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Whitepaper

Usability engineering

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Development of more user-friendly and ergonomic software

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SUMMARY
- Definition of Usability engineering
- From roles to the click dummy: The approach of usability engineering
- Extended usability engineering for demanding requirements towards the software
- Guidelines in the normative regulated environment

KEYWORDS
Roles, tasks, cluster, navigation map, abstract prototype, visual prototype, click dummy, EN ISO 9241, MDD, MDR, FDA, IEC 62366, data mining analyses, eye tracking

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1 Introduction

Ergonomic work stations, optimised processes and taking account of the entire value chain as part of a lean management process – many companies are going to great lengths to create the perfect basis for intuitive, ergonomic and, subsequently, efficient work. Despite the level of awareness of the issue, ergonomics is often regarded insufficiently or too late in the case of software development. However, modern user interfaces increasingly need to keep pace with trend products and rival products, thus placing increasing focus on usability engineering or software ergonomics. The growing use of mobile devices with relatively small screens and fewer functional keys further is rapidly intensifying this demand.

Usability engineering is not about the development of stylish or ultra-modern interfaces. It is rather the step before this, as the goal is to create a perfectly structured user interface which enables the user to perform complex actions intuitively with just a few clicks. This saves the user time, reduces the number of errors in their work and brings them to accept the software as a support resource. Various principles and normative standards need to be met in practice, which play a key role in the approval process in regulated environments, such as in medical technology. Only once usability engineering is complete can the design connect to the optimised software and interface structure through the development of modern graphical elements.

2 Principles and development process

Usability engineering is often considered too late in many software projects. This means that basic decisions regarding the structure of the software and user interfaces are already made and implemented. Any restructuring with regard to increasing the level of user friendliness would involve greater changes, thus requiring further financial investment and more time, and leading to potential delays in the completion of the project. Usability concepts are therefore often developed and implemented somewhat half-heartedly, or not at all.

Efficient, meticulous usability engineering should be practised from the very beginning and regarded as preliminary work for subsequent implementation. Key to this is an adapted development process highlighting roles and responsibilities, rather than functions, as was previously the case.

2.1 Creating roles and responsibilities

- Responsibilities: users typically use software for complex work, such as controlling production facilities, in which they need to perform a large number of individual steps, or responsibilities. These include recording a fault in a production facility, for example. In the case of a task or responsibility, it is not important how it is technically implemented. The level of detail of task descriptions (and also subsequently of system response and system responsibility) grows with the increasing advancement of usability engineering. Starting with the main general tasks (e.g. generate logging of commissioning), all tasks end up with specific detailed tasks, known as user intentions (e.g. qualification of logging parameters, selecting log types, creating logs).
- Functions: on the software side, a task often involves carrying out a large number of function. This only relates to the technical implementation of tasks, which does not affect usability engineering.
- Roles: depending on the area of application, the software may be used by different target groups. In production fields, for example, it may be used by start-up engineers, developers or service staff. Each of these roles involves specific responsibilities. In theory, a single user can fill multiple roles, while multiple users can also perform a single role.

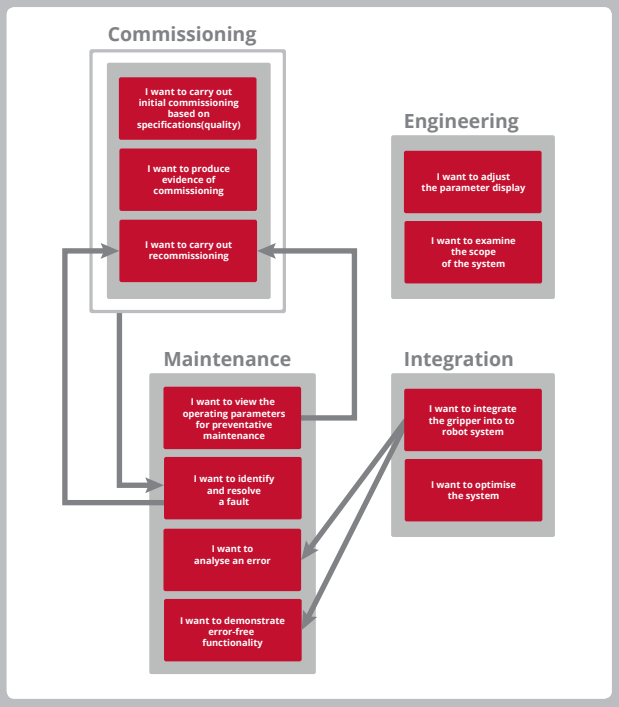

Figure 1:
The navigation map visualises the navigation between clustered tasks

Depending on whether the usability engineering is carried out for a newly developed piece of software or for existing software, the procedure varies in relation to roles and responsibilities. As the users and various role types already exist, existing software can be used to identify (missing) links in relation to software ergonomics by directly observing and enquiring with users while they use the software. In the case of new software, however, detailed personas should be drawn up as preliminary step, from which the various roles for subsequent usability engineering can be derived. The level of detail here should extend to photographs, demographic information (age, education, family status, etc.), profession, primary responsibilities, expectations of the software, and general likes and dislikes of the individual personas. This should ensure that the subsequent user base is reflected by these personas during the development phase of the software ergonomics as much as possible.

2.2 Forming clusters and creating navigation maps

Particularly in the case of software covering various types of roles, there is overlap in the responsibilities for the various roles, for example if user registration or saving files is relevant for each role. For all roles and relevant responsibilities, clusters with similar or identical responsibilities can be created and presented in the form of diagrams. A navigation map or navigation model then depicts the navigation between the various clusters (fig. 1).

2.3 Visual prototype and click dummy

By means of the interim step of an abstract prototype (fig. 2), in which an initial operating structure is derived from all responsibilities, a visual prototype of the user interface is developed. The type of device for which the software is designed plays a key role in this. Is it a desktop application? Is the software designed for mobile devices involving multi-touch applications or does it involve the operation of a different type of embedded system? The input interfaces which are available for operation are also important here.

Often in the form of a paper draft (fig. 3), the visual prototype serves as a basis for the click dummy (see fig. 4). The latter depicts the ergonomic arrangement of the user interface components in heavily simplified form, without finalised elements, in order to verify the efficient usability of the interface. In this status, no executable functions are provided. The click dummy is used for reviews, click studies with test subjects and ultimately as a template for the graphic designer. To develop the click dummy, programs such as PowerPoint or Expression Blend from Microsoft, or Balsamiq Mockups, are used.

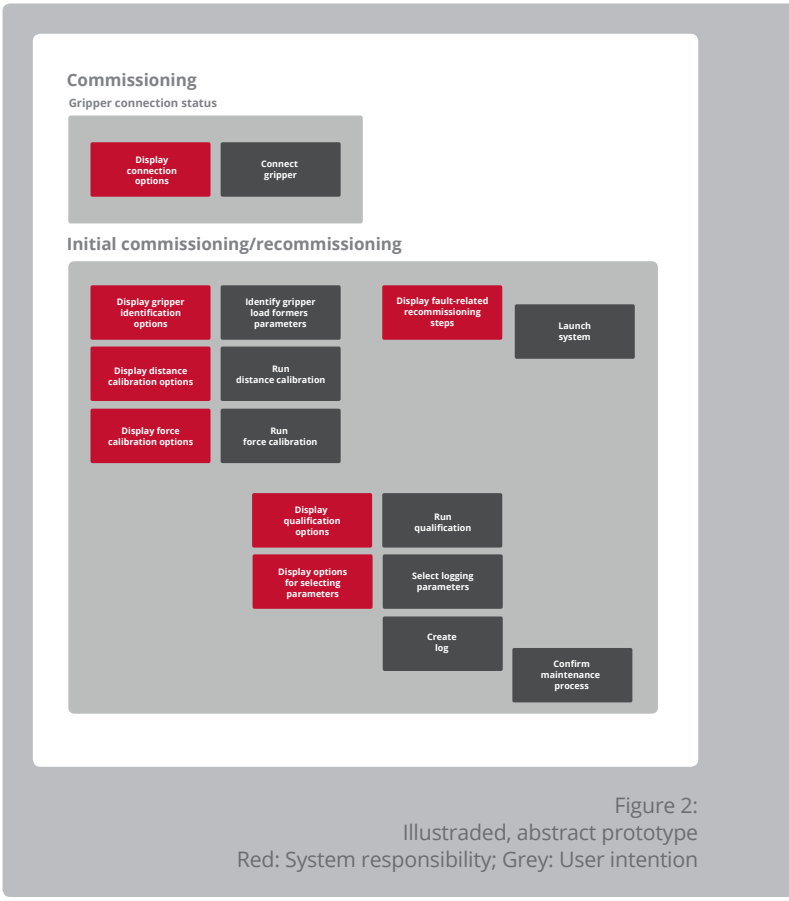

Figure 2:
Illustraded, abstract prototype
Red: System responsibility; Grey: User intention

2.4 Normative standards and usability tests

Figure 3:
Development of a visual prototype as template for a click dummy (see Fig. 4)

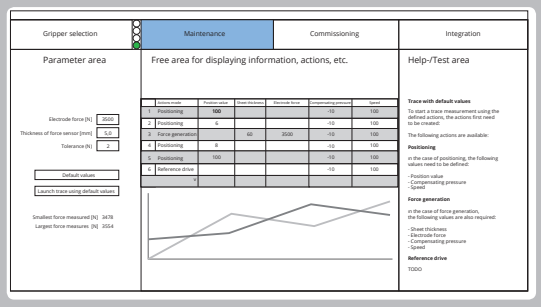

Figure 4:
Click dummy

The EN ISO 9241 series of standards describes generally applicable guidelines for the usability and design of dialogue interfaces between man and machine. These cover the ergonomic arrangement and design of user interfaces as well as the customisability and fault tolerance of a piece of software.

In cases where operating errors could involve a risk to human life, usability engineering is even more vital. In the field of medicine, for example, a high percentage of serious incidents occur due to the poor usability of the software used.

In particular for software relating to medical products and accessories, the European Union developed the Medical Device Directive (MDD), or the Medical Device Regulation (MDR) coming into effect from the beginning of 2017, which requires evidence of appropriate usability. The best way to implement this is by meeting the harmonised standard IEC 62366, which requires the precise description of the main operating functions, general operating conditions and user groups. The US Food and Drug Administration (FDA) also places a strong focus on the human factors involved in medical software and sets similar requirements, though differing from the EU directive in certain key aspects. Both directives highlight the close relation between usability and risk management processes. Usability should be documented, verified and validated in accordance with strict criteria. In many cases, this requires the involvement of real users. For effective software development, prototypes and click dummies can be provided at an early stage and used for testing, in order to identify and make necessary adjustments as early as possible.

However, software for use in less regulated or non-regulated environments should also examined on an ongoing basis by means of usability tests, insofar as usability is a key factor in the success of the software. Typically in these tests, the user behaviour of a test group is recorded on video and then subsequently analysed. Any anomalies can be identified quickly and resolved.

3 Extended usability engineering

Software available across a wide target group, such as consumer software, is suitable for big data and data mining applications. This is particularly the case if there is an Internet or server connection. First, information is collected about the buttons the user clicks and the actions they perform. Using this database, special data mining application establish connections between the click behaviour and the actual goal of the user, and identify any anomalies in relation to software ergonomics. For example, if several users take an unnecessary intermediate step in performing a task, conclusions may be drawn for usability engineering. Users can also be encouraged to click on further offers or information by displaying targeted, optimally placed messages, for example.

In the case of software that requires a high level of software ergonomics (e.g. if a user needs to make and carry out a decision very quickly), high-end processes such as eye tracking can be used. Here, special cameras track the eyes of users during a series of tests, as they use the software, thereby offering insight into the subconscious minds of the test subjects. For example, if a user increasingly focuses on a certain area of the user interface in the case of borderline situations, it would be a good idea to place information elements or important buttons in this area, thus offering a key benefit in relation to shorter response times.

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