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The integration of rapid prototyping within industrial design practice

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CASE STUDIES IN THE USE OF DESIGN PRACTICE BY PHD RESEARCHERS

DPR
 case studies

THE INTEGRATION OF RAPID PROTOTYPING WITHIN INDUSTRIAL DESIGN PRACTICE
CREATIVE DISCIPLINE: Industrial design

RESEARCH METHODS:

- Literature review
- Questionnaire
- Interview
- Action research
- Weighting/rating

NUMBER OF DESIGN CASE STUDIES UNDERTAKEN BY THE RESEARCHER: 4

LENGTH OF THESIS: 75000 words

EXAMINATION FORMAT: Thesis and oral examination

DURATION OF STUDY: 6 years part-time

EXPERIENCE OF DESIGN PRACTICE BEFORE START OF PHD:

- Bachelors degree in Design and Technology
- Masters degree in Industrial Design
- Industrial designer with major manufacturer of garden products and in-house consultant (3 years)
- Consultant industrial designer (7 years)
- Clients include British Airways, Unilever, British Gas, Boots and Pilkington Optronics

PERSONAL MOTIVATION FOR UNDERTAKING PRACTICE DURING PHD:

- Desire to continue to undertake creative design practice
- Maintenance of capability as a practitioner to support the teaching of core industrial design skills to undergraduate students and advanced techniques to masters students
- Desire to develop skills and knowledge in emerging digital design methods such as computer aided industrial design and rapid prototyping

AIM OF THE RESEARCH:

Direct experience in the challenges of model-making/prototyping during professional practice enabled the candidate to identify potential applications for the emerging technology of rapid prototyping in the mid-1990s. The aim of the PhD was to develop a methodological approach for the integration of rapid prototyping within industrial design practice to support a reduction in lead-times and enhanced output.

RESEARCH QUESTIONS:

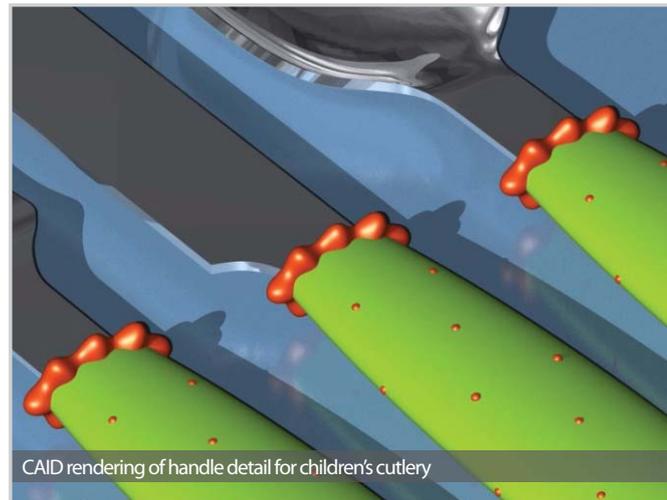
- To what extent are industrial designers using rapid prototyping?
- Which rapid prototyping technologies are of direct relevance to industrial design practice?
- How can rapid prototyping be integrated within industrial design practice through a methodological approach?
- How will practitioners respond to the methodological approach?

OBJECTIVES:

- Undertake a literature review with respect to the nature of industrial design and rapid prototyping so as to illuminate the research field and determine parameters for a methodological approach
- Evaluate the methodological approach through its application during the industrial design of a new product(s)
- Compare and contrast models produced using rapid prototyping with those of workshop – based fabrication techniques
- Validate the methodological approach through the use of an appraisal framework



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INSTITUTION: Loughborough University, UK
DATE OF AWARD: 2002
SUPERVISOR(S): Professor Mark Porter
 Dr Ian Campbell
EXAMINER(S): Professor David Durling
 Professor Martin Wooley



CAID rendering of handle detail for children's cutlery



Z Corp sketch model handles for children's cutlery in various sizes



Appearance model for children's cutlery

SUMMARY:

The commercialisation of the first rapid prototyping systems in the early 1990s identified an opportunity for this technology to be integrated within industrial design practice. This was explored using a methodology that combined the researcher's professional practice with a methodological approach that integrated Computer Aided Industrial Design (CAID) with Rapid Prototyping (RP). Following feedback from practitioners on a draft CAID/RP methodological approach, this was modified before its appraisal using action research that involved the industrial design of a nylon line trimmer. This case study identified three problematic issues: the detail involved in generating the required .stl files; the use of rapid prototyping to produce sketch models; and the inability to engage in tactile interaction with physical form during form-giving. These problematic issues were explored through the use of emerging technologies and the design of an additional three products: an automotive control binnacle for audio, communications and navigation; a range of children's cutlery; and a communication device. Having addressed the key issues, the final CAID/RP methodological approach was validated via expert feedback.

RATIONALE FOR THE INCLUSION OF DESIGN PRACTICE UNDERTAKEN BY THE RESEARCHER:

The investigation into the contribution of rapid prototyping to industrial design practice was undertaken when the use of the technology was in its infancy. While there were some case studies in the use of rapid prototyping by engineers, no evidence was available to demonstrate how it was being used by industrial designers. Detailed information was required on the capabilities of build systems, build times, costs and workshop-based finishing of components. Product development is a notoriously competitive and secretive activity and it was not considered viable to collect data to the required level of detail. A decision was therefore taken to use action research whereby the researcher would undertake design activity that mirrored that of commercial practice.

HOW THE PHD DESIGN PRACTICE DIFFERED FROM THAT OF COMMERCIAL PRACTICE:

The process of generating product proposal was no different to that undertaken during commercial design practice. However, the fact that the activity was within a methodology for academic research enabled elements to deviate in support of answering research questions. These can be summarised as follows:

- Professional practice would not typically require more than one appearance model during a specific phase of a project. The fact that the design practice was for academic research required two appearance models for the line trimmer (one using conventional workshop-based techniques, the other using rapid prototyping) for comparative evaluation and collection of quantitative and qualitative data
- Advanced design technologies, such as early UNIX-based 3D surface modelling software, were available in an academic research environment but relatively rare in commercial practice. The use of this software was of specific relevance to the automotive control binnacle case study that explored the capacity of the industrial designer to define exterior form and supply geometry to engineers
- At the time of the research (late 1990s), lower cost rapid prototyping systems such as Z-Corp were emerging as a tool to support early design decision-making. As such, the use of this technology to economically produce a relatively large number of concept models for user-evaluation represented a disruption to conventional practice
- One of the roles of academic research is to explore the capacity of new tools to support practice and report on their contribution with impartiality. Whilst the communication device case study did not involve a client, it employed related methods and enabled the strengths and weaknesses of haptic feedback modelling to be explored. The outcomes identified the problematic nature of this technology and, had this been part of a commercial exercise, would have caused a significant delay due to the problematic nature of the outcomes

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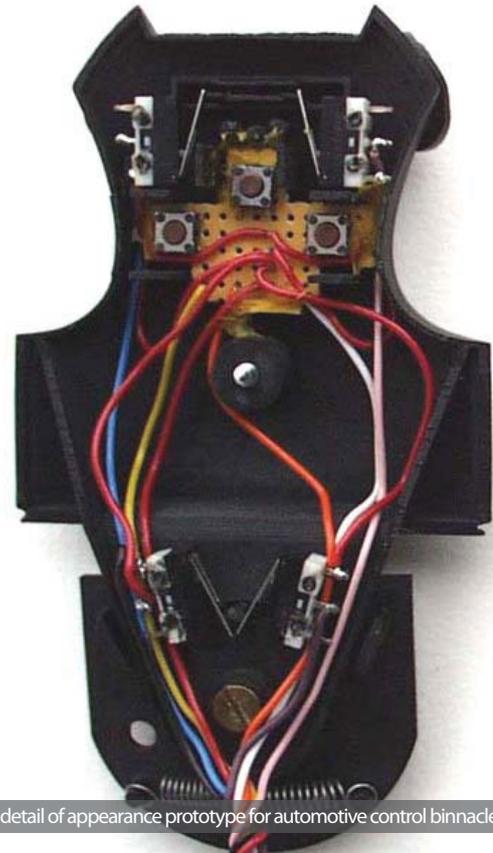
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CAID rendering of automotive control binnacle



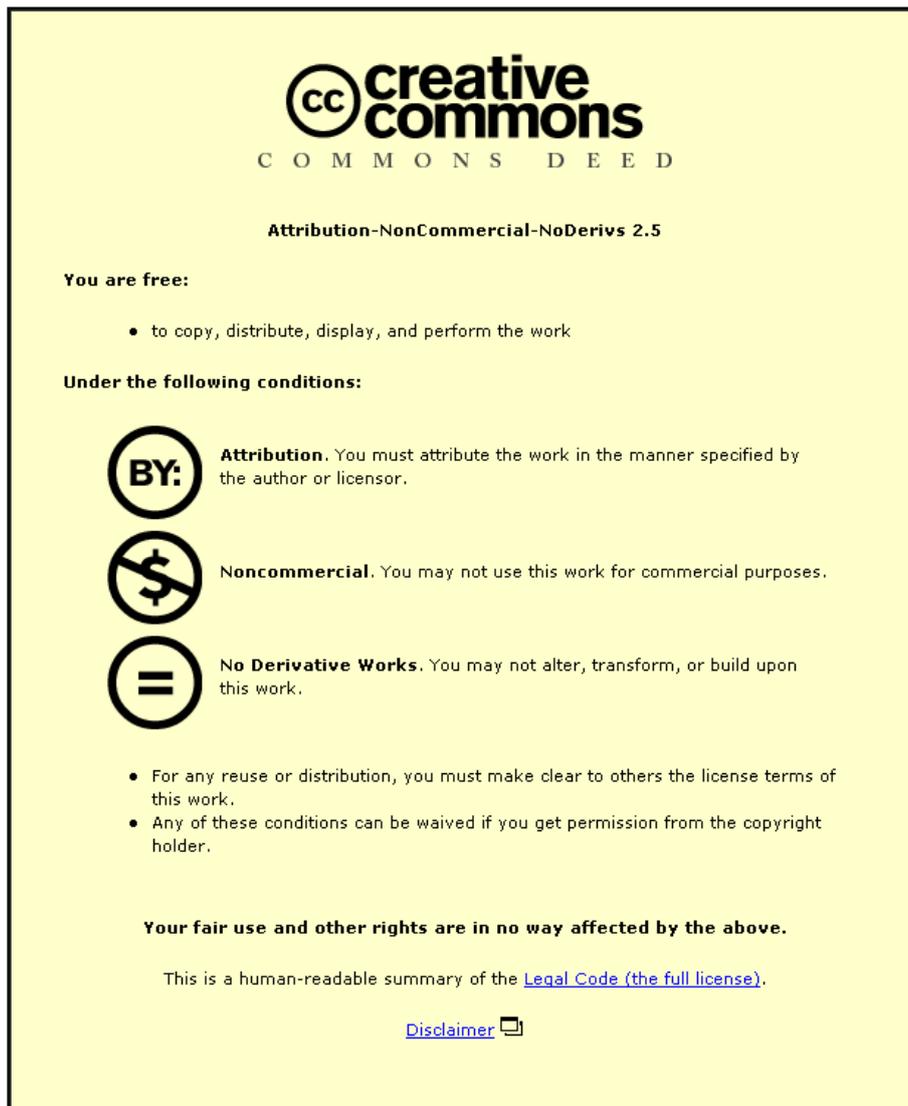
Cutter head on appearance model of nylon line trimmer



Internal detail of appearance prototype for automotive control binnacle

Design Practice Research Case Studies have been compiled by the Design Practice Research Group at Loughborough Design School. If you would like to work with us or contribute a case study, please contact the Design Practice Research Group Leader, Dr Mark Evans (M.A.Evans@lboro.ac.uk).

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