

# Contract Research in Design

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Contract research is a commercial research service undertaken for commissioning clients. This activity may pose difficult questions for researchers in the design area, since a commercial service may appear capable of producing little more than jobbing practice. The present paper considers case studies of work carried out by the Design Contract Research Unit at Nottingham Trent University in light of various theoretical positions on research. The aim of the discussion is to better clarify the controversial relationship of commercial design practice to what is now coming to be recognized as design research.

## Research and Practice

In the UK, there is political pressure on academic communities to reach a consensus about the nature and value of research in their chosen disciplines, most obviously evidenced in the introduction of national Research Assessment Exercises. Politicians and civil servants seem increasingly drawn to the idea of fixing an apparently tangible value on the quality of public activity by creating new funding equations. An audit like the RAE is a useful means of demonstrating their diligence and the accountability of their fund management. However, success in such an exercise is not the beginning or end of funding support for design research. Design is an element of industrial culture, and some of the most impressive research campuses to be found are those belonging to giant industrial corporations, such as Microsoft and Nestlé. Armies of researchers also inhabit those campuses, and it would be a serious misunderstanding by those of us less well accommodated in universities to believe that somehow our industrial colleagues are working one level below us, tied as they are to the directions of greedy masters. Consider that such masters may provide academics with patronage additional to that given by politicians and bureaucrats, whose motives (such as maintenance of personal office) are not obviously purer.

Some may argue that the outcomes of commercial research and development evidence “applied” research, which seems by implication to be a rung down the ladder from “pure” research. A less specious distinction to make is that between research with a predetermined goal, and research without the same (which often is called “fundamental” research in the sciences). An example of the former would be to find a way of preventing a carbon filament that becomes incandescent when an electrical current passes through it, from burning up after a few seconds. This was a major research project that

led to the invention of the first durable electric light bulb by Edison, using a largely empirical trial-and-error method.

Investigating what happens when an electrical current is passed through strands of different materials would be an example of fundamental research. In hindsight, this may seem like a necessary precursor for inventing a light bulb but, in foresight, it does not appear to be a research program guaranteed to add even to the theoretical understanding of electromagnetic behavior. It is invidious to value one approach more highly than another. Both exist in design research, yet goal-led research evidently is the more dominant form because research programs can be very expensive, and so market forces in both the public and private sectors favor the goal-led form in design. Indeed, it is hard to imagine that design researchers could learn much of value from practice-based activity unless there were commercial manufacturers and developers available to collaborate in essential realization processes such as tooling, fabrication, and distribution. It is largely due to this consideration that my own unit has been led into accepting goals set by clients, rather than us, and why the term “contract” prefixes our research activity.

With regard to the notion of practice in relation to research, Nigel Cross is persuasive in insisting that practice itself does not constitute a significant research activity because, in a community, others may feel that if they cannot gain access through public reports to the methods behind the outcome, they cannot easily assess their value or further applicability.<sup>1</sup> In the case of craft production, many crafts people probably would go to considerable lengths not to disclose their methods to others. The success of such an approach, both in defending innovation as well as adding value or mystique to the products, is well evidenced by the successful transition of famous Renaissance figures such as Leonardo da Vinci from the status of craftsman to artist. Parallels can be found in contemporary design, where the status of designers such as Armani and Starck indicates that, even in an industrial culture, mystique still plays an important role in the value systems of consumers and the profit margins of marketers.

More commonly in industrial cultures, we have mechanisms for protecting personal innovation by actually disclosing outcomes in formal public ways. Patents and copyrights are the most obvious examples, and both are recognized as satisfactory research outcomes by UK research assessment exercises. Patents, by definition, must be: (1) new ideas, not previously publicly disclosed, (2) involve an inventive step such that, “when compared with what already is known, it would not be obvious to someone with a good knowledge and experience of the subject,” and (3) “be capable of industrial application.”<sup>2</sup> In this respect, “industry,” in its broadest sense, is meant as anything distinct from purely intellectual or aesthetic activity. Under such definition, natural discoveries, scientific theories, mathematical methods, and aesthetic creations are excluded from patent protection.

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1 N. Cross, 1999, “Design Research: A Disciplined Conversation,” *Design Issues* 15:2, (1999): 5–10.

2 UK Patent Office, [www.patent.gov.uk](http://www.patent.gov.uk) (2002).

On the other hand, the specific form of an aesthetic creation, such as the exact words of a text or the patterns and shapes of a designed object, can be protected under copyright or a design patent.

Patent definitions are then most instructive in telling us about the forms of knowledge that are pertinent to the definition of design research. Design practice primarily concerns the creation of apparatus, devices, processes, or methods of operation that are capable of industrial application. While it is by no means necessary that the outcomes of design practice are in any way inventive, many of them may be claimed to take a specific form that is novel and can be disclosed and protected. The ordinary patent involves creating products, methods, or processes that can be described in such a way as to enable others to reproduce and apply the inventive steps. The design patent involves creating a specific arrangement of symbols, shapes, lines, or patterns that so differs from precursors that just describing it in patent form prevents others from trying to reproduce the arrangement without permission. Of the two kinds of disclosure, the ordinary patent makes it far easier for others to gain insight into the particular research and creative processes giving rise to the outcome. Designers, like other professionals, may then wish to comment publicly through means such as conference or publication on the kinds of approaches and insights underlying particular design outcomes. This constitutes a third form of contribution to public knowledge that is not patentable, but is recognized as a vital part of the research culture of any discipline.

### **Research and Knowledge**

As to the relationship between research and knowledge, the dictionary definitions of research include “collecting information about a subject” in a way that is “careful or diligent.” This diligent way also may involve a more complex “investigation and experimentation aimed at the discovery and interpretation of new facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or laws.”<sup>3</sup>

An attribute of research in general that is embedded in the official guidelines of organizations such as the UK RAE is that it “contributes to knowledge.” In this sort of description, knowledge seems to be principally the public kind, and accordingly, a contribution may be seen as something that is new, or different enough, to add to a public “bank” of knowledge. For patents, there is a highly developed and complex method that allows professional examiners to determine the extent to which knowledge claims may be deemed new additions. Unfortunately, for forms of knowledge “excluded” from patenting, such as intellectual discoveries and theories, it is far less clear-cut how they come to be accepted as additions. The primary mechanism is that of peer review by academics, publishers, and media editors.

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3 Britannica Webster's, Encyclopaedia  
Britannica Online ([www.britannica.com](http://www.britannica.com),  
2002).

As a relatively young and emergent discipline, design introduces problematic issues of its own. There seems to be consensus that design is very much an interdisciplinary activity, attracting inward a variety of research paradigms from longer established academic disciplines.<sup>4</sup> There also seems to be some agreement even between those with differing views of design research, such as Charles Owen<sup>5</sup> and Ezio Manzini,<sup>6</sup> that it is right and proper for all the different specialists gathered under the design umbrella to develop new research paradigms.

Among the new paradigms entering design, is post-structuralism, or “the new criticism,”<sup>7</sup> which challenges traditional knowledge hierarchies. Although most evidenced in what used to be called literary criticism, the new approach is derived from the work of cross-disciplinary mentors including psychoanalyst Jacques Lacan and philosopher Jacques Derrida. Derrida argues that no form of knowledge is “centered,” and that there is no unique “logos” or knowledge structure that is truer than any other.<sup>8</sup> In fact, Derrida’s main point here already has been expressed by other philosophers, as different as Karl Popper and Richard Rorty. Popper has argued that knowledge comprises a network of theories, in which even the firmest beliefs appear to be provisional; subject to the discovery of a better theory.<sup>9</sup>

Rorty attacks the “foundational” view of knowledge, by which philosophers traditionally have assumed a privileged view of knowledge in general, which portrays different forms of knowledge building up from a hard base layer of the cognitive kind to progressively softer layers of the hermeneutic kind.<sup>10</sup> Popper seems to be one of these traditional philosophers, arguing that objective knowledge such as “The Earth orbits the Sun,” holds a special place because the veracity of such propositions does not appear to depend on subjective choice. Objectivity is clearly an important feature of the way knowledge is viewed in the hard sciences, and may help to explain why even great creations such as relativity theory are more usually described as “discoveries.” As recognized in the earlier discussion of patenting, design activity may involve some form of new discovery that can be tested in a way that provides reproducible results. However, design also encompasses forms of creative output which can be recognized, described, and evaluated; but only in the form of a critical activity that appeals to a sharing of personal experiences and aesthetic codes.

It is unlikely that many in design would want to claim that critical arguments impose the same sense of necessity on the understanding as do objective findings about, say, the physical performance of designed objects. Accordingly, by its very nature, design seems divided between views of knowledge that differ according to the kind of activity undertaken and questions posed. Designers frequently are called upon to tackle different problems, which involve different forms of knowledge and, thus, methodology. For

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- 4 V. Margolin, “Design Research and Its Challenges,” *Design Journal* 15:2 (1999): 14–19.
  - 5 C. Owen, “Design Research: Building the Knowledge Base,” *Design/Research Conference* paper (London: Royal College of Art, 1994).
  - 6 E. Manzini, “Design Research for a Sustainable Environment,” *Design/Research Conference* paper (London: Royal College of Art, 1994).
  - 7 A. Seago and A. Dunne, “New Methodologies in Art and Design Research: The Object as Discourse,” *Design Issues* 15:2 (1999): 11–17.
  - 8 J. Derrida, *Margins of Philosophy* (Brighton: Harvester 1982).
  - 9 K. Popper, *Objective Knowledge: An Evolutionary Approach* (Oxford: Oxford University Press 1972), 71–81.
  - 10 R. Rorty, *Philosophy and the Mirror of Nature* (Oxford: Blackwell, 1980), 313–22.

instance, the writing of this paper involves critical discourse, which appeals to subjective experience, leaving the arguments open to a spectrum of personal interpretations. Although some of the product design work I am about to discuss is not open to the same level of subjective interpretation, it either performs to an international standard, makes valid patent claims, or it does not—and these issues can be resolved by reproducible testing and examination. Such work is not even typical of much product design, which concerns restyling familiar objects, an activity that could be the subject of a design patent, but not an ordinary one. Differing research methodologies are bound to underlie such different tasks, and people working on three such projects are bound to adjust their goals, knowledge claims, and research methods, without ceasing to be engaged in some form of worthwhile design research.

However, caution should be exercised in the selection of research methodologies and paradigms, as evidenced by the example of some of the new criticism. Consider the “Theory of the Gaze,” which came from Laura Mulvey’s 1975 article “Visual Pleasure and Narrative Cinema.”<sup>11</sup> This has been a very influential, critical stance on film narrative, based on an entirely uncritical acceptance of Freud’s theory of scopophilia, which although probably new to most in visual studies at the time, already was regarded as outmoded and unreliable by many in psychology.<sup>12</sup> When introducing ideas and methods from contingent disciplines, it is more advisable to select methodologies from them that seem appropriate for particular tasks. Through informed adaptation to specific requirements in design, existing methodologies may even be revised or expanded to become generally useful in design research. For instance, asking if a design is patentable is a useful way of assessing the degree to which people from all disciplines may consider it innovative, but not of regrading it critically.

Returning to the value of patents as indicators of worthwhile research activity, if numbers demonstrate anything, our colleagues in the corporate sector are making a far more prolific contribution to the field of product innovation than ourselves. However, to recognize this is not to exclude academic researchers from the field. There are many small-to-medium enterprises (SMEs) that cannot afford to maintain their own research and development units. To such organizations, universities can offer what in today’s parlance is called “knowledge transfer.”

In many countries, this transfer can be supported by state funding initiatives. We have been supported by European Regional Development Funding, with a directive to provide a subsidized knowledge transfer service to SMEs. This imposes the condition that we should not be competing for work with local design agencies. Academics have the benefit of being part of a much larger expert community, whose presence greatly increases the range of methods, techniques, and resources we can bring to bear in planning a goal-led

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11 L. Mulvey, “Visual Pleasure and Narrative Cinema,” *Screen*, XV1:3 (1975).

12 J. Eysenck and G.D. Wilson, *The Experimental Study of Freudian Theories* (London: Methuen, 1973), 1–13.

research program. Few private design agencies could or would want to compete with these resources, so this makes it easier for us to identify the kind of projects in which we want to get involved. Our rule of thumb is that we say “sorry” to any company asking us to “Design one of those,” but welcome collaboration with anyone asking us “Do you think it would be possible to design something that...?” or “Are we going the right way about designing this?” A good demonstration of this principle is a case study of our collaboration with a small, but successful plastics company in our catchment area.

### **Case Study: Design for Rotational Molding**

Europolite Ltd. molds plastic products such as road cones and grit bins by rotational methods. A rotationally molded form essentially is a single plastic surface bounding a closed volume—a hollow sphere is a basic example. On the other hand, an open form like a bowl is not typical, but could be made by cutting a rotationally molded sphere in half. The process also allows more complex shapes, such as a form pierced through by a hole—“genus 1” in mathematical language—as well as genus 2, 3, and so on; provided the walls of the holes are all orientated on the same axis and do not “return” into the body of the basic form. While the method is less flexible than other molding processes in allowing a variety of geometries, plastic offers more opportunities for constructing complex forms than similar processes such as clay slip casting. The vast majority of molds are split into two parts, which are filled with finely ground plastic, sealed, and then rotated biaxially in a large oven that causes the polymer to melt and attach to the wall surfaces inside the mold, which later may be split open to release the finished product. The two great advantages of rotational molding are that it can produce large products, and the mold tools are cheap to fabricate or cast, typically costing between ten and twenty-five percent of the price of much smaller injection tools. It is a relatively simple process, often associated with large utilitarian products of relatively low production quality, and large tolerances of accuracy.

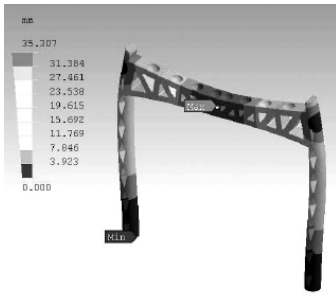
The managing director contacted us because he thought the process was capable of far more than his industry has demonstrated thus far. Early in our association, he suggested to that we investigate the possibility of designing an adjustable builder’s trestle to compete with the tubular steel variety that are fabricated to meet stringent British Standards in safely supporting a working load of 650 kg (BS 1139:4:1982). His cheerful justification of why he should want to attempt such a project was, “Because I make things in plastic.” While this had scared away design agencies, it proved irresistible bait to people who enjoy getting their students to build improbably strong bridges out of drinking straws. It was a project through which we felt we could learn, and this made it seem an ideal form of knowledge transfer.

Figure 1 (right)  
Adjustable builder's trestle to BS 1139 650 kg  
SWL.

All images provided courtesy of the author.



Figure 2 (below)  
Finite element analysis of trestle beam under  
650 kg point load.



For this project, we purchased a basic Finite Element Analysis (FEA) computer software program, *Design Space*, not only to assist the design process, but also to evaluate an application which, in principle, should be usable by product designers and not just trained engineers. Having generated a number of concept designs (figure 1), some were input into *Design Space*, which grudgingly started to give answers to the engineering questions (figure 2). It was not until the project was almost completed that we discovered we had been asking the program to do more than it was designed to, analyzing hollow forms rather than solids. We cross-checked the FEA solutions by taking small segments of a given part and calculating the answers manually. Then we fabricated a prototype steel tool using the final design selected.

In this case, we discovered that the loading simulations were within twelve percent of the real values found in the final design. We concluded from this that the latest FEA applications could be viable tools for product designers without formal engineering training. Despite our reservations about the eventual commercial viability of the trestle, we sought throughout the project to exploit the inherent advantages of a molded trestle by limiting the components to four forms that could be inexpensively molded with few fabrication steps thereafter, and assembled from a flat pack by the user. We were able to contract the standards testing in-house to our engineering laboratories. The dissemination of what we had learned was accomplished in part through the filing of a patent.

Another vital part of our mutual learning was an investigation into whether it was possible to increase the strength of the polyethylene polymer we were using, perhaps by glass fiber

reinforcement. This investigation demonstrates the value of patent literature to design researchers, since we found two patents from the 1980s which showed the polymer suppliers to be wrong in their assertion that rotationally molded plastics could not be successfully glass reinforced. When we tried to replicate the methods disclosed in the patents, the results showed the fiber tended to migrate into the inside of the product walls and was poorly packed, which made the strength of the compound less than expected in comparison to other molding methods. Proceeding in a way more reminiscent of Edison's empirical approach to the light bulb than of contemporary polymer engineers, we guessed that the problem lay in the glass strand dimensions. So we obtained samples of several nonstandard strand types to compound in a variety of different test batches. We were fortunate in achieving the desired result of a greatly strengthened product within a few hours of molding.

The next task was to further improve the strength of the glass-to-polymer bond by finding a more appropriate chemical coupling agent than those described in the patents. Despite superb support and advice from Akzo Nobel and Hoechst, we encountered far greater difficulty in these tests. The eventual solution again was derived from a leap of designer's intuition, rather than formal analysis. We felt an instinctive discomfort in suggesting that the workforce made up the molding compound with a rather hazardous liquid chemical. This led to a search for a powder-based form, which we could not find, but we did come across a similar product used in rheology rather than coupling, that had a fine chalk powder of similar grain size to the polymer. Again, we used empirical methods to find the correct concentration, and the strengthening effect was so tangible we scarcely needed laboratory testing to tell us which measure and mixing method gave us the best coupling. The results of this work are to be disclosed in another patent application.

The final example concerns a project more within our range of expertise, which arose from the company's success in persuading us that there was untapped potential in rotational molding. The problems to be overcome had more to do with the standards of toolmaking than of product design. The tolerances of steel-fabricated mold tools are at least 2mm over 1m, and wall thickness can vary up to twenty percent. In theory, an aluminum tool cast from a wooden model, or pattern, can be made accurate to fractions of a millimeter, but then the patterns are hand-built from the design drawings and therefore prone to larger errors. In the trestle, we had to connect opposing walls in the hollow form to create a true structure, rather than a void enclosed by unconnected walls. We did this by dimpling key areas of the walls to create "kiss points" inside the form as the product molded (figure 3). The unconventional dimple forms we created did not endear us to the toolmakers, whose notions of engineering tolerance did not endear them to us. If we could find a more



Figure 3

Cross section through trestle beam.



accurate way of generating the patterns, we felt we could overcome the limitations of the process to liberate its potential.

The molding ovens can be as large as four meters in diameter, which means smaller products can be tooled as “parasites” that are just fixed into any space not filled by a larger product being molded. Given tooling costs of as little as £2,000 to £3,000 for a product the size of a flashlight, the parasites can act as prototype generators which, if successful, can be duplicated so that arrays of these small products can be molded ten or twenty at a time at a fraction of the cost of an injection-molding tool manufacturing them at a comparable rate. So rather than trying to apply rotational molding to products never made before in plastic, we were seeking to advance rotational molding into a more competitive form of making plastic products. A good vehicle for this idea turned out to be a “hard hat,” a product always injection molded, with a typical tooling cost of £80,000 to £100,000. Since a hard hat essentially is a shell supported by an adjustable webbing cradle, we set out to see if it were possible to turn the underside of a rotationally molded hat into a webbing, and find an alternative method of adjusting the headband to fit all sizes of head (figure 4).



Figure 4

Desktop model of rotationally molded hard hat.

The design solutions seemed relatively simple. The adjustable back of a baseball cap shows how a broad range of hat size adjustments could be made by attaching a belt-type strap to two small lugs on the rim. The webbing could be created by cutting the shapes of the holes in the webbing from a low thermal-conducting material, and then fixing these cut-outs on the relevant surfaces of the mold tool so that no plastic would form on them. However, the real problem was how to ensure the accuracy of tooling that was essential

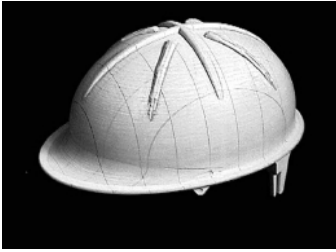


Figure 5  
Rapid prototype model of hard hat in  
laminated paper.

from a structural point of view as well as an aesthetic one, because this was an apparel item. Construction workers appear to have a greater consciousness of their appearance than may be imagined. Evidence comes in the form of the novelty *Stetson* hard hat, which apparently is a major seller in the U.S. heartlands. The fact that our hat has ribs which form a Union Jack is completely fortuitous, a result of our mainly structural approach to the task. Nevertheless, we were perfectly happy to exploit this accident and have only half-jokingly suggested that the client might consider marketing it in the UK as the “Jack Hat.”

As to making an acceptably accurate model, we turned to our colleagues at Nottingham University to help us rapid prototype an extremely accurate solid model direct from our original CAD files. For this relatively small product, it was economically acceptable to use the LOM (laminated object manufacture) process. This produces the “wood” model by scanning the CAD model in paper-thin horizontal slices, and then laser-cutting the slice from a sheet of paper, running a glue-impregnated roller over the slice and then repeating the procedure to generate the complete model (figure 5). Plaster patterns were taken from the model, from which the aluminum mold tool parts could be sand-cast. The tool casting is taking place at the time of this writing, so the results are not yet fully known. However, we are confident that our approach is the way forward to realizing the larger objective of introducing rapid, accurate toolmaking right from the designer’s CAD files in order to facilitate a new generation of products that conform both to consumer expectation and to the necessary regulatory standards for public health and safety.

### Conclusion

As to the lessons that can be learned from the practice of contract research in design, the following seem instructive. Unlike art or craft activity, professional design generates plans that are seldom realizable by the designer, and require the application of technologies and resources largely controlled by third-party commercial enterprises. Those seeking to develop a consensual view of design research should not overlook the real relationship of design with commerce. Commercial imperatives clearly impact on designers’ research approaches as well as their practice. It may appear from the case studies that goal-led research for commercial clients encourages less inhibited methodology, because the primary goal is research that produces a tangible commercial effect. Yet while ends very much justify means in contract research, they do not necessarily handicap good design research. The design researcher need not have all the expertise required by the project, good project management skills are more appropriate, and key among these is the ability to recognize what expertise and methodologies need to be introduced from outside the discipline. This suggests that breadth of knowledge is an important characteristic of both design researcher and practi-

tioner, and further implies that depth of specialist knowledge may not count as much as in other disciplines. We have found that the effect on clients of working with academic researchers is to liberate their risk-taking and playfulness, which are vital ingredients both for creativity and formulating interesting research questions. Play involves a considerable element of trial and error, an approach that may have become rather unrespectable in formal scientific research, but is very much a part of the designer's working method—especially since product design involves speculative activities such as criticism, which appears to play little or no role in the practice of “hard” science. Some of the research methods described in our case study might appear too informal to purely academic researchers. We defend the methods on the basis that the contracted goals were achieved, allowing new products to be realized and their designs appropriately reported and disseminated, for instance, through patent applications. These reflections may suggest that a shared understanding of design research is as well assisted by retrospective examination of practice as by prospective theoretical debate.