

Research through industrial design

Industrial design in the context of an Australian Cooperative Research Centre.

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Abstract: The creative arts and industries, including design, are currently legitimating to higher education and funding bodies how project work, documentation of research process and critical reflection is the appropriate mix for scholarship in these fields. Central to industrial design is the role of making and products in the design research process although this emphasis may not be shared by the fields with which industrial design works. Cooperative Research Centers (CRCs) are contexts where science, design and industry collaborate offering unique opportunities to examine interdisciplinary similarity and difference and an environment for design research to prove to government and higher education the legitimacy and quality of its work. Drawing on evidence from two recent doctoral projects in CRC industry/university collaboration for Wood Innovation this paper analyses the design, science encounter and its consequences for knowledge production in the project text. The authors further argue that only a balance of prototype, process and reflection can help establish the academic and disciplinary status of design, itself a precondition for convincing the institutional skeptics of the current and future legitimacy and value of the creative fields.

Key words: *Industrial design, product design, science, cooperative research centre.*

1. Introduction

According to Cross [1] design knowledge has various relations with designed artifacts. ‘Some of it is knowledge inherent in the artifacts of the artificial world (e.g., in their forms and configurations—knowledge that is used in copying from, reusing or varying aspects of existing artifacts), gained through using and reflecting upon the use of those artifacts. Some of it is knowledge inherent in the processes of manufacturing the artifacts gained through making and reflecting upon the making of those artifacts. And some of each of these forms of knowledge also can be gained through instruction in them’ [1, 54-55]

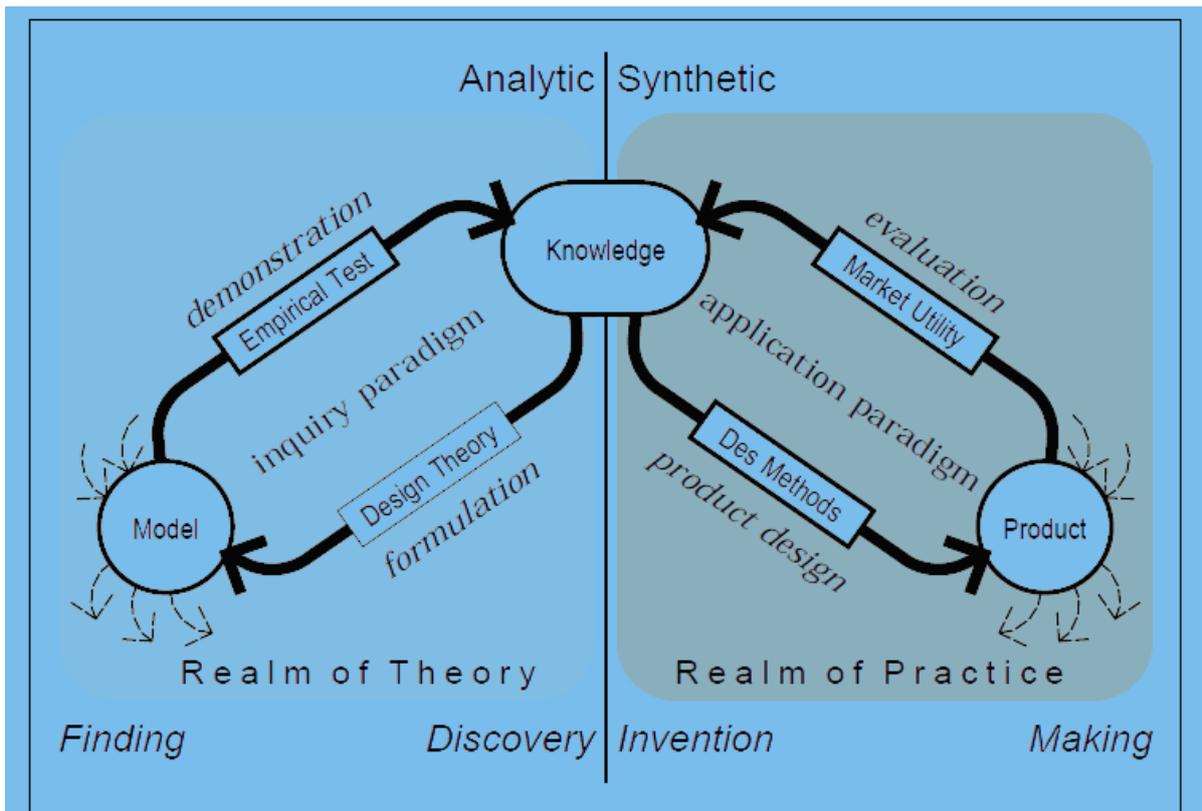
Although some question the value of practice and projects in design research [3], making in the design research process has significance for knowledge creation in creative arts and industries [7]. In doctoral design, the artefact or project, reflection and practice may play a role as the material resolution of practical ‘applied’ problems with more general theoretical or methodological consequences [11]. The issues of knowledge and making in design research have particular relevance to industrial product design.

2. Product design: knowledge and making

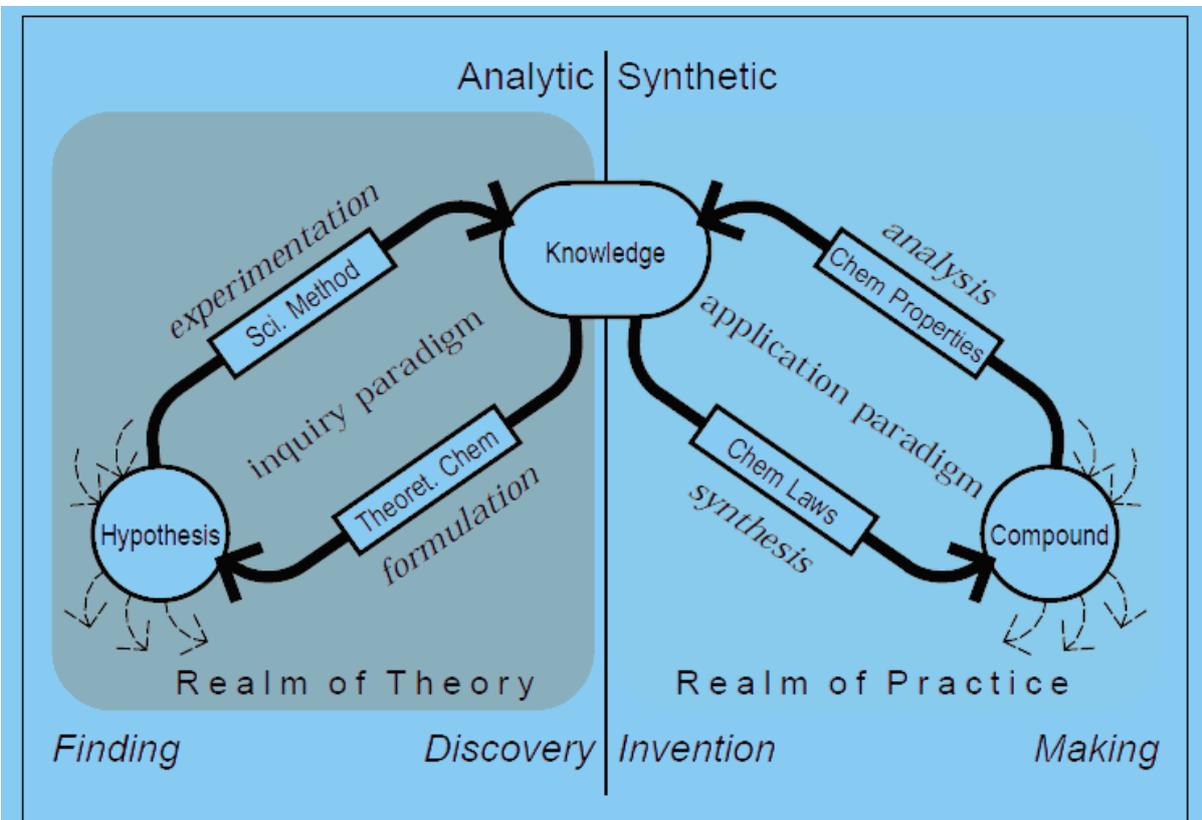
Although (industrial) design is still presented at times as a stylizing phase in the product design process, in fact, it is distributed more broadly throughout this process [14]. Industrial design in practice works with a number of partners in the product development process, including marketing and manufacturing, and there can be conflicts of perspective here [9]. Cross [2] notes that ‘designerly’ thinking in the context of product design can conflict with the more sequential engineering approach to product design evident in some texts [13]. These potential conflicts are potentially even more evident in multidisciplinary research centres where (industrial) design may have a real handmaiden status compared to other fields.

One characterization of the place of knowledge at the intersection of practice and theory and its relationship to product is that of Owen [10] (see figure below) who develops a set of (comparative) images to represent the different disciplinary interests and aims of fields in research. The images attempt to capture *grosso modo* some distinctions of relevance to this particular paper. In product design, theoretical knowledge is developed through an inquiry paradigm driven by the formulation of a design problem according to prevailing design theory. This analytic formulation of the problem leads eventually to the proposal of models at both conceptual and prototype levels, whose value, aesthetics and functionality - and whatever other features we deem important - are tested and evaluated, typically through successive phases. Such product oriented knowledge, is in fact, often materialized into the realm of practice through product design methods and evaluated by measures, including but not limited to market utility, feeding back into the dynamic knowledge state of the product design process where theory, modelling and evaluation continue again.

By contrast, a mainstream science such as chemistry, in the realm of practice is focused on the chemical compound and hypotheses driven by theory and scientific method drive the theoretical input into knowledge making. Thus, although in both cases there is a making process the scope of the making differs enormously. Other differences of focus and concerns are also, hopefully, evident in the contrasting figures. Whether or not the portrayal of both processes is entirely accurate, it points up the fact that in multidisciplinary contexts, involving design, there are different viewpoints that need to be negotiated. One of the authors of this paper has suggested that the practical concerns of designing in comparison to some fields but also evident in other applied disciplines illustrates the fundamentally pragmatic nature of design practice and theory[8].



Product Design



Chemistry

Figure 1: From Owen (1997, p.4)

3. Industrial design in Cooperative Research Centres (CRC)

Increasingly, academia and industry work together creating what has been called mode 2 knowledge, having degrees of support both financial and other from industry, government and academia [4]. This knowledge and relevant practices in particular circumstances may owe more to industry than academia depending on the nature of the product. Senker, Faulkner & Velho [12] conclude that the potential for interaction varies according to project; industry innovation is most aided by basic research conducted in the public sector; the greatest contribution comes through indirect and intangible flows of knowledge not the commercialization or technology transfer emphases; and in-house academic capability must be built up incrementally. Collaborative Research Centres (CRC) in Australia are a particular example of ‘technocratic organization’ subunits [5] in the university sector which encourage industry-academic relations and are increasingly seen as ideal sites for producing industry –ready doctoral candidates [6].

The analytic and synthetic theory and practice interaction noted above as typical for product design includes a central place for making (products) and evaluation as a key process in the generation of knowledge. Such an emphasis on making, however, is not necessarily shared by other fields with which design interacts such as materials science and engineering. In a CRC context where designers play a secondary role to these other fields and their representatives the need to generate designed outcomes as part of the theory-practice investment into knowledge may be poorly understood and appreciated. In the following two cases by two co-authors of this paper some of these tensions and resolutions of these differences in approaches to research through design as fundamentally guided by making are discussed.

4 Case studies from Wood Innovations CRC

In what follows two doctoral research projects involving industrial designers in an Australian CRC are used to illustrate the different perspectives and challenges to multidisciplinary contexts of design research .

4.1 Investigating the application of innovative manufacturing techniques to new product development using a technology led design process, Lotars Ginters

My PhD grew out of the work that I developed in the Australian Co-operative Research Centre (CRC) - ‘Wood Innovations’ which was a centre of excellence that included the University of Melbourne, Swinburne University of Technology, the CSIRO and government. These research and industry partners investigated the application of microwaves to determine commercial opportunities for microwave modified timber, and my work looked at new and innovative timber production, bending and forming methods. The project work looks at microwave assisted bending, deformation and machining applications to create new bent and shaped timber components for product design. The science is demonstrated through new timber machining techniques, design examples and presents performance characteristics for bending microwave modified wood. In my project work I investigated six production and manufacturing techniques that demonstrate, tabulate and compare these technologies. Research outcomes, product design examples, prototypes and final design proposals will be presented as a part of my PhD.

Six Production Techniques and Design Opportunities

- ‘Flexiwood’ - Rubberised Timber Components – to increase the flexibility or ‘bounce’ of timber components using precision cutting and routing techniques with flexible fillers for use in the furniture and building construction industries.
- ‘Kerfies’ and Kerf Cutting - cutting and routing techniques as a way of producing tight curves and twists in timber components.
- ‘Feather’ Cutting and jointing as way of enhancing the flexibility and strength of timber furniture components.
- Microwave Bending - the application of microwaves to prepare timber for bending using a new bending machine to shapes timber components.
- Wood Shapes Template System - a jiggging system for bent timber components required for microwave drying and conditioning of bent timber components.
- Pressed Compound Shapes - the application of microwaves to prepare timber for pressing to create compound bent timber shapes using a multi-adjustable former.

The CRC - Wood innovations developed innovative manufacturing techniques that enabled Innovative design possibilities and new production technologies for the manufacture of high value furniture and wood products from microwave-modified wood. This led to the design and development of a new range of high performance wood products and timber components. Working with scientists also required me to reconsider the way in which we, as designers work. My work consisted of the accepted approach to new product design development - sketchbooks, visual renderings, models and prototypes. It also required me to adopt a much more experimental approach to allow me to develop new ways of production for the forms and shapes that grew out of my design work. I had to work in a much more systematic manner, making test components, experimenting with materials and production equipment. This required me to consider new production machinery, equipment and new ways of working to create the forms and components I needed for bending, shaping and assembly.

Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life-cycles. Therefore, design is the central factor of innovative humanisation of technologies and the crucial factor of cultural and economic exchange. Design is focused on balancing needs with outcomes. Industrial designers are able to develop design strategies and determine the design parameters needed to successfully develop the design outcomes necessary. The whole process of these interdisciplinary relationships raised questions about the relationships between science, technology, industry and design. It is my contention following experience gained in the CRC Wood Innovations that when designers work with scientists difficulties arise in agreeing to priorities. Designers establish the user and the expertise required in a research and development team. Design focuses on balancing needs with outcomes while science is focused on arriving at a predetermined result based on empirical and reductionist methodologies. A more satisfactory method for designers and scientists to work together needs to evolve to compete with economies where scientific innovation is rapidly absorbed into invention and translated into products that meet needs, create markets and produce wealth. So it is that design has helped locate scientific research into a needs directed, market, social and environmental context that includes design parameters that relate to outcomes for human needs and market viability.

Technology Led Designs, such as evidenced in this context, is different to the way in which designers generally work as it puts an emphasis on design parameters such as materials and production processes rather than considering and balancing the full potential of a wide variety of design parameters that meet the broader outcomes expected in design proposals. The work demonstrated in my sketch books, design concepts, experiments, technical specifications together with the critical reflection this engendered shows that it is difficult to fully appreciate and develop the broad possibilities expected in these design proposals.

4.2 Science and design; Surface modification for timber construction, Blair Kuys

Working within the framework of the CRC Wood Innovations, this doctoral research project promotes timber as the sustainable material of choice for outdoor use in the construction industry with a design focus on window frames. This research is revolutionary by strengthening surface properties of timber through scientific developments and utilizing industrial design as a means for innovation. The role of design within this project sets parameters for science-driven engineering advances for the surface modification of timber. Working alongside scientists in the development of an improved material, this project has identified successful areas of innovation that contribute to a superior product outcome.

Scientists at the CSIRO led the scientific contribution for this study. It is important to note that the role of the designer is not to understand the chemistry behind the graft chemicals that are used to engineer the material, but to understand the application of these chemicals and to work with them to recognise their advantages. This is done by quantitative data collection through experimental testing of the modified material specimens, and mapping the results against experimental testing of non-modified specimens to understand the improvements made with the modified specimens. Research through the act of designing is done after new knowledge is gained from the scientific testing. This is research into design by the actual process of designing. Having said this, it needs to be acknowledged that the design research in this study is not strictly linear, substantiated by overlap with each specific design research area.

With the quantitative data collection identifying the significant advantages with the modified specimens compared to the non-modified specimens, research through design is performed after the successful collaboration between material scientists and designers to produce innovative developments for a new material that is then incorporated into a product. It is important to understand the limitations of the material to successfully design a product that is not only comparable to existing products, but also better, due to the scientific advancements in the material. This innovation is of key significance in contributing to new knowledge and legitimates this research at a doctoral level.

In order to successfully design a window frame that will be an innovative advancement on what already exists, it is important to learn from industry professionals to gain knowledge on what can be a very technical object. With necessary development in energy-efficiency requirements and a greater need to reduce maintenance and extend the service life of the product, a window frame is of major importance to a dwelling and every intricate detail must be thoroughly resolved and designed with the highest quality. An understanding of the functions of a window and knowledge on all functional requirements is the fundamental stage of the design process for improved advancements in future designs.

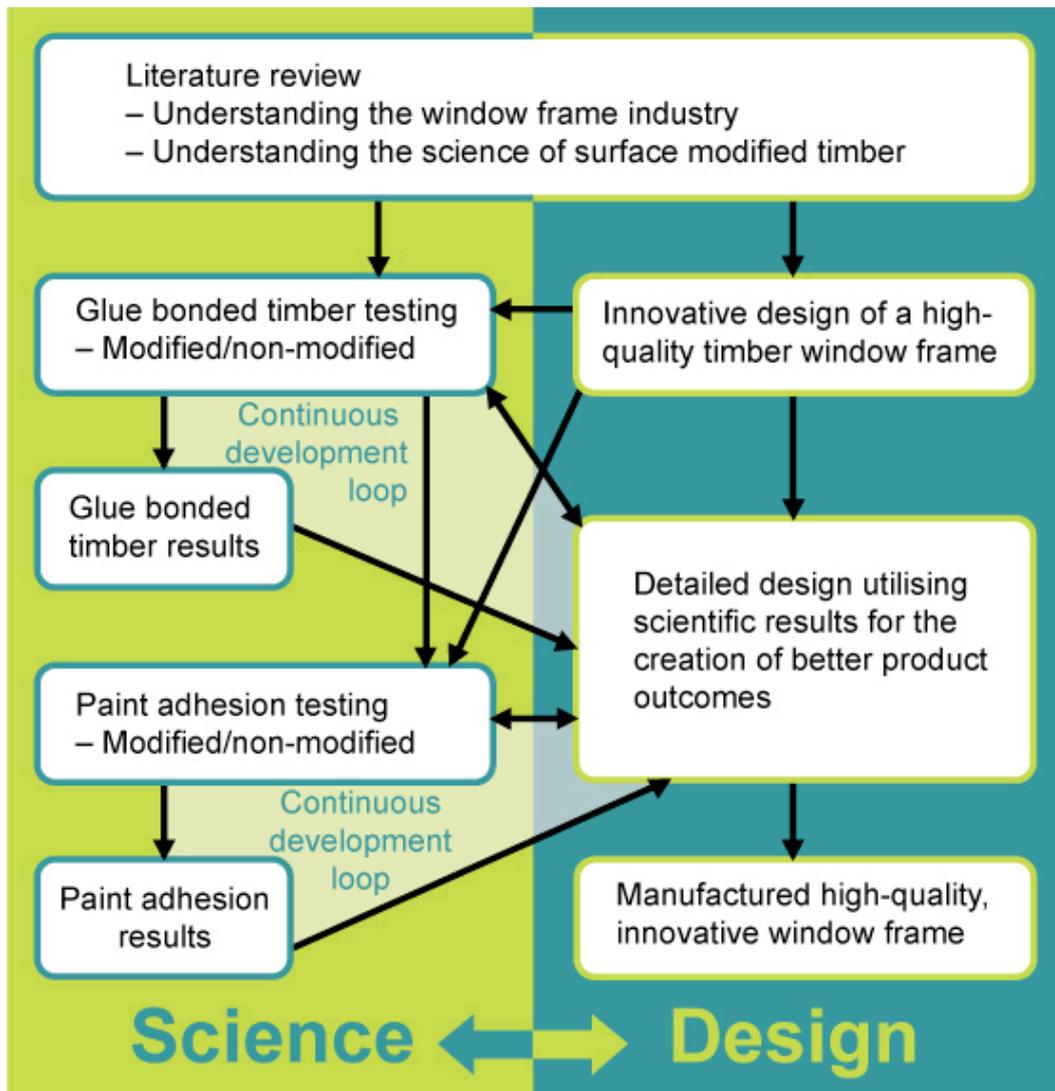


Fig 2: Working method showing the cross-collaboration between science and design

The design process in this case consisted of a review of window frames and materials that make up their construction. A vast array of literature was collected from credible manufacturers and research facilities and conversations with industry professionals formed the foundation of the research. One-on-one conversations with scientists, manufacturers and researchers were effective in helping understand the window frame industry, new window frame technology, material development and scientific advancements to assist in the development of better products. Training with scientists at the CSIRO, led by Dr Voytek Gutowski, created an understanding of scientific applications that led to an independent study to advance the characteristics of different timber species. The quantitative data that influenced the use of specific timbers for further development has helped construct a superior window frame from a structural and environmental perspective. This collaborative working environment between science, design and industry provided the best opportunity for validation of a doctoral research project. Science played a significant role in developing a new timber material; design played a significant role in utilising that new material and industry helped construct working parameters to create a commercially viable product.

Visiting manufacturers and understanding the processes of construction increased knowledge in design and manufacturing of window frames. An extensive literature review was done in this area, which helped develop an initial understanding of the importance of design for window frames. Innovation was developed through knowledge gained from manufacturers, leading to a greater understanding of the detail required in designing a window frame. The design research for this study therefore falls within the landscape of experimental methods, as design intentions lead scientific developments. This formative method of research uses design as a catalyst for innovation as it seeks for resolution in experimental testing of surface-modified timber with intentions of creating an improved, sustainable product. It is important for design to lead science, firstly to identify a need for the science and secondly to push the science for design applications that were perhaps never considered by a scientist, or once deemed impossible.

5. Discussion

The encounter between design, science and industry is particularly significant in the context of the CRC. It is here that questions about the particular nature of design research may be elucidated with the particular clarity afforded by real world constraints and disciplinary confrontation. Such contexts may help designers develop an appreciation for the limited value of the creative individual artist discourse that is favoured in visual arts research inquiry. Designers can begin to appreciate the contribution they can make to the real world production of products requiring (materials) science and industry considerations. Likewise, the sometimes abstract commitment of science-based disciplines to experimental work and outcomes can be challenged in such contexts providing this discipline with an opportunity to consider its own limitations. A certain legitimacy is offered to design fields through their collaboration in such CRC projects. In this still early state of the design research argument the importance of reflecting on the interdisciplinary encounter and processes of design work leading to particular material products should have a central place in the doctoral text. Unlike the more established science and engineering disciplines, design must spend time textualizing the interdisciplinary applied design research process. This historical moment and the interdisciplinary context offer ideal conditions for developing the legitimacy of design research as creative industry.

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