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Managing attribute complexity for user-centered decision support systems

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Abstract

Decision making in engineering represents a highly complex and therefore challenging process for the involved stakeholders. The high complexity emerges from the combination of a multitude of factors that have to be considered simultaneously within a decision situation. Hereby the factors examined represent decision situation and human (decision-maker) attributes. To help decision-makers in dealing with highly complex decisions several decision support tools, methods and systems (DSS) have been developed. One main disadvantage of DSS is the little adaptation to and integration of user needs and attributes. This paper aims in providing a multilevel stepwise approach for the management of human and decision situation attribute complexity in order to enable a more effective decision support. The decision support is tailored to adapt to decision makers individually and therefore a higher acceptance and use-rate of DSS can be achieved. The approach was developed using findings from literature research and results from several research projects performed in cooperation with industry partners. The presented procedure represents a main design element of the user-centered DSS currently being developed at the Institute of Product Development.

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Keywords: decision-making; decision support systems; complexity management; cognitive engineering; user-centered design; human attributes; decision attributes; decision description

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1. Introduction

Decision-making within product development represents a complex process which can involve many different stakeholders. These stakeholders bring in their different perspectives (technic, strategic, organization perspective), decision-making styles, educational background (mechanical engineer, software engineer and business economist), level of knowledge and experience (novice or expert) and mind sets within the process.¹ These characteristics represent examples for “human attributes”. Decision-making is also highly influenced by the considered decision situation and its characteristics. Typical “decision attributes” are: the decision duration (short-, middle- or long term decision), the predetermined amount of resources (budget, human resources, tools, materials) and the degree of decision criticality (critical or non-critical decisions).² The correlation of human attributes with decision attributes leads to a complex and difficult to manage decision-making process.

To deal with the emerging complexity within decision-making processes powerful decision support tools, methods and systems (DSS) were developed. Most DSS focus on the analysis and evaluation of alternatives within decision situations. The integration of human needs and preferences is not directly addressed.³ General beliefs regarding usability, functionality and effectiveness of DSS are divided among DSS users and range from acceptance to completely unacceptance of the support provided. The unacceptance emerges from the lack of usability perceived by users regarding the integration of user preferences and skills, the high training required and the difficult interpretation of generated results. Nowadays users of DSS demand more specific and individually designed systems which address their actual needs and adapt to their specific mind-sets and decision-making styles.⁴

Human-centered design (HCD), user-centered design (UCD), cognitive engineering (CE), human-computer interaction (HCI) and human-systems integration (HSI) are only a few examples from the variety of human-centered approaches which have been developed to put human needs and characteristics into the center of system design considerations.⁵ Human-centered approaches are used in domains where a product or service is designed to be used by people. The application field expands from software and product development to financial services, healthcare, libraries and museums. Compared to these domains the application within decision-making and DSS is still very scarce.⁴ Kulyk et al.⁵ describes a human-centered system as one that has to: “adapt to the user’s needs, skills and limitations; engage users; adapt to the context; and work in real life”. These aspects have to be considered also for the development of a DSS.

To address the stated challenges, a user-centered DSS is currently being developed at the Institute of Product Development of the TU München (Germany). The DSS serves as a demonstrator for the application and testing of attribute-based description, structuring and analysis approaches for integrating human characteristics within decision-making processes.

For this purpose a procedure was developed which uses a combination of user and decision attributes. Classification and structuring, problem description and solving and structural complexity management methods are combined in order to enable the individual assessment of decision support. Human attribute complexity is being reduced due to attribute filtering, selection and structuring techniques and relevant decision attributes are identified by applying a specific designed decision description template.

The attribute complexity management procedure will be presented in detail in the following chapters of this paper. Following objectives have to be fulfilled by the developed procedure:

- User and decision situation attribute complexity reduction
- Efficient attribute correlation and allocation of decision support
- Improved assessment of user attributes in DSS
- Increase of DSS acceptance among users

2. Related work

The attribute complexity management procedure presented in this paper represents the logical backbone of the user-centered DSS developed. To understand the specific characteristics of the procedure an overview over the topics: decision support systems, human-centered design and attribute-based structuring is given in the following.

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