Product Evaluation Methods and Their Applications

V Popovic
School of Architecture, Interior and Industrial Design, Queensland University of Technology
GPO Box 2434, Brisbane 4001, Australia

Abstract. This paper discusses methods and techniques to be used for an ergonomic evaluation of products, product interfaces and systems. In this context evaluation is seen as a part of the design process that interacts with all design stages. It plays an integral role in it and is concerned with assuring a high degree of likelihood of the user's acceptance. Traditional and new evaluation methods such as task analysis, checklists, TA (talk/think aloud) protocols, CAD simulation are addressed.

1. Introduction

To succeed a product or system must provide satisfactory interaction with its user/customer on both a functional and a cultural level. Manufacturing companies are competing on national and international levels to achieve a competitive edge in the market. This creates demand for faster product development and production. Product quality refers to the performance, overall design and interface design of the product/system, the manufacturing process and the product life cycle. This means that better design developed in detail and based on applied research during the design and development process plays a significant role in the competitiveness of a company. This demonstrates the increasing importance of the role of design both for economic competitiveness and for improvement of the quality of life and work.

Design is a prediction concerned with how things ought to be. It is aimed at changing an existing situation into a preferred one. The designers attempt to predict the behaviour of a product and its users using their knowledge and expertise. To use the product the human has to understand it. To achieve this designers have to understand what is the knowledge structure domain that humans have regarding products/systems and their contextual environment This means the environment in which products are used. However, designers still operate in their traditional role (that is professional-client relations). The designers receive the client's brief in which needs and wants are specified and design a product outside of its contextual environment by predicting the behaviour of a product and its users on the basis of their knowledge as experts or from personal experience. The outcome of this are products/systems that do not respond to user's expectations. They are designed "for users" but not "with the users". The user is interpreted by a designer via market research information or designers utilise themselves as a user stereotype. This causes the problem of user interaction with products via their interface (Norman, 1986, 1988, 1993). However, the traditional role of the designer and client interaction is changing into a more complex one. This also means that in depth research is needed in order to design better and more valuable products/systems that will respond to contemporary demands. It will require designers to apply more sophisticated knowledge in order to respond to market demands and users' satisfaction.

2. Evaluation Methods and Design Process

The most innovative phase of the design process is its conceptual phase in which most decisions were made. With advanced product development and manufacturing more detailed product concepts are needed. This means that in this stage of the design process designers need to predict users' behaviour and operation of products or systems. One of the major directions during the design process is *that the products should manifest end users point of view, from initial concept to their distribution to the market place***.** This means that user constrains should

be included into the design project from its initial stage and followed throughout the project consistently (Popovic, 1983). In order to achieve this a designer must have the body of knowledge about users and their behaviour which can be obtained from (a) research, (b) evaluation of same products/systems, (c) evaluation of related products/systems, (d) evaluation of predicted products/systems. Therefore, evaluation is seen to be the part of the design process that interacts with all its stages. It occurs during the whole design process. Because of potential weaknesses in design concepts and their consequences evaluation should be reinforced. The nature of the design project determines which kind of methods, strategies and knowledge are required. Table 1 shows the most common evaluation methods/techniques used. They are applied for assessing product useability as separate techniques or in combination. The selection of the appropriate method will depend on design goals - which design constraints have to be evaluated. For example, to identify users' needs a designer may decide to select interviews or check list evaluation; to understand user's tasks and the knowledge behind them task and protocol analysis can be used. In this paper task and protocol analysis will be further due to their applicability to design and because they can complement each other.

EVALUATION METHODS/TECHNIQUES	PURPOSE
CAD simulation models	To evaluate design and its perceived use during the different stages of design process.
Checklists	To define operations of a product/system and identify users' needs.
Interviewing users	To identify users' needs
Mock-up evaluation	To evaluate product usage with users participation
Motion studies	To evaluate motion performances and identify critical conditions
Protocol analysis	To evaluate a design, user's expertise level and understand users' concept of products.
Prototype evaluation	To verify a design outcome under real conditions.
Task-analysis	To define and evaluate operational procedures of a human/product/system.

Table 1. Common Evaluation Methods and Techniques

Protocol Analysis

The protocol method or the think-aloud (TA) method is applied to studying human behaviour in different domains of expertise. This method was first described by Ericsson and Simon (1984 and 1993). It was expanded by van Someren et al (1994). The protocol method is widely accepted in the research community. Its data is unstructured and very rich and flexible analytical methods can be used. In general verbal and video recording of a user's task is taken. Transcripts are made, segmented, interpreted and analysed. It is required that verbal protocol data should be put in an appropriate framework in order to get the best understanding of the analysed activity. There is some criticism about giving verbalisation concurrently with the cognitive processes (Baindrige, 1990). The distortion may occur if a person does the work in a non-verbal way and is not aware that other tasks as part of their skills is done automatically. It is possible that the verbal reports become distorted as task performance and verbal representation become incompatible. However, Berry and Broadbent (1984) investigated the relationship between cognitive task performance and reportable knowledge associated with it. Their experiments examined effects of task experience, concurrent verbalisation and verbal instructions. They found that concurrent verbalisation did not have any effect on task performance. Despite of the criticism think-aloud protocol is found to be very useful for interface design, human computer interaction and human expertise. The method can help designers to get a better understanding of the principle behind their concepts. It is applicable at any stage of the design process.

Task Analysis

Task analysis is used to evaluate products and the user's interactions with them via their interface and assess their useability. In this context task analysis refers to overall user's activity. Its most common form of representation are diagrams or charts. The methods and techniques are different for specific applications such as workplace design, medical equipment design, interface design, or knowledge elicitation. Many task analysis of different products I conducted identified the discrepancy between users' and designers concepts of product or systems. The outcome of this analysis is used as constraints for new product designs and their concept evaluation.

Task analysis and protocol method compliment each other. They can be used concurrently. In case when distortion of a TA protocol may occur task analysis can clarify the sequences of operation. Video recording of the performance during concurrent verbalisation can be analysed to determine task components. In this situation task analysis techniques are used to support protocol data.

3. Conclusion

End user satisfaction is becoming more and more a standard requirement for all products and systems we design and use. Kato(1986) referred to Moran's paper in which he pointed out that it is unsuitable that designers use themselves as users as they differ from them. This approach is still common in many other design areas where designers design a product based on personal experience. This is not acceptable because designers' concepts and users' expectations and understanding of the system differ. This suggests that users' knowledge is different from the designers' knowledge. (Jørgensen, 1990). Therefore, it is very important that designers must understand that they need to take into consideration many different factors and study, users' needs, expectations, concepts, behavioural patterns, culture and the contextual environment in which the products are used in order to assure user's acceptance.

References:

Bainbrige, L., 1990, Verbal protocol analysis. In *Evaluation of Human Work* by J. R. Wilson and E. N. Corlett (eds) (Taylor and Francis, London), pp. 161-180.

Berry, D. C., and Broadbent, D. E., 1984, On the relationship between task performance and associated verbalizable knowledge, *The Quarterly Journal of Experimental Psychology*, 36A, pp209-231.

Ericsson, K. A. and Simon, H. A., 1993, *Protocol analysis verbal reports as data*. (The MIT Press, Cambridge, Mass.).

Kato, T., 1986, What "question-asking protocols" can say about the user interface. *Int. Journal of Man- Machines Studies* 25, pp 659-673.

Jørgensen, A., H., 1990, Thinking-aloud in user interface design: a method of promoting cognitive ergonomics, *Ergonomics*, 33 (4),pp. 501-507.

Norman, D., 1986, Cognitive Engineering, In *User centred system design* by D. Norman and S. Draper (eds) (Lawrence Erlbaum Ass., London), pp. 32-61.

Norman, D., 1988, *The psychology of everyday things*. (Basic Books, New York).

Norman, D., 1993, *Thinks that make us smart*. (Addison-Weslay, New York).

Popovic, V., 1983, A systematic ergonomics evaluation procedures and its application to ergonomics research. In *Proceedings of the 20th Annual conference of ESANZ "Ergonomics in the community"* by T. Shinnick and G. Hill (eds) (ESANZ, Adelaide), pp 15-23.

van Someran, M. W., Barnard, Y., F. and Sandberh, J., A., C., 1994, *The think aloud method; a practical guide to modeling cognitive processes*, (Academic Press, London).