Designing Interfaces for Users with Intellectual Disability

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Usability of technical equipment is pre-requisite for the successful introduction of users with intellectual disabilities on the labour market. In this project, an iterative user-oriented product development process was applied in order to develop a new user interface for a cash register to be used in e.g. cafés, restaurants, and hotels. The results show that general principles for usability (e.g. consistency, feedback, etc.) could be applied. However, some design elements proved particularly important to consider especially to achieve an agreement between the user's physical activity and the occurrences on displays / screens. The project shows that users with intellectual disabilities can participate in and contribute to a development project. However, special care has to be taken in designing e.g. problem inventories and usability evaluations.

1. Introduction

Today, efforts are made in order to introduce individuals with intellectual disability and learning difficulties on the labour market. Some of the business areas that are judged especially interesting are cafés, restaurants, and hotels. However, a survey of the technical equipment typically used in these jobs has revealed several problems (Sperling 1997). The cash register was considered to be one of the most complex and difficult tools to handle.

The aim of the project was to develop a new user interface for a cash register to be used in cafés, restaurants, and hotels. The goal was to find a solution that fit as wide a target group as possible, even though the focus was users with intellectual disabilities and learning difficulties.

2. The development process

2.1 Problem analysis

In order to reach a more in-depth knowledge of the problem picture, five persons with different degrees of disability were interviewed and field observations were made of six persons in two work places. The study showed that in order to complete different work tasks, most often the users performed certain sequences of actions which had been learnt by heart but with no real understanding involved. Lacking this understanding, the users had difficulties coping with problem situations, e.g. when the users had difficulties memorizing prices, had to enter the prices of a large number of items, had to deal with discounts, or had to calculate the right amount if change was to be given. The users sometimes avoided the cash register completely, e.g. by trying to add/subtract in the head, by using a simple calculator or simply by asking the customer for help. Not being able to cope with the technical equipment resulted in stress, something which further deterred the users’ problem solving capacity.

2.2 Specification of requirements

A literature survey of existing knowledge on intellectual disabilities, available guidelines for user interface design, and the problem analysis formed the basis for the specification of requirements. The most important requirements were that the new interface should fit users with intellectual disabilities and learning difficulties as well as ‘ordinary’ users; should allow easy correction of errors; should eliminate the need to memorize information; and should provide feedback on actions.
In addition, the design should be perceived as attractive and motivating and it should not be identified as an ‘aid’.

2.3 Development of concepts

In order to develop new concepts, a survey of existing technical solutions was made, including an assessment of different input principles (keyboard, touch screen scanner, voice). In addition, different information principles were evaluated in user trials which involved 18 individuals, 9 with an intellectual disability. Comparisons were made between e.g., pictures and text, and between pictograms and photographs for visualising different functions and items for sale.

A first design principle was to allow users to move ‘from the general –> to the specific’. If the user chooses a category (e.g. ‘hot drinks’) before a more detailed list of options is presented (e.g. coffee, café au lait, tea, hot chocolate etc), the amount of information and hence the number of possible options are reduced. A second principle was to use a separate display for visualising what actions had been taken and what was the next step forward.

The above principles were implemented in three solutions. Input technology in design A was a combination of keyboard and displays (Figure 1). Design B was a touch screen solution. In design C, each item was presented with a photograph. Attached to the photograph was a strip code which was to be scanned with, e.g., a pen shaped scanner.

![Figure 1. Design A, adapted from Frid (1998). The user chooses e.g. ‘hot drink’ in the display to the left. The list of options is presented in the display to the right. After choosing the desired option, the item and the price tag appears in the ‘Receipt Display’ to the far right.](image)

2.4 Evaluation of concepts

Twelve subjects, six of whom were intellectually handicapped, participated in the evaluation of the concepts. All subjects tested all three propositions according to a 3*3 test design. The evaluations took place in a ‘lab’ environment. In order to make them as realistic as possible, the subject acted staff (cashier) while one of two evaluators acted customer in a café. Four different scenarios were used, each of them illustrating different use situations and degrees of complexity (e.g. purchase of a single item vs. purchase of several items). The test equipment consisted of simple physical models. Some parts of the model were fixed (a few of the function keys) while others were exchangeable (displays, keyboard). The subject interacted with the model and the displays were consequently changed by the second evaluator (a kind of ‘open’ Wizard-of-Oz methodology).
In terms of time to complete the tasks, the results show that the intellectually disabled users performed better interacting with design A, while design C improved results for the ‘ordinary users’ (Table 1). However, the difference between design A and C was small.

Table 1. Total time to complete evaluation tasks (Mean values, n=12). Overall, intellectually disabled users took longer completing their tasks than did the able users. However, the difference between the individuals were more noticeable in the disabled group compared the ‘ordinary’ user group.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Solution A</th>
<th>Solution B</th>
<th>Solution C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intellectually disabled</td>
<td>320 sec.</td>
<td>434 sec.</td>
<td>367 sec.</td>
</tr>
<tr>
<td>‘Ordinary’ users</td>
<td>190 sec.</td>
<td>264 sec.</td>
<td>169 sec.</td>
</tr>
</tbody>
</table>

All subjects were asked to complete a short questionnaire. The subjects’ assessments of different qualities were given on a five-point scale with the anchor points ‘very bad’ – ‘very good’. Symbols describing different facial expressions had been added in order to increase the intellectually disabled subjects’ comprehension.

In general, the subjects gave a rather high rating for most qualities (Table 2). However, when asked about overall preference, nine subjects preferred solution A while three subjects preferred solution C.

Table 2. Subjects’ ratings of different usability qualities on a five-point rating scale. (Mean values, n=12). ID=’Intellectually disabled’ users, O=’Ordinary’ users.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Solution A</th>
<th>Solution B</th>
<th>Solution C</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>O</td>
<td>ID</td>
<td>O</td>
</tr>
<tr>
<td>Comprehensibility</td>
<td>4 4.3</td>
<td>3.8 4.3</td>
<td>4.3 4.5</td>
</tr>
<tr>
<td>Learnability</td>
<td>3.5 4.2</td>
<td>3 3.7</td>
<td>3 3.8</td>
</tr>
<tr>
<td>Legibility</td>
<td>4.3 4.3</td>
<td>4.5 4.8</td>
<td>4.3 4</td>
</tr>
</tbody>
</table>

Some of the problems detected in the trials were that keys, shaped as arrows for moving up/down in a list of items, were not understood by the subjects with intellectual disability. Furthermore, the information presented in the ‘Receipt Display’ (see Figure 1) was not used or observed, nor did the users seem to make a connection between the operations made to the left and the information presented to the right. In addition, both user categories had problems understanding when to use and when not to use ‘OK’ (see Figure 1). The trials also showed that the ‘ordinary’ subjects did not use the symbols/pictures to the same extent as the disabled subjects.

2.5 Final solution
Principles which had proven particularly important in the earlier evaluations were ‘closeness’ and ‘similarity’ and reducing the number of decisions that had to be made in each step of the interaction.
Based on the evaluation results, a new interface solution was developed. The key principle was to establish a clearer and more obvious relation between the user’s actions and what happened on the screen on the screen/display.

Three users from the concept evaluation took part in an evaluation of the new solution. A touch screen allowed the users to move (drag) a symbol for, e.g., a cup of coffee from one place on the screen – the assortment area to the left – to another area – the customer's receipt area to the right (Figure 2). Consequently, items could be retracted from the list in the same way. When all choices had been made, the users pressed ‘OK’. The display asked for the amount of money received from the customer and this sum was entered by using a keyboard.

The customer’s change was visualised on the screen once the user had pressed the button marked ‘Change’.

The new tests showed an overall high acceptance of the design and few errors occurred. Especially ‘moving items to and from the customer’s receipt’ was considered very easy to understand.

Figure 2. Final solution adapted from Frid (1998).

3. Conclusions and final remarks

The project demonstrates that a design, based on knowledge about the specific users' abilities and limitations, will result in improved product usability. The work also shows that general usability principles, e.g. consistency and feedback (e.g. Nielsen 1993) can be applied when designing interfaces for users with intellectual disabilities and learning difficulties. However, some principles proved especially important, e.g. closeness and similarity in terms of colour coding or other ways of grouping information. Interface transparency seems particularly important.

The results show further that user participation in the development of products for intellectually disabled users is feasible. However, it is especially critical that tests and product evaluations are carried out in an environment that is well known to the users and where the users feel secure. The aim of the tests must be explained carefully so that the users no not perceive themselves to be the ones to be assessed. In addition, the tasks must be as realistic and as physically 'active' as possible while the representation of the future product can be fairly simple.
Acknowledgements
The interface project was a joint endeavour between Lindholmen Development, Chalmers University of Technology and the School of Design and Crafts, Göteborg University. In particular, the authors wish to thank Thomas Nyström for creating the graphics.

References
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