On the use of computerised decision aids
Dijkstra, Jacob Jan
Summary

The results of this study show that an expert system is a persuasive message source and that users tend to follow the advice of an expert system without critically examining it. Accordingly, users will probably not notice when an expert system gives incorrect advice. These facts comprise a serious problem, because expert systems can make mistakes and have been developed on the implicit assumption that the user will judge the applicability of the expert system's advice.

The Elaboration Likelihood Model (ELM; Petty & Cacioppo, 1986a, 1986b), a social psychological theory of persuasion, helps to explain what makes people accept or reject advice. The theory posits that people evaluate messages by either careful examination of the message (the central route to persuasion) or by using simple decision rules without actually studying the message (the peripheral route to persuasion). It is the latter behaviour that can lead users to misjudge the advice of an expert system.

An expert system is a computer program that can solve a restricted set of problems using specific knowledge of these problems. Chapter 2 provides a description of an expert system and gives insight into the limitations of expert system advice. An expert system has a knowledge base, an inference engine, and an interface. The knowledge base contains the knowledge model that the inference engine uses to deduce the advice. Knowledge acquisition, the obtaining and construction of the expert system's knowledge model, is the most difficult part of expert system design (Waern, 1989). Some of the problems of knowledge acquisition are the definition and restriction of the knowledge domain, the limitations of models, the consideration of different experts' opinions, and the use of common sense knowledge. As a result, the expert system's knowledge model is probably incomplete and possible incorrect. Consequently, an expert system ought not be treated as an oracle (Boden, 1990). It is an advisory decision aid and the user should evaluate the applicability of its advice. Adequate explanation facilities and a user friendly interface are necessary to provide the user with sufficient information to
to be given to the expert system, and the user should do the actual problem solving. That is, expert systems should be designed as a tool for decision making in which its user is critically placed in the centre of the decision making process.
make such an evaluation.

However, several studies show that users often misjudge the usefulness of computerised aids. Sometimes users believe that they come to better conclusions with the help of the computer, although in fact the computerised aid does not improve their decisions. Chapter 3 gives an overview of these studies and introduces the ELM (Petty & Cacioppo, 1986a, 1986b), a model of persuasion that can be used as a tool for explaining this behaviour. According to the ELM, recipients do not always pay attention to the contents of a message. When motivation and ability to study the message is low, people often use simple cues, such as beliefs about the communicator, when they evaluate a message (the peripheral route to persuasion). Thus, users may accept the advice of an expert system without actually studying it. In such cases the expert system would merely function as a persuasive communicator.

Chapter 5 describes an experiment regarding the persuasiveness of an expert system. In the experiment 63 lawyers judged nine legal cases. Each jurist used one of two expert systems in obtaining advice on the cases. The expert systems had different incomplete knowledge models, and they consistently gave opposite advice on each legal case in question. The results of the experiment show that the incomplete and incorrect advice of the legal expert systems could easily mislead the lawyers who worked with them. Furthermore, subjects hardly used the explanation functions of the expert systems to verify the argumentation. This suggests that the expert systems persuaded the lawyers through the peripheral route. If the lawyers had carefully studied the advice, they would probably have noticed that the advice was inadequate.

Chapter 6 provides a study of the peripheral cues associated with expert systems. When users follow the peripheral route to persuasion, they may accept the advice of an expert system, because they have certain beliefs about advice given by a computer. In the experiment 84 subjects evaluated advice that was said to be given by either an expert system or by a human adviser. The results show that subjects thought that, given the same argumentation, expert systems are more objective and rational than human advisers. Furthermore, subjects judged a problem as being easier when
advice on it was said to be given by an expert system and the advice was presented in production rule style. Thus, the experiment shows that users have certain beliefs about expert system advice which is not grounded in the contents of the advice. These beliefs may influence the user's evaluation of the expert system's advice and bring about persuasion through the peripheral route.

Chapter 7 reports on an experiment that studies the link between the persuasiveness of expert systems and the peripheral route to persuasion. In the experiment 71 subjects were asked to judge the advice of an expert system on three law cases. For each case correct advice was given on paper. However, subjects also consulted an expert system that consistently gave incorrect advice on the law cases. Subjects who always agreed with the incorrect advice of the expert system experienced less mental effort, scored lower on recall questions, and thought the problems to be easier than subjects who disagreed once or more with the expert system. These findings indicate that subjects who agreed with the expert system had studied the advice less carefully than subjects who disagreed with the advice of the expert system. This is in agreement with the ELM and it indicates that rejection of expert system advice is associated with the more effortful central route to persuasion whereas acceptance of the advice is associated with the less effortful peripheral route to persuasion.

This third experiment also involves an investigation into factors that moderate the persuasiveness of expert systems. According to the ELM, recipients with low motivation and less ability to study expert system advice are more likely to follow the peripheral route to persuasion. The user's motivation to study such advice is looked into more carefully in Chapter 4 by focusing on beliefs that may bias someone's motivation to interact with a computer. The beliefs discussed in the chapter are perceived usefulness, perceived ease of use, computer anxiety, computer playfulness, and computer self-efficacy. In Chapter 7, the results of the third experiment suggest that subjects with low motivation to interact with an expert system will agree more often with an expert system's incorrect advice, especially when the advice is presented in a production rule style.
Taking together, the results of the three experiments should make us rethink the concept of expert systems. Their overall message is that expert systems are persuasive message sources. That is, users of expert systems will often use the peripheral route to judge the expert system's advice and, consequently, they will probably not notice when an expert system gives incorrect advice.

Chapter 8 draws some implications that arise from the persuasive effect that an expert system can have on its users. Software designers should be made aware of this effect and should strive to develop computerised decision aids with human limitations and human capacities in mind. Improving the expert systems user interface will not be enough, because even useful explanation facilities with a well-designed interface do not guarantee that the user actually will consult them. This lesson may also be important for the design of other types of intelligent computer support.

Unfortunately, most computer support is machine-centred in design. Often all parts that can be automated are, and 'leftovers' are given to human operators. Consequently, human errors result when machine-centred tasks are imposed upon us through technology, as it forces us to behave in ways incompatible with our fundamental capabilities (Norman, 1993, p. 138). Mostly these problems are caused by a lack of understanding of the social impact of technology. Therefore, models from social psychology, like the ELM, may help in the design of computerised decision aids that fit human needs better than those currently available.

Then there is a potential legal liability that may accrue from the use of expert systems, in the light of which users and designers should rethink the relationship between the user and the expert system. Users should be aware that they are probably accountable for decisions taken on incorrect advice of an expert system, even when they treat the expert system as an infallible oracle. Designers should assure that users are made aware of that fact.

Finally, it is urged that expert system projects should start with a task analysis which ensures that the user is not confronted with a task that he or she cannot handle. An expert system should support those routine parts of decision making at which humans are less adept, such as mathematics and looking up information in tables or databases. These simple routine tasks are