UxLab: Usability Optimization
Case Study of a Environmental Management Information System (EMIS) using Eyetracking Studies

Peter Krehahn, Volker Wohlgemuth, Herbert A. Meyer
HTW Berlin, University of Applied Sciences, Department of Engineering II,
Industrial Environmental Informatics Unit
Wilhelminenhofstraße 75A, D-12459 Berlin
peter.krehahn@htw-berlin.de, volker.wohlgemuth@htw-berlin.de meyerha@htw-berlin.de

Abstract
This paper focuses on improvements of Environmental Management Information Systems (EMIS) from a usability perspective. A certain EMIS were tested as a case study using traditional usability studies as well as the eye tracking method as useful complement. Usability studies can lead to competitive advantages for the providers of services and products, especially when the studies are integrated at a relatively early stage, in the design and development phase. As a result of usability studies shortages and deficits in developments can be avoided and adaptations to existing functionality of a software application can be complemented with a special focus on future users. The combination of the newly initiated research project called UxLab (User Experience Lab) and the ongoing development of EMIS at the HTW represents a win-win-cooperation. The essence of this combination and why it is so beneficial will be discussed in this paper. Furthermore the results of a case study done within the course of the research project will be presented. For that study, a software tool has been tested, that was developed within a project sponsored by the Federal Ministry for Education and Research, which allows the creation of carbon footprints. This application mainly aims at small and medium sized enterprises (SME) in Germany, which are expected to have no prior knowledge or training in the use of the software. An introduction in the field of usability studies, the case study itself and its results shall follow.

1. Scope and Goal
The discipline of Industrial Environmental Informatics emerged in the mid1980s from environmental computer science in combination with business informatics. Along this emergence, systems were developed, that were focusing on an assistance of industrial environmental protection problems at operational level (cp. [Woh05] p.142, [Rau99] p.11). The scope of these Environmental Management Information Systems (EMIS), ranged from the creation of computer-based environmental management systems to the analysis of systems and the simulation. The users of the new software solutions had mostly been introduced to EMIS via specific training courses, while their success arose from the extent of their functions. Two kinds of perspectives were identified, the one of the developer and the one of the user. The first one focuses on the functionality of the software. An arising question in this context is if the software works. The occurrence of an error in perception resulted in the idea that developers or CEOs believed that the main criteria of a working software rested in functionality, disregarding the possibility of new users not being able to reach the given potentials and or how they would obtain the knowledge to do so. Usability studies are used to understand more about the user's perspective and to analyze it in order to reach a larger group of users with the respective software solution (cf. [APr99] pp. 14). There is a variety of methods for
the implementation of usability studies, for instance the observation of real users during their handling of the software or the use of questionnaires or more complex methods such as eye tracking studies. These studies are used while real users are working on real systems or system components. Through usability studies EMIS, which are often very complex, are supposed to be optimized in a way so that the acceptance by the users will be improved. There are many guidelines about what usability is and how it can be measured, e.g. DIN EN ISO 9241-11 or ISO/IEC 9126 suspended by the ISO/IEC 25000 series (cp. [DIN92], [ISO91], [ISO25]). The process of usability testing however is not known to every developer. Especially in big companies usability is a well known standard to analyze the possible market acceptance of their products. Positions as "usability engineers" are totally integrated. For software developers working in a small and medium sized enterprise the know-how and the financial opportunities are usually not given. It is the intention of the UxLab project to give selected SME, operating in the field of EMIS, the possibility to learn more about usability and in that regard make use of the methods introduced in the project. Especially in the field of EMIS the need for usability testing is given due to an absence of prior focus (cf. [Fis09], p.65). This paper will therefore give a short introduction to the project UxLab (chapter 2), while presenting the results of a case study (chapter 3) at the end of the paper. At the end we will give a conclusion and a short outlook of our further work.

2. UxLab- Usability Lab of the University of Applied Science in Berlin

2.1 Prerequisites at the HTW

In February 2010 the Industrial Environmental Informatics Unit at the University of Applied Science in Berlin (HTW Berlin) established a usability laboratory to facilitate the improvement, adaptation and development of software systems using eye tracking analysis. Due to the close relationship of researchers, students and engineers EMIS can be tested here by test persons with different skill levels and background knowledge. Additionally researchers are enabled to draw upon the test devices from the industrial environmental informatics unit for their research activities. As a result those systems are being examined by actual practitioners from the field of environmental informatics.

The advantage lies in the proximity of technology, scientific research and a big number of test persons. EMIS providers and producers also get the possibility to explain and discuss the challenges that arise in small development projects, therefore leading to further knowledge transfer with benefits on both sides.

2.2 Basics of Usability

The term usability is defined in the ISO 9241-11 and aims to examine systems according to their effectiveness, efficiency and satisfaction (cf. [DIN92]). Meanwhile program components are observed under a specific set of conditions and the user interaction for these is analyzed.

Usability tests share five characteristics:

- The goal is to improve the usability of a product
- The participants represent real users
- The participants do real tasks
- You observe and record what participants do and say
- You analyze the data, diagnose the real problems and recommend changes to fix those problems
2.3 Eye Tracking Analysis

A well-known usability method is the eye tracking analysis, in which visual foci and eye movements are tracked and documented ([Gol09] pp. 18). In the same time other information such as facial expression, gesture and language is recorded to get an ever bigger picture of the user’s interaction, handling and feeling while using the software. Examples for the methods that track these expressions are:

- **Gaze Overlay**
- **Scan paths** visualized eye tracking analysis, gaze paths
- **Heat maps** visualization of the focus of visual attention; also be used for group comparisons
- **Areas of Interest** Attention maps of any defined areas

The operating range of usability studies considering EMIS can spread from web portals of the software providers to the EMIS themselves. The main aims of web portal studies are to enhance the allocation of necessary information of EMIS vendors to possible future clients in an appealing way and to ensure that the marketplace (cost, order, product information) becomes no obstacle but rather a place people would feel comfortable at. Thus the main objective of usability studies concerning the EMIS is to represent their complexity in a user-oriented, preferably complexity reducing manner and to empower users so that training exercises to use the software can be minimized. Beyond this point the extension of the number of possible users is also a desired side effect, as this would lead to a higher acceptance of the EMIS, even though their complexity remains untouched.

The market for EMIS was characterized by some contributors and their “pragmatic” software products in Germany. The need of such EMIS was tough, because the consumers were enterprises, which had their interests in their business operations rather than in the environmental aspect or environmental responsibility which was partly motivated by governmental law. In the last years this point of view changed dramatically, so far that nowadays consumers create much more competition between producers of these EMIS as well. With the growing competition the usability or easy handling of software becomes a more and more crucial part considering its market-acceptance.

3. Case Study

3.1 Introduction to the Resefi Carbon Footprint Tool v0.2

In 2009 a project at the HTW Berlin supported by the Federal Ministry of Education and Research was started which had the scope to provide SME with information and software support in the field of material and resource efficiency. In that scope a web-platform was created were the SME could find guidelines, partners and also small software tools to assist several perspectives in this field. One of the first software applications created was the Carbon Footprint Tool, currently version: v0.2, which should give the user the opportunity to create a quick and simple carbon footprint of their company or facilities.
In figure 1 you can see a screenshot of the graphical user interface. This interface is composed of different views, which are dockable at different positions of the screen. The composition of the elements consists of views to visualize analyses of input data in pie-charts and bar-charts (at the bottom), as well as the “Contingent Summary”, which can be seen in the upper right section of figure 1. These three windows do not allow data input. On the left side of the upper section the project browser and the positions editor are displayed which are only shown when a position in the browser is selected. Finally the Carbon Footprint Editor is shown in the middle and allows the administration of the project name, project description and the number of employees. In order to get to the window shown in figure 1 the software loads a welcome screen, which explains the methodology behind the Carbon Footprint. It also shows the provided functions of the tool. This tool was selected as a first case study for the usability lab at the HTW Berlin.

3.2 Case study: Testing Software - Experimental Object

The case study presented in this chapter was conducted at the HTW Berlin in June 2010 to improve the software prevented in chapter 3.1. In the following the conditions of the case study are briefly stated:

**Experimental Object: RESEFI Carbon Footprint Tool v0.2**

26 cf. http://www.resefi.de/software, last accessed 24.06.2010
Apparatus: The Eyegaze Analysis System™-eye tracker from interactive minds was used to record eye movements. The operating system was Windows XP using the NYAN2-Software version 2.4.2 with a normal flat screen as the stimulus for the user. The eye tracking system is a binocular system with 0.45 ° accuracy and a 120 Hz sampling rate.

User: The Software should be tested by 6 participants with no further experiences of the software tool.

Created tasks and goals:

<table>
<thead>
<tr>
<th>No.</th>
<th>tasks</th>
<th>concerns and expected results</th>
<th>max time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Read and understand the welcome screen.</td>
<td>Does the welcome screen give enough or too much information about the carbon footprint methodology and the tool itself?</td>
<td>5 min</td>
</tr>
<tr>
<td>2</td>
<td>Create a new project called “DEDIDAS”.</td>
<td>Does the user quickly find a starting point?</td>
<td>1 min</td>
</tr>
<tr>
<td>3</td>
<td>Create a property item from type flight with the name “management” and the distance of 1500 km over one year.</td>
<td>Does the user find the add property function?</td>
<td>3 min</td>
</tr>
<tr>
<td>4</td>
<td>Create a property item from type flight with the name “distribution” and the distance of 800 km over one year.</td>
<td>Are the user faster than they were at task 3?</td>
<td>3 min</td>
</tr>
<tr>
<td>5</td>
<td>Create two property items from the type buildings with the names “plant1” and “plant2”.</td>
<td>Does the user identify the symbol “building” or is he confused of the given name “Primärenergie” (engl: primary energy)?</td>
<td>2 min</td>
</tr>
<tr>
<td>6</td>
<td>Insert the values given over the year for plant1.</td>
<td>Are there misunderstandings about how to enter the given values for task 5?</td>
<td>4 min</td>
</tr>
<tr>
<td>7</td>
<td>Insert the values given over the year for plant2.</td>
<td>Are the user faster than they were at task 6?</td>
<td>4 min</td>
</tr>
</tbody>
</table>

total max 22min

3.3 Main Results of the case study

The table below shows the results of the individual tasks and the total time per participant, as you can see the total time is between 5 and 13 minutes, which is acceptable for the given tasks. The individual results, especially in the column called Task 5 have to be further explained.
Table 1: Results of the tasks 2-7 for the RESEFI case study

<table>
<thead>
<tr>
<th>participant</th>
<th>Task2</th>
<th>Task3</th>
<th>Task4</th>
<th>Task5</th>
<th>Task6</th>
<th>Task7</th>
<th>overall time</th>
</tr>
</thead>
<tbody>
<tr>
<td>User 1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>9.32</td>
</tr>
<tr>
<td>User 2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>13.47</td>
</tr>
<tr>
<td>User 3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>8.15</td>
</tr>
<tr>
<td>User 4</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5.14</td>
</tr>
<tr>
<td>User 5</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>8.05</td>
</tr>
<tr>
<td>User 6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>6.08</td>
</tr>
</tbody>
</table>

results defined as
1 = finished with ease, 2 = completed with difficulty, 3 = failed to complete

In order to explain the short time for the solving of the tasks and the different times for different users, figure 2 and 3 offer some explanations. In these figures you can see that only one participant reads the welcome page carefully while the others are trying to get started quicker and do not read the information on the screen intensively.

Figure 2: Eye tracking of the reading of the welcome page (not thoroughly)

Figure 3: Eye tracking of the reading of the welcome page (thoroughly)
In figure 2 and 3 the visual foci (shown as red bubbles) and saccades (shown as green lines) are marked which represent the transitions from a visual fixation to another. As can be obtained from figure 2 you can see that the participant does not read very carefully, only the first lines of the explanation of the Carbon Footprint Tool stays in sight. This participant said afterwards that, in his opinion, the welcome screen was overloaded with information and that he was firm in the topic. Figure 3 shows the result of a participant that was not quiet firm in the field of carbon footprinting and there were more visual fixations and evenly allocated along the text.

All participants said that the given information on the welcome screen was too much and that the description of the software features and the project information should be outsourced to the help content files.

Another result is shown in the learning process of the participant while he did task 3 and 4. At both tasks he had to create an entry of the type “flight” with different properties (shown at figure 4 and figure 5). The participant looked at the position window, where you can choose the type of position that one wants to create. On the left side you can see, that the participant looked at every entry in this window and at the right side the same participant looked at the position flight before and while the window is opened, that’s why the fixation is bigger, but on the same position all the time.

The tide turned at the task 5, as the result for 3 participants reached “failed to complete”. The reason why can be answered with the impossibility of the test users to find the position of the requested “buildings” as the position was marked “primary energy”, even though the icon chosen resembled to a building. The participants were only able to continue with the work after advice was given by the instructor (see figure 5).
In the following example a “scan path” is visualized, which demonstrated how a participant tried to find the “add-button”, which is used to add positions (see figure 6). In this sense the participant checks the available icons/buttons provided by the browser in the top left corner, doing that one by one and only later realizing that the add-button was placed in the middle of the Carbon Footprint Editor. The learning effect in this respect was relatively limited, however all participants articulated during the execution of the experiment that the absence of the button in the button-list on the top of the browser was strange (see figure 6).

The evaluation of so-called areas of interests shows that the Carbon Footprint Editor was only perceived in respect of the add-button, leading to the question why this was a central element of the user interface. Furthermore there were errors during the refreshing of the results in the tool, which were also only noticed by one of the participants. This strengthens the conclusion that the test users showed less attention to the Carbon Footprint Editor. Another “error” was noticed, which was not intentionally part of the usability test, namely the fact that the storage of project data as a firebird database file did not allow German umlauts.
After the evaluation of all results and an extensive discussion with the developers of the tool, changes of the graphical user interface were implemented (see figure 7). In that regard the old Carbon Footprint Editor was deleted, while however the Positions Editor was renamed to Carbon Footprint Editor and placed at the bottom right corner. Also the graphical displays of the results (pie-chart, bar-chart) were increased in size and even the add-button, which the participants were searched during the usability experiment, was integrated in the browser’s tool bar.

Figure 7: Screenshot of the Carbon Footprint Tool v0.3 after the usability study

4. Conclusion and Outlook

The case study presented in this paper shows an effective application of a usability study and what kind of results can be expected if such studies are introduced. Even though the software was small and the number of participants as well, this usability studies leads to the improvement of the software. In that regard it is logically that studies made at an early development stage have the benefit of already adding to the development of user-friendly while the software is still flexible enough to be changed in a short period of time and therefore enabling the possibility of the creation of an optimal user-orientated product. Furthermore this paper intended to show the possibilities to draw conclusions from and with the eye-tracking analysis, especially regarding the user-reactions given an amount of predefined tasks. This procedure established itself regarding web-applications and will help developers of software in general or EMIS in special to create software products with a higher focus on usability. This fact should then add to the acceptance of the software, which is also crucial to convince possible decision-makers. The advantage for
the UxLab in particular lays in the fact that considering EMIS, domain-specific and target group orientated research can be performed. For the third quarter of the year a new study is planned with a professional material flow management software.

5. Acknowledgement

This research project is funded by the European Regional Development Fund (ERDF). The authors thank for the support.

6. Literature

Duchowski, Andrew T.: Eye Tracking Methodology: Theory and Practice (Berlin, 2007)
Fischer-Stabel, Peter; Kremers, Horst; Susini, Alberto; Wohlgemuth, Volker: Environmental Informatics and Industrial Environmental Protection: Concepts, Methods and Tools, Volume 3, (Aachen, 2009)