

Enhancing Product Development Through *Physical Prototype Rapid e-Delivery*

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Conceptual design stage is of utmost importance as it influences all the other product life-phases in terms of cost, time and quality. When generating solution concepts it is common to alternate between paper-based sketching and physical modelling to detect errors and weaknesses in the early form design concepts. Yet, despite this fact, available commercial Computer Aided Design (CAD) tools are more oriented towards the later stages of the design process since their user-interface (UI) is based on the WIMP (Windows, Icons, Menu & Pointing Device) paradigm. This UI lack the fluidity of freehand sketching, thus also reducing their usage from non-experts.

The purpose of this joint research is the development of the necessary tools for setting up a scenario where a physical prototype can be automatically generated from a 2D sketch, drawn directly on paper or an a digital tool such as a Personal Digital Assistant (PDA) allowing the best exploitation of the available resources in a geographically distributed environment, allowing the best exploitation of the available resources.



Experiment

To achieve the above objectives, the paper-based sketch has first to be robustly recognised to either generate the equivalent 3D computer model or to infer problems that may arise during the product's life cycle. Considering that sketches contain incomplete information and that every person draws in his own style, one of the major research challenges is to find a compromise

between preserving the natural way of freehand sketching and the possibility of computer recognition. Related to this issue is the fact that although many drawing standards (such as ANSI, DIN, BS, JIS) have been established for detail design drawings, for conceptual sletches no standards have yet been set up, thereby making computer sketching supporteven more difficult.

To address these issues, (i) two sketching languages to represent formally simple prismatic components; (ii) a software prototype for sketch recognition and (iii) a Knowledge Intensive Sketching (KiS) software to detect Life-Cycle Consequences of conceptual form design solutions were developed at the University of Malta. In order to evaluate the concept, two experiments have been carried out in collaboration.

Experiment 1

The first experiment has been done to evaluate the overall approach and the developed software components.



Experiment 2

The two alternative sketching languages (SKL1 & SKL2) developed to represent formally a 3D component have been tested through structured interviews carried out in the different countries with 43 evaluators consisting of 21 practicing industrial designers, 10 final yearengineering students and 12 postgraduate design research students. The aim of the interviews was to evaluate the easiness and acceptance of the sletching languages.



Do you use paper-based freehand sketching during conceptual design



Would you prefer to sketch with a stylus on a graphics tablet instead with a pencil or



Would you accept a predefined sketching method instead of your usual style, provided that as a benefit a virtual CAE model can be generated



Do you think that a virtua CAD model that is generate



A simple part has been sketched in Genova (1), the scanned drawing has been sent to Malta, where it has been processed by KiS to evaluate possible problems that may be encountered during the fabrication of such plastic component and also suggest solutions (2); following the recommendations by the KiS system, a new sketch has been created in Genoa (3) and sent to Malta, where, it has been reevaluated by KiS and an STL file of the CAD model of the 'defect-free' component has been derived and sent to Technimold in Genoa (4), where the part has been prototyped (5)

Research Publication

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Examples of the description of simple objects by meansof the two proposed sketching languages predefined method will be useful during early design?

from the sketch?

Which sketching language do you prefer to use (if any)



The evaluation results revealed that:

>93% still use paper-based sketching in conceptual design

>86% considered the generation of a 3D CAD model from a freehandsketch as useful during conceptual design

>42% of the participants were willing to accept a standard sketcling language, provided that as a benefit a virtual 3D CAD model is generated fom a sketch

>49% replied "not sure" since they still have to evaluate this approach concept rather to what they think of such approach