

EVASERVE

Module: User Interface

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Evaluation goal

User interface means the interface between the user and the technical system (human machine interface). User interface evaluation also incorporates the evaluation of the interaction between the user and the system (human machine interaction). It is vital for the evaluation to establish what kind the interface should be in order to meet the set system goals as well as possible. Technical systems can also be developed into a so-called embedded system where the interface is not consciously discernible to the user.

User interface evaluation concentrates on the user viewpoint at the development or implementation phase of systems. The purpose of the development work is to improve the ergonomics of the interface by considering user needs and actions. At the implementation phase the emphasis of the evaluation is either on can the interface be allowed to be used in traffic or on comparison of competing interfaces.

User interface evaluation is close to the concept of usability evaluation but the concepts differ from each other. Usability is a concept defined in information technology (ISO 9241-11:1999) containing also the evaluation of the system accuracy and efficiency. The use of the usability term in transport applications easily leads to conceptual ambiguity and overlap.

The goal is to connect the acquisition of the evaluation data to development work so that the results of the evaluation can be exploited as well as possible in the design of the system. The evaluation is carried out in order to ensure that the users interaction with the system is optimal. If the interface is not good for the user many other system goals fail: a system with a bad interface is hard to market and its social impacts are not realised optimally. Also the reliability, availability and safety of the system are at risk if the user has difficulties in interacting with the system due to a bad interface. The result is at worst endangered traffic safety, disappearance of system clients and complicated launching of a new similar service or system.

Evaluation process description, definition and viewpoints

The goal of the evaluation is to produce information to be used at the different phases of design in the development of the user interface. The evaluation process of a user interface can be divided into five phases:

1) Analysis of user actions and use of designed system

- ✓ Analysing the operation and its goals, how the system operation should be changed and what kind of interface can best achieve it.
- ✓ At this phase it is important to study among other things the actions susceptibility to risk. E.g. driver actions can be divided into strategic, tactic and operational levels (Michon, 1985). User interface requirements are different at the different action levels.

2) User interface elements

- ✓ Different user interface components can be studied even before constructing prototypes. Breaking the user interface evaluation into subtasks assists the sufficiently thorough evaluation of important details.
- ✓ These elements or alternative solutions are e.g. the following decisions
 - the senses used in transmitting information
 - the symbols used and the best alternatives
 - what content should be prioritised and what is the data structure

3) First prototypes

- ✓ Very primitive versions can be sufficient for the study of many issues and the evaluation does not need to be done in the genuine environment but usually rather in simple laboratory circumstances. These evaluations avoid spending valuable design time on the development of solutions unsuitable for the user
- ✓ The user viewpoint (both on the needs and user interfaces) should be clear in sufficient detail before the first operational prototypes

4) Prototype in use

- ✓ All the characteristics of a user interface do not become evident until a situation imitating real use or actual situation

5) Prototype / system in established use

- ✓ Established use still gives important and qualitatively varied information about system use and also about the functionality of the user interface. Ways of using often change in the long run so the long-term impacts of user interfaces should be evaluated only after the use has been established.

The user interface connects the user to the system. In the above phases of the design process the user interface evaluation is analysed from the user action viewpoint as a sense-observation-decision-action chain (e.g. Häkkinen & Luoma 1991, Wickens & Hollands 2000). Effective operation requires that the

system is observable and understandable to the user, interaction is efficient and the system has to produce intended reactions and minimise malfunctions.

It is essentially important that user interface evaluation is made a part of the initial stages of design with sufficient investments. Early user interface evaluation means that the system can be realised more economically. It is also important to ensure efficient dialogue between the suppliers and designers of the evaluation data and the service owner.

The requirements set for user interfaces in traffic are exceptionally great for a number of reasons. The main reason is that user interface deficiencies can critically endanger traffic safety. The second reason is that usage situations and circumstances vary and they can be very demanding especially when using the system while driving. Thirdly the system used while driving must usually be suitable for users varying in knowledge, skills and experience (see Häkkinen & Luoma 1991). The systems must be equally suited for young and old, inexperienced and experienced, professionals and other road users etc.

Evaluation methods and instruments

The studies features can be evaluated using several different methods and techniques. The most common are different use tests and experiments, observations, user interviews and questionnaires and expert evaluations. Meticulous evaluation requires usually the application of several methods and sufficiently differing users and operating situations.

The user interface should be evaluated very early on at the system development phase. User interface evaluation is in this respect closely connected to the study of user needs. Often a more shallow evaluation has to be accepted.

The basis for the evaluation is user interface legislation and its application and dimensioning guides, international standards, pre-standards and international recommendations (among others European Commission 1998 and 2005). Many regulations provide only a general base for user interface expert evaluation. The phases of the evaluation are shown briefly below.

The matters examined in user interface evaluation are shown in Table 16.

Table 16. User interface evaluation checklist.

USER INTERFACE EVALUATION	
Evaluation object	Example
Perceptivity	Legibility of visual information, volume of sound information
Intelligibility	Interpretation of message for its operation in the environment
Order of information	Possibility of getting lost in the menus
Information compatibility with the other system	Compatibility between the information of variable message signs and the vehicle terminal
Control system	Distance, operation method, reliability in different circumstances
Interaction between user and system	Adequacy of feedback, action in error situations
Impacts on driving and stress	Focusing the eyes, vehicle control, use of control system
Acceptability	Seeing the features as beneficial
Mounting and connections to other systems	Display location
Supplementary information and instructions	Legibility of instructions

One basic condition for system operation is the *perceptivity* of the user interface and the required details. Several systems produce visual stimuli. Their important features are among other things legibility, size of signs and symbols, contrast, luminance, resolution and colours (Luoma 1981). A single message is also a part of a series of messages and distinguishing it from others is thus an essential criteria (Alferdinck et al. 1998). The messages should usually also be perceptible under different lighting circumstances. The essential characteristics of voice and sound messages are volume and clarity, repeatability and the control of other possibly distracting noises. A study can also be made whether the appearance of new information or message is clearly expressed in e.g. a vehicle terminal. Correspondingly the visual stimuli in the environment should be visible in sufficient time and also conspicuous (see e.g. Sivak & Flannagan 1993).

Intelligibility means that interpreting the meaning of the message from the user's viewpoint in the connection and environment of actions (e.g. Luoma & Rämä 2001, Rämä & Luoma 1997). For example the intelligibility of symbols, numbers and abbreviations should be evaluated so that there are no uncertainties about user interpretations. Intelligibility is one of the most important evaluation criteria of messages.

Order of information evaluation studies if the information is presented (e.g. on display or menu) in such an order that perception and comprehension is as efficient as possible. Evaluation can also be made whether passing from one subject to another and subject hierarchy are easy and errorless, whether the user can get lost in the menus etc.

Evaluating *information compatibility* with other system means studying whether the information from the user interface is harmony with the circumstances and the information from the other environment.

If the user interface contains a *control system* the ergonomics of the solutions should be evaluated. Evaluations should be made on whether the controls are close enough, are they explicit and consistent (turn-

ing, pushing etc), are they discernable under different lighting circumstances, is the colour coding correct, are they operable also when the vehicle shakes etc.

The *optimal formats and functions* of the user interface should be evaluated. Evaluations should also be made on whether the system gives enough feedback in user error situations and how the feedback system works from the user viewpoint. The user interface should give out sufficient information about the state of the system and should not present information which may lead to dangerous action.

If a telematics system is used while driving a vehicle (or generally while moving) it is essential to evaluate what impacts the user interface has on the execution of the drivers primary task. E.g. The main task of a driver is to hold the vehicle on the intended part of the road and avoid collision with obstacles and other road users (see Wierwille 1993). The system should primarily be a user aid and should not disturb the user. The impacts of the user interface can be evaluated by analysing the focusing of the drivers' eyes, consideration of traffic situations and other road users, vehicle control, use of controls etc.

In addition to perceptivity of individual stimulus evaluations should be made on the total amount of information per time unit, information timing and what kind of reaction the system requires from the user (e.g. not to require time-restricted reaction from the user).

Acceptability means the recognition of the systems features and appreciation of the features as good and worthwhile (see e.g. Luoma & Rämä 2002). As the systems get more complicated it may be essential to evaluate how the user understands the operation and control principles of the system. In the case of systems already in use the number of use instances and willingness to pay are signs of acceptance.

Mounting evaluates among other things the place of the vehicle terminal from the visibility and accessibility viewpoint and from the other control and system component viewpoint. The user interface should not cover other equipment or block visibility. On the other hand, the displays should be mounted as close to the drivers' normal line of sight as possible. Reflections and lighting conditions are checked.

Lucidity, legibility, scope and intelligibility should be evaluated for *supplementary information*.

The EU commission has issued a directive (so-called ESoP 2006) on the main traffic safety design and use viewpoints to be considered in the design of in-vehicle information and communication system user interfaces. The directive substitutes the earlier (1999) recommendation. The directive spans six target areas i.e. design; mounting; information presentation; display and control user interfaces; system behaviour; system information. Each target area has been specified using descriptions or presentations, examples, application area, verification and references.

Results

Reporting and development suggestions. Disclosure of testing circumstances

Conclusions, recommendations and reporting

It is essential to carry out the evaluation at a sufficiently early stage. The risk is that the information does not reach the designers.

Connection to other modules

The module is connected especially to the User needs module.

References and other material

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Ajoneuvojärjestelmien turvallisuusvaikutuksiin liittyviä (myös käyttöliittymäarvioontia koskevia) ajankohtaisia hankkeita EU:n 6:ssa ja 7:ssä puiteohjelmassa.

eIMPACT, Socio-economic Impact Assessment of Stand-alone and Co-operative Intelligent Vehicle Safety Systems (IVSS) in Europe

PREVENT Preventive and Active Safety Applications Integrated Project, Subproject PReVAL

FESTA Field Operational Tests – Support Action

HUMANIST HUMAN centred design for Information Society Technologies