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ABSTRACT

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Title : Knowledge Based Computational Support System To Enhance Industrial Design: Conceptual Design Decision Making

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Researchers have always acknowledged the difficulty faced by industrial designers in understanding new designs in the process of sketching ideas. In exploring new concepts, industrial designers are required to support their reasoning based on concrete objects and ideas. In doing so, industrial designers normally use sketches to bring forward the ideas and tailor the explanations based on prior knowledge to come up with the new concepts. It is often observed that there is a lack of interactive pedagogical agents that can coach industrial designer's reasoning and to adapt the explanations to their cognitive state. The design of such agents can be based on learning theories that explains how industrial designers understand new concepts, as well as from studies on how industrial designers support conceptual understanding. Further goal of this research is to develop a computational framework to inform the designers of a pedagogical agent capable of engaging in a drawing dialogue that supports industrial designer's conceptual understanding. This thesis proposes an approach for Schema Support System Conceptual Activation ("SSCA") to support cognitive tasks that occur when an industrial designer is learning during the exploration of new concepts through one-to-one interaction with a computer agent. The approach is based on visual art schematic theory that explains how meaning-making occurs and stresses the importance of prior knowledge, and on the results of sketches analysis

study that identifies idea exploring method designers use to keep up schema-based cognitive tasks. A novel architecture of a pedagogical agent whose behaviour is based on visual art schematic theory is described. The architecture addresses three important issues: describing the process of idea activation and idea modification of industrial designer's relevant prior knowledge to be used in introducing new concepts, defining the reasoning and decision making of the agent to promote visual art schema-based cognitive tasks, and providing adaptive explanations tailored to the industrial designer's relevant prior knowledge. The SSCA agent's visual arts schematic knowledge is represented as frames; the idea coaching is planned as a sequence of drawing dialogue, and the interactive drawing language is implemented with idea transformation templates extracted from a study of the sketches. The applicability of the SSCA approach has been demonstrated in a multimedia e-learning system as an integrated component in a knowledge exploration and information seeking session. An experimental study with the multimedia system has validated the SSCA design approach and has examined the usefulness of the agent in supporting industrial designer's conceptual understanding in terms of improving their visual art schematic knowledge. The thesis makes original contributions to the fields of Artificial Intelligence in Education by defining reasoning and decision making process based on the principles of visual art schema theory and by designing a visual art schema-based pedagogical agent to support industrial designer's conceptual understanding; sketching by demonstrating the application of learning theories to inform the design of intelligent coaching systems; and Knowledge-based systems by demonstrating the feasibility of frames as the representation formalism in Conceptual Design Coaching Systems, and by proposing some original mechanisms for using frames to design pedagogical agents.