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Synthetic environments as design tool - A case study

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Abstract

Successful product design requires intensive communication between all stakeholders of the product or service in the very beginning of the development process. In this stage of the development, often communication is inefficient due to the absence of a prototype. We propose the use of a synthetic environment as a methodology and tool to support communication about a concept design among stakeholders; e.g., designers, end-users, and manufacturers. A case study with industrial partners revealed that a low-cost, easy accessible setup, consisting of haptic and visual simulation only, was sufficient for a realistic evaluation of a product and to provide meaningful information to improve its design.

Keywords: product design, stakeholders, communication, mixed reality, synthetic environment

1 Introduction

Despite the abundance of supporting tools and methods that mechanical and industrial design engineers have at their disposal nowadays, the early stages of design processes are still not extensively supported. It is striking that the whole of design aids is characterized by mono-disciplinary, dispersed availability and most design aids aim to support the later design stages. As a next step in design engineering we aim at supporting the early design stages with a method that integrates the available aids and allows stakeholders to experience the consequences of the design decisions they take. Since in the early design stages a prototype of the product (either physical or virtual) is not yet available, the communication among the various stakeholders is typically inefficient or even absent. To improve on this, we propose a work environment, called synthetic environment (SE), dedicated to specific product design activities. By simulating the behaviour of products that do not yet exist they support the performance of selected design activities. Representation of different product life-cycle scenarios in mixed reality situations will help human actors perceive the product behaviour sufficiently realistically to perform real-world design tasks (*e.g.* brainstorming, concept assessment or end-user evaluations) on a virtual product. Gaming techniques can be used to assess the design decisions taken. Ultimately, all possible stakeholders, from end-users to manufacturers and designers should be able to communicate and negotiate reliably about the product's concept, which is represented in a form of lowest commitment, lowest fidelity and lowest cost. To test the concept of this approach we conducted a case study inspired by a recent product design from one of our industrial partners. This paper describes the specific configuration of the initial, experimental, SE and the outcomes of the study.

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2 Aim and implementation of the experiment

The scope of the experiments was the assessment of the operation of the lid of an X-ray material analysis machine as manufactured by the PANalytical Company (see Figure 1). Due to the nature of the machine, the lid should be perceived by its user as solid, robust and easy to use. In the experiment the behaviour of the lid was simulated for two modalities: vision and haptics. Modelling was done using commercially available software and hardware exclusively. This allowed the creation of a simple, low-cost SE.

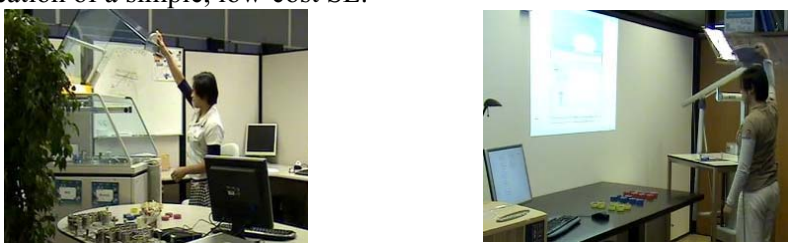

Figure 1: The real product (left) and the SE configuration (right).

The concerned stakeholders were end-users and designers. A specific scenario was devised to conduct the experiment. The case study aimed at answering the following main questions:

1. Is the fidelity of the chosen configuration sufficiently realistic such that the stakeholders can reliably conduct their task?
2. Will communication between the stakeholders be encouraged and/or enhanced? Will design or usage issues be revealed? Will design improvements be expressed by any stakeholder?
3. Can the SE be built sufficiently inexpensive and is it easily accessible to its users?

Two groups of test persons volunteered to participate in the experiment. Group A consisted of 16 lay participants. Group B consisted of 19 designers and engineers, some of which were involved in the X-ray machine design. Group A had to perform specific tasks, involving opening and closing the machine's lid. Two conditions were experimented: 1) the real X-ray machine and 2) the SE. Quantitative data about the task performances were collected and analysed. Group B received a demonstration of the configuration and the purpose of the SE was explained to them. In group sessions they were interviewed and encouraged to express their opinions about the configuration and about the proposed concept of the SE.

3 Results

Due to the limited size of this paper we can only briefly list some of the major findings from the experiment, referring to the 3 questions:

1. The performances of group A (in terms of errors and speed) were comparable for the two conditions. The simulation seems sufficient to assess usability aspects of the product.
2. Statements supplied by group B confirmed that design issues could be raised or solved early, where they otherwise typically would be detected in a first series test.
3. The actual implementation of the particular SE used in the experiment indicates that a) it can be assembled from existing off-the-shelf packages which are partly already available in a company, and 2) there is a prospective that the SE can be reconfigured easily.

The latter result is of high relevance, as it indicates that the threshold for potential users of an SE can be kept low. Moreover it can be expected that an SE of the type we envisage will typically be used with little advance planning from the part of its users.

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