Shared Conversations Across Design

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Introduction

Design is an ubiquitous part of human life, from mundane, day-to-day activities to the most sophisticated concerns of society. Yet it is generally studied from specific disciplinary viewpoints, where a field develops strongly focused academic traditions to meet the needs of that field. For example, engineering design research places significant emphasis on prescribing how complex design processes should be carried out;[1, 2] architectural research is greatly concerned with the creation of design ideas;[3, 4] product designers are concerned with generating and meeting customer needs;[5] fashion designers are interested in the cultural context of their products.[6] This characterization of different interests in different fields is neither rigid nor exclusive—there is significant overlap between the interests of particular fields. Nevertheless, it draws attention to a fragmented picture of design as a whole.

This paper is concerned with the experience of being a designer and doing design, regardless of the discipline in which the designer works. We want to draw a rich picture of what it means to be a designer by comparing design practices across projects and design domains. Previous researchers have more often aimed to establish general criteria by which core concepts in design research and theory-making can be related to designing and designs.[7, 8] They have compared design activities in order to define the general principles across all of design. Other work does not always set out explicitly to be generic but does so by implication when careful analysis of design instances leads to general principles of design, as in the general paradigm of the reflective practitioner, which was derived from a detailed study of conceptual design in architecture.[9]

By contrast, our aim is to consider the patterns of behavior that designers display across a variety of fields. Here we may find that while professional concerns, such as the need to meet customer requirements or general market trends, are often the same, their manifestations can be very different. Thus, we have developed a research method that brings to design research the benefits of phenomenological analysis, emphasizing comparison of personal experience rather than trying to describe truths that are independent of any person. As described in a previous paper,[10] we ran a series of

11 A.F. Blackwell, C.M. Eckert, L.L. Bucciarelli, and C.F. Earl (2009), "Witnesses to Design: A Phenomenology of Comparative Design," *Design Issues,* 25:1 (Winter 2009): 36–47.

research workshops, at which small groups of expert practitioners from very different design disciplines were asked to present, discuss, and compare project case studies typical of their various types of design.

Being exposed to this variety of experience allows designers to better understand their own behavior through comparison, reflecting on strengths and weaknesses, as well as gaining new understanding of their design practice as reflected by the mirror of others' professional work. None of the disciplines is seen as normative, and none is used as a benchmark. The goal is not to describe what design "is" in a definitive and generic sense, or indeed to prescribe how design "should be," but rather to understand how it manifests itself from the perspective of those who take part in it. In the remainder of this paper we report on key themes that emerged from these workshops, illustrating the diversity of responses that can occur to the many common issues and challenges. This is not an exhaustive comparison between design domains or even an exhaustive list of potential design behavior, but an illustration of how the professional experience of design can vary.

Preparation

The Across Design project was established under the auspices of the Cambridge-MIT Institute, with additional collaboration from design researchers and educators elsewhere. It consisted of a series of six research workshops between 2002 and 2004, each including between three and five professional designers, who were invited to report on a particular project of their choice. Each informant had at least ten years of design experience (in one case of a new technology, only five), although the majority had twenty or more years of professional experience. Rather than well-known "stars," we sought to invite experts who were well respected by their peers without being affected by media attention. The theoretical motivation, facilitation procedure, and analytic approach are described in our previous paper, "Witnesses to Design."[11]

Although our research team started from research backgrounds in clothing, architecture, typography, engineering, and software, we recruited designers from as many fields as

Table 1 (below)
Participant Domains

Oct 2002 (UK)	Automotive engineering[e], software[s], health, transport, and consumer products[a], architecture/urban planning[aa]
April 2003 (UK)	Civil engineering (structures)[e], websites[mm,] automotive styling and consumer products[a,] drugs/pharmacuticals[ss]
July 2003 (UK)	Graphic media[mm], aerospace engineering and senior management[e], documentary filmmaker[a]
Nov 2003 (UK)	Artistic fashion[a], medical devices[s], food[ss], packaging[a], architecture[aa]
Jan 2004 (USA)	Architecture[aa], technical fashion[a], automotive engineering and senior management[e]
July 2004 (UK)	Electronic products[e], furniture designer[a], software[s], course design[mm]

possible. Each workshop tried to provide a balance between disciplines, in particular between artistic and technical designers. We also tried to stretch the boundaries of what might typically be considered design—for example, by recruiting a drug designer and a documentary filmmaker. Table 1 shows an overview of the workshops and their range of participants.

At the outset of the project, research team members created their own framework for comparison, drawing on individual research interests and experiences. This framework formed the basis for agreeing on important research topics among ourselves, as well as serving a wider role through its potential to help negotiate common terminology among researchers coming from different countries and communities. This common understanding among the research team members was communicated to participants through illustrative open questions that were topically grouped (as in Figure 1) and a graphical overview of the areas of concern (Figure 2). However, the workshop briefing material emphasized that these were not to

Figure 1 (right)
Example Question in the Design Framework

A1 Models

What kind of temporary or evolving products (e.g. sketches, models, or functional prototypes) get created in the course of your design?

What do you call these intermediate representations?

Why do you use a particular representation at a certain stage in the design process?

Figure 2 (below)
Categories of Features of Design Used
in the Across Design Project
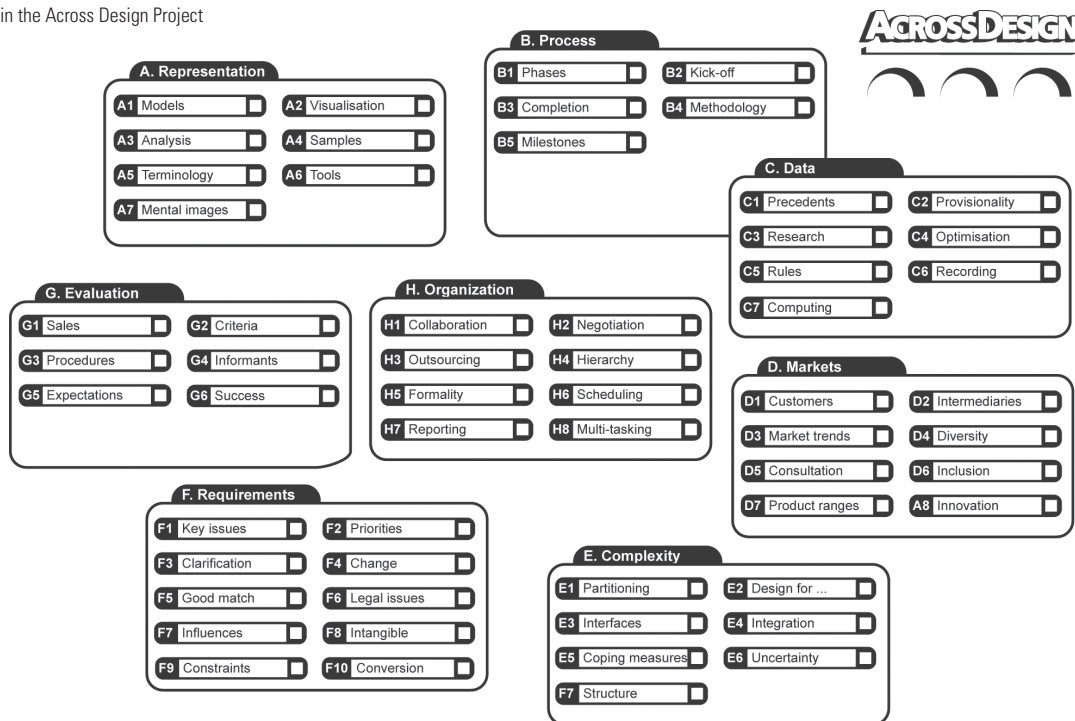
be taken as constraints or as questionnaires to be completed in an exhaustive manner but as a guide to identifying what we might be interested in. As a result, participants structured their contribution according to the case studies they chose, in the style of their own particular discipline.

The findings from this reflective process by participants, followed by transcript analysis and further interviews with the research team, have been rich and diverse. In the remainder of this paper we present a number of recurring issues, illustrating them by considering ways in which the same, sometimes surprising, phenomenon is played out in different fields. We highlight the importance of these particular issues to designers from a wide range of different domains, while illustrating the range of different ways in which design processes can be expressed.[12]

Shared Understanding of Practice
The most striking finding through all six of our research workshops was the recognition by our participants of the commonality in their own experience. This uniformity was not previously expected (and therefore preconceived), arising from the treatment of all design as a generic abstract endeavour. On the contrary, we observed appreciative surprise among our informants as they recognized the degree to which the experience of other professionals, who they might not have considered as natural peers, did in fact extend across design. They all saw themselves as designers and recognized the others as designers. For example, in one workshop we brought together the chief engineer for conceptual design of a jet engine, a documentary maker for the BBC, and a graphic designer. The jet engine designer has a wholly technical background, managing a large team of engineers working on many different engines in parallel and interacting with several engine projects comprising hundreds of experts having very specific knowledge. The documentary maker pulls his team together for each film, and he works on a variety of different topics in very varied environments, including both filming on location and working with rich archive material. The graphic designer works on her own, carrying out short projects for return clients. On the surface they have different tasks and different lives, but they all recognized the common challenges they faced in getting a project out on time: getting the right brief from the clients, coming up with good ideas when you need them, coordinating the input of the people they worked with, etc. They were inspired by the way each of the others worked, the structure of the engineering processes, the strong personal links of filmmaking, and the exhaustive solution searches of the graphic designer. They could easily abstract the experience of others to a level that was useful for their own reflective practices.

It was striking that none of the designers seemed to have a problem understanding their colleagues' presentations. Terminology

12   This article does not offer a fully comprehensive description of the project findings. Further and complementary material will appear in a forthcoming book, to be published by MIT Press. The book describes in greater detail the Across Design project and focuses more specifically on the drivers that result in differences of behavior between industry sectors.

was rarely a problem, and meaning was clarified easily when questioned. Even if they were unfamiliar with the domains and thus the terminology, the context disambiguated the details, and participants at least had a subjective and expressed comprehension of each other's major concerns. For example, the graphic designer talked about generating "thumbnails"—small, quite rough sketches—to explore her solution space. The meaning of the term was fairly clear from context, somebody asked a clarifying question, and the workshop moved on.

Agreeing on the Criteria of Good Design
We were surprised at the criteria by which designers evaluated their work and motivated their professional activities. For many, recognition by their community of design peers is what motivated them. Some acknowledged that they were fortunate to work in a field where it was possible to make a living while maintaining this professional integrity. The television documentary maker was accustomed to working for the publicly funded BBC, where projects were traditionally funded by a process of patronage. Viewing numbers for first screening, peer recognition, and in the case of controversial work, influence over opinion-formers appeared to be a far more significant concern than the market concern of whether his work was viewed by a large audience on repeat screenings. One of the architects referred to recognition from professional lobbying groups, such as the influential Commission for Architecture in the Built Environment (CABE) in the UK. Although he took personal pride from seeing people living happily in his projects, this quality aspiration was difficult to measure or quantify. Architects are often accused of creating award winning but uncomfortable buildings. For them making a statement through their buildings and being recognized by their peer group is extremely important. A furniture designer at our workshop took this to extremes and told us not about a chair that you could sit in, but about a series of chairs created for the Milan furniture fair that were witty commentaries on classic chairs—but not pieces that could be sat on. This exhibition was a personal and public exploration of the notion of a chair.

Conversations with Materials and Tools
For many of our participants, design was a physical interaction with the materials and tools they worked with. They enjoyed the direct interaction and were in many ways inspired and guided by the properties of the material and tools, both of which provided opportunity as well as constraints. All participants wanted to use their materials to the best advantage and the greatest potential, but they also wanted access to those materials that provided freedom to realize design concepts or requirements. This desire was expressed by designers in all domains, even though more artistic designers had more freedom in exploring what their materials afforded.

For example, the participant who is a lighting and furniture designer works in a very hands-on way. For her, designing is a genuine conversation with the material, a back-and-forth exploration of what she wants from the material and what the material "wants" to give her. In her early career she made little paper models of lampshades, just by folding up pieces of paper. Now she makes chairs out of different materials to explore what the material can give her and how people respond to the material.

Fashion designers often model garments on a stand. They physically drape fabric of the right weight over a dress dummy and pin it into shape. They can endlessly change it until they have reached a shape that they are happy with, inspired by or responding to the fabric. In the case of the fashion designer at our workshop, she used this method to make an evening gown out of black plastic rubbish sacks as a commentary on the wasteful nature of our society.

The graphic designer's materials are fonts and pictures. She uses a structured process of selecting them to provide herself with the constraints that she needs to be creative in her process.

The engineers, working in large teams, reported maybe the least direct interaction with material, although they were intimately concerned with designing for and within the capabilities of available materials. The jet engine designer brought a very sophisticated fan blade to his workshop. This blade had been produced in a novel way and was both unusually light and exceptionally strong. He was no less intrigued and challenged by the material than the furniture designer.

The TV documentary film director works with found materials. He looks in archives for the right footage and tries to film people engaged in activities that express his story idea. However, he is also responsive to what he sees, and he develops his emerging story around new material.

The food designer reported on her team's spending a few days in the kitchen experimenting with different ingredients to get the right texture for ice cream, and the laborious process that followed to work out how to produce this texture on a commercial scale and in a way that is safe throughout the product life cycle through production, distribution, and consumption. For this food designer, cooking is a way of sketching out ideas, of externalizing and sharing vague concepts that could not be expressed in any other way.

Many of the other designers sketch on paper or a computer. Architects generate sketches to capture and develop their own ideas through the entire process but are very well aware of the personal nature of many sketches. They produce different sketches, often more detailed or computer rendered for interactions with customers who might be misled by the ambiguous nature of sketches. Sketching is not limited to those domains that generate visual or physical

products; software designers, for example, also sketch very frequently. They express the structure of their programs and their processes through sketches and share them with each other through these visual depictions. The participant who designs jet engines told us that he encourages engineering staff to work quickly with a pencil, to help address the challenge of turning an analytic problem statement into a mechanical solution. These engineering sketches are depictions of relationships and functions, as much as of physical embodiments.[13]

Relationships with the "Customer"
The professional designers we met in Across Design have surprisingly little contact with the end users of products they design. The design brief might be founded on market research, including surveys of the eventual end users or customers, but among our participants the designer rarely had a chance to meet those users. Exceptions occurred and seemed to be most likely in the large consumer, food, or domestic product manufacturers, where designers have the opportunity to join focus group sessions. In the case of packaging for detergents, for example, formal user trials of the designs were an integral part of the design process. In the case of a "skunkworks" undertaken outside normal rules and processes of the company for the conceptual design of a car re-launch , the unusual enthusiasm of the designers made it especially appropriate to initiate contact with other enthusiasts outside the company, inviting participation from members of the product owners' club. However, in the reports of most of our participants, it appeared more common for fashion, design trends, or conceptual visions to drive design than direct acquaintance with user needs. The graphic designer described how, when commissioned to create a brochure with an "edgy" aesthetic for a teenage audience, she consulted her graphic design students as more informed representatives of youth culture, but they did not formally evaluate her design. Other designers projected their own vision onto anticipated markets.

If the designer works on behalf of the same client over the course of multiple product cycles (perhaps as a permanent employee of a manufacturing company), then a closer working relationship is likely to develop between design and marketing departments as products are refined in response to market evolution. These relationships generally bear fruit in industries where product designs are repeatedly revised over periods of many years. A diesel engine designer was able to report a highly developed organizational structure of this kind. His market data included feedback on product reliability and lifetime operating costs, allowing his team to make incremental improvements that would benefit future users. However, the end users of his products are still once removed. Diesel engines are sold to vehicle manufacturers, who gather performance and maintenance data from their customers. This statistical data,

13 A longer discussion of sketching in different design domains will be available in the article, "Sketching Across Design Domains" by C.M. Eckert, A.F. Blackwell, M.K. Stacey, and C.F. Earl, accepted for publication in *Visual Communication.*

rather than contact with users, is what drives the design process. This particular designer spends much of his time dedicated to the collection, organization, and distribution of this data to direct the design process and inform the inevitable trade-offs that take place as design progresses.

Customer relationships are presently changing for some complex products, such as aircraft engines. Rather than the product being owned and maintained by the customer after sale, it is now owned throughout its lifetime by the manufacturer, who leases performance capability to the customer at a negotiated rate. The risk of ownership is thus shifted from the customer to the manufacturer, and the manufacturer takes over many of the concerns that were formerly the customer's. This shift from product to service has triggered a new way of thinking among manufacturers and designers.

The working relationship between designer and design client can become even more complex in fields that combine large-scale financial or legal processes with substantial demand for creative innovation or an individual response to specific requirements and conditions of use. In the field of architecture, these factors, which can conflict, are segregated into separate project phases. Our participants described how large projects often start with a design competition, where several design firms submit preliminary plans to be judged by a client or the client's representatives on a competition panel, but none of the designers have much direct interaction with the client. The winner of this creative competition is then expected to form a relationship with a construction or development company, after which the two work together to develop detailed plans and cost estimates. As the construction phase of the project approaches, the client is transferred from the architect to the construction firm. In a reversal of roles, the architect becomes the contractor of the construction company.

Another of our participants, a civil engineer with close links to a famous architectural practice, described a visionary design for a city train station, conceived to express the creative and innovative image the city wanted to express, with dramatic sweeping curves spanning a huge area of ground. This grand concept had captured the imagination of the clients, who proceeded in confidence that the vision could be achieved. However, only some time later was the engineering question of how this building would be structurally attached to the ground resolved. The tensions between creativity and practicality, or between form and function, are a constant factor in design work. Helping to resolve these tensions is a fundamental role of the designer.

Representations as Communication Tools
In designers' interactions within their teams and with their clients, one of the key success factors is the use of appropriate represen-

tations, which enable both groups to understand each other's intentions and provide each with the means to express themselves. In many different types of interaction, the representations that are used have a significant effect on the interactions themselves.

One of the car designers, working as an independent design consultant, described the work of a specialist clay modeller, whose role in the project was specifically to create a 1/8-scale clay concept model that would sell the idea to a client and fund the detailed work of mechanical and production design. The clay model provided a prop for communication with clients, but it also provided a communicative tool among the members of the design team. The central collaborative relationship was between the car designer and the model maker, and their communication took place around the model as it took shape between them. Because the subtleties of visual and physical form are not always expressible in words, the representational tools of the designer form a language among members of the design community. These representations and the conventions to interpret them enable colleagues to engage in a dialogue with each other. Further, they allow designers to explore design possibilities in a metaphorical "dialogue" with their material.

The introduction of computer representations has produced a "generation gap" among the staff of design offices. Several participants complained that young designers no longer use a pencil but work directly on the computer. The computer, in addition to representing, clearly brings both new technical opportunities and new ways of relating to the object of design, so this phenomenon may be a transient one. However, we did observe that senior designers often preferred to work rapidly with a pencil, exploring options, before committing an idea to the computer. Even designers who already make full use of computer technologies might, when they present their ideas to the public, return to paper sketches and traditional drawing tools. An architect who regularly presents preliminary design work to members of the public told us that he would take computer renderings of the design in its built environment, and trace over them with colored pens because he found that more handcrafted-seeming representations facilitated direct dialogue and a more immediate response. The evidence of craft skill in these drawings helps to establish a relationship based on recognition of professional training.

The ways in which visual and physical representations provide points of external reference for conversation is an essential feature in the management of complexity. In many design activities, the users of the product may be unaware of internal complexities that have been resolved using specialized representations during the design process. Examples range from highly technical analysis, such as the software visualization of predicted wind tunnel performance for jet engine components, to straightforward organization of design elements. In the latter category, the TV documentary

director described the central organizational tool for his team: It is a whiteboard divided into two columns—a column of concepts to be communicated to the viewer and a column of the filmed images that will be used to convey each of them. These representations often provide shared vocabularies for coordination and cooperation. Members of an electronic product design team all recognize the circuit schematic of the product and use it as a central meeting place. A software team has a "master diagram" describing the overall structure of the system. Drug designers all recognize the chemical structures of standard compounds they combine. In the absence of suitable conventions, designers improvise.

Uncertainty in Collaborative Processes
Almost all of the design projects that were described to us involved collaboration between teams of technical specialists, and they extended over periods of months or years. Even those who produced comparatively simple products, such as the graphic designer, the furniture designer, and the fashion designer, often worked over many years with the same people in stable teams. The uncertainties inherent in creating a novel product mean that any aspect of the process may take longer than expected, or that required interfaces and parameters may change in the course of the project. In these circumstances, a great deal of design work is, in fact, project management.

In fields where the required functionality of the product is flexible, especially the software industry, many management strategies are intended to minimize the risk of change. A developer of large software systems described the way that multiple versions of the product are delivered: Each cycle of refinement is short enough that any necessary change can be discovered early, so that managers can plan around them and not compromise final deadlines. His process followed detailed and well-established software method-ologies, developed to mitigate these risks, but they had been adapted to address his particular problems. An architect who specialized in community-managed projects, such as churches and schools, had to take special precautions to allow for the fact that her clients were often inexperienced and might not be aware of the importance of maintaining an agreed-on design brief. She therefore took care to educate them regarding the stages of the design process, and used "sign-off" design phases so that committees of (often voluntary) client representatives would recognize and acknowledge the points at which they were fully committed to prior decisions.

Engaging with Public Policy
We found many situations in which the designers' role appeared to be largely to implement public policy. Designers in the transport industries are highly constrained by environmental regulations on noise and emissions, for example. Public policies on emissions of

particulate exhaust or greenhouse gases often set industry targets over a five- or ten-year horizon.

Both diesel and aircraft engine designers reported that their work has become dominated by the demands of continuous improvement arising from environmental legislation, and that a particular client's requirements regarding cost and functionality must be accommodated as much as possible only after regulatory targets have been achieved. In addition to environmental regulation, safety constraints and testing regimes are also central to the processes of aircraft engine design. Appropriate safety processes are both negotiated among major manufacturers and either ratified or imposed by national and international regulatory authorities. Reliability of the product has also been key to the brand image of both engine companies.

When the public is at risk from the product, stringent tests are required by legislators to protect the user of the product. Meeting these requirements is an important issue in the validation of complex engineering products, such as aircraft. Its significance was illustrated rather graphically by our aero-engine designers, who showed us footage from their bird strike testing rig. Whole defrosted turkeys are shot at a running engine with a big gun because the certification authorities require physical damage testing after the company has already used computer simulations. However, testing is an even greater part of the entire process in medical and pharmaceutical products. The testing of drugs is highly regulated as a sequence of both lab tests and clinical tests. Our participant from the pharmaceutical industry reported that the necessary clinical tests to develop a promising drug compound into a publicly available medicine costs $800 million, after which only one in ten becomes commercially successful. In comparison to such high testing costs, the cost of designing the original compound is almost negligible.

Publicly sanctioned or sponsored design work can also be seen as a direct tool of public policy, rather than simply a social constraint on production of goods for the free market. Public housing schemes are one example of a situation in which the designer may be perceived by end-users as an instrument or representative of the state. For example, large housing developments in the UK are required to provide a certain proportion of "affordable dwellings" that may be managed by a housing association established alongside privately owned housing; however, developers are often motivated to construct such schemes to a minimum cost standard. Here, the designer can be an advocate of product quality on behalf of end-users who are only indirectly represented within formal review processes. The strong voices in public debate are often entrenched interest groups seeking to maintain privileges, such as access rights to public land (e.g., for car parking). Our participant talked at length about his engagement in local politics, attending public meetings and establishing a relationship of trust by listening to the initially

extreme opposition of local residents who feared that their concerns would be ignored by municipal bodies.

Education Within a Profession

Our design participants were deeply concerned with the structure of their profession and with recognition by their professional peers. Many of the most experienced designers were also concerned with the future continuity of their own professional community. This concern was particularly apparent in fields where international competition was devaluing traditional design values, or where technological change resulted in the loss of traditional skills. For example, a garment pattern designer, who had run her own business and designed make-to-measure garments, was particularly concerned with developing skills and understanding process, arguing that as production is moved offshore, designers lose the link to manufacturing and do not understand anymore how to optimize a design for production.

Several of the designers stressed the shortcoming in design education, in that it does not prepare designers for the practical aspects of running projects or businesses. One of the architects stressed that the difference between a successful project and a failure often lies in the customer/client relationship. She has gathered much useful experience in the projects she runs but felt that these skills were largely absent from design education. Similarly, the engineers commented that they were not trained to manage and lead people but were promoted for technical excellence. This point was echoed by a furniture designer, who commented on the importance of learning how to interact with all people in design teams. For her it was critical for design students to learn to interact with the materials they use and the technicians who help them, rather than to rely solely on computer simulation. The fashion designer had really struggled when she set up her own business as a young practitioner. Although she became very well known very quickly, she did not achieve a sound financial footing because she was poorly prepared for the commercial side of the business.

Conclusions

Designers are engaged in many of the same activities and concerns, but in very different guises according to their particular technical domains and social or business contexts. Looking across different domains shows the rich manifestation of these activities. This understanding can help to foster respect between designers from different disciplines, who might otherwise see the differences rather than the commonalities in their collaboration.

A better understanding of design processes is also required to develop more effective methods to support designers and to provide them with better tools. As design researchers, we must be able to define the scope of descriptive theories across a range of professional

activities as experienced by designers themselves. It is important to recognize that, although design domains are certainly similar, they are also different, in ways that become more apparent when we address the reluctance of designers to abstract the nature of their work from any specific context. To properly understand the common features that emerge across particular processes, techniques, and contexts, it is necessary for us to adopt a research perspective that arises from the details of each of them.