results of the User Interface Evaluation.
Most participants mentioned that concept B was more fun because more space was available to do interesting things. Positive comments were made about the objects moving on the screen and the bigger size of the graphic elements representing the applications. Some participants mentioned that although concept A appeared to be easier and more efficient to use, this benefit would only be temporary. The children expected that after a short learning period, both concepts would be equally easy to use.

It was striking that many of the arguments the design team had used when discussing the interface concepts internally were recognized by the children.

Concept Interaction Design

A metaphor that suits the user as well as the technology
The paradigm of an interface metaphor has a user as well as a technology side. A metaphor may seem to fit to the user expectations and needs nicely until another technological idiosyncrasy appears and has to be incorporated within that same metaphor.

For instance the idea of using a little animated battery to display the power level of the batteries (Figure 14) at a later stage proved not to be feasible because of difficulties in measuring the power level of rechargeable batteries.

Figure 14: Screen showing an animated battery (bottom center)

Another example were the 'vector' based drawings that the interface initially allowed for. These drawings were internally described by vectors as opposed to bitmaps. As each drawing is allocated a fixed amount of memory it can only hold a limited number of lines. We tried to explain this concept to the user by using an 'inkpot' tool that indicates the amount of ink left (Figure 15); if it runs out of ink you cannot draw any further. You can 'recycle' the ink by erasing lines which refills the inkpot.

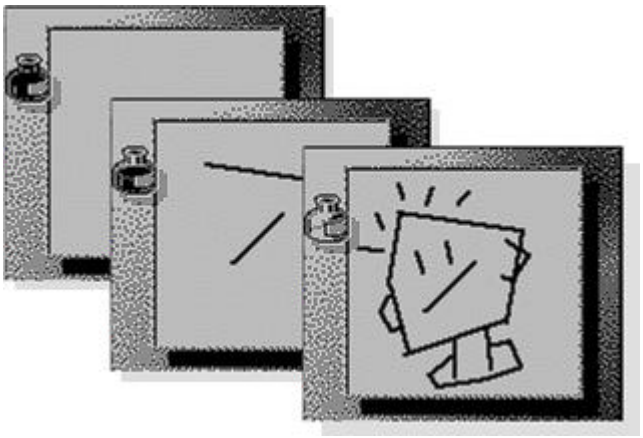


Figure 15: An inkpot (at the left in each screen) was used to explain memory usage for vector based drawings

In user tests it became clear that the concept of vector based drawing caused such misunderstanding and frustration that we left it out of the interface.

Designing in the Dark.
In the detailed concept phase many hardware and software decisions were uncertain for a long time. Issues such as the type of microprocessor, display size, using standard or proprietary software made it difficult to provide clear boundaries for the 'design space'. Equally difficult was to decide on hard- and software requirements with no clearly specified user interface design!

Who Is Our User?
Though we adopted a user centered approach from the start, we did not have a formal structure for recording the information generated. Having no clear understanding and definition of user requirements hampered progress as many user-related issues were repeated over and over in discussions.

FINALISATION

The goal of the finalisation phase is to engineer the product and get it out! Typically this phase is the most intensive and time consuming of the entire development process. More people are added to the team, putting more pressure on communication overhead and requiring more formalized procedures for transferring information.

Usability evaluation

Various usability evaluations were performed to provide answers to general user interface issues (such as consistency of interface mechanisms) as well as to specific questions. Examples of issues that were investigated were ideas for games, children's writing and drawing performance, and the understanding of specific applications.

The approach taken in most sessions was that the children were asked to play with a game or an application for a certain period of time (Figure 16).

In order to simulate more expert use, some test participants took part on several occasions. They were asked to use applications and games repeatedly.

Figure 16: Children using infrared communication on a during a usability evaluation

The Results.
Many opportunities concerning the improvement of specific applications were suggested. For example drawing and especially writing performance with 'vector drawing' was difficult for the children and found to be unacceptable to be added to the device.

During the development process we discovered the importance of always communicating the validity and limitations of our investigations to the development team. For example, the designers were told that it was impossible to draw firm conclusions based on our tests about the 'playability' of the games that we tested.

Since the product-market combination was new for Philips, the marketing of the product was considered to be an important and difficult issue. The results of the qualitative user involvement sessions were sometimes used in discussions about marketing issues. The human factors people had to ensure that usability data should not be interpreted as marketing data.

Engineering Interaction Design

The development of a detailed design of the user interface is a process of iterative refinement. As constraints in hardware and software become clearer (e.g. display size and quality, memory and computational speed requirements) the design can be adjusted accordingly.

Not Having the Final Hardware
Though in this phase most hardware decisions were specified, actual sample components were not available until the very end of this phase. That made the specification of interface graphics and sound very difficult as we could only approximate how they would work out within the final product.

Prototyping
The use of prototyping played an important role in this final phase. Simulations of the interface were used as part of the market evaluations. More functional and detailed prototypes were used to obtain more specific feedback. When prototyping you have to clearly keep in mind the law of diminishing returns, as it takes more and more time to prototype more detailed issues, while at the same time it does not add much more quality.

Transfer of User Interface Specifications
Through many discussions with hardware and especially software people we tried to get to a mutually acceptable method of specifying the user interface.

Here designers and engineers had a clear conflict of interests: software engineers required a complete and formal specifications document, while designers wanted to combine formal as well as informal methods (such as simulations using an animation tool) to explain and illustrate general concepts and rules. This was quite a struggle and at one point the software team was not even allowed to look at the simulations the interaction designers had made as those were considered 'inaccurate and only adding confusion'.

Freeze Functionality Before It Freezes You
Well into the finalisation phase, the functionality changed or new functions were being added, making it more difficult to produce a realistic planning. It is important to fully use the creative forces in the project team. However it is more important to realize when to stop the addition of new functions may at one point only result in delays without any improvements to the product. Ideas on additional products as well as services started also to develop in this phase. It was difficult to decide whether or not to adapt the current product to these 'future' uses.

LESSONS LEARNED

General Lessons On The Design Process

Specify Your User Requirements And Define Milestones
The rationale behind specifying user requirements is not just to develop them, but to make sure that the team agrees on the assumptions and realizes how and when they have and can be changed.

A Product Is Not Designed In A Vacuum.
Start thinking on additional and follow-up products in an early stage, so one does not have to suddenly change or add extra functionality in a later phase .

Users Are Not Designers.
Not all answers can be generated by user or market tests. Users will generally relate any new product concept to existing products. The pen interface for instance was regarded as 'old fashioned' by parents because for them a keyboard was the most sophisticated input device. They had only just 'accepted' computer keyboards in their lives and could not understand that pen input would be the next step.

Act Quick And Dirty If Necessary.
Often, the purpose of our tests was not to decide whether one interface concept was more usable than

an alternative concept, but to discover issues that are important to the children. Small qualitative user involvement sessions are therefore often appropriate. Furthermore such sessions provided an opportunity for designers to 'enter' the children's world.

What Is Specific About The Design Process When Designing For Children?

Let The Team Participate In Testing With Youngsters.
Provide situations where the whole development team has close contact and interaction with the target group. Especially in the first stages these sessions are most fruitful.

Children Can Use Their Imagination.
Children appear to be more imaginative than adults as well as are more capable of expressing their imagination. This can be very useful in discussing a new inventive product as well as in testing a prototype that presents only a small representation of the total product. Actively involving children in the concept phase of the product creation process can be extremely valuable.

Sensitivity About The Purpose Of Sessions.
Explaining to children that not they but the product is being tested is sometimes difficult. For instance, when performing product testing at schools, where children frequently have exams and tests, it can be difficult for them to change their attitude towards the "official visitors." In addition, children can be very direct and tough towards their peers and having group discussions therefore can lead to severe altercations.

Limited Powers Of Expression.
Since children, compared to adults, have limited experience in expressing their feelings and thoughts, it is very common that one group of children may feel more comfortable communicating verbally while others may prefer to use pen and paper. It is important for the human factors specialist to cater to these differences in communication.

Enter Their World; The Media Generation.
The children of today are sometimes referred to as the 'media generation'. Watching television, movies and reading flashy magazines with lots and lots of images are important activities within their daily lives. We can relatively easily gain access to the information available to the children. However, we do not know how they perceive the stimuli unless we "enter their world" and discuss the topics with them.

Avoid The Second Childhood Fallacy.
A common mistake is to think that adults can explain why a child likes a particular game without talking directly to the child. It has been the experience that the reason why adults like a certain product as well a why they think a child would like a certain product is frequently completely different from why children actually like it. One of the most common examples of this are Disney's animated movies. Children often appreciate completely different aspects of these movies than adults.

What Is Specific About The Product When Designing For Children?

Quick change of Interest and Fashion.
The interests of children as well as their perception of things change rapidly. This is one of the most important difficulties that designers of products for children are confronted with. Products, television series, celebrities, etc. can be trendy and 'cool' today and considered to be boring, old fashioned and ugly tomorrow. Therefore, one of the most important design guidelines is not to try to be fashionable.

Designing For Children Means Designing For Pleasure.
Human factors specialists are trained to focus on product usability. This may be one of the most

important aspect for a fax machine. However, an important aspect of most children's products is entertainment; providing pleasure is therefore a primary goal. Human factors engineers therefore, need to make "pleasure-of-use" measurable and provide more feedback of this dimension to the product team.

Importance Of Designing For Product Usage Over Time.
Products should be able to 'grow' with the users and be efficient and effective as well as be a "pleasure to use" in the initial learning phase well as in ensuing stages of product employment.

Importance Of Sophistication In Design And Interaction.
Children are very skilled and experienced users of technology. In many families, only the children can perform a timer recording with the VCR. As a result of this they have high expectations for new products. Children will automatically compare 'their' products with products that their parents have at home.

Limit Target User Group.
Children in the age-range of our product are developing at an incredible speed, physically as well as mentally. It is important to focus on a very specific range, as widening the concept to fit a larger group will more probably make it suitable for no-one.

THE FUTURE...

The product is expected to be launched in the United States and Europe in September 1996. Currently Philips is putting effort in expanding the product range as to address other age groups as well.

INFORMATION AND QUESTIONS

For more information contact the authors, or I.Boots at +31 40 27 33 621

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Footnote 1: all interface graphics as shown in this paper are pending registration.