USAGE RESEARCH IN THE DELFT DESIGN PROJECT ONTWERPEN 4

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ABSTRACT

The paper discusses the integration of usage research in design education. It focuses on a usage research module that we run, and which is embedded in a design project for students, the 'Ontwerpen 4' project. This project is part of the third and last year of the industrial design bachelor course at the Faculty of Industrial Design at Delft University of Technology.We present the layout of our module, as well as first results from action research that we did on it.

The results of our study show that the students are able to gain a thorough insight into the usage of their product through usage research. We also found indications that they may be missing another step to enable them to take a more comprehensive view on their design. It is a matter for future research to use the outcomes in developing the module further.

Keywords: usage research, design project, usecues

1   INTRODUCTION

While the students work on their product design during 'Ontwerpen 4', they also develop ideas about how the product will eventually be used by consumers. Our module seeks to provide the students with a framework for thinking about this product usage. It also provides them with techniques to test their assumptions, by inviting users to try out a prototype of their design.

Our research objective is to trace how the guidance that the module provides, affects the ways the students eventually think about the usage of their product. We also trace in how far they are able to integrate the knowledge gained into re-design proposals. Finally, some questions are raised for further investigation.

2   USAGE RESEARCH WITHIN A DESIGN PROJECT

2.1   The usage research module

The 'Ontwerpen 4' project places particular emphasis on the prototyping and usage research phase of the design project that the students carry out. In the human centred approach that is championed at Delft, usage research is seen as an important part of a design process. While usage research can take place at every stage of designing, it is concentrated at the end of the compact three-month 'Ontwerpen 4' project (Figure 1).

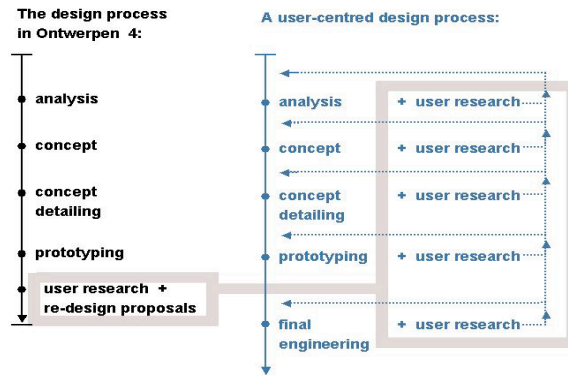| The design process in Ontwerpen 4:	A user-centred design process:	
analysis	analysis	+ user research
concept	concept	+ user research
concept detailing	concept detailing	+ user research
prototyping	prototyping	+ user research
user research + re-design proposals	final engineering	+ user research

Figure 1. The design process in 'Ontwerpen 4' compared with a user-centred design cycle.

Learning goals of the usage research module are that the students can test the usage of the product they have developed to the level of a functioning prototype with previously uninvolved 'test' users, and that the students can evaluate their design using recorded observations of usage of their prototype. The usage research group at Delft designed the module, based on a conceptual framework of product usage. In user product interaction, users are active through perception, cognition, and actions in making meanings with material and functional product characteristics that appear as cues for usage, i.e. usecues. A product designer can seek to let a product communicate opportunities for usage through usecues, so that users can activate its functionalities. Usecues communicate through e.g. form, colour, graphics, texture, even smell. They may be an addition to a product or simply have arisen during designing. Kanis [1] has shown that the intended communication often fails. Because usecues are only 'produced' in context, through the actual usage of a product, it has proved useful for designers (here: the students) to research how this happens [2].

2.2 Students researching product usage

In the module, the students are required to make presuppositions about the expected usage of their product. The purpose of this is, firstly, that they think their product through in terms of usage opportunities and messages it offers. Secondly, there is a methodological idea underlying this requirement. When one intends to observe users who may end up doing the oddest things with one's product, we consider it useful to first make explicit one's own expectations about what will happen. This enables a researcher to *then* look with a more open mind at what actually happens, less hindered by implicit and unrecognized expectations.

2.2.1 Products involved

The design briefs that groups of five students are given, usually involve tabletop products with mechanical and electronic functionality. In the year we did our action research, each of the 18 student groups designed one of these three products: a foam cutter consisting of a hot steel wire which burns through foam, e.g. for quickly making foam models of a design, a table saw with the saw pointing upwards from a table surface, and an electric perforator for punching holes in paper.

3 METHODS

3.1 Data

As data for our action research on the module, we used the written plans and reports of the students and the video material from their research, as well as the data from a small-scale study we did while running the module in the autumn of 2003.

Activities of that small-scale study were:

- Audio recordings of our tutorial meetings with the student groups, during which their research plans were discussed,
- Video recordings of the students just prior to their usage research, in which we asked them to point out for the camera the usecues they had designed into their product, and to show us the user actions they expect people to carry out with it. We asked the students: "Please explain the usecues in your product and the decisions on which the design of these usecues was based. Imagine you are a user thinking out loud, how you would use the product? Please demonstrate that for us."

Five groups out of the 18 taking part in the design project were included in the research. They were selected by convenience, having signed up for their tutorial meetings on the same day. Two groups designed electric perforators, and three groups, foam cutters.

3.2 Analysis of the students' use of usecues

When previously running the module, we had sometimes noticed differences between the students' ideas about their product prior to usage research and afterwards. Now we studied what the students said about the usecues they had designed into their product. We also studied how their ideas changed throughout their research, from initial plan to final report. In our analysis, we look at usage problems and 'smooth' usage as instances of user actions in which one or more usecues explicitly play a role. User actions, and usecues, are seen as parts of the context of usage of (a part of) a product.

The students' ideas on usage *before* their research were looked at in terms of usecues and their presuppositions about them, as well as design decisions concerning usecues, where students reported having specifically made such decisions. For these aspects, we drew on the written research plans and their explanations of their product on camera.

To gauge whether the ideas of the students had changed *after* the usage research, their answers to two of their research questions were analysed, which they had written up in their final report. It was compulsory for the students to pose these two research questions specifically: (I)'What are participants actually doing in using a product and what problems do they face in using it?' and (II) 'What is the role of presumed/designed usecues when usage problems occur, or, indeed, when the user-product interaction appears to be going well?' The students' conclusions and proposed redesign(s) for the problems encountered in the usage research were analysed in their final report.

This results in four categories of the students' ideas, to be analysed:

1. Presumed or specifically designed usecues
2. Design decisions underlying the choices of the usecues
3. The role of usecues in the emergence of usage problems or in a 'smooth' user-product interaction, which can be (at least) threefold:
   - usecues that did work (usage of usecues as foreseen).
   - usecues that are important for designers but do not attract attention from users (no observed usage of those usecues),
   - usecues that worked in another way than foreseen (usage different

than presupposed),

4. Proposed redesign(s) for the product.

3.3 Grouping the results for presentation

The results of this analysis cannot be fully reproduced within the scope of this paper. We have therefore chosen to present the results in two ways:

3.3.1 Case study of one student group's usage research

Firstly, focusing on one group, we present their case in detail. This student group designed a foam cutter that was unusual in its orientation towards a user. With existing foam cutters, a user typically stands at the cutter's short side, facing its arm and wire head-on. With this student group's foam cutter, users were supposed to stand alongside of it, facing the arm sideways. To communicate this unusual (and thus possibly counter-intuitive) orientation, the students rounded off the top edge of the work surface at the long side supposed to be facing the user. Furthermore, the buttons to control the product were placed at the front (Figure 2).

The students were aware that it would be useful to research the orientation of their foam cutter, besides other aspects of their product. Their plan therefore included an additional research question on the role of users' previous experience in understanding the orientation of the product, whether facing the user frontally or sideways. In the set-up of their usage research, the students placed the foam cutter on the corner of a table, leaving open for a user the possibility of a front or side approach.
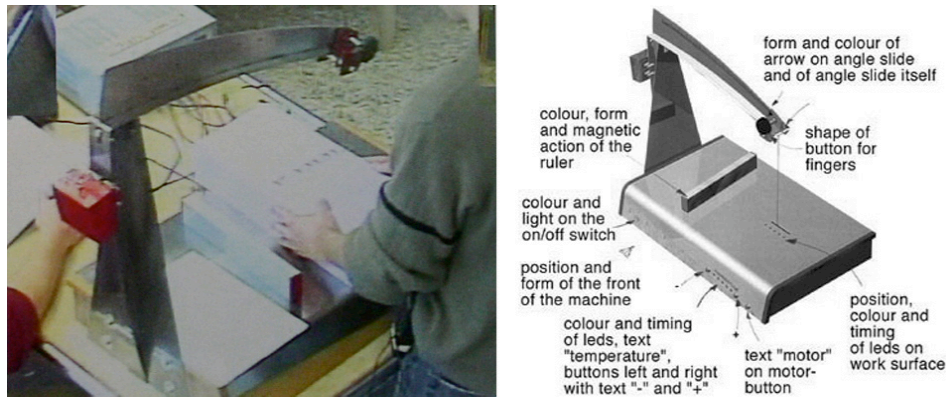
Figure 2. Usage research showing front orientation (left picture) and important usecues of the students' foam cutter (right picture).

3.3.2 Overview of the usecues researched by all the groups we studied

Secondly, we present a summarized overview of the number of usage problems found through usage research by the other four student groups we studied, and a count of the redesign proposals they made in response to the usage problems found. This is done in order to be able to draw conclusions on the relation between problems that were identified, and the solutions that the students offered as a result.

4   RESULTS

4.1 Case study of one student group's usage research - analysis of usecues
This case study gives an insight into the steps taken by the students in the module. The student group identified important usecues before their research, and made presuppositions on the role of these usecues in usage. They carried out their research and discussed the outcomes in a final report. Table 1 reproduces their results.

4.1.1 Closer analysis of the usecue concerning the orientation of the foam cutter
In order to take a closer look at issues surrounding the orientation of this student group's foam cutter, we draw on the students' video records of their research and analyse the activities of and verbal information given by the students' research participants.

The student group had made the presupposition that research participants *with* previous experience with foam cutters would be less open-minded for the unusual orientation of this design. After the research, the students concluded that this was indeed so. But our later analysis showed a different picture. According to the report of the students, participants 1,2,3 and 5 had used existing foam cutters once or more before the usage research. In the research, however, it was participants 4 and 5 who did not recognize which side is the supposed front of the foam cutter until they started cutting foam at an angle, which could only be done facing the machine frontally. So participant 4 had no previous experience *and* stood as not intended. This ran counter to the students' presupposition, and possibly indicated a problem with the students' design intentions. Participant 6, conversely, had no previous experience but still went to stand at the front side of the machine, which might indicate that the students' design worked as intended. In effect, no clear pattern could be discerned. The students did not realise that their data showed that both participants *with* previous experience, and participants *without* experience, chose either side of the foam cutter.

Possible points of departure also emerged, unnoticed by the students. Two of their research participants discovered the supposed front side while cutting at an angle. The students did not include this relation in rethinking the usecues for orientation. And participant 3 had decided which was the front of the machine on the basis of other cues than presupposed by the students - namely on the basis of best support for a piece of foam when standing at the short side of the machine. This observation could have yielded an idea for advantageous usage.

4.1.2 Redesign proposals
The students made redesign proposals in order to address usage problems with three usecues: firstly, a usecue to be able to recognise the front of the machine. Secondly, a usecue to be able to measure foam in another way than with the ruler which had been found not to function as intended. For these two issues combined, the students made a redesign proposal of arrowed gridlines on the work surface, pointing towards the front of the machine. A third usecue issue was that users did not use the motor/pause button. The students proposed the addition of a text line 'MOTOR PAUSE' next to the button (see Table 1 and Figure 2). These design proposals all suggest graphical changes or additions and do not affect the form of the product as a whole.

Table 1. Analysis of usecues case study group
Notes: The usecues for the orientation, highlighted in grey, were not noticed or understood by three of the six research participants.
The LED in the ON/OFF switch was not working but the function of the switch was simulated and tested and is therefore included in the table
Participants mostly used the angle-slide with both hands rather than with one hand as presupposed, but the group did not regard this as a usage problem

Part of product	Usecues	Design decisions on usecues	Role of usecues			Redesign Proposal
			Used as presupposed	No usage observed	Used differently	
Front side	Control panel and rounded corners				Usage on the right side of the machine[2]	Five arrow lines from back of surface to front panel
ON/-OFF switch	Green light comes on when ON[3] is pressed	Colour green indicates OK	ON/OFF function			
Surface	Red lights on surface flash to indicate that the wire is warming up, and burn continuously when wire is hot enough	Colour red for getting attention and warning of heat			Misunderstanding or ignoring the lights or assuming relationship with motor-pause button	
+/- Buttons	Row of 5 red lights; text 'Temperature' placed above lights	When +/- is pressed one more light or one less comes on. Colour red for heat.	Buttons were used to set temperature of the wire			
Motor-pause button	Text 'MOTOR' placed below button			Button was not used		Change text into 'MOTOR PAUSE'
Angle-slide	Arrow point indicating angle, flower-shaped button with space for fingertips to hold and turn	One handed use: using button to move angle-slide on arm	Users turn knob with one hand and push angle-slide with other hand[4]			
Ruler	Fixed to surface with magnets (not visible)	Small high shape for whole hand grip		Users miss grid on the surface		Five arrow lines (grid) from back of surface to front panel

Table 2. Analysis of the orientation usecues in the case study

Participant no.	Activities and verbal information
1 (experienced)	Stands in **front** of the machine. Indicates afterwards that he hesitated because he was used to existing cutters, but in front seemed handier
2 (experienced)	Stands in **front** of the machine
3 (experienced)	Stands to the **side** of the machine. Says afterwards that, though the front seemed handy because of the control panel, the surface seemed to support foam better when standing to the right of machine
4 (no experience)	Stands to the **side** of the machine. Discovers the front through usage of the angle-slide. Comments afterwards same as participant 3
5 (experienced)	Stands to the **side** of the machine. Discovers the front through usage of the angle-slide. Comments afterwards same as participant 3
6 (no experience)	Stands in **front** of the machine

4.2 Overview of the usecues researched by the other four groups we studied

Table 3 gives an overview of the number of usage problems found through usage research by the other four student groups we studied, and of their redesign proposals. All groups report usage problems in which usecues play a role. Three groups only propose redesigns for some, rather than all of the usage problems found. One group proposes redesigns for all usage problems found. All groups' redesign proposals suggest alternatives or adjustments for the designed usecues but no integral design changes.

Table 3. Overview of four student groups' analyses of usecues

Product	Number of reported usage problems related to usecues	Redesign proposals
Foam cutter	6	3 adjustments
Foam cutter	5	4 adjustments
Perforator	4	1 adjustment
Perforator	7	7 adjustments

5 DISCUSSION

In our module, the students are required to name the usecues they have designed into their product, and to explicate the presuppositions they have about the usage of their product. The results from our study show that the students gained a thorough insight into the usage of their product by conducting usage research.

The students did not however carry that insight through into a sufficiently far-reaching analysis of the usage of their product, as was illustrated by the case study on the 'orientation' usecues, above. The students did not recognize that a presupposition they had made was neither supported nor refuted. Other potentially valuable points raised by their research participants were overlooked.

5.1 Looking back on the methodology of the research module

The aspects that have been highlighted touch on the whole process of foam cutting. The compulsory first research question "What are participants actually doing in operating a product and …", is designed to enable students to look at this whole process. However, the students tend to focus on the last part of the question about usage problems and then

immediately go on to focus on the usecues and on their presuppositions. Possibly as a consequence of this, the students' redesigns remained focused on usecues at 'button-level'. It appears effective for students to make presuppositions while preparing to do research, enabling them to explicate many aspects of their product and look closely at its usage. But in analysing the results of their research, the students may be missing another step that could widen their view.

For example, we might place more emphasis on associations users have with other instances of usage or products. Possibly students can relate this to design decisions they made earlier in their design. Eliciting associations from users may help the students in considering redesigns that go beyond adjustments to designed usecues.

6 CONCLUSION

Through action research on a usage research module, we have investigated issues that arise with respect to the methodology underlying it. The students are able to use the guidance that we provide in looking at the usage of their designed product closely. Our research has provided us with points of departure for developing this tool further. Issues we want to look at in future are the relationship between characteristics of a product, termed usecues, and the associations it may evoke, as well as product usage that stretches across its characteristics. We have found that the students are not (yet) able to maximize on this relationship in the conclusions they draw from their research results and the re-design proposals they make in response to these conclusions. It is a matter for future research to look at how these aspects can be adapted to allow students to take a more comprehensive view.

We have investigated the module activities quite critically. It may be worth adding, anecdotally, that students often comment that they find the usage research module valuable to do. We hope to use our study results to make it even more so in the future.

REFERENCES

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