Comfortable earth moving machinery

Knowledge and experiences from the Eurocabin project

Editors
F. Krause
R.E. Bronkhorst
M.P. de Looze

This publication can be ordered at:
TNO Work and Employment
P.O. Box 718
2130 AS HOOFDDORP
The Netherlands
Fax: +31 23 554 93 94
E-mail: receptie@arbeid.tno.nl
Price: EUR 20 excl. VAT

ISBN 90-6743-977-0

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

Print:
PlantijnCasparie Heerhugowaard

2 A new model of comfort

Michiel de Looze
TNO Work and Employment, Hoofddorp, The Netherlands

2.1 Introduction

In Western societies the comfort of products has developed into an important issue. This holds not only for the end users of products. Producers recognize comfort as a major selling point, as it is thought to play an increasingly important role in product-buying decisions. Also, employers are getting interested in comfortable equipment for their employees in order to create a healthy and stimulating working environment. For the design of comfortable equipment (e.g. the cabins of vehicles) it is important to have a good notion of the concept of comfort. What is comfort?

Comfort as well as discomfort are very common terms in common parlance. Everyone seems to have some kind of idea about their meanings. While comfort is generally associated with some pleasant state, discomfort is associated with an unpleasant state.

The concepts get more complicated if we think about 'when experiencing (dis)comfort' (Vink, 2002). You may experience discomfort, when it is too hot in a room or cabin. A similar experience may occur when feeling pressure points in your bottom when sitting in a driver's seat. You may also feel discomfort when working in bad body postures like neck flexion of trunk torsion. You may experience comfort when you feel 'at home' in your company or your cabin. You may feel comfortable because of the unexpected good looks of a new cabin's interiors or a surprisingly pleasant feeling when operating a new vehicle.

Hence, comfort and discomfort are influenced by many factors. For designing purposes it would be helpful to have a model in which (dis)comfort is defined and the factors that may contribute to the comfort and discomfort of an operator are incorporated. This model will be presented and illustrated in this chapter.

2.2 What is comfort?

The frequent use of the term comfort in common parlance and in the literature suggests that it represents a consensually held construct. Yet, there is no widely accepted definition of comfort. Webster's dictionary defines comfort as a state or

feeling of having relief, encouragement and enjoyment. Slater (1985) defines comfort as a pleasant state of physiological, psychological and physical harmony between a human being and its environment. Richards (1980) stresses that comfort is a state of a person involving a sense of subjective well-being, in reaction to an environment or situation. In conclusion: comfort is not yet clearly defined, yielding an on-going debate in the literature, but there are some issues that are not under debate, namely

- comfort is a construct of a subjectively-defined personal nature;
- comfort is a reaction to an external factor, a product or environment;
- comfort is affected by factors of a various nature (physical, physiological, psychological).

In other words: though comfort is an individual subjective matter, we need an environment or product to experience comfort, while this experience is physically, physiologically and psychologically mediated.

Discomfort versus comfort

How is discomfort related to comfort? Roughly, there are three views on this matter.

First, some have conceptualised comfort as two discrete states: comfort presence and comfort absence, where comfort has been simply defined as the absence of discomfort and vice versa (Hertzberg, 1958; Floyd & Roberts, 1958). This has two meaningful implications. Comfort does not necessarily entail a positive affect (Branton, 1969), and the ultimate goal of product designers is reaching the state of absence of discomfort, where the working individual is oblivious of the fact that he or she is seated (Bishu et al., 1991).

Secondly, many believe that comfort and discomfort are two opposites on a continuous scale, ranging from extreme discomfort through a neutral state to extreme comfort. One can distinguish ordered levels of subjective responses across the entire continuum from strongly positive (extreme comfort) to strongly negative (extreme discomfort).

Third, some argue that comfort and discomfort are not strictly the opposites to each other. Instead, they state that comfort and discomfort are different constructs which are affected by distinctly different variables (Kleeman, 1981; Kamijo et al., 1982). Feelings of discomfort are mainly associated with pain, tiredness, soreness and numbness which are assumed to be imposed by physical factors like joint angles, tissue pressure and circulation blockage. Comfort, on the other hand, is associated with feelings of relaxation and well-being, which do not only result from physical factors but also from psychosocial and emo-

tional factors. This view is supported by experiments showing that aesthetic design matters with respect to comfort, but not to discomfort (Helander & Zhang, 1997). It was also found that at low discomfort rates, comfort rating may range form very low to very high. At high discomfort rates however, comfort ratings are also low. Thus, discomfort has a dominant effect.

For the designer, this third view is interesting, as within this view he is confronted by two challenges (Paul et al., 1997). First, he should reduce discomfort by creating physically well designed products. Secondly, and even more challenging, he should increase comfort, which goes further than the physical optimization. Creating feelings of safety, exceeding expectations, or even provoking 'Wow-sensations' are important in relation to the end-user's comfort.

A model for comfort and discomfort

The view of comfort and discomfort as different entities is modelled in figure 2.1, where underlying factors are presented on a human, product and context level.

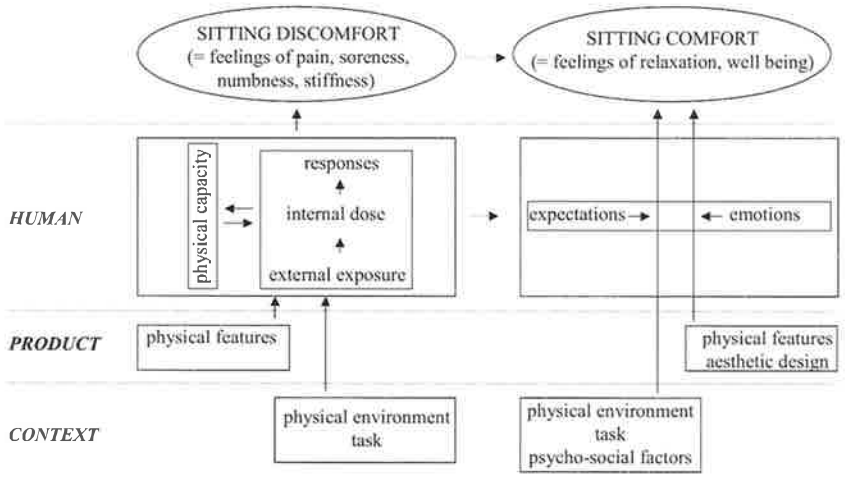

Figure 2.1 Theoretical model of comfort and discomfort and its underlying factors at a man, product and context level

The left part of this model concerns discomfort. Physical processes underlie discomfort. For an operator of an earth moving machine the physical characteristics of the cabin (e.g. location of seat and handles, climatic conditions), the environment (the riding surface, window reflections) and his task (the operation of the handles or steering wheel) expose the operator to physical loading factors (pres-

sure, force, joint angles, micro-climatic loading), which may lead internally to a loading dose in terms of muscle activation, internal force, intra-discal pressure, nerve and circulation inclusion, and skin and body temperature rise. These invoke chemical, physiological and biomechanical responses. The perception of these responses underlies the feelings of discomfort.
The right part of the model concerns comfort, i.e. feelings of relaxation and well-being. Again, the influential factors are presented on a human, product and context level. At a context level not only the physical features are assumed to play a role, but also psychosocial factors like job satisfaction and social support. At the product level the aesthetic design of the cabin may affect the feelings of comfort. At human level the influential factors are assumed to be individual expectation and other individual feelings or emotions.

2.3 From model to design

The model in figure 2.1 shows us the aspects that are important for comfort and discomfort. From the model we can deduce several issues that should be recognized by the designer who aims to design a cabin with minimal discomfort and maximal comfort for the operator:

- comfort and discomfort are affected at a human, product and context level. Therefore, it is important in product design to involve the end-user in the design process and to take the relevant features of the task and the environment into account;
- for reducing feelings of discomfort it is important to pay attention to all possible loading factors. These include awkward body postures (back angle, neck angle, upper arm and wrist angles, knee and ankle angles), pressure distribution and shear forces at the contact level of human body and seat and back rest, back compression, whole body vibrations, as well as micro-climatic loading factors. The challenge is to design such that all possible loading factors we can think off are minimized;
- for creating comfort it is important to pay attention to the aesthetic design of the cabin. It is important to get the right picture of the end-user, his emotions and expectations about a new cabin. Factors affecting these emotions (smell, noise, former experiences, and others) should be known. Exceeding the expectations of the future end-user is difficult, but of major importance.

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