

Design Research and the New Learning

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Introduction

The theme of this conference is how we shape and sustain design research programs in our institutions. It is an important theme, and the conference is timely. Despite a growing body of research and published results, there is uncertainty about the value of design research, the nature of design research, the institutional framework within which such research should be supported and evaluated, and who should conduct it. In short, there is uncertainty about whether there is such a thing as design knowledge that merits serious attention. My goal is to address these questions from a personal perspective, recognizing that my individual views may be less important for the goals of the conference than how my views reflect, in subtle or obvious ways, the North American social, cultural, and intellectual environment within which they have formed. The conference is about design research in the United Kingdom, and my role is to provide a contrasting perspective at the outset that may help us understand some of the issues and options that are taking shape in the United Kingdom. My willingness to play this role comes from a belief that we are in the middle of a revolution in design thinking and that events in the United Kingdom, while strongly influenced by issues of national policy, reflect changes in the field of design in many other parts of the world.

Design Research in the New University

The origins of modern design research may be traced to the early seventeenth century and the work of Galileo Galilei. Galileo's *Dialogues Concerning Two New Sciences* was the culmination of thirty years of personal research into the motion of bodies, and the book presents his theory of motion. We are well aware that Galileo is considered the father of modern physics, but this is a story told by philosophers and historians who work under certain cultural beliefs that deserve closer examination. *The Two New Sciences* begins not with a discussion of physics but with a discussion of design in the great arsenal of Venice. Salviati says,

The constant activity which you Venetians display in your famous arsenal suggests to the studious mind a large field for investigation, especially that part of the work which involves mechanics; for in this department all types of

instruments and machines are constantly being constructed by many artisans, among whom there must be some who, partly by inherited experience and partly by their own observations, have become highly expert and clever in explanation.

Salgreto replies,

You are quite right. Indeed, I myself, being curious by nature, frequently visit this place for the mere pleasure of observing the work of those who, on account of their superiority over other artisans, we call "first rank men."

Conference with them has often helped me in the investigation of certain effects including not only those which are striking, but also those which are recondite and almost incredible.

The present condition of the field of design owes much to this brief discussion and the cultural environment within which it takes place. Instead of turning to investigate the human power or ability that allowed the creation of the instruments and machines of the arsenal of Venice, Galileo turned to an investigation of the two new mathematical sciences of mechanics. This reflects a general tendency following the fifteenth and sixteenth centuries to turn towards theoretical investigations in a variety of subject matters, laying the foundations of the diverse fields of learning that are now institutionalized in our universities.

Galileo's work was published by an English press in 1665, where it entered the tradition begun by Francis Bacon, who was Galileo's contemporary, and subsequently developed in monumental fashion by Newton in the *Principia* in 1686. Francis Bacon, too, plays an important role in the origins of design research, because his project was to begin a Great Instauration of learning that would lead to our ability to command nature in action, where nature would be molded by art and human ministry in the creation of "artificial things." Bacon's project is clearly a design project. And perhaps it is *the* design project, if we allow that the hubris and enthusiasm of Bacon would have been tempered over time if he had been able to witness the many mistakes and tragic failures of the application of knowledge gained in the natural sciences over the centuries. There is a deep humanism in the work of Francis Bacon, borne of his understanding of the role that rhetoric plays in human culture and in the advancement of learning. In truth, we may say that Bacon's project remains with us today, unfinished in its core purpose. After a hiatus of more than three centuries, during which human beings have explored the foundations of matter and natural processes, we are returning to the humanism that is required for a firm understanding of design.

Design was not one of the fields institutionalized in our uni-

versities following the work of Galileo, Bacon, Newton, Decartes, and others. The reason is not difficult to discover. As the new liberal arts of western culture took shape in the fourteenth, fifteenth, and sixteenth centuries, design was not included, except in the general work of architecture and the fine arts. Design as we have understood it in the twentieth century was then regarded as a servile activity, practiced by artisans who possessed practical knowledge and intuitive abilities but who did not possess the ability to explain the first principles that guided their work. Newton, for example, distinguishes the mathematical science of mechanics from practical mechanics and the manual arts.

In the *Battle of the Books*, which is an English characterization of the long struggle between old and new learning in our culture, design was clearly part of the old learning. It was “paleo-teric”—the term that was used to name the old learning. The new sciences, which promised to put all human understanding and activity on a firmer footing, were the new learning. They were “neoteric,” since they addressed new problems in understanding the world and tended to shape the organization of learning around such problems. The new learning was theoretical and oriented towards subject matters, marked off from each other by principles and causes that were, in a sense, in the nature of Being.

The subsequent unfolding of the new learning is a long and complicated story, but for our purposes we may observe that theory was highly prized in the universities, practice was tolerated, and production or making—the creation of what Bacon calls “artificial things”—was generally ignored as a subject of learning, except to the extent that the design of instruments played a greater and greater role in the investigation of the natural sciences. All that survived of production or making as a subject of study in the universities was captured in the literary and fine arts, which were studied through their results or tangible products as a subject matter for historical inquiry. In the Renaissance formulation, the results of design, to the degree that they merited attention, belonged to “*belle lettres* and *beaux arts*.” The actual work of fostering natural talent and teaching individuals how to create was relegated to art schools and academies, which were first established in Europe in the sixteenth century, independent of universities. Subsequent art academies, established from the middle of the eighteenth century, show a concern for maintaining or raising the intellectual stature of the visual arts, but the activity remained essentially outside the universities. Even then, as Sir Joshua Reynolds demonstrates in his lectures, design was regarded as needing the guidance of the fine arts of painting and sculpture in order to reach its ends. In his first discourse, delivered at the opening of the Royal Academy of Art in 1769, Reynolds writes:

An institution like this has often been recommended upon considerations merely mercantile; but an Academy,

founded upon such principles, can never effect even its own narrow purposes. If it has an origin no higher, no taste can ever be formed in manufactures; but if the higher Arts of Design flourish, these inferior ends will be answered of course.

The legacy of the art schools of design is with us today in the United Kingdom and in most other parts of the world, though the vision and effectiveness of these schools in teaching design grows fainter every year under the need for young designers to have more knowledge and a broader humanistic point of view in order to deal with the complex problems that they must face in their professional careers. Fragments of the human power or ability to create have, indeed, moved into universities in the past century or more, particularly in the form of engineering, “decision science,” and most recently in the form of computer science. Furthermore, design education, too, has begun to find a place in a few universities—and in some of the leading research universities.

What I want to suggest for this conference is that the discovery of design in the twentieth century is more than a small incremental addition to the tradition of theoretical learning upon which our universities have been based since the Renaissance. True, design and its various branches have entered the universities under this guise, and their practical significance for economic development and the well-being of citizens may help to account for this development in tolerance among those who are committed to the old structure of universities and the old models of research. After all, universities had already found ways to accommodate within their missions the study of Law, Theology and Divinity, and Medicine. However, the discovery of design is more than this. It is a sign, I believe, of a new battle of the books in our time: a new round in the struggle between the old and the new learning in human culture.

The reason for this new battle is evident. While we do not deny the value and the ongoing benefit of theoretical investigations of subject matters in the sciences and arts, we also recognize that the powerful development of this learning has left us in a deeply troubling situation. We possess great knowledge, but the knowledge is fragmented into so great an array of specializations that we cannot find connections and integrations that serve human beings either in their desire to know and understand the world or in their ability to act knowledgeably and responsibly in practical life. While many problems remain to be solved in the fields that currently characterize the old learning—and we must continue to seek better understanding through research in these areas—there are also new problems that are not well addressed by the old structure of learning and the old models of research.

It is a great irony that what was once the new learning is now the old learning, and what was the old learning is now the new

learning. For I believe that is what has happened to design; it has become the new learning of our time, opening a pathway to the neoteric disciplines that we need if we are to connect and integrate knowledge from many specializations into productive results for individual and social life. To be sure, those who practice, study, and investigate design in the contemporary world are themselves divided along paleoteric and neoteric lines. Some see no need for design research, and some see in the problems of design the need for research that is modeled on the natural sciences or the behavioral and social sciences as we have known them in the past and perhaps as they are adjusting to the present. But others see in the problems of design the need for new kinds of research for which there may not be entirely useful models in the past—the possibility of a new kind of knowledge, design knowledge, for which we have no immediate precedents. We face an ongoing debate within our own community about the role of tradition and innovation in design thinking.

Without developing this theme further at the moment, I want to suggest that our discussions of design research hold open the possibility of a core insight regarding a new kind of university that is in formation today and that will emerge more clearly in the next century. The old, venerable universities will remain with us because they contribute valuable knowledge that must be disseminated through well-educated individuals. But there may be a new kind of university that will also have value. It will be a university that prizes theory but does not disdain practice and does not ignore the distinct problems of, and the need for substantive knowledge about, making or production. Making products—and by “product” I mean a range of phenomena that is very broad, including information, artifacts, activities, services, and policies, as well as systems and environments—is the connective activity that integrates knowledge from many fields for impact on how we live our lives. This new kind of university—and there may be only a few of them in the future—will discover a dynamic balance among theory, practice and production, a balance that we do not now find in the vision of most universities today.

Rather than elaborate these ideas with the results of my work in strategic planning for the institution with which I am associated—an institution that I regard as one of the emerging neoteric universities of the United States—I would like to turn to some of the issues of design research that we are gathered to discuss. In the long run I believe that discussion of these issues will lead us back to the nature of universities in the next century, but for now they are issues within our own community that we must address in order to advance the understanding of design today.

The Role of Definition in Design

Efforts to establish a new field of learning require a definition of the

field, and design is no exception. Unfortunately, our community has often foundered on the problem of definition. The literature is filled with contrasting and sometimes contradictory definitions of design, and efforts to define design have often led to acrimony. I have watched this struggle unfold, and I am grateful that the disputes have tended to die down in recent years. There has been an unfortunate misunderstanding about the nature and use of definitions, and this has caused our discussions to become unproductive and wasteful of time and energy. Frankly, one of the great strengths of design is that we have not settled on a single definition. Fields in which definition is now a settled matter tend to be lethargic, dying, or dead fields, where inquiry no longer provides challenges to what is accepted as truth. However, I believe that definitions are critical for advancing inquiry, and we must face that responsibility regularly in design, even if we discard a definition from time to time and introduce new ones.

Definitions serve strategic and tactical purposes in inquiry. They do not settle matters once and for all, as many people seem to believe they should. Instead, they allow an investigator or a group of individuals to clarify the direction of their work and move ahead. There are many kinds of definition, but for present purposes it is sufficient to identify two kinds: descriptive and formal. Descriptive definitions tend to identify a single important cause of a subject and point towards how that cause may be explored in greater depth and detail, allowing an individual to create connections among matters that are sometimes not easily connected. When Paul Rand says that "Design is the creative principle of all art," he identifies individual creativity as an important or even the essential part of design. When someone else defines design in terms of the materials employed in a specialized branch of design—e.g. "graphic design is the presentation of images and words in print"—he or she also identifies an important or even essential cause of design. Most of the definitions of design are descriptive definitions, and they are frequently metaphorical. They are as varied as the insights of human beings and as varied as the causes that may account for design. Some speak of the power of design; other speak of the material constraints; still others speak of the forms and processes of design and product development; and, finally, some speak of the end or purpose of design—as in Ralph Caplan's definition of design as "making things right." I find them all fascinating and helpful, because they capture different perspectives on what is a very difficult subject.

Formal definitions are somewhat different. They tend to identify several causes and bring them all together in a single balanced formulation. There are fewer formal definitions of design than descriptive definitions, but formal definitions are also useful. In *Industrial Design*, John Heskett provides this formal definition: "...industrial design is a process of creation, invention and definition separated from the means of production, involving an event-

al synthesis of contributory and often conflicting factors into a concept of three-dimensional form, and its material reality, capable of multiple reproduction by mechanical means." This definition does not have the clean simplicity and emotional force of a descriptive definition such as Paul Rand's—and Heskett is no longer entirely satisfied with it, I am sure. But it served to bring together the several causes that he wished to investigate in his history of industrial design. In this sense, a definition, whether formal or descriptive, is like a hypothesis in research: it gathers together what will be investigated and sets the relation of causes that will become the themes of subsequent inquiry.

In my own work I have used both descriptive and formal definitions, as the problem and the occasion have warranted. For this meeting I would like to present a formal definition of design, because I am interested in advancing discussion in a field where there are several important and interconnected causes that are the focus of diverse kinds of research. I want a balanced formulation that expresses the functional relationships of the many causes that contribute to design. For this purpose I offer the following definition: "Design is the human power of conceiving, planning, and making products that serve human beings in the accomplishment of their individual and collective purposes." Those who are interested in what are the causes I have identified and seek to relate in this definition may find it useful to place the separate elements in the context of Aristotelian causes.¹ I suggest this not because I am particularly attracted to Aristotelian philosophy, but because Aristotle's investigation of formal definitions has had great influence throughout history in establishing the boundaries of fields and relating many otherwise separate lines of research. "Power" is the efficient cause or agency of action in design, comparable to Rand's concern for creativity. It resides in human beings as a natural talent that may be cultivated and enhanced through education. "Conceiving, planning, and making" is the final cause, in the sense that it identifies the sequence of goals towards which design thinking and practice move. "Products" represent the formal cause, in the sense of the formal outcome of the design process that serves human beings. And "in the accomplishment of their individual and collective purposes" represents the material cause of design, in the sense that the subject matter or scope of application of design is found in the activities, needs, and aspirations of human beings. The definition suggests that design is an art of invention and disposition, whose scope is universal, in the sense that it may be applied for the creation of any human-made product.

Whether this definition is amicably received—it certainly does not serve the purposes of communication with the general public, and I present it here only for those who have practiced and studied design for a long time—it provides a beginning for understanding design research. I think it provides a way to connect an

1 For a comparison of this definition with the four causes in the context of Aristotle's *Rhetoric*, see R. Buchanan, *Design and the New Rhetoric: Productive Arts in the Philosophy of Culture*, *Philosophy and Rhetoric*, forthcoming, 2001.

exceptionally wide array of design research that is now ongoing in the United Kingdom and in many other parts of the world. While we investigate design from many perspectives, we are also aware of the need to integrate our diverse results into a comprehensive framework that explains the pluralism of inquiry.

However, my goal is not to survey the range or substance of design research. Instead, I want to focus on one aspect of our field that I believe has become critical to our explorations of design in practice and theory. This concerns the nature of a “product.” For the general public and for many of our colleagues in other fields, a product is usually understood to be a physical object—the result of industrial design. In contrast, I believe we should regard the changing meaning of “product” as one of the important features of the revolution in design that we are now witnessing.

What is a Product?

To understand the changing meaning of “product” in design and the consequent problems and issues of design practice, design education, and design research, I have suggested that there are four orders of design in the twentieth century. Each order is a place for rethinking and reconceiving the nature of design. The orders are “places” in the sense of topics for discovery, rather than categories of fixed meaning. The distinction between a place and a category may appear subtle, but it is profound. It illustrates what I regard as a fundamental shift in the intellectual arts that we employ to explore design in practice and research—a shift from grammar and logic in the early part of the twentieth century to rhetoric and dialectic. Our early theories of design found expression in grammars and logics of design thinking, but the new design finds expression in rhetoric and dialectic. We will not elaborate this distinction further at present, but its import will soon become apparent.

The first and second orders of design were central in the establishment of the professions of graphic and industrial design. Graphic design grew out of a concern for visual *symbols*, the communication of information in words and images. That the name of this profession or area of study has changed over the years only serves to emphasize the focus: it has evolved from graphic design, to visual communication, to communication design. Initially named by the medium of print or graphical representation, the introduction of new media and tools, such as photography, film, television, sound, motion, and digital expression, has gradually helped us to recognize that communication is the essence of this branch of design, independent of the medium in which communication is presented. There is no comparable evolution in the naming of industrial design, except that some people refer to “product design” when they mean the special segment of industrial design concerned explicitly with the creation of mass-produced consumer goods. However, industrial design grew out of a concern for tangible, phys-

ical artifacts—for material *things*. In this sense, *symbols* and *things* are what I mean by the focus of first- and second-order design in the twentieth century.

The process of ordering, disordering, and reordering design is revolutionary, and I believe we are now in the midst of such a revolution. Instead of focusing on symbols and things, designers have turned to two quite different places to create new products and to reflect on the value of design in our lives. They have turned to *action* and *environment*. The argument for the reordering of design is simple and clear. It is certainly important that designers know how to create visual symbols for communication and how to construct physical artifacts, but unless these become part of the living experience of human beings, sustaining them in the performance of their own actions and experiences, visual symbols and things have no value or significant meaning. Therefore, we should consciously consider the possibility that our communications and constructions are, in some sense, forms of action. This does not deny the importance of information and physical embodiment, but makes us more sensitive to how human beings select and use products in daily life. In fact, from this point of view we may discover aspects and features of successful products that have eluded us in the past.

Out of such concerns has emerged a new domain of design thinking and new directions of professional practice. We call this domain “interaction design” because we are focusing on how human beings relate to other human beings through the mediating influence of products. And the products are more than physical objects. They are experiences or activities or services, all of which are integrated into a new understanding of what a product is or could be.

There is a common misunderstanding that interaction design is concerned fundamentally with the digital medium. It is true that the new digital products have helped designers focus on interaction and the experience of human beings as they use products. However, the concepts of interaction have deep roots in twentieth-century design thinking and have only recently emerged from the shadow of our preoccupation with “visual symbols” and “things.” As they have become a growing focus of attention in the design community, the implications have emerged with force, changing many features of design practice and design education. This is arguably the center of design research in the United States today, taking a variety of forms but always turning toward questions of action. How do we plan an action, how do we create the concrete form of experience, and how do we evaluate the consequences of action?

I have also suggested that there is a fourth order of design, focused on environments and systems. Of course, systems thinking is nothing new today. Systems have played an important role in engineering design at least from the nineteenth century—and earlier in design thinking, if we remember, for example, that the third book

of the *Principia* concerned the “System of the World” and Newton’s views on “universal design.” There are important works in more recent design theory that address problems of systems. What has changed today is what we mean by a system. The focus is no longer on material systems—systems of “things”—but on human systems, the integration of information, physical artifacts, and interactions in environments of living, working, playing, and learning. I believe that one of the most significant developments in systems thinking is the recognition that human beings can never see or experience a system, yet we know that our lives are strongly influenced by systems and environments of our own making and by those that nature provides. By definition, a system is the totality of all that is contained, has been contained, and may yet be contained within it. We can never see or experience this totality. We can only experience our personal pathway through a system. And in our effort to navigate the systems and environments that affect our lives, we create symbols or representations that attempt to express the idea or thought that is the organizing principle. The idea or thought that organizes a system or environment is the focus of fourth-order design. Like interaction, a new focus on environments and systems—which are where interactions take place—has strongly affected design thinking and design research in the United States and in many other parts of the world.

We are now in the early formative stage of understanding how third- and fourth-order design will transform the design professions and design education, but the beginning has been made. It is difficult to see how design thinking can go back to its earlier centers of attention without a sustained period of exploration of interactions and environments.

Figure 1
Four Orders of Design

	Symbols	Things	Action	Thought
Symbols	Graphic Design			
Things		Industrial Design		
Action			Interaction Design	
Thought				Environmental Design

To summarize the key point in our changing conception of products, it is useful to consider what the old and the new approaches to design thinking offer us. In design theory of the early and middle decades of the twentieth century, products were often understood from an external perspective. By this I mean that the focus of attention was on the form, function, materials, and manner of production and use of products. This is why form and function loomed so large in theoretical discussions of both graphic and industrial design, and why materials, tools, and techniques figured so prominently in the early phases of design education, as in the “preliminary” or “foundation” courses of the Bauhaus and the New Bauhaus. With the move away from visual symbols and things as the focus of attention, designers and design theorists have tried to understand products from the inside—not physically inside, but inside the experience of the human beings that make and use them in situated social and cultural environments. While form, function, materials and manner of production continue to be significant, we have an opportunity for new understanding through an investigation of what makes a product *useful*, *usable*, and *desirable*.

Only a moment is required to realize that from an interior perspective of the experience of human beings, products reveal many new features and properties that are, at present, only partly and inadequately understood. Indeed, this change of perspective also has important consequences for design education, as we turn away from the “foundation” course and create new introductory courses that cultivate the new perspective among students. For example, the school of design of which I am Head abandoned the “foundation” course nearly ten years ago, in favor of a “first-year” course that is centered on the human experience in design. Instead of teaching the materials, tools, and techniques of design as the primary subject matter, the new course focuses on projects and problems that are situated within the experience and motivation of students. Having a reason to design gives focus and purpose to student development. When a purpose exists, we find it easier then to introduce materials, tools, and techniques. The “first-year” course at Carnegie Mellon is grounded in rhetorical purpose, while the “foundation” course was grounded in the grammar of design. The relationship of these two approaches is perhaps evident if one observes that the last chapter of a school grammar book is usually a chapter devoted to “how to write an essay.” In contrast, the last chapter of a school rhetoric book is a chapter on grammar and style. The analogy is significant for design education.

The Problem of Design Knowledge

To carry this line of thinking one step further, I would like to turn to the problem of design knowledge and how design research today is directed towards new issues and employs new methods. In the traditional model of design knowledge, there are both analytic and

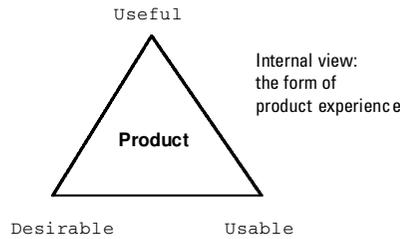
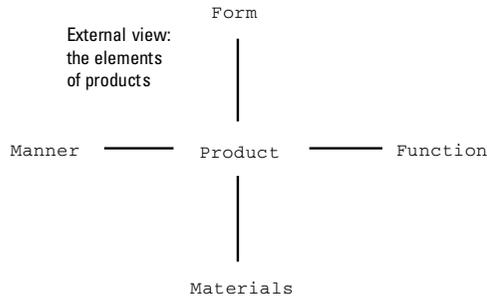
synthetic aspects. The grammar and logic of inquiry focused on an analysis of the elements of form, function, materials, and manner of designing, producing, and using—and then on the synthesis of these elements in the work of the practicing designer. An excellent example of the sophistication of this approach is Moholy-Nagy's "Design Potentialities," where he discusses both the analytic and synthetic dimensions of design, as they were understood in the 1940s.² For Moholy-Nagy, nature and society provided the surrounding context for design thinking on each element, and he sketches the areas where further knowledge may contribute to improved design practice. For example, he discusses how form, function, and materials imitate or mimic natural processes, with manner serving as the distinctively human efficient cause that separates artificial products from natural products. As brief as his paper is, it is a valuable sketch of the problems of design research and how they bear on design practice.

What I believe has changed in our understanding of the problem of design knowledge is greater recognition of the extent to which products are situated in the lives of individuals and in society and culture. This has given us two areas of exploration that are, in a sense, mirror images of the same problem. On the one hand, we are concerned to place products in their situations of use. The product then is a negotiation of the intent of the designer and manufacturer and the expectations of communities of use. The product is, in essence, a mediating middle between two complex interests, and the processes of new product development are explicitly the negotiation between those interests. Clearly, issues of strategic planning, collaborative design, participatory design, and, above all, human-centered design rise to a new level of intensity, requiring new kinds of knowledge to effect successful solutions. On the other hand, we are concerned with the experience that human beings have of products—how they interact with products and how they use products as a mediating influence in their interactions with other people and their social and natural environments. This is the interior perspective on products that I discussed a moment ago. As the following diagram suggests, the new perspective on products deepens our concern for, and understanding of, the nature of form.

Rather than investigate form from an external perspective as shape or visual pattern, we regard form as a synthesis of what is useful, usable, and desirable—that is, the content and structure of performance, human affordances, and product voice. In essence, form becomes a temporal phenomenon of communication and persuasion, as human beings engage with products. Time is clearly one of the most important features of the new understanding of products. However, this is such a vast subject that we cannot dwell on the implications at the moment. Instead, we should consider what kinds of knowledge bear on the creation of products that are useful,

2 Laszlo Moholy-Nagy, "Design Potentialities," *Moholy-Nagy: An Anthology*, Richard Kostelanez, ed. (New York: Da Capo Press, Inc., 1991), 81–89.

Figure 2
Perspectives on products.



usable, and desirable, because these are the areas of the most intense design research today in the United States and in other parts of the world.

Investigation of the useful clearly takes us to problems of the deepest content and structure of product experience. To be useful, a product must meet a basic criterion: it must work. “Working” is partly a problem of engineering or computer science, or a combination of both, and in this respect designers continue to explore their relationships with the disciplines that bear on engineering. However, “working” is more complex in products today, for it is not only engineering that plays a role but the natural sciences as well. Indeed, in the new information products there are also many issues of content that force us to consult with content specialists in many other fields, including the social sciences, the humanities, and the arts. Wherever intellectual content is an issue in a product, design-

ers must understand how to work with content specialists. In the past, designers have tended to deny explicit responsibility for content in their products. Quietly, they have often affected content in significant ways. In the new circumstances of design, content and structure have become intertwined in ways that are puzzling and troubling, requiring further research.

Investigation of the usability of products clearly takes us to human and cultural factors. In essence, it is not enough that a product works; it must also fit the hand and mind of the person who uses it. Issues of usability are exceptionally complex, and they have taken designers and design researchers into the behavioral and social sciences in ways that are unprecedented in our field. What is perhaps most important to remember as designers move deeper into the human sciences is that the universal propositions of the behavioral and social sciences do not lead directly to the specific, particular features of successful products. There is a profound, irreducible gap between scientific understanding in this area and the task of the designer. This does not mean that designers may escape their responsibility of understanding the contributions of the human sciences to their work. Instead, it focuses one of the problems of design research: how do designers employ knowledge from the human sciences to discover specific features of products. In the past, there was some confidence that the discipline of marketing could provide the connective link. However, it is increasingly evident that marketing has been asked to carry too great a burden in the product development process—a burden beyond the limits of the marketing discipline. For this reason, the relationship of design and the human sciences has become a new focus of research and exploration.

Investigation of the desirability of products takes some researchers back to the fine arts for insights into aesthetic form and style. However, the desirability of products has proven to be more complex than it was thought to be in earlier design theory. Aesthetics plays a role, but the deeper problem seems to be one of “identification.” What is there in a product that leads someone to identify with it and want it to be part of his or her life? This is surely one of the most puzzling and intriguing aspects of design today. Recent interest in “branding” or product brand identity—the new effort at transforming the “brand” of the United Kingdom may be an example of such interest carried to a new level of marketing!—is a sign of how some researchers and practicing designers are exploring the issue of desirability. However, this area remains one of the weakest topics of design research today. Clearly, there is a need for more serious consideration of persuasive communication—what is properly the issue of “ethos” in classical rhetoric—in successful products. This is one area where design practice remains far ahead of design research.

Above all, the investigation of what makes a product useful, usable, and desirable points toward one final issue that is perhaps

the central dilemma of the new design research. What is the nature of a discipline that brings together knowledge from so many other disciplines and integrates it for the creation of successful products that have impact on human life and serve human beings in the accomplishment of their individual and collective goals? Those involved in design research are easily drawn into research in other fields. Indeed, it is tempting to evaluate design research by its contributions to other fields. In design research, however, the central challenge is to understand how designers may move into other fields for productive work and then return with results that bear on the problems of design practice. Design knowledge, it seems to me, lies in our grasp of the principles and methods of design that allow this activity to take place and lead to effective products. The alternative, common among some design theorists and researchers, is to believe that design must ultimately be reduced to one or another of the other disciplines—i.e. cognitive science, engineering, fine art, anthropology, marketing, and so forth.

Kinds of Design Research

A young field suffers many misunderstandings on the way to intellectual and practical strength. One of these misunderstandings in the design community is a tendency to think that research means a single kind of activity. There are, in fact, many kinds of research, some of which are very familiar to every designer and others of which are rare and unfamiliar. Since many faculty members in design schools are wrestling with the problem and are under institutional pressure to demonstrate that they are “researchers,” it may be useful to review an important distinction that is employed by universities as well as corporate and governmental funding agencies. From the perspective of the type of problem addressed, research may be *clinical*, *applied*, or *basic*.

Clinical research is, as the name suggests, directed toward an individual case. Many forms of clinical research are common in the design community and they play an important part in design practice as well as in design education. For example, when a designer must conceive a new identity for an institution, the search for information about the organization is clinical research. Clinical research focuses on the problem for action that the designer faces. To solve a particular, individual design problem, it is essential to gather whatever information or understanding may be relevant in its solution. Educators teach their students how to find such information and how to organize it as part of the design process, leading to a particular design solution suited to an imaginary or real client.

Clinical research also plays an important role in organized research activities and programs. In a field such as medicine, clinical research is the investigation of the effects and consequences of a particular course of treatment. In business, clinical research often emerges in case studies, where an investigator attempts to observe

and record all of the relevant events that have shaped a course of action or a business decision. Design, too, uses the case study method, and there are organizations in the United States that promote the creation and dissemination of case studies as a basis for understanding a wide range of issues, ranging from branding and identity systems to new product development. A couple of years ago, an organization reported that in the Harvard Business School catalogue of case studies there were fewer than twenty studies of design in business, among the ten thousand published case studies. The numbers have changed since then, but there are still very few case studies of design in the business literature. In contrast, case studies are more common in design literature. They range in quality from stories in popular design magazines to serious and methodical reports in some of the better academic design journals. The common trait of case studies is that they assemble information or data that may give insight into problems that reach beyond the individual case.

In contrast, applied research is directed towards problems that are discovered in a general class of products or situations. The goal is not necessarily to discover *first* principles of explanation but to discover some principles or even rules-of-thumb that account for a class of phenomena. For example, Edward Tufte's interesting and popular books on information design provide rules-of-thumb for the designer faced with problems of information design—they do not provide clear principles. Applied research is more common in design today than it was even thirty years ago. And, of course, applied research tends to be well-funded and common in disciplines such as engineering and computer science. The common trait of applied research in design is the attempt to gather from many individual cases a hypothesis or several hypotheses that may explain how the design of a class of products takes place, the kind of reasoning that is effective in design for that class, and so forth. It is systematic in its procedures and certainly more rigorous than case studies. In addition, because applied research lies between clinical research and basic research, those engaged in applied research are often conscious of the application of more fundamental principles to investigate a class of products or activities. The application of a general principle is seldom an easy matter, because many other factors, governed by other principles, may enter into the class of products or activities that one wishes to study. The kind of understanding that designers must have in order to work most effectively in concrete situations usually requires qualification and refinement through applied research—of the type provided by academic research or of the type that comes with extensive practical experience gained in working on many individual design problems.

The third type of research is basic. It is research directed towards fundamental problems in understanding the principles—and sometimes the *first* principles—which govern and explain phe-

nomena. This is a rare form of research in the design community, but some does exist as systematic speculation on the nature of design or as empirical investigation, where the hypothesis is particularly significant and far-reaching in its implications. In general, this type of research is associated with design theory, which provides a foundation for all other activities in design. Furthermore, the development of basic research often suggests bridges to other disciplines, as the problems unfold and become more focused. We suggested earlier that the origins of modern design research could be traced to Galileo and Francis Bacon. Galileo's discovery of a theory of motion from observations of particular cases of design and machine operations as well as observations of natural phenomena is a demonstration of how basic research may connect phenomena and fields. We may well wonder how many other discoveries in the natural and human sciences emerged from observations of design phenomena. And we may further wonder why it has taken so long to focus attention on the nature of design as a discipline that integrates knowledge for practical action.

To summarize, there are many kinds of research in the design community today. It is often difficult for designers and design educators to distinguish these kinds, and this has led to some confusion about how we should evaluate progress in the field and uncertainty about how to present our proposals to funding agencies. Designers are correct in believing that they are quite familiar with research and that research is an essential part of the design process. However, the type of research that designers and design educators recognize is usually a form of clinical research, often cut off from more fundamental applied and basic research. We will do well to recognize that gathering data and assembling facts is only a small part of the challenge of research to advance the understanding of design. Applied research is critical to this task, since it seeks to establish connections among many individual cases. And basic research is the most difficult and critical to the future of the field, because it seeks to establish which are the significant facts and connections in our experience of design.

An Example of Design Research

I would like to conclude with a concrete example of design research in the United States that may signal the changes that are taking place in the field of design. My objective is not to report results in any detail but to point toward the kind of problem and the kind of institutional arrangements that are emerging. I hope this will have some relevance to the conference as we discuss experiences in the United Kingdom.

The example I have selected is a three-year project to investigate "customer-valued quality" in the product development process. This work was supported by the National Science Foundation in the Transformation to Quality Organizations (TQO) Program. The

TQO program is particularly interesting because it represents a significant investment of private funding along with governmental funding. In fact, the TQO program is funded more by private industry than by the government—a sure sign of the perceived potential value of the results. I was a co-principal investigator on this project, working with colleagues in three other institutions in the United States.

We were puzzled by the problem of what constitutes value for the customer when selecting a product and, particularly, how customer values enter into the product development process. To address this issue, we investigated a variety of products and, with the cooperation of several corporate partners and design consultancies, looked closely at the working relationships of industrial designers and engineers, with some attention to the collaboration of these groups of professionals with experts in marketing. In the initial phase of this work we produced a number of case studies of different kinds of products—in this work, my colleagues in business schools were invaluable in directing our work and writing the studies in accord with the standards of business school case studies. With these results in hand, we then set about the task of inductive inquiry, seeking common threads in successful product development work in each corporation.

The case studies gave us insight into how customer-valued quality entered into the product development process through collaborations among engineers and industrial designers, with evidence of a new approach to user observation and user experience. At first, it was unclear how the new approach was different from the more traditional influence of marketing in suggesting desirable product functions and, overall, setting product criteria for the development process. We began to observe, however, that marketing played a somewhat smaller role than we expected. Indeed, we found that engineers and, particularly, industrial designers went directly to user observation and interviews with potential users. The technique was not the classic form of focus group discussion—though some use of focus groups was made in some cases. Instead, there were conversations with potential users and, sometimes, the conversations were shaped around modest product prototypes that elicited comments and observations.

As we looked at the case studies more closely and discussed the matter in follow-up conversations, we began to detect a new stream of thinking and influence in the product development process. The source appeared to be some form of social science methodology or methodologies—concepts and methods drawn from the social sciences, but adapted to the work of product development. This attracted our attention and we began to look for more systematic efforts to introduce this stream into organizations. The significance of this became quite evident in the second annual conference that we held in cooperation with our industrial partners

and with our collaborating design firms. The focus of this conference was the “user experience in product development.” The presenters from our partners in industry spoke explicitly about the development of new “usability testing” facilities and contributions from anthropologists, social psychologists, and others educated in the social sciences. Indeed, we had begun to anticipate this theme by inviting representatives from three small design consultancies that have made “user experience” the focus of their business. These were consultancies that were, and still are, employed by our major industrial partners.

It quickly became apparent that we had framed our work precisely on what is an emerging trend in industrial organizations. One sign of the timeliness of the meeting was the number of other corporations that requested permission to send representatives to the conference—purposely to discuss concepts and methods of exploring “user experience.” From the perspective of our work on the project at Carnegie Mellon University, the most significant outcome of the conference was an overview of what appear to be three major approaches to bringing social science insights to bear in developing new products. Each approach was represented in sharp profile by one of the small design consultancies that participated in our conference. Furthermore, these approaches had their counterparts within the large corporations, in new or relatively new “user testing,” “usability testing,” or “user experience” groups comprised primarily of social scientists.

The second significant outcome of the conference was the identification of a distinct “gap” between the general insights of social scientists and the specific work of designers (engineering and industrial). As our discussions at the conference and in subsequent interviews revealed, the emerging problem is how to transfer or translate the general insights of social science into product features. The gap is large, and all parties were exploring different methods for bringing the insights to bear in actual product development.

Thus, our work on the grant focused on these two points: alternative approaches to exploring “user experience” and alternative methods or techniques of crossing the gap. We developed a conceptual framework for the alternative approaches. Then, we began a series of interviews with individuals in corporations and the new design consultancies, with the goal of characterizing and assessing different approaches. For example, we interviewed Gary Waymire from GVO, Mark Dawson from Hauser, Gianfranco Zacchai from Design Continuum, Rick Robinson from e-Lab, and Christine Riley from Intel. Our interviews followed a pre-determined set of questions, intended to draw out both conceptual and practical features of the new dimension in product development.

This work has formed the core of a master’s thesis by Neil Wherle, a student in the Interaction Design program of the School of Design at Carnegie Mellon. His work speaks to the new dimen-

sion in product development, the new kinds of design firms that have come into being to carry out this work, the new groups within corporations that are pursuing similar ends, and, finally, the implications that this development may have on the matter of customer-valued quality in new product development. The work associated with this thesis was part of a broader effort to develop a model of product development in which “quality” is reinterpreted as an issue in design. Design theory has tended to focus on the decision-making processes in the creation of artifacts, with too little attention to the sources of innovation that come from user observation. In a sense, the discipline of marketing may have been asked to carry too great a burden in supporting the product development process. The new focus on “user experience” points toward other sources of insight that may enrich the contribution of marketing without reducing customer-valued quality to the outcome of classic marketing methodologies.

To me, this project is an example of applied design research, because it was directed towards a general class of phenomena in the product development process. However, I believe it also demonstrates how such research connects back to clinical research for relevant data—evident in the case studies that we produced in the early phase—and to basic research. The connection to basic research is perhaps evident only to this degree: work on this project has helped to identify problems for inquiry that have become one area of concentration in a new doctoral program in the School of Design at Carnegie Mellon. It is too early to tell whether work in this area of doctoral inquiry will involve basic design research, but the formation of a broader design theory is clearly one of our goals.

Of course, this project is not the only element in shaping the direction of the new doctorate. Ten years of experience in what we call “integrated product development,” involving collaboration with faculty from engineering and marketing in an experimental studio course has played a critical role. So, too, has our ongoing work with the Human-Computer Interaction Institute, with faculty from the School of Computer Science, the School of Design, and departments of behavioral and social sciences. But the NSF project was a decisive event in demonstrating the ability of design research to identify and even anticipate emerging trends in the design professions and contribute to their understanding. Perhaps I should add that comparable experiences in other areas have led us to focus our doctoral program on four interrelated areas of concentration: Design Theory, Interaction Design, Typography and Information Design, and New Product Development. I will not explain the rationale for these areas or the specific issues that we expect to address in design research, but this is where design research at Carnegie Mellon is headed.

3 “Doctoral Education in Design: Proceedings of the Ohio Conference, October 8–11, 1998” is available from the School of Design at Carnegie Mellon University.

Future Directions: Doctoral Education in Design

As our experience at Carnegie Mellon suggests, doctoral education in design will grow significantly in the future. It is already evident in the United Kingdom and in many other countries around the world. For this reason, I would like to conclude with a brief report on an international conference that was held in October 1998 in the United States. The theme of the conference was "Doctoral Education in Design," and the meeting was sponsored by the School of Design at Carnegie Mellon, the Ohio State University, and the journal *Design Issues*.³

While doctoral programs in design have existed for several decades at various institutions around the world, it is apparent that doctoral education is still in a formative stage. Nonetheless, a community of inquiry has formed in the field of design and is moving ahead to consolidate what is known about the field in its most sophisticated and well-grounded form and to prepare researchers and educators who will expand that knowledge through original inquiry. I will not try to summarize the discussions, except to say that they were wide ranging and some of the most interesting that I have encountered in the design community in the past decade. The issues included some of the most difficult in our field today, ranging from the relationship between research and design practice to the nature of design knowledge and the influence of national policy on the direction of doctoral programs.

Behind the discussions, however, were fundamental differences of philosophic perspective and vision. The diversity was impressive, as was the determination of all participants to avoid narrow ideological disputes. The conference gave me confidence that design has reached a watershed moment in its development as a field of inquiry. We may not see major consequences from the development of design research in doctoral programs for some period of time, but there will be consequences, affecting design practice as well as design education. The changes will come sooner than many believe. This is why I believe our conference today, at the London Design Council, is important. As we discuss the design of research and the problems of investigating design, we are preparing for a new time in the field. Personally, I am less concerned about how we, as individual faculty members, will fare in the future than in how we will prepare a new generation of students who will understand the legacy of design and rise to the challenge of the new learning.

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