A framework for using simulation methodology in ergonomics interventions in design projects

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1. Introduction

The aim of this paper is to outline a framework of simulation methodology in design processes from an ergonomics perspective. The framework is intended at helping researchers and practitioners in analysing and planning participatory ergonomics interventions in architectural and engineering design projects. Participatory simulation is pointed at representing aspects of a future work system in order to make it possible for employees and designers to communicate, explore and co-design the system. The future work system needs to be represented in a model, which can be drawings, mock-ups, scale models, and other kind of materials. The simulation may take place through scenarios targeted at exploring different aspects or situations of the future work system.

2. Methods

An initial framework was developed in a Brazilian-Danish workshop with participants from two Brazilian universities, one company, and a Danish university. The method was based on coding and comparing six participatory ergonomics projects in which some kind of simulation had been applied. The simulation activities covered a wide range, which made it possible to detect a variety of elements and dimensions that need to be considered.

3. Results

Table 1 shows the identified 15 central elements when applying simulation methodology in participatory ergonomics. Seen from an ergonomics perspective three main points to pay attention to emerged: 1) It is important to understand the design context and the work domain that are the object of the design project, 2) A number of questions in the simulation setting have to be clarified by the ergonomist on beforehand, and 3) The ergonomist has to consider what kind of simulation outcome is intended, and how this outcome can impact the design project.

Table 1. An initial participatory ergonomics simulation framework

ELEMENT	DIMENSIONS
Design context	
Design object or task	Work system domain and scope, space, technology, software
Design process	Client, project management, design phase, designers
Work domain	Work system analysis, ergonomic work analysis
Simulation setting	
Simulation purpose	Usability testing, innovation, organizational capability testing, user participation, mutual learning, communication across knowledge domains
Simulation planners	Researchers, ergonomists, project manager
Role of ergonomists	Facilitator, expert, simulation manager
Participants	Workers, architects, engineers, managers, OHS consultants
Preparation of simulation	Workshop scripts, simulation questions, simulation scenarios
Simulation events	Location, duration, number of participants, simulation leader, de-briefing
Simulation objects	Full-scale mock-up, scale model, LEGO model, tabletop objects
What is being simulated	Work system, organizational structure and processes, work space, work practices, work flow, characteristic action situations
Modes of interaction	Scenario playing, object manipulation, language, bodily, rules of simulation
Simulation outcomes	
Simulation outcomes	Design proposal, layout, new work system concept, learning
Documentation	Report, photos, video recording, layout diagram, requirement specification
Transfer of simulation results	Transfer to design project, text documents, drawings, "on-the-spot" design, learning process

From a research perspective participatory simulation may be seen as a tool or boundary object to facilitate communication and learning across different knowledge domains. However, the mode of operation by wich it can affect the design project needs further research efforts. At least two situations are of importance: 1) If the designers participate in the simulation it is a question under which circumstances designers' learning will actually be transformed into design changes? 2) If the designers do not particpate in the simulation, the outcome has to be transferred to them and the design project. What kind of intermediary objects can make this transfer and affecting the design outcome? Are face-to-face meetings the way to do it or can it be accomplished by objects such as text documents, diagrams, drawings, photos, and scale models?

The framework can help researchers to analyze simulation-based participatory ergonomics projects as part of a design project. It can help action researchers and ergonomics practitioners in planning and implementing simulation events as a part of a participatory design project. Understanding the elements and the relationships between them accommodate further studies of simulation methodology as well as development and testing of new simulation methods.