

DESIGN, MAKING, AND A NEW CULTURE  
OF INQUIRY

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When I was a student at the University of Chicago in the early 1970s, the eminent philosopher Richard McKeon came to class one day with a news clipping. This had never happened before in all the time that I had studied with him, so I listened carefully to understand what had attracted his attention. What he read was a story about the creation of a new university, formed from the union of the Carnegie Institute of Technology and the Mellon Institute of Science. The new institution would be called Carnegie Mellon University, and it would explore new problems in areas such as technology, cognitive psychology, decision making, and information processing. It would build on existing strengths in engineering, the natural sciences, cognitive psychology, economics and industrial administration, and the visual and performing arts. Thus, it would have some of the traditional disciplines found in other universities. However, it would also emphasize interdisciplinary collaboration and encourage the creation and develop-

ment of new disciplines that would likely emerge from such collaborations in areas such as computer science, information and decision sciences, and design. In essence, Carnegie Mellon would cultivate the new sciences of the artificial, the domain that was articulated by Herbert A. Simon in the Compton Lectures, delivered at MIT in 1968 and soon afterward published as *The Sciences of the Artificial*.<sup>1</sup>

At the time, I had little understanding of what the “sciences of the artificial” meant, except as a possible, if somewhat unusual, translation of “poetics” in the Greek tradition established by Aristotle. For Aristotle, “poetics” meant the productive sciences or the science of human-made things; he used the word as the title of his famous treatise on tragedy, which provides the primary example of his method of productive science. The leap of imagination from a study of the literary and dramatic form of tragedy to a study of technology, decision making, and human behavior was suggestive and, at the same time, puzzling. I did not know that the sciences of the artificial, whatever they are today or will become in the evolving intellectual environment of Carnegie Mellon, initially represented Simon’s theory of design. Even more puzzling was the idea that “poetics” or the “sciences of the artificial” could form the basis for a new kind of university that would explore interdisciplinary connections among established disciplines of human learning and a variety of newly emerging disciplines focused on new problems of inquiry.

After reading the news clipping, McKeon paused and seemed to look briefly into the distance. He had already written his provocative and visionary paper, “The Uses of Rhetoric in a Technological Age,” as we knew from the course in which we were enrolled.<sup>2</sup> The title of the course was somewhat misleading if one did not understand the direction of McKeon’s genius. Called simply “Creativity: Poetic and Rhetoric,” it was a course on discovery and innovation in inquiry. When he turned back to the class, McKeon commented that the new institution was clearly a “neoteric” university. It was a university devoted to inquiry into the new problems and the new learning of our time, as Chicago had been at its founding and continues to be to the present.<sup>3</sup> Almost as an afterthought, he added a comment that only later would become personally significant for me. The new institution, he remarked, would play an important role in higher education by the next century because it would both reflect and contribute toward some of the most significant changes taking place in our culture. Few of us understood precisely what McKeon meant,

but I wrote “Carnegie Mellon—1968” in the margin of my notebook and placed beside it a small question mark.

The question mark grew larger and larger in my mind over the years as I watched confusion and uncertainty of purpose settle over many established disciplines and institutions in the United States and abroad. However, I did not associate it again with Carnegie Mellon for many years. At first, the issue in my mind concerned the relationship between the old learning and the new learning in the disciplines of the humanities. Educated in philosophy and rhetoric, with the distinctive interdisciplinary orientation that characterized the Chicago “committees” of the 1950s, 1960s and 1970s, I did not find the traditional established disciplines entirely satisfying as locations for pursuing the kind of intellectual questions that were taking shape in my mind. Disciplines form over hot spots of intellectual inquiry, centered on the problems that human beings find significant in their experience and environment. In this sense, they are like ocean atolls that form over hot spots of geological activity that lie far beneath the surface of the earth. However, like the hot spots beneath the ocean that move on and lead to the creation of new atolls, the hot spots of inquiry also move on in human culture, creating new ferment and leading to new disciplines and organizations of learning. I was certainly interested in many theoretical issues in philosophy, the humanities, and the social and natural sciences, but I was also interested in practical matters. And, as I gradually learned, I was deeply interested in the problems of “making”—how human beings make the world around them, beginning with literature and the fine arts, but extending much further in human culture. For me, the emerging field of design—with special professional disciplines in areas such as graphic design and industrial design—was hospitable and perhaps ideal for exploring the connections among theory, practice, and production that attracted me. I found a place in the new field and felt the freedom of pursuing questions that seemed to cross and connect a variety of other disciplines.

I soon learned, however, that new disciplines, unless they merely add incremental extensions to established disciplines, do not fare well within traditional institutions—whether those institutions are art schools, technical institutes, liberal arts colleges, or large research universities. Established disciplines are jealous guardians of new ventures, often seeking to reduce new forms of inquiry to their own ideas and methods. Cultural change comes slowly in colleges and universities. New disciplines that challenge

the traditional organization of learning face high walls that frequently block communication and understanding, and stand in the way of administrative, financial, and political support.

The problem is one of entrapment in success. It is a serious problem for established universities that seek to lead in inquiry and education by moving on to new problems and new challenges. How can such an institution balance its devotion to the old learning that was once the basis of its success with the new learning that is needed to address new problems in the changing circumstances of society and intellectual culture? It would be too simple to suggest that established universities are entirely "paleoteric"—solely devoted to the old learning—and that new universities are entirely "neoteric"—solely devoted to the new learning of our time. The old learning and the new learning are often closely related in a strong, purposeful university. Those who are devoted to traditional disciplines speak of the extension and application of ideas to new areas of subject matter. In turn, those who are devoted to exploring new problems in new disciplinary forms are often quite mindful of earlier ideas and the struggle to establish what are now regarded as traditional disciplines, studying them for insights that may bear on the solution of present problems. Yet, there is typically a dominant spirit in each institution that leads one to think of it as either paleoteric or neoteric. I think of Carnegie Mellon as a university that is neoteric in spirit, though it, too, now faces the challenge of balancing old accomplishments with new ideas and intellectual ventures.

#### DISCOVERING DESIGN AT CARNEGIE MELLON

I came to Carnegie Mellon as a visiting professor in the fall of 1991 and returned the following year as Head of the Department of Design, now known as the School of Design. I returned because the department offered a hospitable environment for new ideas and possessed an excellent faculty and student body with the courage to rethink the future of their discipline in the context of a changing world. I also came because the university was open to thoughtful and well considered arguments for change, and because the various colleges and departments of the university were willing to provide the kind of interdisciplinary cooperation that I felt was needed to advance the theory and practice of design in the contemporary world. I admit, however, that there was another reason. I remembered Richard McKeon's prediction about

Carnegie Mellon, and I wondered if he was as prophetic in this matter as he had been in so many others. For me, the evidence came in three forms: a personal encounter with a distinguished colleague, work on developing a new design curriculum and related design research, and broader observations on the liberal arts and the place of design in the culture of the university.

The first evidence came during my term as a visiting professor. Colleagues from the Department of English invited Herbert Simon to join me in presenting public seminars in successive weeks on our respective work and its relationship to rhetoric. I remember Professor Simon sitting in the first row of seats as I began my presentation on what I saw as an emerging relationship between design and rhetoric. It was late in the afternoon and few undergraduate students were in the building, but some raucous noise broke out in the hallway. Simon virtually leaped from his chair and went into the corridor, sternly telling a small group of startled students that there was a seminar in progress and that they should be quiet.

I continued reading my presentation—I seldom read a formal text to audiences, preferring a more spontaneous style of delivery, but on this occasion I decided I would—until I reached the section of my paper where I dealt directly with Simon's *The Sciences of the Artificial*.<sup>4</sup> At that point I put my paper down and spoke directly to him, discussing what I found to be a conflation of poetic science and rhetoric in the book. I argued that this led to a weakness in the proposed method of decision making, since it reduced invention to memory and neglected the role of "topics" in shaping radically "indeterminate" situations, situations such as those in design where "things may be other than they are" by human choice. Simon listened carefully but asked no questions in the discussion period following the talk.

Students told me later that he was uncharacteristically quiet, since he was known to respond vigorously when he was dissatisfied with a speaker. However, he simply came over afterward and invited me to visit him in his office when I had an opportunity. We subsequently talked for two hours or more, covering a wide range of topics that included some of our philosophical differences, his experience teaching in an architecture program early in his career, and his experiences with Rudolph Carnap and Richard McKeon at Chicago, where he had been a student of the former, as I was a much younger student of the latter.

Later, when I attended Simon's seminar, I asked only one question in the discussion period. I asked whether his approach

to science and logic, with its special reliance on empirical data, rested on any philosophical assumptions that he cared to share. I expected this question merely to open the way for some general remarks on the philosophical foundations of his work. However, his quick reply was a loud and firm "No." He remarked that reliance on empirical evidence was adherence to truth and reality and required no assumptions. Clearly—and to me, quite ironically—he did not regard his views on the nature of empirical evidence and its role in scientific investigation to involve any assumptions or to be open to alternative views or methods of exploration, at least in the context of that meeting. I, too, have a serious regard for empirical evidence, but I have also found that philosophical assumptions strongly influence what we consider empirical evidence to be and how we interpret it. I include this anecdote because it was, for me, an introduction to the battle of the liberal arts that I would later join at Carnegie Mellon, where logic, rhetoric, dialectic, and even grammar were interacting to shape a new environment for inquiry. I will comment more on this later.

Shortly after my arrival as Head, the Design faculty began a process of discussion and planning that quickly led to a restructuring of the undergraduate curriculum. The goal was to reorient our programs toward what we believed would be the future of our field, based on a study of current problems in design and strategic trends in industry and society. What emerged was, in the words of the distinguished national accreditation team that visited and reviewed our new direction, "the most clearly thought out and interdisciplinary program (produced with the greatest faculty unanimity) we have seen." I will provide a brief sketch of this curriculum for two reasons. First, the curriculum is based on a different vision of design than that represented in Simon's theory of the sciences of the artificial. It is based on the logic of inquiry rather than the logic of empiricism, and it incorporates aspects of rhetoric that encourage invention and pluralism in the study and practice of design. It does not ignore Simon's insights, but it places his approach in a humanistic context with other reasonable alternatives. Second, the ideas behind the curriculum have implications for how specialized studies may relate in new ways to general studies and how educators may approach liberal education in a neoteric institution. This is partly a reflection of "project-based" education. Projects are a core feature of design education and have been from the earliest days of the field. This is an emerging feature of education in many disciplines at Carnegie Mellon and at other institu-

tions as well, so there is good reason to consider how project-based education is addressed in the field of design.

The new curriculum is based on a humanistic vision of design. For this reason it contrasts sharply with visions of design that are based on engineering, the fine arts, or an area of the behavioral and social sciences such as cognitive psychology. The goal is to prepare students for professional life or further study in a world of increasing complexity, where knowledge from many sources must be integrated in order to support a high quality of interaction in the lives of the human beings that we seek to serve. We teach design as an integrative discipline that allows students to synthesize the insights afforded by aesthetics and the fine arts, engineering and the natural sciences, and the social and behavioral sciences. We believe this leads to *informed* intuition among our students, and to a new kind of professional designer.

We began by considering the goal of design education, reflected in the titles of our two undergraduate programs. The term "Graphic Design" is a somewhat outdated expression with roots in the medium of print. It was replaced as a program title with "Communication Design," because the designers of texts and images now work—and will work more in the future—in a wider variety of media in order to accomplish the goals of communication. In addition to print, text, and image, they will work with sound, time, and motion—sometimes in film, video, or the kinetics and dynamics of the digital medium. They will explore new ways of presenting information in visual display and persuasive argumentation. We did not change the term "Industrial Design" as the title of our other undergraduate program, since it remains a current reflection of three-dimensional creation. However, we did change the curricular content to reflect new materials, production methods, conceptual and physical tools, and, perhaps most significant, the increasing importance of the social sciences and research in this branch of professional design practice. In addition, we placed greater stress on the emerging practices of "new product development," involving interdisciplinary collaboration among designers, engineers, and marketing experts. In general, the curriculum was conceived to prepare students for entry-level professional work and, in a clear departure from many other design schools, to prepare students for leadership and citizenship, emphasizing the whole person and what that person could become in society.

Coherence in the curriculum comes from our perspective on inquiry and student development. It is based on the sequence of

student experience as he or she encounters new subject matter and content. Each stage is an adjustment of subject matters and methods to the condition and degree of development of the individual student, with a long-term view toward what is needed in each successive level and, ultimately, what we believe will be needed by graduates.

We distinguish three stages of understanding and mastery for student development and personal growth. The first stage is a one-year period of *discovery*. Students develop sensitivity in perception and expression; explore materials, methods, and techniques; acquire fundamental skills; expand awareness of the social and cultural context of design; learn some of the central concepts that distinguish design from fine art; and learn some of the fundamental similarities and differences among the design professions. It is useful to note, however, that the core studio course of this stage significantly revises the "foundation" or "preliminary course" of the Bauhaus, the school that provides the model for programs of design education. Instead of teaching materials, tools, and techniques as the primary subject matter, the new studio focuses on projects and problems that are situated within the experience and motivation of students. In essence, this "first-year course" turns away from the grammatical approach of the old "foundation" course, toward a rhetorical engagement with purpose and action, encouraging invention and creativity. In this course, the grammar of design is introduced as needed rather than providing a sequence of formal exercises that a student must follow. The second stage is a two-year period of *concentration and development*. Students pursue a set of required and elective courses that deepen their skills and understanding in their chosen field of design—either Communication Design or Industrial Design. In this period students also begin to work on practical projects for corporate or industrial sponsors or not-for-profit agencies, gaining concrete experience of design in realistic, client-focused situations. Finally, the third stage is a period of *integration and advanced study*. Students focus on special projects in both individual and team settings, pursue special topics of advanced study, and often work in collaborative research projects in design or in other areas of the university.

In addition to the sequence of the curriculum, we also distinguish four elements that represent the kinds of experience and knowledge that we believe are essential in undergraduate design education. All of these elements are represented at each stage of the curriculum, with content and methods that are suited to

student growth. The first element is *studio experience*, with an emphasis on practice, creation, and synthesis. This is where students gain practical knowledge of how products are conceived, planned, and made in the form of models, prototypes, or other kinds of concrete realization. The second element is what we call *ideas and methods of design practice*, with an emphasis on investigation. Courses in this area are a mixture of studios, laboratory studios, and seminars. They help the student gain understanding and mastery of some of the central ideas and methods of contemporary design practice. The third element is *design studies*, encompassing design history, theory, and criticism, with an emphasis on reflection. The distinguished designer Paul Rand first proposed this element at Carnegie Mellon when he visited the campus in the 1970s. He urged the faculty to create a sequence of courses to help students gain an understanding of the principles of design. This element has evolved significantly over the years, reflecting our recognition of the importance of pluralism and the philosophy of culture in new design thinking. The purpose of this element now is to help students understand the cultural and intellectual foundations of design, the place of design in society and business, and the qualities of effective thinking and communication that are essential for reflection and practice.

In my view, this element is an exploration of the liberal arts in a context imposed specifically by the field of design. It seeks to provide the core disciplines of reflection that enable students to profit from exploring other courses in the liberal arts and sciences in the rest of the university. The fourth element is *general education*, with an emphasis on breadth of understanding. To be effective in the contemporary world, designers need a wide base of knowledge. They must be familiar with the basic concepts and methods of the natural sciences and engineering, the social and behavioral sciences, and the fine arts and humanities. Fully one third of the design curriculum at Carnegie Mellon is devoted to general education and the liberal arts and sciences, with courses taken throughout the university.

As we began implementing the revised undergraduate curriculum, our attention turned toward development of a graduate program. By the 1990s, design education in the United States was established at the master's level, but it was still not as common as in other fields. In the pragmatic culture of the United States, combined with the youthful nature of design as a profession, many students entered professional practice directly from an undergraduate education. However, we recognized that certain

areas of emerging design practice would benefit from, and perhaps ultimately require, graduate study. So, we began planning a graduate master's program that would be relevant to new problems. This is one of the distinguishing features of the culture of Carnegie Mellon. Instead of planning a program in an already well-established area—merely replicating work elsewhere—the faculty look for special opportunities in new areas of interest and ferment where our resources and special strengths converge. For this reason, colleagues sometimes refer to Carnegie Mellon as a “niche” institution, though this term fails to capture the innovative intention behind our exploration of new problems and disciplines.

Instead of developing traditional master's programs in graphic design or industrial design, we tried to assess emerging design practice, anticipate where the field of design was moving, and determine where we could play a useful role in new ventures. What we discovered was interaction design. Interaction design is the third great field of design to emerge in the twentieth century. It combines qualities of visual communication and information design, which are characteristic of traditional graphic design, with the qualities of the whole body experience in a physical environment, which are characteristic of industrial design. Interaction design is about people: how people relate to people, how people relate to products, and how people relate to each other through the mediating influence of products. It is a synthesis of many traditional and new elements of design thinking, organized into intelligent and emotionally satisfying experiences that meet a wide variety of human needs. Products are no longer treated simply as physical artifacts or visual symbols. Instead, they are expressions and enablers of human action and experience, situated in a social and cultural environment. For many of us, interaction design is more than a new branch of design practice. It is a new approach to design thinking in general, and a foundational critique of the entire field of design and the place of design in culture.

The idea of interaction emerged in contemporary consciousness around problems of digital media and multimedia production, but it is by no means limited to the digital realm. Interaction design is equally important for traditional analog products as well as the new digital products that increasingly surround us. This is one of the distinctive features of the approach to interaction design taken by the School of Design, and it contrasts with other approaches at Carnegie Mellon that emphasize the narrower area

of human-computer interaction. Our approach certainly includes mastery of design in digital media, with all of the sophistication that is required for successful professional practice. But it also encourages students to explore any area of application—whether in graphic design for the medium of print, industrial design for three-dimensional products, the design of services and activities, or environmental design for larger scale creation. Indeed, we explore the interrelation of all of these areas, because interaction design breaks down the boundaries among the old branches of traditional design practice and leads to many new and unexpected areas of application. This is evident, for example, in new applications of the concepts and methods of interaction design to human services and action programs, whether in the context of social agencies, education, governmental agencies, or businesses and corporations.

Interaction is too complex and important a theme to belong to any single discipline. Indeed, its roots may be traced throughout the twentieth century in a variety of fields. However, the development of computers and the digital medium played an important role in returning attention to how human beings interact with their environment, and this theme is explored in a wide variety of contexts at Carnegie Mellon, with the School of Design offering only one variation. The interdisciplinary nature of human interaction led the School of Design to develop one of its master's programs in cooperation with the Department of English, particularly its rhetoric program. We call this program “Communication Planning and Information Design,” and it emphasizes a rhetorical and socially situated perspective on interaction. We call the other program “Interaction Design,” and it emphasizes the poetics of interaction—the creative logic of shaping intelligent and emotionally satisfying experiences. Both programs are explorations of interaction design, and they share many core elements. In addition, however, Design also participated in the development of the Human-Computer Interaction Institute, along with the School of Computer Science, Psychology, and other disciplines at Carnegie Mellon.

Interaction design is only one example of how the School of Design has participated in interdisciplinary ventures at Carnegie Mellon, but it illustrates one of the cultural values of the university in such matters. The walls are typically low among departments and colleges, and individual faculty members are encouraged to take the initiative in pursuing questions that cross disciplinary boundaries. With this in mind, the School has participated

in ventures with engineering, business and industrial administration, and other departments and colleges. One of our greatest concerns today is to gain greater recognition throughout the university community of the importance of new product development as a powerful connecting theme for new research and educational programs. We believe that Carnegie Mellon has become one of the most important universities for exploring this emerging area of inquiry.

When I arrived at Carnegie Mellon, the provost told me that Design would probably never have a graduate program. Within a few months, the undergraduate curriculum took shape, and by the end of the year, the strength of our planning became evident. The provost then came to accept the inclusion of a graduate program. A year later, when I placed proposals for the two new master's programs on his desk, he immediately endorsed them both and asked when we would like to begin a doctoral program in design. This question was encouraging, but we decided to develop thoroughly our new master's programs before exploring doctoral education. However, a doctoral program is now established in the School of Design in a form that we believe serves both the emerging needs of the field of design and the long-term interests of the university as a whole. I know of no other institution of higher education where change can occur so quickly, provided that the arguments are well considered and the planning is thorough.

### DESIGN, LIBERAL ARTS, AND THE CULTURE OF INQUIRY

After joining the university, I soon understood that the idea of design does not belong exclusively to the School of Design. Design is a shared theme among many departments and colleges of the institution. Indeed, I have never found another university where design is so widely discussed. However, I also learned that the term "design" has quite different meanings in the university, depending not only on disciplinary context but also on the philosophical assumptions held consciously or unconsciously by individuals. Exploring these differences has been one of the intellectual pleasures of my time at Carnegie Mellon, but it has also been a practical necessity. The success of arguments that explain the contribution the School of Design seeks to make in the development of the university depend partly on engaging the principles and values of those to whom the arguments are addressed.

The explanation I give is that the School of Design contributes a humanistic or human-centered vision of design in the contemporary world, explored through an integrative process of design thinking. This process leads to "whole" or "total" products—as opposed to the partial products that typically emerge in an academic environment—in four areas of professional design practice: communication design, industrial design, interaction design, and environmental or human systems design. These are areas of product creation that intersect with the academic interests of many other departments and colleges in the university. The School of Design offers a pathway for bringing their knowledge to expression in concrete products. In addition, the School offers an interdisciplinary opportunity for students who major in other disciplines to gain experience in making real products under the significant constraints and demands of studio production.

Over time, however, I became interested in how diverse individuals at Carnegie Mellon are able to work together in a productive manner without the degree of intellectual conflict that one sometimes finds in other institutions. I was interested in how they are able to communicate without the excessive influence of ideology. This led me to reflect on the liberal arts at Carnegie Mellon and how they shape the culture of inquiry, ultimately affecting what we mean by the sciences of the artificial.

By "liberal arts," I do not mean the arts and sciences that have developed and proliferated in Western culture since the Renaissance based on increasingly refined distinctions of subject matter. This is usually what is meant by the liberal arts in most colleges and universities, although specialization and the expansion of factual knowledge has rendered the arts and sciences ineffective in serving the function of integrated understanding that once qualified them as liberal arts. Nor do I mean the liberal arts of the trivium and the quadrivium—the arts of words and the mathematical arts of things—that once provided the organization of learning and knowledge in the Middle Ages.<sup>5</sup> While traces of these arts operate quietly in the background of universities, they tend to reinforce the tensions and divisions that exist between the sciences and the humanities in our time. Instead, I mean the new liberal arts of communication, reasoning, and intellectual inquiry that are emerging in contemporary culture around new problems of expression and experience.

Whatever names we give them, the new liberal arts are suited to our time because they relate what we *say* about the world to what we *do* in the world, and to what we *make* as products of

inquiry. The new liberal arts serve to overcome the specialization of factual knowledge in the arts and sciences, as well as the division between words and other forms of symbolic representation employed in understanding our experience of the world. They offer the opportunity for an integrated understanding of thinking, doing, and making. I believe these arts are still in the process of formation, but they lie at the core of Carnegie Mellon, contributing to the neoteric quality of the institution and forming its distinguishing character and culture among other universities. I will refer to them as logic, dialectic, grammar, and rhetoric, but I do not mean the old arts of words based in the trivium. To me, they are newly emerging arts of communication and inquiry, merging words and things in human experience.<sup>6</sup>

My early encounter with Herbert Simon suggested that one specific form of logical reasoning—the logic of empiricism—played a central role in the university. However, I soon discovered that another form of logic is perhaps stronger in the community, and that a third form of logic is also present and influential. The first form of logic may be characterized as a system of rules of operation and criteria of empirical evidence and prediction. Meanings are established wholly on the empirical elements of which they are composed and on the operations by which they are defined. Some people believe that this form of logic is quintessentially “scientific,” but it is a form of reasoning that one may find as often in the social sciences and the humanities as in the natural sciences or engineering. It is no more scientific than other forms of reasoning.

The second form of logic is the logic of inquiry. In inquiry, logic is characterized by distinguishing the general forms of argument from the concrete forms of reasoning that human beings employ in different situations to address special problems. It is the form of logic explored by John Dewey, among others in the twentieth century. It is also the form of logic focused explicitly on “problem solving,” since it examines concrete situations and seeks to find the instances of more general reasoning that occur in special problematic situations. In the culture of Carnegie Mellon, “problem solving” became a central theme from an early time and is still employed as a general phrase to describe what is characteristic of this university. The phrase comes from the logic of inquiry, but it has become a shared theme of the university as a whole, expressed sometimes in the idea of “liberal professional” education and sometimes in the research mission of the institution.<sup>7</sup>

This form of logic is explored in many disciplines at Carnegie Mellon, including the humanities and the visual and performing arts. Of course, creative artists today seldom characterize their work in terms of logic or even artistic logic. They prefer a term like “poetics” or, more often, some other term more closely associated in contemporary culture with their own specific art form, perhaps fearing that to use a term such as “logic” will suggest a reduction of art to science. Nonetheless, as Dewey has argued and as many artistic movements explain in their declarations, artists think and reason as intently and as clearly in their own forms and media as any scientist in his or her medium of inquiry. In the School of Design, the logic of inquiry is the form of logic most often explored by my colleagues, where they carefully analyze problems and seek the most likely and effective solution or a variety of reasonable solutions.

The logic of empiricism and the logic of inquiry are seldom distinguished explicitly in ordinary conversations within the university community, but they account for some of the contrasting insights that have emerged in the development of disciplines and lines of research around themes such as design. However, a third form of logic also operates in the university community. This is a logic based on the examination of different languages—natural and artificial—and what those languages signify. At Carnegie Mellon, this frequently means constructing languages and interpreting them in concrete applications such as computer programming. This form of logic is closely related to the intellectual discipline of grammar, but it is most often developed and expressed in its logical aspect within the university. This form of logic, too, is seldom explicitly distinguished in ordinary conversation. Instead of being disruptive, the interplay of these three forms of logic has been productive because of a shared focus on the problems of making and designing.

In contrast to the full and varied development of logic as a mode of inquiry at Carnegie Mellon, there is little representation of either idealist or materialist forms of dialectic. This truncation is typical of American culture in general, because these forms of dialectic, as intellectual arts, have never played a central role in our intellectual life. This is in strong contrast to the central role that they play in many European countries, Asia, the Middle East, Africa, and South America. However, there is another form of dialectic that does play an important role in the intellectual life of Carnegie Mellon. It is found, first, in the gradual sifting of opinions through the give and take of private conversation about re-



search and education—such as my private conversations with Herbert Simon. It is found, second, in our public discussions of the vision and mission of the university, where we seek to articulate a coherent account of the remarkable diversity among us and shape our collective plans for the future. This form of dialectic is perhaps best described as pragmatic and skeptical, since it does not depend on an ideological foundation in philosophical idealism or materialism. Its roots lie in the tradition of American pragmatism, the philosophy formally developed by Pierce, James, and Dewey—and developed in a new way by Richard McKeon, a former student of Dewey at Columbia. And its roots also lie in the tradition of rhetorical debate that has shaped American social and political practice from an early period. Because this form of dialectic does not reflect, in itself, a formal ideology but, rather, a shared commitment to community process and communication, it tends to be conducive to pluralism and diversity of opinions.

One of the functions of dialectic is to clarify shared principles through conversation and discussion. At Carnegie Mellon, the process of skeptical and pragmatic dialectic has yielded two principles that, taken together, characterize the university and its culture. The first is a time-honored commonplace of inquiry that, by itself, does not significantly distinguish the institution from many others in the United States. It is a community belief that theory should be tested by how it is applied and by the results that follow from its application. What is perhaps distinctive at Carnegie Mellon is the expression of this principle in the daily life of the institution. One's first impression is that theory is not a subject of intense discussion among faculty and students and may not be highly valued in the workings of the community. What I have found, instead, is that theory is highly valued but does not have the privileged position that it appears to have in other institutions. Theory is found more often in close discussions of practical and productive problems than in broad formulations. In essence, theory is seldom isolated from practical development and testing in application.

This principle has advantages and disadvantages. One disadvantage is that theory is sometimes neglected in the haste to act. The formation of compelling theory takes time and nurturing, and sometimes events move so fast in the university that theory receives too little attention. This is a serious disadvantage that must be overcome through personal determination and vision, often with less surrounding support than one may wish. In contrast, the advantage is that philosophical or ideological dif-

ferences are usually accepted with more grace and less political conflict than in some other universities. I do not know whether this is because of benign neglect or serious intellectual tolerance, but the consequence is the same. The intellectual orientation is toward concrete experience, and the challenge of testing theory often prevents ideologies from dominating the intellectual life of faculty and students. In my experience, the advantage appears to be a fair compensation for the disadvantage.

The significance of the first principle at Carnegie Mellon becomes clearer when we consider the second principle that has emerged in collective discussions. The second principle is a community belief that, for the kind of university we seek to develop, there should be a creative balance among theory, practice, and production—a balance of thinking, doing, and making. This means that the testing of theory at Carnegie Mellon is located not only in the possible practices of application but specifically in the challenge of creating concrete products.

By "product" I do not mean simply the physical artifacts that we often associate with technology. It is true that this type of product has a long history at Carnegie Mellon, beginning in the origins of the campus as an institute of technology. However, other kinds of making also have a long history in the institution. The disciplines of architecture, art, design, drama, and music were established early and quickly attained national recognition and influence. For example, the first degree-granting program in industrial design in the world was established in 1934 at the Carnegie Institute of Technology, providing an influential model for other industrial design programs in the United States. Indeed, the gradual expansion of diverse forms of making in areas such as social and governmental policy, operations research in business, economic models, the languages and applications of computer science, computer hardware, robotics, information systems, and humanly shaped environments is a distinctive feature of the institution. It is surely one of the features that make the university important in contemporary culture, since what is made in the university often significantly affects what is made in society.

Explicit recognition of the second principle is recent at Carnegie Mellon. Despite a history of diverse forms of making and the articulation of a theory of design and the sciences of the artificial by Herbert Simon, general recognition of the creative balance of thinking, doing, and making in our community has emerged only within the past decade. It came through a strategic planning process that drew together what we understood of the

history of the institution, the emerging circumstances of society, and ideas about what the university could and should become in the future. We recognized that at Carnegie Mellon making products is the connective activity that integrates knowledge from many fields for impact on how we will ultimately lead our lives. In essence, we recognized that Carnegie Mellon could be a new kind of university, exploring the dynamic balance of theory, practice, and production—a balance that we do not find in the vision of most universities today.

The radical nature of this principle becomes evident when one considers the difficulty that universities in the past have had in incorporating the disciplines of design, making, and production within their vision.<sup>8</sup> The organization of knowledge following the Renaissance had little place for knowledge about the actual work of making. Making was reduced either to an application of knowledge from the sciences or dismissed as servile skill in craft. Nonetheless, making is a key factor in explaining why Carnegie Mellon is important at this time in contemporary culture. Faculty and students, as well as supporters and friends of the university, are increasingly aware of how deeply our cultural and natural environment is shaped by what human beings choose to make in and of their world—and how they consciously go about the work of making. Our society needs institutions that provide leadership in identifying and addressing problems of the human-made world, bringing to bear the knowledge gained in both old and new disciplines.

#### INVENTION AND THE FUTURE OF THE UNIVERSITY

While logic and dialectic play a central role in the culture of inquiry at Carnegie Mellon, I believe they do not adequately explain the innovative quality of the university. Logic provides a variety of analytical tools for inquiry, and dialectic provides a community process for articulating shared principles. But finding the important problems to solve and discovering the new forms of making that are needed to bring ideas forward in concrete embodiment depend on another liberal art that is also emerging in the culture of inquiry at Carnegie Mellon. They depend on a form of invention, practiced consciously or unconsciously as an intellectual art by individuals who seek the key issues for decision and investigation. In the past, the art of invention was formalized in the old liberal art of rhetoric and typically limited to

verbal invention. In the new culture of inquiry and technology, invention has a wider scope, employed in the sciences, the humanities, and the arts.<sup>9</sup>

The art of invention at Carnegie Mellon may be found in the issues that emerge in the work of individuals and small research teams as they pursue new problems. However, it is also evident in dialectical conversations about the future direction of the institution. One example lies in recent work on strategic planning for the university. In the latter 1990s, the evident success of Carnegie Mellon presented two alternatives for the future. Should the institution seek to remake itself in the image of older traditional universities or should it continue to explore the implications of its own unique genius as a new kind of university? As a participant in the planning committee charged with discussing the vision of the university, I believe the choice was not difficult. Although both alternatives were carefully considered, the vision that came forward was clearly a development of the unique genius of the university. It was a neoteric vision, grounded in humanism and in the circumstances and problems of emerging technological culture. Although there were several important elements of the emerging vision—issues of social diversity, new directions for research, and new relationships with the community, industry, and government—one set of issues addressed the intellectual core of the university. The issues were presented as questions for further discussion.

- *First, how can we give greater emphasis to problem finding as the creative counterpart of problem solving?*  
Focus on problem solving is a legacy of our history as an institute of technology. It led to expertise in analyzing problems and a focus on professional education. In the new circumstances of contemporary culture, we need to explore problem finding, since changing circumstances present so many new opportunities for the exploration of learning and research.
- *Second, how can we reinvent the organization and distribution of subject matters that all students should study if they are to be successful in the future?*  
The traditional disciplines of the arts and sciences remain important, but the old divisions tend to work against integrated learning and action. We need to explore new ways of presenting subject matters so that their interconnections become productive of new understanding.

- *Third, how can we articulate a new vision of the liberal arts suited to a technological culture so that our students can communicate clearly, reason effectively in addressing new problems, and prepare for life-long inquiry?*

We need to reach a new community understanding of the liberal arts, recognizing the pathways that are already evident in our teaching—pathways that promote interdisciplinary understanding, action, and creative production. We also need to understand that technology is not simply the physical artifacts of our culture. Technology—combining the ancient words for art and reason, “*techne*” and “*logos*”—is how we use the “art of science” or the “science of art” to create the human-made world of communications, artifacts, human interactions, and the large systems that provide their environment. This will expand our understanding of the sciences of the artificial in ways that are appropriate for the complexity of contemporary culture.

- *Fourth, how can we give greater emphasis to educating for leadership and the development of the whole person?*

In the past, we have emphasized education for the professions and sometimes neglected the broader framework of humanistic values that lies behind science, technology, and other professional pathways pursued by our students. We need to recognize that our students can and should play leadership roles in integrating knowledge, and we need to be explicit in how we develop the qualities of leadership and responsible action, affirming the place of human beings in the future development of technology.

These are emergent issues in the culture of Carnegie Mellon, and the way that we address them will significantly determine the character and importance of the institution in the future. The implementation of a well-conceived plan of action will complete our transition from an institute of technology to a new kind of university. However, the effort will not be easy. It will lead the university community beyond the early foundational idea of a “liberal professional education” and beyond the initial formulation of Herbert Simon’s “sciences of the artificial.” It will lead us to a deeper understanding of design and technology in contemporary culture and the dimensions of the new learning of our time.

The issues we must address at Carnegie Mellon are also emergent issues at an increasing number of other institutions, reflecting

deep problems in contemporary culture as well as the challenge of balancing old accomplishments with new intellectual ventures. At Harvard, for example, a new president has begun a conversation about the nature of liberal education in an age of technology. The question is whether the university can reorganize education to prepare students for the new circumstances they will face in the twenty-first century. The outcome is uncertain. Resistance among many faculty members is reported to be strong, perhaps because of entrapment in past success, or less experience of the problems of making in our culture, or less recognition of the new meanings of “technology” that are transforming learning and knowledge. In contrast, Carnegie Mellon appears to be well positioned to lead the exploration of these issues. After all, the issues we face are design issues, in the broadest sense of “design” at Carnegie Mellon. They are issues in the design of the university, itself. By a combination of chance, circumstances, and deliberate planning, the university is now positioned at the nexus of some of the most significant problems of a new culture of inquiry and learning. After a decade at this university, I believe I have begun to understand what Richard McKeon foresaw about the future of Carnegie Mellon when he spoke to his class so many years ago.

#### Notes

<sup>1</sup> Simon, Herbert A. *The Sciences of the Artificial*. Cambridge: MIT Press, 1969.

<sup>2</sup> McKeon, Richard. “The Uses of Rhetoric in a Technological Age: Architectonic Productive Arts,” in Backman, Mark (ed.) *Rhetoric: Essays in Invention and Discovery*. Woodbridge, CT: Ox Bow, 1987.

<sup>3</sup> As Dean of Humanities, Richard McKeon was one of the central architects of the “Hutchins College” at the University of Chicago. This was one of the great experiments in general or liberal education of the twentieth century.

<sup>4</sup> Buchanan, Richard. “Wicked Problems in Design Thinking,” in *The Idea of Design*, Margolin, V. and Buchanan, R. Cambridge: MIT Press, 1995.

<sup>5</sup> Buchanan, Scott. *Poetry and Mathematics*. Philadelphia: J. B. Lippincott, 1957. Also, *The Doctrine of Signatures: A Defence of Theory in Medicine*. New York: Harcourt, Brace and Company, 1938. The latter includes a discussion of the liberal arts in the emerging field of medical research in the 1930s. Scott Buchanan (no relation to the author of this essay) played a central role in the development of the liberal arts program at St. John’s College, another of the great experiments in liberal education in the twentieth century.

<sup>6</sup> Schwab, Joseph J. “Eros and Education: A Discussion of One Aspect of Discussion,” in Westbury, Ian and Wilkof, Neil J. (eds.) *Science, Curriculum, and*

*Liberal Education: Selected Essays*, Chicago: University of Chicago Press, 1978. "The 'intellectual' arts and skills with which the liberal curriculum is concerned are not then intellectual as to subject matter, and thus exclusive of other subject matters, but intellectual as to quality. They are the arts and skills which confer cogency upon situations and actions whether these be scientific, social, or humanistic, general and abstract or particular and concrete."

<sup>7</sup> Doherty, Robert Ernest. *The Development of Professional Education; The Principles Which Have Guided the Reconstruction of Education at Carnegie Institute of Technology, 1936-1950*. Pittsburgh: Carnegie Institute of Technology, 1950. This document presents the "Doherty Plan" for liberal professional education at the Carnegie Institute of Technology.

<sup>8</sup> Buchanan, Richard. "Design Research and the New Learning," *Design Issues*. Vol. XVII, No. 4, Fall, 2001.

<sup>9</sup> Buchanan, Richard. "Design and the New Rhetoric: Productive Arts in the Philosophy of Culture," *Philosophy and Rhetoric*. Volume 34, No. 3, August, 2001.

## ARCHITECTURE, THE WORKPLACE, AND ENVIRONMENTAL POLICY

Volker Hartkopf and Vivian Loftness

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### INTRODUCTION

Carnegie Mellon's architecture program, created in 1912, is one of America's oldest. Yet it has remained innovative in its curriculum and outreach, integrating new technologies, seeking appli-