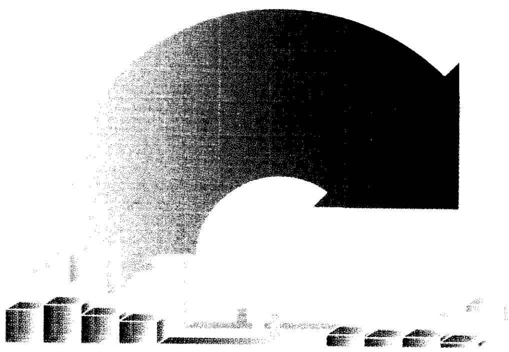
Environmentally-Friendly Product Development



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6.3 Evaluation of the Usability of the ecoDesign Workbench

6.3.1 Usability as Main Objective

The evaluation of software can be carried out with different objectives: (a) determining whether user needs are met, (b) assessing a system's suitability for a task or a group of tasks and (c) comparing a system with other products on the market (Kirakowski and Corbett 1990, in Gediga et al. 1999).

Within the evaluation of the ecoDesign Workbench the first objective was of main interest. This objective refers to the usability of software. Usability is a concept which is, on the one hand, seen as ill defined and vague and, on the other hand, as an important concept in software design and evaluation (Gediga et al. 1999). In our research the usability concept of Gediga et al. (1999) is used, which are defining and measuring usability along the seven design principles of ISO 9241, Part 10: suitability for the task, self-descriptiveness, controllability, conformity with user expectations, error tolerance, suitability for individualisation and suitability for learning (ISO 9241 Part 10 1996).

The evaluation of software-usability is considered as important with respect to several reasons (see e.g. Jordan 1998). Within the present research, usability is measured to assure that working with the ecoDesign Workbench is as efficient as possible and not too strenuous.

6.3.2 Formative Approach

Software evaluation can be executed as well as in a formative or in a summative way: "Formative evaluation is done in order to help improve the interface as part of an iterative design process. The main goal of formative evaluation is thus to learn which detailed aspects of the interface are good and bad, and how the design can be improved [...]. In contrast, summative evaluation aims at assessing the overall quality of an interface, for example, for use in deciding between two alternatives or as part of competitive analysis to learn how good the competition really is" (Nielsen 1993). The evaluation of the ecoDesign Workbench's usability was carried out as a formative one, to find out which aspects of the system have still to be improved and which not.

6.3.3 Previous Studies

Within the formative evaluation of the ecoDesign Workbench, three empirical studies were performed: In the first study, 15 experts were asked about features an IT-based system for ecological product development like the ecoDesign Workbench should have to obtain a satisfying user acceptance of this system (Schramme 1999, Wiese et al. 2001). Not surprising, the usability of such a system was seen as an important aspect of user-acceptance (Wiese et al. 2001). Within the second study, a prototype of the ecoDesign Workbench, consisting only of LCAD and a CAD system, was evaluated with respect to its usability. This was done with the IsoMetrics^{L} (Gediga et al. 1999), which will be described in detail below. The participants of this study were 17 mechanical engineering students. The results of the study showed that the usability of the ecoDesign Workbench was still not satisfying. After a comprehensive revision and advancement process the usability of the system was evaluated again. Methods and main results of this third study are summarised in the following sequences (Felsing et al. 2004a).

6.3.4 Method

Within the third study, usability was measured by a mix of qualitative and quantitative methods, concerning the following variables: (1) subjective assessment of the system by users, (2) well-being of users before and after working with the ecoDesign Workbench and (3) usability problems noted by users after working with the ecoDesign Workbench.

Subjective assessment of the ecoDesign Workbench. The subjective assessment of the ecoDesign Workbench was done with the IsoMetrics, which is an instrument for the formative and summative evaluation of software according to ISO 9241, Part 10 (Gediga et al. 1999) and includes the corresponding subscales. Two versions of the IsoMetrics are existing: One for summative – IsoMetrics^{S} – and one for formative evaluation – IsoMetrics^{L} (Gediga et al. 1999). In the present study, a slightly modified version of the IsoMetrics^{L} was used. With this instrument, formative evaluation is conducted in two steps: First, the software is assessed with items according to ISO 9241, Part 10 ("rating score"). In a second step, the importance of every item for the general impression of the evaluated software is gathered ("weighting index"). The difference between rating score and weighting index is seen as a measurement for usability problems: High differences (that means: low ratings and high weightings) are interpreted as indications for usability problems whereas little differences are seen as indications for good usability.

Well-being of the test persons. The well-being of the test persons was tested with a shortened version of the Multidimensional Mood Questionnaire by Steyer et al. (1994).

Usability problems. Qualitative data were collected within a Heuristic Evaluation (Nielsen and Molich 1990). The Heuristic Evaluation requires writing down subjective impressions on the object of evaluation, after having worked with it. In the present study, the participants had to write down the usability problems they encountered while working with the ecoDesign Workbench. To make this process easier, the participants got an evaluation sheet, which was structured according to the single working steps they had done before. As a result, they were able to assign their problems to these single steps. To stimulate answers, they received a list of nine usability heuristics that should have given an idea about what features a good computer based working environment should have.

Furthermore it was explored if the expertise of the participants with reference to the ecoDesign Workbench had any influence as well as on their assessment of the ecoDesign Workbench and their well-being while working with it.

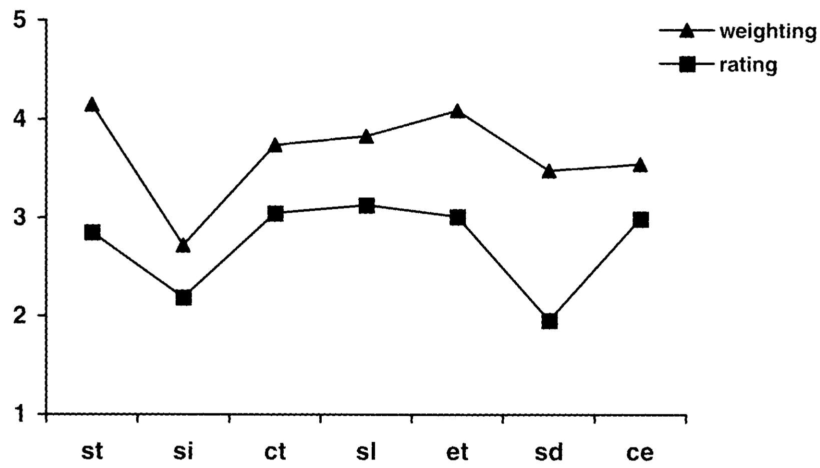
14 participants took part in the study. They were recruited from the CRC 392 staff and had to work about 90 minutes with the ecoDesign Workbench in the Design-for-Environment-Laboratory (DfE-Lab) of the CRC 392. The DfE-Lab is equipped with several workstations with the ecoDesign Workbench installed on them. A video observing system recorded the participants, working with the ecoDesign Workbench, as well as the video signals of the workstations. The audio and video signals were converted into digital files, to make an ex-post evaluation of critical situations possible.

6.3.5 Results

For all subscales, the results of the IsoMetrics^L showed clear differences between ratings and weightings, with the ratings always lower than the weightings (see Fig. 6.39). With regard to the subscales suitability for the task (st), self-descriptiveness (sd), error tolerance (et) and suitability for learning (sl), these differences became significant (Felsing et al. 2004a).

Five of the seven ratings were of middle size (suitability for the task, controllability/ct, suitability for learning, error tolerance and conformity with user expectations/ce), the others were a little weaker (suitability for individualisation/si and self-descriptiveness).

To analyse the IsoMetrics^L-results with reference to the expertise of the participants, the sample was splitted in two subgroups of novices (N = 8) and experts (N = 6) along the criterion "self-reported knowledge about the ecoDesign Workbench". Expert ratings could be found in all subscales lower than novice ratings. In the case of the subscale suitability for individualisation (si), the difference became significant. With respect to the individual weightings of the subscales, results of experts and novices were fairly similar.



Weighting: 1 = not important, 5 = very important. Rating: High ratings are standing for a good usability. St = suitability for the task, si = suitability for individualisation, ct = controllability, sl = suitability for learning, et = error tolerance, sd = self-descriptiveness, conformity with user expectations = ce.

Fig. 6.39. Results of the IsoMetrics^L (adapted from Felsing et al. 2004a).

The well-being of the participants was, after working with the ecoDesign Workbench, significantly lower than before. The comparison between experts and novices showed that only in the subgroup of the experts the well-being was significantly detracted from working with the ecoDesign Workbench, whereas in the group of the novices such an effect could not be observed.

In addition to the quantitative data, the qualitative data of the Heuristic Evaluation-answers served to detect usability problems in a more detailed and more concrete way. The main problems, which were found by this method, concerned the data handling, the insertion of processes within the LCM, the amount of information supplied by LCAD and the user interface (Felsing et al. 2004a).

6.3.6 Key Conclusions

After the above-mentioned evaluation study, the results were mirrored back to the developers of the ecoDesign Workbench to make sure that the latest version of the ecoDesign Workbench – which was described in section 6.2 – became as user-friendly as possible. The main revision steps, which were carried out to reach this objective, concerned the integration of the system, the data handling and the amount of supplied information by LCAD: A uniform appearance and a high integration of the single system components could be obtained and the data handling has been simplified. Furthermore the amount of supplied information has been reduced and adjusted to the users' needs.

All in all, these measures ensure that usability aspects caught up with the high technical standards, which the ecoDesign Workbench has set in the field of environmental impact assessment. And, respecting the "voice of the user" is a prerequisite for the successful creation of an integrative software platform, especially in the domain of design for environment where any additional work is too easily perceived by the product developer as an unacceptable burden. Modifying the ecoDesign Workbench according to the user-specific optimisation potential described in this survey has brought the ecoDesign Workbench a great step forward on the road to an easy to use assessment system which is integrated in the familiar work environment of the product developer.