
Comfortable earth moving machinery

Knowledge and experiences from the Eurocabin project

Editors

F. Krause

R.E. Bronkhorst

M.P. de Looze

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TNO Work and Employment

P.O. Box 718

2130 AS HOOFFDORP

The Netherlands

Fax: +31 23 554 93 94

E-mail: receptie@arbeid.tno.nl

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Editors:

Frank Krause, Robin E. Bronkhorst, Michiel P. de Looze

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9 On user involvement

Frank Krause, Robin E. Bronkhorst

TNO Work and Employment, Hoofddorp, The Netherlands

9.1 The importance of user involvement

Years of designing machinery for people to work with have shown, that it is important to consider human factors in the design. There are many of these factors to take into account.

Human dimensions and especially the differences humans show in their dimensions, are an important issue in the design of a machine. Designers should carefully consider for which population they are designing and then select the proper data on dimensions. Data on human force exertion are important in the design of levers and controls.

The role of the operator is changing. From hard work moving the levers, his job is changing into one in which the machine is operated by multi-functional joysticks that require co-ordinated actions from the arm, hand and fingers. (Semi)-automatic systems further shift his task towards a complex controlling task. These new dimensions to machine operation require knowledge on other areas than before mentioned.

Scientific knowledge about comfort can be used in the design process to try to design a product that is comfortable to the largest group of users.

These are just a few human factors issues, other issues such as knowledge on whole-body vibrations, noise and all aspects connected to vision are also of great importance in the design of machinery.

However, does using this information in the design process of the vehicle then automatically lead to the perfect product? Not necessarily. Creating a functional and comfortable working environment is far from easy. There are many factors influencing the comfort aspect, some of which may conflict. They may also conflict with machine functionality. Also, knowing what people need is one thing, being able to predict what they like is something very different.

Therefore, input from the user should be added to this information. This means the user should be involved in the design process.

There are several stages in the process in which the user can be involved, each with its own advantages. They are mentioned below.

9.2 Stages of user involvement

Reviewing existing machines

As a starting point for (re)design it is important to have information on existing machines. When designing a new machine the manufacturer wants it to be better than its predecessor. The existing machine serves as a benchmark for the new machine. Therefore it serves to have exact information on strong and weak points of all machines serving as a benchmark. The best way to gain this information is through a thorough review of these machines. Manufacturers not often have an independent party perform a detailed, more or less scientific, review of a certain machine among its operators. Generally they rely on the information they will receive during the lifetime of a machine from users through contact with sales and/or service people. This information, mostly concerning weak points, is forwarded to the design department. Often designers also speak to machine operators. It is our experience that this method of information gathering will generate 80% of all weak points of a machine. The question is whether this is enough for the decision making in a (re)design process.

A detailed review will pinpoint all weak points as no subject is overlooked. It will produce data showing frequencies that certain answers have been given. By having data on how often a weak point is mentioned, and by having detailed opinions on weak points, it is possible to prioritize points of improvement.

Further advantages of a detailed review by an independent partner are that the machine is looked at with 'new eyes' and by someone who is not directly involved with the manufacturer. In the Eurocabin project a thorough review by independent experts was performed. How this was done, is explained partly below and in chapter 11.

There are several ways to gather information from the user. The expert may use a structured or non structured interview. Obviously the chance of overlooking a subject is present if the interview is not structured. Then it is also possible to use questionnaires. The questionnaire may be read to the operator or he may fill it in at a suitable time. In the latter case there is always the risk of not returning the questionnaire. However, reading out the questionnaire relies heavily on the time the operator is available for questioning, which is generally not a lot.

In Eurocabin a combination method was used. Operators had little time to stop and extensively speak to interviewers. Therefore we chose to use a short questionnaire that was used both as checklist for a structured interview both as questionnaire. After the interview we handed the operator an extensive questionnaire and asked him to fill this in at home. The non-response was signifi-

cantly reduced by having first met the operator and by calling the operator as a reminder (see figure 9.1).

Of course this method is less suitable when wanting to collect the opinion of large numbers of operators, unless large numbers of the specific machine can be found within small, easy to reach distances of each other, which in Eurocabin was seldom the case.



Figure 9.1 Interviewing an operator at work in the mountains

Redesign/finding solutions

In the redesign phase the input from the user is restricted. To find solutions to the weak points identified in the review users may take part in brainstorm sessions. They can come up with great and simple ideas. Their involvement also has the advantage that user satisfaction is higher, if the user recognizes typical solutions only users could come up with. However, mostly the redesign phase requires technological input for the detailing of the new machine and therefore there is less room for user input. Though not directly involved it is of course still very important to remain focussed on human factors. In all design changes concerning the operator-machine interface human factors knowledge should be used.

Prototype testing

In some stage of the redesign process prototypes are built of complete machines or part of the machine. When testing these prototypes the user's input should again be valued as it will increase the chances of designing a product well accepted by all users.

Prototypes should be tested under conditions that compare to daily use. The evaluation of a prototype should ideally take place by experts as well as users. It is not enough to have test drivers evaluate new solutions. Although very experienced with the machine they do not have the experience of using a machine many hours a day.

Knowing that discomfort mostly takes time to build up, especially in machines that are already quite comfortable, it is important to test prototypes over a longer period of time. Only then the manufacturer can be sure that the solution designed to solve a weak spot in the machine, is really a solution. If a choice has to be made between two or more solutions an experimental test set-up may be

required. In such a test the conditions are controlled as much as possible so that results from the test can be compared.

The testing of the prototypes will generate input for further decision making.

9.3 The expert versus the user

In a good design process both the human factors expert and the user are involved. Why the user is needed, we explained above. In this part we would like to explain the role of the expert with respect to the user. User centred design does not mean that all user wishes are incorporated in the new design. Apart from financial consequences this is probably impossible, as wishes will differ. So many users, so many wishes. The expert can help in this process as he can interpret the outcome of data from users.

Second it is arguable whether the user is capable enough of making the right choices in his desire to not only have a comfortable workplace but also one in which high productivity can be achieved. Third it may be very difficult for the operator to imagine what consequences certain desired changes might have. This appears to be especially true regarding health. Workers often adapt postures that require minimal energy expenditure. However these postures may put extra stress on the musculoskeletal system and thus pose a health risk for the long term. The expert is necessary to judge the situations that do not seem hazardous, however may be so in the future.

In general it can be said that while user participation in the design process is of utmost importance, the expert is needed to guide this process. Table 9.1 contains an overview of the user's and human factors expert's strengths and weaknesses regarding design input.

Table 9.1 Strengths and weaknesses of users and experts in the design process

	user	expert
strength	• target group of design • only person capable of testing real usability and comfort • not employed by manufacturer, independent	• asks the right questions in a user test to get the right useful answers • weighs answers and translates this in design requirements • has knowledge on what's comfortable, healthy and functional • independent, if not employed by manufacturer
weakness	• ignores financial consequences of own wishes • less capable of identifying long term musculoskeletal risk factors	• little or no experience in machine operation

9.4 Conclusions

To be able to design the best machine possible requires the involvement of experts and users, who are in fact of course also experts, only in their own field. Designing without user-input will lead to sub optimal solutions, because they are less functional or fail to address the demands an operator places on his machine. Not using expert knowledge on human factors will also lead to sub optimal solutions. They will be less ergonomic and thus directly influence the operator's opinion about the machine's comfort. In the long run they may cause health problems. The fact that operators are increasingly becoming the ones who decide what machine is to be bought, in our opinion increases the need for both user and human factors expert involvement.