Design Education and Research for the 21st Century

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From a speech delivered at the **First International Design Forum, Singapore** October 20, 1988. Published first in **Design, Your Competitive Edge,** Proceedings of the First International Design Forum, 34-45, Singapore: Singapore Trade Development Board, 1989. Also published in **Design Studies** [UK] 11, No. 4 (October 1990): 202-206. Published as *KIT '89 International Design Seminar. Design Education in the Information Age* (in Korean). **Industrial Design** [South Korea] 20, No. 107 (1989): 35-39. Published as: *Design Education in the Information Age,* **Design Processes Newsletter** 3, No. 3 (1989): 1-5. Published as: *International Design Seminar, Design in the Information Age* (in Korean), **Monthly Design** [South Korea] 10, No. 139 (January 1990): 102-107. Published as: *Design Education in the Information Age,* **Statements.** American Center for Design (1990): 1,2. And published as: *Design Education in the Information Age,* **Design Issues** 7, No. 2 (Spring 1991): 25:33.

Summary

The role of design is increasing in importance both for economic competitiveness and for improvement of the quality of life. Never before has design played such an obvious role in the success or failure of companies. Companies and countries are enjoying explosive growth in productivity and per-capita income as a result of improvements in production technology, global awareness and world trade.

Advances in design theory and the computer technology to support its application are making it possible to undertake greater responsibility for the successful development of new products and systems. Design technology has begun to mature, to leave styling as an end, and to use new computer-supported design tools to deal with the entire range of planning and design requirements. Smaller, cheaper and faster computers have given the design researcher the means for working with complex design problems, and have finally opened the door to the application of theory only speculated upon heretofore.

Fundamental changes must take place in the nature of design education to take full advantage of the new capabilities. Design students no longer can be thought of as commercial versions of fine art students. The demands of the new computer-supported design tools and the expectations of the newly emerging design research fields demand that the finest minds as well as talents be encouraged to study design. Curricula must be revised to serve these needs and faculty must be recruited or developed to fill the new teaching and research roles.

The reality of world markets and world communications makes it mandatory that design researchers, educators and practitioners establish global networks of interactive communication—for institutional self-interest as well as for economic stability. The problems of a global economy are beginning to be understood, and much of the success of a 21st century world economy will depend on the ability of countries to work together to prevent radically uneven development and unbalanced trade. Critical to this will be means for sharing advancements in design technology and market knowledge. Key players in this activity are the design professionals, who must begin to create effective global communication systems.

The Coming of Age of Design

When industry can make anything consumers desire, the priorities among elements of production systems change. What is important to the delivery of goods and services at one stage of development is not so important at another. Certainly as a global society, and even as national societies, we have not yet reached the stage where we can have *anything* we want. Yet, we are far closer to that vision than we were centuries ago or even decades ago, and the nature of our production systems is changing to reflect that reality.

The great engine of production and distribution that emerged from the industrial revolution, has evolved into a very sophisticated system for supplying wants and needs. As developing countries are brought more fully into the system, the benefits spread, and the increasing sophistication enables ever greater numbers of people to live more productive lives.

In the last century, the ability to produce quantities of anything was practically the sole issue for business competition. Entrepreneurs who were able to invent products that could be mass produced had a distinct advantage over the craftsman/artisan (Fig. 1). As an element of the production system, however, inventive entrepreneuring swiftly diminished in

- Entrepreneuring
- Manufacturing
- Marketing and Sales
- Business Management and Finance
- **Design**

Figure 1. Coming of Age: The competitive Advantage

importance as the industrial revolution took full command. It was replaced by a new competitive advantage: manufacturing expertise. Production efficiency meant lower prices and a competitive sales position. The golden age of manufacturing, with assembly lines and true mass production techniques, widely distributed the fruits of industry to waiting populations. Manufacturing expertise also was inevitably disseminated among companies, and the competitive advantage moved again, this time to marketing and sales expertise. Purchasers now could make decisions on higher levels than whether a product was available or within budget—manufacturing expertise had seen to that. The marketing/sales difference spoke to the individual—or at least to individual market segments—and offered product lines with versions for everyone. Within two decades, the benefits of good marketing strategies were assimilated by most aggressive corporations, and a new competitive advantage emerged: business administration methodology. Better-managed, more financially astute companies were able to operate more successfully. Now, in the late 1980's, this advantage too has been dispersed within the business community, and the next competitive advantage is beginning to emerge: *design*.

The position of design among the elements of production has changed through the various phases of industrial growth (Fig. 2). When entrepreneurs reigned, design as a profession did not exist. To the extent that conscious use was made of design at all, it was in the context of invention or engineering. In the great period of manufacturing growth, design was almost exclusively engineering. Finally, in Europe first, most notably at the Bauhaus, and then in the United States, artists and craftsmen began to work with industrialists and to commit their talents to the design of industrial products. By the 1930's, companies were beginning to look for consulting advice in design or, in the case of the larger companies, were actively hiring industrial and graphic designers to work with engineering and marketing departments. Particularly in the United States, designers worked with marketing, advertising and sales to differentiate products for the newly recognized market segments. By the time of the ascendency of the financial and management experts, the design function had been institutionalized as a necessary element of product development, but most frequently only for appearance design.

• Entrepreneuring	→	*invention as design*
• Manufacturing	→	engineering design
• Marketing and Sales	→	product styling
• Business Management	→	appearance and human factors

Figure 2. Coming of Age: The place of design

Today, once again, we are seeing a maturing and expanding industrial capability looking for a competitive edge. The change in context this time places industrial competition in a world marketplace. Good management is not enough to face the new competitive environment. Companies now compete with each other at home and abroad, and they compete not only with companies from their own countries, but with multinational companies and companies from many locations around the world. Products may be quickly copied, prices may be effectively undercut, markets are subtly different and expectations among an increasingly critical consuming population are high.

	Level	
Craftsmanship	**1**	better construction
Detail Design	**2**	better appearance better human factors better performance
Concept Design	**3**	better ideas better integration better understanding deeper penetration broader consideration

Figure 3: Coming of Age: The design advantage – quality

Design in the 1990's will assume a high priority in corporate strategies (Fig. 3). The forces of world-market business have placed the idea of quality foremost in purchasers' minds. Initially, this meant "craftsmanship" because products were not equally well made. As companies have responded to the need for better quality control, the idea of quality has broadened to include better detail design -- in appearance, performance and human factors. Growing awareness of the competitive advantages of well detailed products has led to greater in-depth participation by designers in generating product ideas and in making decisions regarding their production. The trend continues, and another level of quality is now emerging as the touchstone for competitive advantage:

concept. Better concepts, dependably developed will be the decisive factor separating the successful companies of the 1990's from all others. This will require increasingly powerful means for design: design technology.

Design Technology for the Turn of the Century

Fortuitously, the changing marketing environment has arrived almost in synchronization with the emergence of technologies important for the accelerated development of design technology.

An economy once thoroughly committed to mass production, supported by mass communications and mass marketing, has now moved into what some call a "post industrial" era. Improvements in technology, most notably in the fields of computation, control and communications, have changed the way we produce and distribute goods. Although the end is not yet in sight, it is clear that we have entered a period in which the voice of the individual will be heard clearly by the manufacturer.

Post-industrial means a new kind of production system with equipment and factories that can respond quickly to changing demand. In the early 1960's, numerical control (NC) first made it possible to direct the movements of a machine tool without the active participation of a machine operator. As an immediate consequence, machines were developed that were able to perform sequences of operations specialized for the workpiece. In quick succession, machines were designed that could change their own tools; robots and other smart "transfer" devices were developed to move workpieces between machines; adaptive control (AC) systems were created to adjust machining operations to individual differences in workpieces; and a series of expansions to the concept of the "factory of the future" were embarked upon to give us Flexible Manufacturing Systems (FMS) and Computer Integrated Manufacturing (CIM). In today's world of manufacturing, it is possible in many situations to run extremely small production lots *(even lots of 1)* efficiently enough to be profitable.

The impact of this on design has not yet been realized, even partially. Among other things, it will mean substitution for the design of single products, the design of *rule systems* for families of products. Within this concept, products can be individually tailored to the needs of purchasers *in the production process,* yet remain within the controlled intent of the designer.

Computer-Supported Design

In addition to its impact on the means of production, the growth of computational power has created the means for fundamental changes in the way we design (Fig. 4). Computers in the early 1960's were large-scale machines, awkward to use and beyond the means of all but government, universities and large corporations to own. Progressively, size has diminished, power has increased and cost has dwindled until, now, the power available even to an individual purchaser is adequate to many of the tasks of interest to design. Personal computers today in the cost range of $3,000 to $5,000 have greater power and memory resources than large mainframe computers of the 1960's.

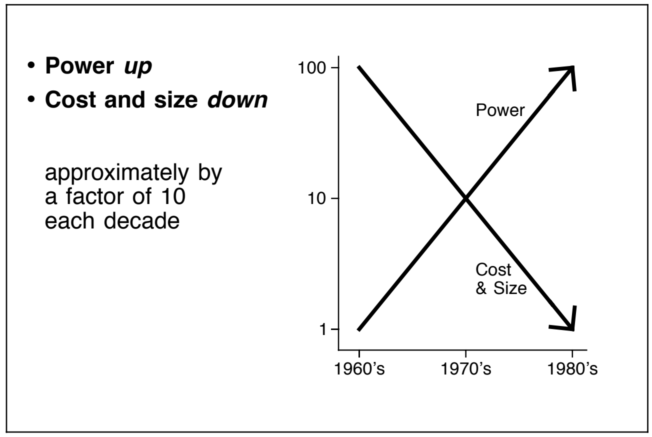

Figure 4. Research: Computational power

The evolution of the computer has made it possible to extend *mental capabilities* as well as physical capabilities. For the first time, it is possible to conceive tools that will allow designers to study issues of design in depth—with nonconventional as well as conventional methods of analysis, and with speed that collapses time to real-time dimensions.

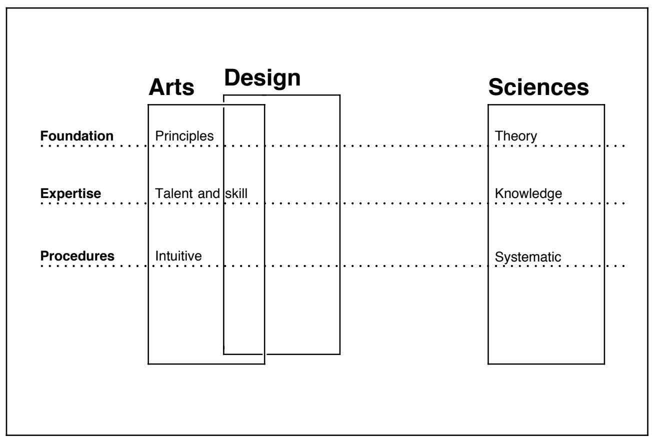

Figure 5. Research: Models for practice

Because the issues it confronts have been either intractable under conventional means of analysis or too consuming of time to be effectively investigated systematically, design has been more an art than a science (Fig. 5). Under such conditions, experts are seldom theorists. Indeed, design experts have been able practitioners, noted for their talent, acquired skills and ability to make sound choices intuitively, through natural sensitivity and experience.

Without modern computational power, the work of early design methodologists (Bruce Archer, Fritz Zwicky and J. Christopher Jones, among others in the 1950's) was limited to pencil and paper technology. The inadequacy of the means available was highly frustrating. "Design methods" were little more than check lists or theoretical exercises, appropriate for simple cases, but impossible to extend to complex problems.

In the two-and-one-half decades since then, computer power has been increasingly applied to problems of design. Predictably, the major contributions have been to supplement the *hand skills* of designers with computer graphic tools that help with drafting, drawing, rendering, image processing and typography. Relatively little has been done yet to develop the *mind extensions* necessary to make substantial contributions to designers' capacities for dealing with complex problems. Design programs in the universities and other tertiary educational institutions must take a large share of the blame for this, because they were not prepared for the computer revolution or for the research opportunities it would afford. To develop new design tools, a program must have design faculty able to work with computer technology at a fundamental, programming level. The most perceptive tools for design will be designed by *designers,* not by others guessing about the content, problems and processes of design (Fig. 6).

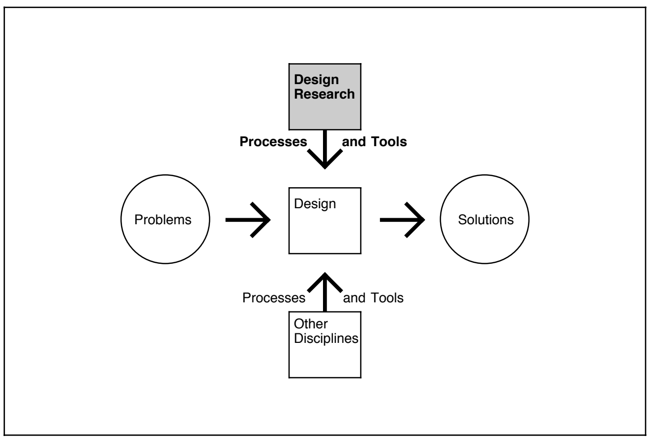

Figure 6. Research: Computer-supported design

Nevertheless, original work is being done in some schools and in some corporate software development groups. Beyond this, modified software developed for others -- engineers and scientists, particularly—must fill the needs until the design community can attend to its own modernization.

The good news is that some sense of the nature of *design technology* has appeared; and design as a discipline has begun to mature, to leave styling as an end, and to incorporate some of the new computer-supported design tools to deal with planning and design requirements. Small, fast and inexpensive computers have supplied the means for researchers to explore the horizons of their imaginations. The frustrations of the early years of design methodology have given way to myriad opportunities. Properly funded by industry and government, university research *could* produce a bonanza of new tools for the design professions in the next decades. Advances in design theory and its application *should* make it possible to meet the industrial challenges of a world economy.

Design Education at the Juncture

Design, as an academic discipline, is at a time of expectation. World economic conditions are placing great pressure on industry to produce competitively, and the fast-paced development of computing power and, potentially, design technology, portend quantum jumps in design capability. The question is, will design education be able to rise to these challenges?

Beginnings

Design education is a young discipline (Fig. 7). Born from the needs of an industrial economy, it has painfully moved through the stages of growth required of a new discipline. Early designers came from many backgrounds, pressed into service for their ability to contribute artistically to the products and communications of industry. Educational programs only came into being when the value of design thinking was well enough recognized to create a demand greater than that which could be supplied naturally from diversified sources.

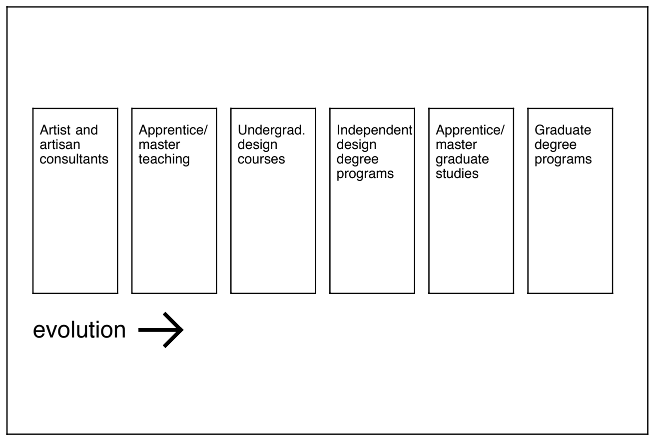

Figure 7. Education: Evolution of design education

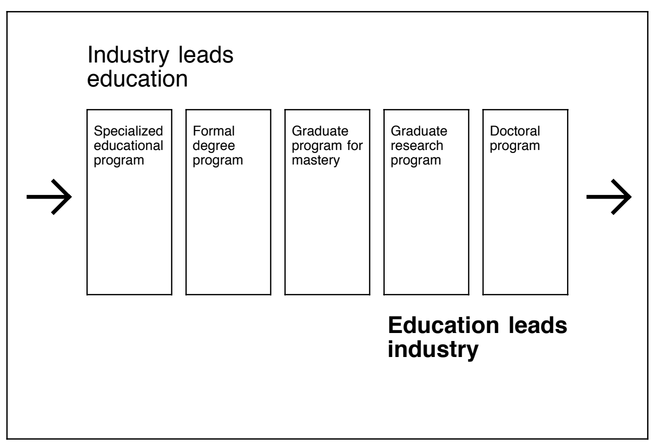

Figure 8. Education: Evolution of a discipline

Programs for product and communication design began invariably in art schools. The problems of industry were introduced into studios and treated by art faculties in master-apprentice fashion. As the knowledge required to succeed as a designer became better understood, courses were defined to teach it. Undergraduate degree programs in design were described and proliferated, gradually also separating from parent art programs.

The beginnings of graduate education in design followed a similar paradigm. Those choosing graduate work studied closely with faculty members in a one-to-one mode and, after sufficient experience, conducted a comprehensive project to completion for the Master's degree.

The path to the present state of design education is not unlike that traveled by many other disciplines (Fig. 8): Initial demand is first created in industry. Programs in advanced education institutions are constructed to meet the demand. Course structures are modified and refined as knowledge expands, eventually forming specialized curricula with individual degrees. Graduate study is introduced to achieve "mastery" and to explore the areas of advanced interest not yet well enough structured for classical courses. Research is formalized when specialists exist in enough numbers to begin substantive long-term investigations of topics important to the field. Finally, doctoral programs are described as the body of knowledge considered to be graduate level is great enough to teach in classical Master's level programs and the forefront of research has progressed to a level requiring more thorough preparation.

Design education has matured to an extent that the last two stages, formal research and doctoral programs, can now be contemplated. A few PhD programs already exist in Japan and Europe and, although their structures will undoubtedly be different, programs are being considered and written in the United States.

The Deep Challenge

The capability to extend and refine design education as a mature discipline comes at a time when wise actions are needed. Although it is clear that the design function is absolutely critical to the economic world fast emerging, design, as it has been practiced, is not ready in quality or quantity for the tasks it will be asked to perform. Fundamental changes must take place in design education to take advantage of new capabilities and meet the new responsibilities.

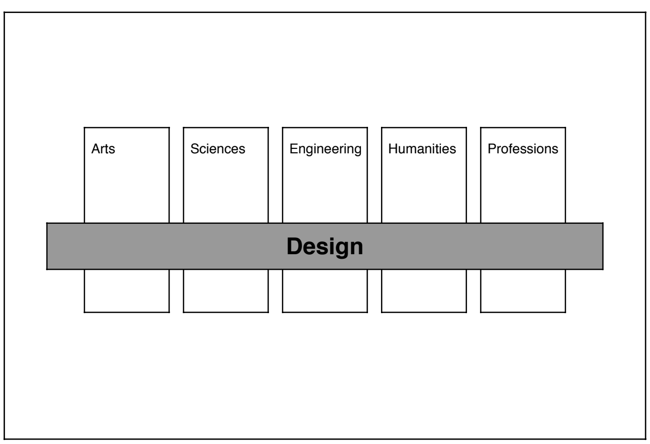

Figure 9. Education: What is design?

Design is not art. It also is not engineering, and it is not science or a number of other less likely candidates for association. It is time to recognize this and distinguish the differences. Design is not separative, it is integrative (Fig. 9). One of the *hallmarks* of design is its penchant for integration. Although it is not fashionable to think that generalism can any longer be taught in our complex society, it is just this generalism that makes a good designer so valuable. Someone has to be able to reach *across* disciplines to bring in information, to extract ideas, and to think critically from the viewpoints of many. It used to be that general education was valued. A good liberal arts education, as general preparation, was sought out by those who hoped to lead in business and the professions. With increasing specialization, this is now seldom enough; liberal arts preparation in itself is not sufficient for almost any career. Nevertheless, for a career in design, general knowledge is now more important than ever, and it should be *required* as a foundation for those entrusted to design the communications and artifacts of a society. Good design education is good *general* education augmented with *special* education for problem solving, conceptualization, visualization and communication (Fig. 10).

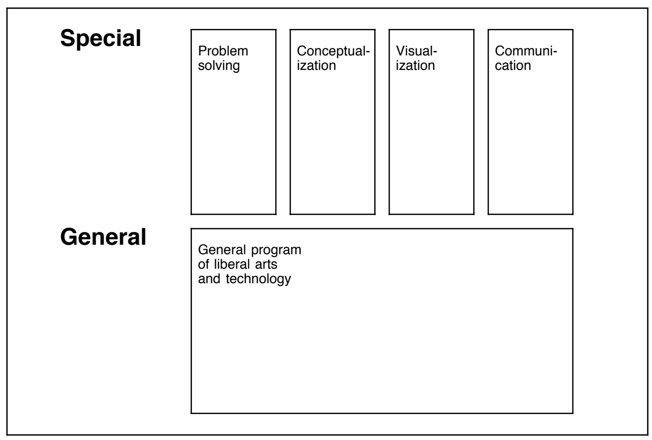

Figure 10. Education: What is design education?

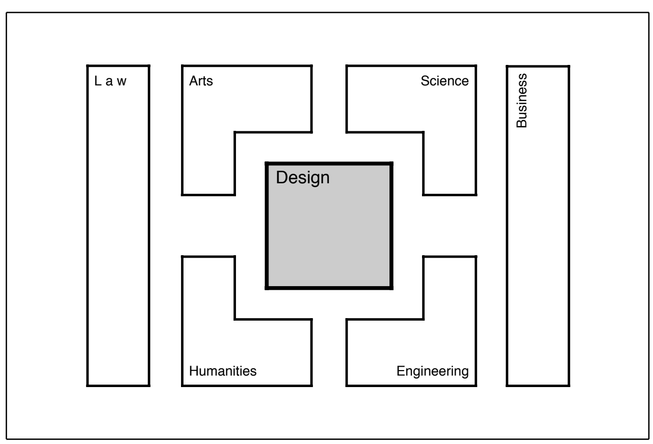

Figure 11. Edcuation: Positioning

Because design is integrative, design education needs firm grounding in the subject matter of the arts, the sciences, technology and the humanities. To strengthen this "position of balance", the ideal location of a design program is *not* in any one of the typical colleges of art, engineering, sciences or humanities, but in a college or school devoted to the integrative use of all of those reservoirs of knowledge (Fig. 11). For teaching students how to design, the sources of information and inspiration are those of the *whole university;* the processes to use that wisdom in better products and communications are what are special to the design program.

The New Student

However it is administratively positioned in the university, the college, school or department of design needs a different vision. Further, it needs a *different kind of student* than it has traditionally received. In the United States, and in many other countries, students who enter programs of design often do *not* do so because they have actively sought this career. Instead, they arrive through a process of elimination; deciding *against* potential careers that would require strength in mathematics, science or language arts (Fig. 12). Very frequently, students in design programs arrive only after trying the arts programs and deciding that design education offers greater potential for obtaining a job.

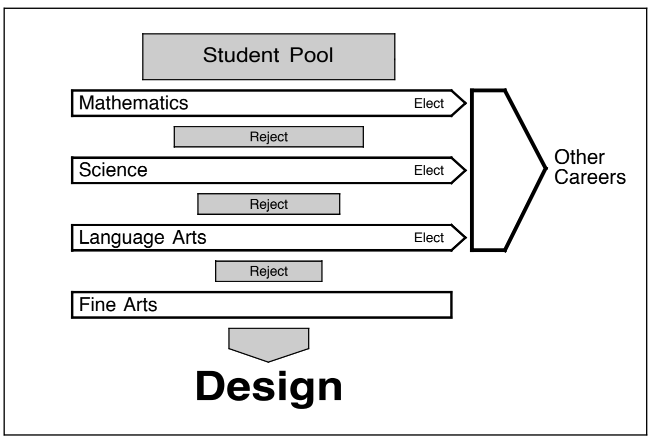

Figure 12. Education: Selection by rejection

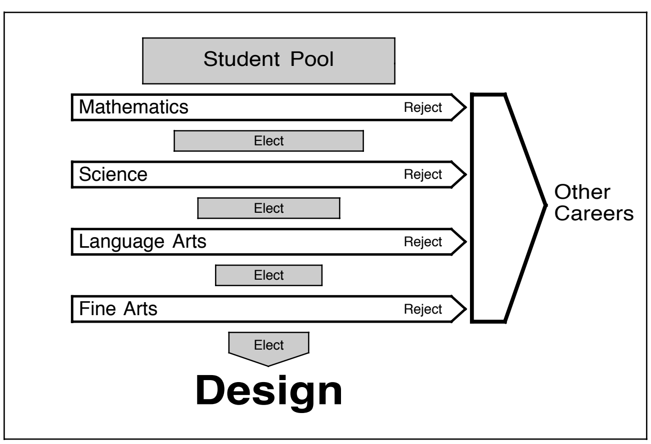

Figure 13. Education: Selection by election

This form of non-recruiting is simply not capable of supplying the kinds of students needed for the future. A design student should not be running *away* from disciplines of specialization; he should be running *toward* a discipline of integration. He should be good in *all* the disciplines and should be marked by his desire to find a profession in which he can *put it all together (Fig. 13).*

To attract the best among students who excel in many disciplines, the design professions must become better known to the primary and secondary schools of the world. Studies made at the Institute of Design indicate that, at present, the design professions are not well known or understood in the United States and do not compete well for student esteem with more traditional careers in science, engineering, architecture and the liberal and fine arts. To correct this, the work that designers do that deserves respect must be accorded it. Recognizing good design nationally and internationally will go a long way toward making the design professions more visible and competitive as recruiters (Fig. 14).

Success sells itself

- Reward comprehensively good design
- Recognize exceptional designers
- Communicate design achievements
- Communicate career values

Figure 14. Education: Recruiting

New Curricula

To take maximum advantage of the aptitudes of students chosen for all-around excellence, the curricula of design schools must be upgraded.

Undergraduate programs should be university level programs awarding four or five year baccalaureate degrees. Alongside the special program of knowledge and skills necessary for design, should be a strong program skillfully mixing elements of a liberal arts education with those of a technological one. Because graduate level programs now exist in significant numbers, it is no longer necessary that an undergraduate program undertake to teach all that is known of design. Rather, the undergraduate program can develop fundamental skills; inventiveness and sensitivity; general knowledge; integrative and critical thinking; and the ability to apply design processes to problems of institutions and industry (Fig. 15).

Graduate level programs can be differentiated to offer opportunities for professional mastery in Master of Design

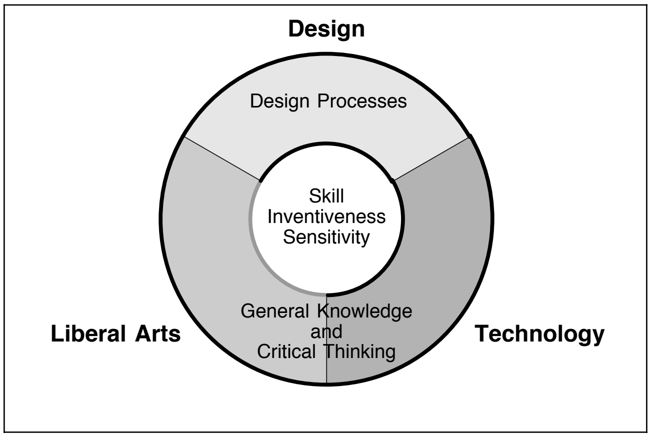

Figure 15. Education: Undergraduate programs

programs, and for research in Master of Arts or Master of Science and PhD programs. This will provide the incentive for schools to pursue excellence in specialized design areas, pointing the direction for the investments in personnel and facilities required to achieve depth.

Specialized professional programs for transportation design; design for the aged and disabled; industrial and construction systems design; consumer products design; communication and control systems design; and many other industry-specific forms of design can be imagined readily. Generalized professional programs can also be implemented with less specific emphasis on content and greater attention to contemporary design theory and processes and their mastery through application.

Research programs similarly can be specialized to individual school strengths. Some may become content specific, seeking better understanding of the design requirements of specific fields, for example, the human factors, performance and aesthetic issues involved with problems of transportation. Others may focus on general aspects of theory and process relevant to design, for example: the nature and meaning of form, typography and information graphics, computer-supported design and planning, etc. Research programs at the master's level will emphasize the development of research and development skills. At the PhD level, these skills will be employed to help create the body of knowledge that will be used in industry and taught in the masters' and bachelors' programs of the future.

Improved Faculty

Graduate programs and undergraduate programs of the kinds described require faculties with special capabilities. Probably the most difficult task facing the design fields today is that of developing the faculty needed for tomorrow.

Although there are many dedicated individuals teaching in the design fields today, the problem of finding appropriate students applies also, and more insidiously, to the selection and development of faculty. Noticeably in the United States, perhaps less obviously elsewhere, an incestuous loop has formed that operates to maintain the status quo and deter the evolution of design programs (Fig. 16). Students choosing art programs (and, ultimately, design) exhibit frequently a dislike or inability to deal with the content of other fields, particularly the technical fields. In the learning process, their fears, prejudices and knowledge gaps go unattended because their faculty, returned from industry, are products of the same process and hold similar viewpoints. When they graduate, the students go into industry to departments or consulting offices staffed by graduates before them with like dispositions. They then act on the schools from their professional positions to ensure that the schools prepare students as they were prepared, so that future employees will have the same skills and attitudes that they have—now perceived necessary to the work of their firms. Since, in most cases, design schools hire faculty from the ranks of business, some inevitably return to the schools to complete the loop.

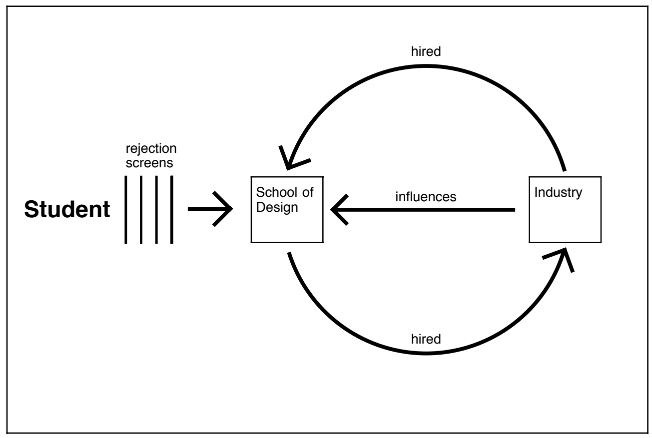

Figure 16. Education: The incestuous loop

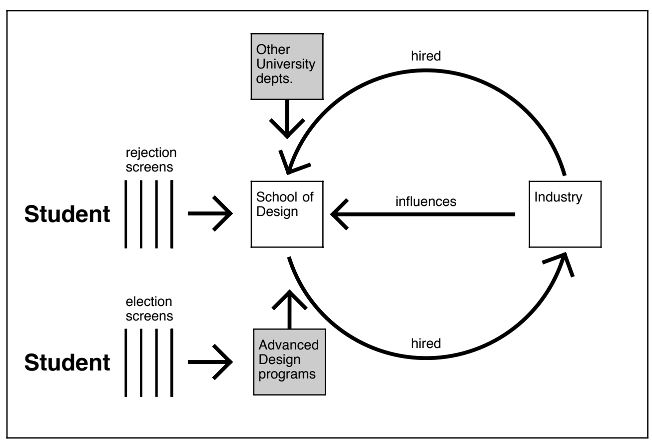

Figure 17. Education: Breaking the loop

This loop must be broken for the evolution of design education to continue (Fig. 17). The faculty necessary for tomorrow's schools must have the same essential breadth of interest and capability as the students that must now be sought. Finding such individuals in any number now, however, will be difficult. As more progressive programs emerge, there will be a growing pool of new graduates to draw from, although these will be also competitively courted by industry. Ultimately, PhD programs will produce graduates especially prepared for research and teaching. In the interim, wise administrators will draw upon specialists from other fields who have interests sympathetic to those of design. It is not uncommon to find scientists, scholars and technologists whose own breadth of interest extends to issues of design. Sought out by design faculties, they can offer rich extensions to traditional curricula, either in specialty courses or in courses team-taught with design teachers.

Research faculties will be even more difficult to develop in the beginning. Design education, except for engineering design and some architectural design, has had the tradition of the fine and applied arts as its model, where personal exploration substitutes for research (Fig. 18). Developing the substantial knowledge base and system of communications necessary for vital research, will require more than just the efforts of individual schools and faculties. Given a supportive climate and resources of time and money to seed projects, there will be individual success stories; but for progress on a broad front, an effort on a larger scale will be required.

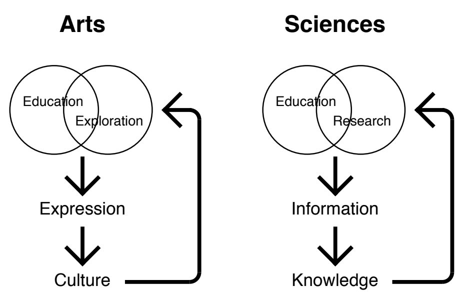

Figure 18. Education: Modifying the paradigm

The forces to break the loop and to begin the next phase of evolution, fortunately, are at hand. Manifestations are already visible in some schools. Industry preparing for a volatile, highly-competitive, global market cannot ignore shortcomings in design education. Senior executives in companies whose products thrive or languish according to their design advantage are already making their interests known by the judicious support of schools taking positive steps to address the need for change. Concurrently, the accelerating growth of capabilities in computing, communications and allied technologies is reducing the distance design educators must cover to become effective researchers; the tools of computing are *easier to use* and *easier to learn to use*.

Design Communications

For effective research, channels of communication must be opened. The design disciplines have been slow to create the systems of communication necessary for the growth of knowledge. Design publications are primarily trade magazines and portfolio presentations, *not peer-reviewed journals*. Conferences set public spirited and high minded objectives, but seldom produce proceedings and contribute little of lasting value that can be built upon by those who follow. If design research and design education are to have any chance to meet the objectives extrapolated for them, channels of communication new to design (but familiar to other disciplines) must be constructed and used (Fig. 19).

- Journals
- Trade magazines
- Thesis and dissertation abstracts
- Newsletters
- Conferences, symposia, seminars, congresses
- Books
- Proceedings
- Reports
- Monographs
- Computer networks

Figure 19. Communication: Informational communications

Parties to the communication should include design educators, researchers and practitioners from companies, institutions and universities. The thread of common cause should be a joint commitment to developing, learning and sharing knowledge about planning and design.

International forums of many kinds already exist for specialists in design and other fields. A new channel should not duplicate the functions of these professional and political structures. It should have as its goals the creation and support of continuous educational and informational communications for the cooperative development of design knowledge (Fig. 20).

Parties	Goal
• Educators • Researchers • Professionals	***Creation and support*** of ***continuous educational and informational communications*** for ***the cooperative development of design knowledge***

Figure 20. Communication: A design communication channel

In form, it should support multiple media, taking advantage of all useful forms of communication from face-to-face meetings to computer networking. Modern computer and communication technologies provide many ways to link institutions and individuals effectively. Computer networks allow messages to be transmitted between distant communicators in relatively short time. BITNET already links hundreds of university and research sites worldwide, allowing users to communicate at little more than the institution's cost of maintaining a telephone line to the next node. Messages now can be text, computer programs or anything else that can be typed on a keyboard. Soon to come will be visual images (already possible on some networks). As equipment improves and costs drop, real-time, graphic interaction will be technically and economically feasible for those in compatible time zones.

Computer programs presently available support typed-message forms of continuous, computerized telecommunication conferencing, and improvements can be expected to expand this spectrum of "conference-like" services. For example, programs are being created to "mediate" activities for remotely located planning and design team members, and to coordinate the work of educational or other special-purpose groups. Capabilities for creating and sharing information bases; presorting communications for action with "smart" message inspection systems; automatically tracking and keeping records of remote meetings, discussions and decisions; and supporting group decisionmaking to obtain the wisdom of consensus, rather than the frustration of compromise are indicative of what now is or soon will be possible.

But face-to-face, in-the-flesh communication is important too, and a channel for design communication should include its use appropriately. Social as well as professional activities take place in the get-togethers of traditional conferences. The friendships and respect developed over days of sustained work and relaxation in conference settings lead to trust and a sense of mutual commitment immensely important to long-term relationships.

First Steps

The time is right to begin the construction of a design communication channel. The *technology is good enough,* if not yet widely implemented. *Interest is high:* Design awareness is growing. Design conferences, forums and competitions are being sponsored in increasing numbers. Designers, educators and researchers are expressing frustration at the lack of communication among cultures and countries. And great interest in emerging research on design processes has been shown by individuals and institutions wherever the opportunity to express it has arisen.

Because the form of a modern, cooperative system for research and professional communications of the kind discussed has not been well defined, there is an opportunity to develop it from the beginning, through rethinking the nature of the communication activity. Toward this goal, a "PanPacific Design Conference" could be called. The charge for the conference's activity would be the establishment of a regional communication channel for designers and planners -- the first step to global communications.

World markets and the growing importance of design to industry mandate the establishment of global networks of interactive design communication. As the workings of a global economy become better understood, the success of companies, countries and society itself may depend on the ability of all to work together. From the design standpoint, a critical aspect of this undertaking will be sharing advancements in design technology and market knowledge. An effective communication channel for design will meet this need and help to ensure balanced growth and economic stability.

Framed in global terms, such an ambitious goal for design cooperation seems idealistic. But if a beginning can be made, there is a chance that the demonstration of the benefits of shared knowledge will have impact on how future economic problems are prevented. Research on the nature of a ***Pan-Pacific Channel*** is now being conducted at IIT. With hard work and the support of the design community, it may be possible in the next few years to make the beginning. It is my hope that one day, when we look back to these exciting times, we will see them as the genesis of the golden years of design research and education.