RESEARCH AND DESIGN:
THE NEED FOR INTEGRATION

by

James A Moore

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Signature of Author

Department of Architecture
May 4, 1982

Certified by

Harvey J. Bryan
Assistant Professor of Building Technology
Thesis Supervisor

Accepted by

N. John Habraken
Chairman,
Departmental Committee on Graduate Students

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ABSTRACT

"Ars sans scientia nihil est."

Today's architectural knowledge base is a heterogenous mixture of empirical wisdom generated in numberless ways by thousands of practitioners through centuries' of trial-and-error. Architecture has never developed a professionally recognized system or research, nor any organized method for continuously developing the body of commonly held knowledge.

Traditionally, this lack or organization has not hindered the profession's ability to successfully integrate available means to meet the desired ends. The past decades, however, have produced a myriad of new techniques, materials, building products and processes, and a similar increase in societal demands. The abundance of knowledge necessary for successful intuitive design has overwhelmed the traditional methods of assimilation. The lack of an organized knowledge base and the means of producing such a base threaten the ability of the profession to fulfill its traditional responsibilities.

Research entails the organized production of knowledge, and for over twenty five years, architecture has been struggling to develop an effective form of research. Initial attempts, however, have generally not had any tangible results; borrowed almost directly from science, investigative methods have not been tailored to the needs or nature of architecture. Architectural design is not a pure science; the scientific method, unadapted, in not an appropriate method of inquiry.

Traditional methods of architectural inquiry can be updated and combined with appropriately modified scientific attitudes to form an effective system of architectural research. Initially, the relationship between organized inquiry and design must be clarified, and the work of the former directed towards the needs of the latter. To effect the integration between analysis and synthesis, a new type of professional must emerge, the facilitator. With a background in both design and research, the facilitator will be able to fill a variety of roles within the profession, always working to develop a systematic and effective way of adding new information to the knowledge base and bringing this knowledge into professional practice.

Intuition is still the foundation of successful design, but intuition can spring only from knowledge. Organized research is a means of providing such knowledge, but only if research is appropriate to both the subject and the user.

Thesis Supervisor: Harvey J. Bryan

Title: Assistant Professor of Building Technology
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An Introduction to the Problem

As a profession, we've avoided scientific methods and behavior, arguing that they are not conducive to creativity nor appropriate to design. As a result, we've never organized the facility to record and classify knowledge. We've created new ideas, whole movements in fact, but without an established theory or knowledge base.

The author of this statement, a well-known architectural educator, was attempting to give a valid reason for contemporary architecture's increasing failure to adequately meet current design needs and to competently address today's architectural issues. His thesis was that modern architecture is not only directionless, it has no backbone. There is no inherent organization to modern design methods and practices, and therefore architects are finding it increasingly difficult to deal with increasingly complex environmental design problems. Research, as an organized system for extending the architectural knowledge base, is one way of resolving this professional weakness.

Yet, despite the growing concern that traditional methods may not be adequate for handling today's design issues, there is an enormous reluctance to adopt anything vaguely resembling scientific objectivity or rigor into architecture. The same educator describes reasons that fellow educators have given for rejecting the notion of organized research:

They've told me, "We the architects who teach have tried research for a while and have found that it doesn't work for architecture. Besides, there's nothing about the way we teach or practice for which we need to apologize."²

There is some validity to the first point; recog-
nized 'research' in architecture has been around for over twenty five years, and to a great extent, the results of these investigations have been useless. In many ways, however, this failure has been due to a lack of understanding of both research and architecture on the part of both the researchers and architects; the fault is not found in any inherent weakness in the idea of organized architectural inquiry.

The second point is indefensible, yet typical of architectural tradition. There is a considerable amount about current methods of architectural education and practice which deserve intense scrutiny if not total overhaul. The fundamental concepts of environmental design may still be sound, but a great deal of contemporary ornament deserves to be cleared away. The claim that the profession has nothing to apologize about originates more in the fear that someone will indeed seek to inculcate more rigorous intellectual discipline into a notoriously slack profession, than in any real belief in its veracity.

Since its inception as a recognized facet of Western society over five hundred years ago, architecture, as a unified body, has assiduously avoided the scientific and technological aspects of its calling. The 14th century declared that architecture was an artform, and the profession has resolved to maintain that status ever since. Architecture, almost alone amongst the modern professions, has no research tradition; research carries overtones of science and technology, and architects have fought very hard --too hard-- to maintain their status as 'non-scientific' in an increasingly scientific world.

Architectural design and the creation of effective human environments do indeed defy many of the characteristics inherent in pure science. Living environments
cannot be analytically dis-integrated and designs cannot be contrived successfully through additive aggregation; the whole is indeed more than the sum of the parts. Variables affecting the environment cannot be manipulated at will; factors cannot be quantified or disregarded with impunity, and sometimes, essential factors cannot even be defined. A myriad of mitigating circumstances surrounds each and every environmental design problem; it is these inconsistencies which help distinguish the 'open' process of creating effective human environments from the 'closed' operations of scientific observation, analysis, and investigation.

Architects are well versed in an awareness that their calling is distinct from science and engineering. Distinctly lacking, however, is an awareness of the similarities between architecture and science. Both stand to gain through an increased understanding of each other, a fact which scientists are increasingly willing to acknowledge, but which architects still regard as apostasy. There have been many recent attempts to 'rationalize' architecture through the imposition of scientific methods; but, such efforts have failed partially because of the single-mindedness of their promoters, who knew a great deal more about science than architecture, and probably didn't know enough about either. In part, too, these efforts failed because of a singular lack of acceptance on the part of the profession, whose rejection was generally based on erroneous or mis-informed opinions when it wasn't made from outright disdain.

Ironically, in disclaiming the need for research as an unwarranted imposition of science into a distinctly non-scientific field, architecture has not only been doing itself a disservice, but it has also revealed a singular lack of self-awareness. For, as every designer
should know, all architectural creativity is, in some way, rooted in research; inquiry is the fundamental base from which every architect begins his work.

The focus of this work is design, and it implies a responsibility for prediction. Architects and other designers are responsible for determining the visual, aesthetic, physical and social characteristics of an environment, before that environment is manifested. One's ability to predict, however, can only come from one's prior knowledge; the larger one's knowledge base, the greater one's resources for prediction. The knowledge is this base can be garnered objectively or subjectively, purposefully or randomly, intuitively or via direct study; in any form, however, the designer's ability to assimilate information is essential to his ability to design.

Learning about the problem is the most essential activity in design. As one learns more and more about the problem, one also learns more and more about possible solutions.

... it is obvious that any improvement in design is directly related to the increase in the rate of learning and the amount of accumulated knowledge. Any strategy attempting to improve the design process must therefore be concerned first with improving the learning.3

The essential meaning of research is the search for knowledge; it is a form of learning. It leads to knowledge of circumstances and this knowledge of past and present can be used to create a 'knowledge' of the future. Research provides the knowledge base from which we derive our ability to predict:

... knowledge developed through careful research carries an element of predictability such that we may know more about what is likely to happen that we would have had we not carried out the research.4
Strange as it may seem, architecture, with this unavoidable need for knowledge, has never developed an organized system for accumulating such knowledge. This failure is not due to any deliberate decision based on a rigorous investigation of architectural needs. (In fact such a study --obviously outside the scope of architecture itself, and therefore not worthy of admission-- leads almost inevitably to the conclusion that architecture desperately needs some form of organized inquiry.) Rather, this lack is predicated upon beliefs handed down through history, stemming from some of the oldest traditions in a tradition-bound profession.

There is great validity to the claim that successful design can spring only from an intuitive understanding of environments, people, materials, and processes. The greater one's experience, the greater one's exposure to the practice of design, the greater one's ability to design successfully. However, if everyone is intent on merely developing an intuition for that which already exists --and this is not to imply that such is not a full time commitment-- then who assumes responsibility for expanding the extant knowledge base?

The answer, within architectural tradition, is no one and everyone. No one is specifically called upon to rigorously investigate areas of architectural concern, yet every practitioner is responsible for developing his own intuition through whatever methods he finds most beneficial. Therefore, as opposed to science, where each scientist sees himself building on previous work, standing on the shoulders of those who preceeded him, architects spend endless time repeating what others have done before. Architectural education is often seen as a vehicle which
permits the student to grasp in a few years of intensive study that which might take dozens of years to learn through empirical means. Yet, by and large, architectural education does not foster an ability to think clearly, nor does it enlarge the capacities of innate curiosity so much as it encourages students to absorb, believe, and adhere to established precedents.

Because these precedents tend to deny rather than explore the relationship between architecture and other areas of intellectual and physical endeavor, namely science and engineering, as science and technology became greater forces in modern society and the complexity of means available to the design profession increased—far beyond its traditional abilities to assimilate them—the professionally trained designer found that he had less and less control over the development of the built environment.

This loss of control was perceived as early as the beginning of the 19th century, but anti-rational sentiment eschewed organization or systematically rigorous methods of thinking in favor of professional isolationism and mystification. After the second World War, the explosion of building materials, processes, and techniques combined with an explosion in social demand to overwhelm the traditional profession's ability to provide adequate environmental solutions. Building proceeded at an unprecedented scale, less and less of it influenced by any sort of design training.

Architecture and the related design professions were not involved in the many sins of commission; trained architects are responsible for only about ten percent of the building currently built, and that number is steadily diminishing. Designers, however, have been guilty of enormous sins of omission, by preferring to maintain blind adherence to traditional methods and models rather
than investigate and attempt to capitalize on the opportunities presented by inevitable change.

During the 1960s, architecture finally received a formal introduction to scientific methods and organized thinking, but the relationship was not convivial. Experts from external professions -- mathematics, computer science, physics, psychology, sociology, physiology -- all of which had some definite tangential relationship to environmental design, began to seek ways of resolving architecture's increasingly evident problems. Most of these experts had no fundamental understanding of architecture or design. They brought their own traditions to bear on what they perceived as the relevant issues, and to a great extent, they failed to accomplish any significant results.

Many of these outsiders were discouraged by their lack of success. Some gave up to investigate other affairs; some pursue their erroneous conceptions of environmental design; a very few were perceptive enough to begin to understand the distinctions which separated the methods of science from the methods of design, and to attempt to find mutually amenable ways of linking the two. Members of this last group, however, have been few and far between and they have received only minimal assistance from those who stand to benefit most from their efforts, designers themselves. The attitude of the profession towards most of the 'research' that has been conducted over the past twenty five years has been polite disdain and benign neglect. In a few instances, erroneous research material has, in fact, been whole heartedly accepted, with disastrous results, causing the profession to grow even more distrustful of 'intrusion' from without.

Such external intrusions, however, cannot do anything but increase in the day-to-day development of the
built environment. The traditional design professions are slowly eroding from within, to a point that more than a few observers have begun to question the future existence of architecture as a discipline. If, like the ostrich with its head in the sand, the design profession continues to ignore the realities of its time and society, it will succeed only in signing its own death warrant. If, however, designers look upon science, technology, and a more rigorous intellectual methodology with a less jaded view, these elements might be properly integrated with tradition to create a dynamic and viable resource for solving contemporary environmental design problems. Architectural research, properly derived from the traditional methods of architecture and an awareness of today's needs and resources, can function as a means of increasing the architectural knowledge base and instituting an intellectual organization into the profession. As such, architectural research is essential to the future of the architectural tradition.
The Professional Tradition

Until the 15th century, those in charge of creating the man-made environment viewed themselves, first and foremost, as craftsmen who were unique from fellow builders only in their ability to master the essentials of their mutual trade. The 'architect' did not see himself as the bearer of esoteric talents or creative endowments, nor did he feel that his genuine superiority as a craftsman merited any untoward acclaim or praise. The men who designed the lasting monuments of classical Greece and Rome are virtually unknown. Their works, if labelled at all, generally bear the inscription of the presiding monarch or the sponsor who supplied funds for construction of the particular structure. Similarly, the highpoints of the Medieval tradition, the Gothic cathedrals, are also the products of anonymity. Neither the socio-religious structure of society nor the organization of the building trades before the 1400s promoted the exaltation of architectural processes.

If architecture and architects were not merited with any especial distinction, neither was the designer of pre-Renaissance buildings called upon to justify any of his design decisions. There was no personal or social need for justification. Buildings were designed and built in time-honored, traditional manners, methods which had been perfected through trial and error over the course of time. Architecture, to a large extent, was based on 'objective' standards dictated by both culture and environment, and relied only minimally on personal volition. And, what little personalization was permitted lay in the hands of the worker rather than the overall planner.

Environmental beauty in the pre-industrial age was very much a matter of enforced humility and restraint, a matter of
technological necessity and economic scarcity. The craftsman listened to the demands of site and climate, he intimately knew the social functions to be satisfied, and he was given a narrow range of locally available materials. The limited amount of energy and the limited choice of tools made human artifacts expressive, not of human arbitrariness and caprice, but of environmental laws and values beyond the individual, and in this sense, objective.¹

The virtues deemed most admirable in the design and construction of the built environment were usually not within the realm of architectural responsibility at all. As architectural historian, James S. Ackerman, relates:

While those passages from medieval descriptions that praise the achievement of an architect or patron can sometimes be read as an aesthetic criticism, the virtues are actually defined in terms of craftsmanship, labor, elegance -- especially of materials -- strength, and piety, not inventiveness or novelty of design.²

In fact, the architect did not see himself as distinguished from his fellow workers, and the notion of architectural design as a form of art did not enter the minds of pre-Renaissance builders. Both art and architecture were primarily unselfconscious. Building was an accepted societal workform, while art was an integral aspect of everyman's life; it was not an isolated form of knowledge or an esoteric, restricted hobby. All men were, in some way, artists, and artistic talent was described primarily as gradations in ability in one of the recognized crafts. The notion that artistic ability was a divinely inspired gift, unique to only a chosen few, arose from the Humanist movement of the 15th century. (Ironically enough, this same movement led to the first ideas of analysis and experimental justification which subsequently solidified into the scientific method, whose dramatic powers have helped eradicate the role of art, in any form, from contemporary Western life.) And, with
the change in attitude towards art came the simultaneous transition of architecture and design from a craft into an Art.

The 1400s were a tumultuous time in Europe, especially in the Mediterranean countries. Capitalism was making its initial appearance, feudalism was beginning to fail, and the first seeds of science and technology as we now know them were being sown. Social conditions and cultural norms were in a constant state of change and revision. Humanism became the prevailing social attitude and cultural philosophy. It venerated the study of the past -- ancient literature, history, rhetoric, and politics -- and the leading humanists were writers, scholars, editors, and philosophers. From the original Humanist philosophies came the hitherto unknown notion of human creative ability. Previously, creativity was solely a Divine talent, belonging to God alone. People possessed the ability to create only through God's generosity; their talents were only a feeble reflection of the infinite talents of their Creator.

The Humanists, however, believed that creativity was a human talent, a talent possessed by a few, rare individuals, and that this possession marked these few as favored by God. According to Ackerman, the Humanist notion was that "the great artist had the capacity to make something out of nothing by virtue of his genius (ingegno) which made him superior to other mortals..." The Artist, therefore, during the 15th century, was suddenly elevated above the rest of humanity, and the Arts simultaneously became the possession, not of the people, but of a chosen elite.

Humanist dicta and rising capitalist attitudes alone were not enough to immediately turn the tides of tradition, however. Artistic ability did not guarantee pecuniary recompense, and capitalist gains did not assure social
esteem. Many great artists were still required to work for their livings and could not devote their full attention to the development of their gifts. Similarly, the newly-rich merchants could not command social status and respect through mere ostentation.

The artist, therefore, commanded something that the merchants found desirable -- respect -- while the merchants' vast supplies of money were similarly desirable to the artists. Renaissance architecture, in a large way, arose from an unwritten agreement between the artist and the merchant. The latter desired status and respect, the former wanted monetary support, and buildings were chosen as the appropriate vehicle to effect both desires. The artist lent his name and abilities -- in some capacity -- to the design and decoration -- primarily the latter -- of large new villas and palaces. In return, he received a substantial patronage and his patron had a tasteful and socially acceptable way of displaying his power and wealth.

Traditional architects, the master craftsmen, saw this movement towards artistic patronage as a means of elevating both the social and financial status. The tacitly lobbied for the notion of architecture as one of the fine arts, with the architect receiving the status of a divinely endowed, unquestionable artistic creator. Architects and master builders rushed to divorce themselves from their humble, anonymous heritage.

Whereas the master builder had plied his craft through a type of design 'intuition' which was grounded in years of practical experience and observation, the architect as artist focussed almost entirely on theoretical and abstract justifications for his design decisions. During the 15th century, a class structure began to emerge, with the architect as artist clearly seeing himself as superior to the craftsman master builder. Ackerman quotes one of the most famous of these artists cum designer, Alberti, and relates, "this passage from
the first Renaissance treatise on architecture by Leone Battista Alberti (1404-1472) is the first that differentiates the architect from the builder by virtue not of his specialized learning but of his possession of an intangible gift of the spirit." He quotes:

"The building of something that seems functional and which is without doubt suited to the program and to the available funds is not so much the work of an architect as of an (ordinary) builder. But to design in advance, to formulate by good judgement what is to be resolved and perfected in every part, that is particular to the genius that we seek."

Clearly, however, Alberti was making a serious error in thus delimiting architecture from mere building. True architectural ability, then as now, was not merely attributable to divine inspiration. Although the very best designers did indeed seem to possess an intangible 'sense' that was not evident in lesser men, the perfection of this 'sense' was a much a matter of hard work, study, and experience, as of any innate inheritance from God. Alberti, a skilful designer and builder, who considered himself purely an artist, was the exception rather than the rule, a fact that is often misunderstood or simply ignored.

Alberti, the key figure in formulating the concepts both of creativity and of art as we think of it today, was a gentleman-architect and amateur painter, a humanist and philosopher, who wrote immeasurably influential treatises on painting (1435) and architecture (before 1450), as well as on a wide range of other subjects: he was the archetypal universal man of the Renaissance. In a way, Alberti was the opposite of his equally famous and versatile contemporary, Filippo Brunelleschi (1377-1446), who belonged to the medieval tradition of the master mason with his scientia, but at the same time to the prehistory of modern experimental science -- a great engineer, architect, mechanic and inventor, who expressed himself more readily in numbers and geometrical figures, drawings, models and didactic demon-
strations (like the first picture constructed in rationalized perspective) than in words. He did not think of himself as a superior being with unique endowments, though he might have granted that he was cleverer craftsman than his contemporaries.6

This drift of pure artists into architectural design had some deleterious effects on the overall development of architecture during the course of the Renaissance. While the period had enormous lasting influence on the future development of the design profession, it was during the Renaissance that the organic nature of architecture, the integration of the pragmatic and the aesthetic, of the objective and the subjective, of the art and the science of building, began to come apart. As artists first and foremost, the architects of the Renaissance did not know all that much about building. Not only did they neglect or ignore many of the technical and pragmatic aspects of architectural responsibility, the actually began to foster a professional disdain for them.

The sixteenth-century sculptors and painters who undertook the designing of buildings cannot have brought to their first attempts much more than a trained eye and an admiration for antiquity. Even Michelangelo complained that he was forced to build though he was not an architect. Generally the solution to structural problems had to be left to masons and carpenters who had been accustomed for centuries to inventing means to achieve a given end. Bramante, in spite of some 30 years in the practice of architecture, never did gain much competence in technical matters, and after his death, Antonio was kept busy patching up his errors. The Vatican loggia had to be reinforced from below, the Belvedere corridors crashed to the ground nearly killing a pope, and the St. Peter's crossing piers had to be fattened, much to the detriment of their handsome profile. This lack of technical discipline may explain in part why the High Renaissance is one of the few great eras in architectural history in which a new style emerges without the assistance of any remarkable structural innovation.

The Renaissance succeeded in elevating architecture to an artform, and in elevating art to an esoterica high
above the heads of the mass of men. Architects, therefore, were able to begin ranking themselves amongst the upper classes in society, and the connection that began between the trained designer and the wealthy and powerful flourished and grew. Throughout the 16th, 17th, and 18th centuries, the men who went by the name of architect pursued their practice as a form of social artistry, and lent their services primarily to the wealthy, the powerful, and the elite. The mass of buildings were untouched by 'architectural design'; the average man built as he had always built, using conventional means and materials, designing by intuition and tradition to fit the framework handed down by his predecessors.

Only the 'professionals' therefore, worried about innovation or novelty, or justification of a design. But, their worry centered around theoretical rather than material concerns. While social needs were changing and technologies were similarly developing, it was the 'builders' rather than the 'architects' who responded most fluidly to these evolutions. The pragmatic tradition coupled with the increase in technological opportunities led to an abundance of innovations and developments. The artistic tradition, on the other hand, had only a peripheral interest in technical development or social change. The architect as artist from the Renaissance forward, was profoundly in love with his design talent, and considerable effort was dedicated to the tautological task of analysing, theorizing, and justifying his subjective decision making processes. During these centuries considerable time was dedicated to a form of architectural 'research.' This investigation was not research in the same sense as was understood by the burgeoning field of natural sciences, but intellectual theorizing of the traditional Aristotelian form. Designers based their designs and theories on geometry, logic,
subjective feelings, symbolism, Classical precedents, and natural analogies. Little, if any, architectural interest was expressed in attaining a greater understanding of functional, social, or technical issues. Inquiry into the methods of architecture ruled solely on a theoretical base.

However, as leaders in social consciousness, the architects and artists of the 18th century were affected by the increased development and interest in the natural sciences and the scientific method. This latter was grounded in the belief that there was an underlying objective order to all of Nature. It was man's goal to discover this underlying logic, and to do so, he developed the notions of analysis and scientific investigation. Speaking of this period leading up to the Industrial Revolution, Lewis Mumford has written:

\[\ldots\] the invention of the experimental method in science \ldots was, without doubt, the greatest achievement of (this) phase \ldots For, out of the hitherto almost impenetrable chaos of existence there emerged, finally, an orderly world: the factual impersonal order of science, articulated in every part and everywhere under the dominion of 'natural law.' Order \ldots once rested on the pure act of faith \ldots Now order was supported by method \ldots the very essence of Nature \ldots was that its sequences were orderly and therefore predictable. It was on this external physical order that men began to systematically reorganize their minds and their physical activities.\]

Now, artists had always regarded that their work too was a seeking after order, but against the increased challenge of science they held out that art represented another sort of order, a personal intellectual order as opposed to a clinically objective logic. Increasingly, however, the order of science was used to scrutinize the 'order' of art and architecture. During the 1750s, Alexander Baumgarten, a German philosopher, published two volumes entitled Aesthetika. These treatises attempted
to give an objective, scientific base to the creative powers that artists and architects claimed to possess. Baumgarten conducted his investigations according to the extant scientific methods, and his conclusions reveal his belief in objective, rational logic, and his skepticism regarding artistic 'logic.' He was forced to concede that non-objective, personal intuition derived from the senses or emotions was in fact a viable way of knowing. Intuition, like pure intellection, could be effective in solving realistic problems. However, Baumgarten was emphatic in his conclusion that sensible knowledge was clearly of a secondary nature, vastly inferior in quality and applicability to logical intellectual knowledge derived from scientific objectivity. To those who cared, science had proven that art was inferior to science. ⁹

Even as Baumgarten was conducting his investigations, architecture, while maintaining its traditional professional role in society, was beginning to adjust itself from a 'fine' art to an 'applied' art. Society at least, was beginning to recognize that mere artistic ability or knowledge was no longer sufficient justification for design expertise; increasingly, the creation of the built environment was becoming an area of scientific and technological inquiry. In the mid-17th century, the Royal Academy of Architecture was originated in Paris. Its members, not necessarily with any artistic training, hoped to apply the latest scientific principles and analytic methods to the acts of building. They had no grievance with architecture's traditional association with art; they merely wanted to satisfy their own curiosity about the field. Increasingly, however, the pragmatic aspects of the built environment began to see scientific and technical modification and improvement. Analytic principles and scientific laws were applied to traditional building practices and methods. Improvements were made in structures, materials, and environmental systems.
In response to such changes, and to precipitate further developments, during the 18th and 19th centuries, schools were organized to begin educating students in the basic principles of scientific and-engineering knowledge. Architecture, as its professional practitioners and society saw it, was conspicuously absent from these first academies. Architecture as art as divine inspiration could not be taught; the first schools were interested in translating primarily pragmatic educations.

In 1794, after the furor of the Revolution had died down somewhat, Napoleon initiated the rejuvenation of French society by opening the first National academy, the Ecole Polytechnique, a school of science and engineering. Building, and principles of construction were included in the Polytechnique's curriculum; architecture was not. It wasn't until 1797 that the French formally recognized the need for some sort of organized education for its architects; design was included as one of the programs offered at the Ecole de Beaux Arts, the official academy for the fine arts.

Perhaps the French example can be used as a formal announcement of an increasing social trend at the end of the 18th century. Increasingly, the art of architecture was separated from the science of building, and gradually societal emphasis began to shift from the former to the latter. The latest skills and intellectual developments were taught to the engineers and technicians; architects saw school merely as an opportunity to learn the classical orders and improve their ability to paint. And, as the ramifications of engineering knowledge and science began to make their effect during the blossoming of the Industrial Revolution, increasing emphasis was given to these areas. In a materialist society, the burgeoning 'power' of science and technology far outstripped the more subtle glories of artistic achievement. Architecture as art, however good, began to get lost in a technological society.
During the 19th century it became apparent that there were three types of 'architect' responsible for the design of the built environment: artists, builders, and businessmen. The first group was comprised of the traditional professional, the artist trained in an academy or atelier. The second group included trained engineers and construction men with and without training, but all with a great deal of practical experience. The third group included a growing number of real-estate brokers, speculative builders, and architectural developers. Increasingly, throughout the 19th and 20th centuries, the built environment was the product of the last two bodies. Businessmen looked for the quickest and cheapest way to make money from architecture. They hired the most technically competent builders who could do a job efficiently and without fanfare. By and large, they wanted little to do with architectural theorizing or problems of aesthetics, design justification, or symbolic and artistic significance. Society from the 19th century onwards was driven primarily by technology and capitalism. Architecture as practiced by the artists was neither technologically proficient nor, in the majority of cases, was it monetarily profitable.

Individual architects during this period became aware of this dichotomy between the artistic tenets of their tradition and the increasing manifestation of buildings for technological or pecuniary reasons. Social critics such as John Ruskin, Horatio Greenough, and William Morris were a few of those who brought notice of this dichotomy to both the profession and the public, yet the former chose, by and large, to disbelieve such reports and the latter felt absolutely no obligation to respond at all. Faced with changing means and ends, the traditional profession did little to alter its conventions. Where a keener insight into the overriding responsibility of the design profession coupled with less prejudicial attitudes
towards new technologies and social demands might have worked towards re-uniting the art and science of building design into a single integrated practice, the architectural profession in the 19th century turned towards professionalism, propaganda, and ideology as a means of justifying its traditional stances. Reflecting on these attitudes, 19th century British architect Eward Prior wrote:

That responsibility for the building art of the nation which had been delegated to the architect at the Renaissance became more than he could manage. He could not square himself with the popular notions of what an artist should be, and felt out of place in an academy of the fine arts. So, in 1834 there was founded for him the Institute of British Architects as a learned society.¹⁰

What Prior went on to imply was that this professional body acted more as a means of allowing the traditional architects to justify their resistance to change than as a way of assisting the practitioner to adapt to changing circumstance. Architecture wanted primarily to retain its image of 'pure design' as an artform. Where the realities of creating the built environment dictated otherwise, the architecture 'profession' refused to alter its self image. Whereas other professions during the 19th and 20th centuries expanded to encompass additional aspects and responsibilities --ie. medicine, law, politics-- architecture alone chose to reduce its responsibilities.

In a perceptive study of the nature of the design professions, Horst Rittel has defined a profession as "a societal device meant to provide and to guarantee knowledgeable, skilled and reliable services pertaining to the resolution of a particular class of problems." He then goes on to demonstrate that the architectural profession since its formalization during the 19th century has constantly chosen to re-define the 'class of problem' in order to fit its self image rather than re-define its self image to adapt to changing classes of problems.
Architecture has never proliferated into specializations. Whenever an area within architecture became systematized and showed signs of life, it was happily abandoned and left to the claims of other professions -- new or old.

Thus, the structural aspects of building were surrendered to the engineers, the same happened to heating and other 'environmental control' problems. Architecture did not even bother to make economic and financial problem of buildings its own. "Urban design" -- nothing but large scale architecture-- is using its elbows to settle between architecture and city-planning. . . 11

As the problems of creating the built environment changed during the 19th and 20th centuries, the profession of architecture adapted only grudgingly and under severe pressure. A great deal of energy was expended in denying the need to change, and when such efforts became futile, rather than seeking ways of integrating advances in technology, materials, and social perception into the architectural framework, the profession simply reduced the scope of its recognized responsibility. As an organized professional body, architecture over the past 150 years became increasingly devoted to self-protection rather than the fulfillment of socially allotted responsibilities. Ideology and propaganda rather than skill, ability, or perceptive thinking became the critical vehicles of the profession.

Speaking of the use of ideology by the architectural profession during the past century, Conrad Jameson has written:

At its most modest, a professional's ideology seeks only to guarantee security of employment; it must ensure that there is work, that the work is plentiful, and that the work is so defined that the profession's services are thought to be essential. It is not enough for the professional to find a job; he must also make sure that, once found, the job is explained in such a way that everyone believes -- not excluding, it should be added, the professional himself-- that no one else could do it so well. At its most ambitious, a profession's ideology plays directly for power and influence...
Sometimes a professional's ideology will make a mystique of technical expertise; often it will practice a subtle deception whereby technical knowledge of means becomes a moral knowledge of ends; almost always it will insist that without the professional's services those whom he aids and advises would have more to lose than the professional himself.

If (one) . . . were to seek an example of a profession's ideology, he could hardly do better than to study the belief system of modern architecture.\textsuperscript{12}

While Jameson's comments may be unduly critical of the architectural profession, they also carry considerable validity. The profession is traditionally guilty of 'mystification,' a practice which has increased dramatically over the past century. Designers who view themselves as artists rather than even craftsmen or responsible professionals, have also been historically lax in keeping pace with technological developments and social change, and in adding to the common knowledge base, preferring instead to concentrate on re-investigating traditional practices and enhancing novel approaches to 'pure' design. The core of the profession has never escaped its Renaissance love affair with artistic genius, and the practical and functional aspects of the built environment -- i.e., the elements of primary social concern -- have always been held as less important than aesthetic and subjective concerns. Where technology, social demand, or economics have clashed with these traditional values, the profession has stubbornly refused to back down. When faced with 'do or die' situations, the profession has chosen to sacrifice part of itself rather than water down its own cherished self-image.

In recent times, the conjunction between technological ability and economic concerns has produced a number of innovations in traditional building practices, none of which have been given the least approval by the profession. Pre-fabrication, modularization, synthetic materials, and new construction processes are but a few of the recent developments aimed at more easily meeting social demands.
In some instances, the architectural profession has been forced to accept such innovations, through the overpowering influence of economics or the organizational structure of the construction industries. In situations where innovation met with professional resistance, the architects have often found themselves being sidestepped; buildings are increasingly being built with only minimal assistance from trained designers, and the built environment reflects this deleterious development.

To a degree, architectural criticism of contemporary building trends can be justified. Prefabrication, systems building, and industrialization to name but a few innovations have obvious flaws and unappealing features, not the least of which is their aesthetic influence. However, by choosing to ignore these innovations, the profession has done nothing to eradicate the inherent weaknesses, and in fact, has only compounded the flaws by leaving their solution to untrained skills. A policy of responding to rather than attempting to dictate social demand would see architects applying their very real faculties towards successfully integrating new products and processes into the existing environment. Instead, architecture has tacitly chosen to proceed with its traditional 'mystification', to the point that today, the profession has lost a great deal of social credibility.

Architecture has become the mongrel offspring of engineering and the beaux arts... architecture is lost between the worlds of real estate and esoteric taste, of cultural change and cultural romance. The 1300 American architectural firms form a charming subculture, controlling a small and shrinking share of the total investment in building construction. Most of the jobs of building design are carried out by other people: engineers, developers, construction firms, manufacturers of pre-fabrication systems, and amateurs.
Reaction from within the profession to the forementioned situation varied between extremes. Traditionalists were content with the shrinking responsibilities of the profession. "We cannot affect the way buildings are designed, anyway, so we might as well simply acquiesce" became a common sentiment amongst some. Others, however, were not so willing to have their diminishing responsibility further eroded. To a limited extent, they looked to non-traditional means for rejuvenating their claims on the environmental design process. In a great way, however, the impetus to rejuvenate the traditional architectural responsibilities for overseeing the design and creation of the built environment came from outside the architectural profession, from people who were disturbed by the increasing futility of architects to others who simply saw architecture as an interesting case study in professional failure. The 1960s witnessed a dramatic increase in what became known as 'architectural research.' To a large extent, this 'research' comprised the efforts imposed on the design profession by non-designers to create a systematic, rational explanation of architectural design and practice. In many ways, the focus of this investigation was not problems in architecture; it was architecture itself. And, the aim of this work --and, to a large degree, it is still the aim of much ongoing work-- was not to solve the very real problems facing the profession so much as to test theoretical pre-conceptions about architectural practice. Implicit in the work of many investigators --very few of whom had any design training-- was the assumption that traditional architectural methods were no longer equal to the task of designing the modern environment. (Indeed, through its recalcitrance and stubborn resistance to adaptation, the profession lent a considerable aura of validity to this assumption.)

Architectural research as it has been known over
twenty-five years arose from erroneous belief that the human environment is essentially objective, and that its design was merely a well ordered, logical, linear process. Like science, architectural design, when analyzed would yield itself to an object system of definition. All that was needed to create this objective methodology was some insight into the mandatory elements of environmental design to be used as a background from which to create the 'new way.' Pre-conceptions firmly in hand, investigators attempted to discover the underlying system of architectural creativity. When the results of their investigations began to refute their pre-conceptions, investigators saw fit to discard the data or re-organize it to fit the designed framework. So intent were these researchers on establishing an objective, unassailable, scientific background for environmental design, that they neglected to examine the validity of the traditional design methods. Had their investigation been directed towards understanding architecture as it was, rather than gathering material for the creation of a new 'architecture' their effort might have had a vastly more useful impact. For, by and large, the sole impact of years and years of intentional, but misguided, architectural investigation has been the grudging verification of many of the traditional notions about design. Professional antics notwithstanding, the application of objective, non-architectural methods of thinking to the study of architecture has concluded that the nature of architectural design is very much what the architects always claimed it to be.
The Nature of Architectural Design

Temporarily leaving aside the mandatory aesthetic responsibilities, the traditional duty of the architectural profession has been to initiate, oversee, and bring to completion, the design and creation of the built environment. The process required to fulfill these responsibilities includes a number of interactive, but descriptively distinct, phases:

Initiation, during which the specific problems to be addressed are identified.

Transformation, during which appropriate solutions to the specific problems are identified.

Implementation, during which individual solutions are manifested in their entirety, or as stepping stones towards a more complex solution.

Within even the most rudimentary design problem, these three stages are mutually overlapping and iterative. Architectural problems invariably do not lend themselves to a single solution. Rather, the designer must not only bring several potential 'answers' towards completion, he must also address the problem of selecting the most appropriate 'answer.'

Similarly, architectural problems are usually of a compound nature. An apparent problem can be identified as three or four --or many more-- interrelated problems, each of which must be dealt with in some way before the designer can even begin to address the compound problem. The implementation stage of one of these sub-problems might coincide with the initiation stage of another sub-area. Like a juggler in the circus, the designer must have the ability to perform a variety of interrelated tasks simultaneously, and, just as with the juggler,
the designer cannot always call 'time out' in the middle of his act.

Whereas many scientific and technological problems lend themselves to analytical fragmentation, isolated experimentation, and theoretical abstraction, such intellectual techniques are only partially effective for environmental design problems. Design solutions are inescapably constrained by time, space, and the objective laws of nature. Overlaid on these, however, are equally constraining but far less definable social, personal, and cultural criteria. Unlike the scientist who can conclude several years of effort with the simple report, "It didn't work," the architect is committed to achievement. The products of his efforts must work, and this mandate, combined with the interrelated complex of objective, semi-objective, and purely subjective criteria with which he must contend, makes his creative efforts a truly extraordinary example of human intellect.

However, because the architect's purpose is not self-examination but rather creative production, the nature of the design process has traditionally cloaked in a shroud of mystery. Architects and the society they work for are generally more interested in what is produced than in how it is manifested. Before the Renaissance no one ever bothered to question the methods of architectural design; afterwards, the divine creative faculties implicit in the connection of architecture with art were a satisfactory enough explanation. As long as the built environment reflected some degree of technical and functional competence and a modicum of social concern, the semi-mysterious nature of architectural design remained unchallenged by both the profession and society.

The effecting of traditional responsibilities has not remained static over time, however. Technologies
and social needs -- means and ends -- both increased in size and extent; the design process, of necessity, became increasingly complex. During the late 1950s and early 1960s, the process of architectural creation, design, became the source of increasing scrutiny from both within and outside the profession. Sociologists and psychologists, interested in pursuing their theories relating personality and environment, were curious about the process of creating environments. Mathematicians and systems analysts were sure that there was some connection between human intelligence and structured logic, and they felt that design was an ideal test study. Architects, themselves, beginning to feel overwhelmed by the complex nature of some of their design problems, were looking for a method of reducing this complexity to a more manageable scale.

Most of these initial studies publically acknowledged that which architects had always tacitly or explicitly realized: good design involved an intellectual 'leap of faith.' The design process was not merely a one-dimensional additive assembly of data, albeit an abnormally complex assembly, nor was it science with social constraints. Nor, still, was design merely an overly constrained branch of artistic creativity (as the profession so often presented itself). Rather, architectural design revealed itself as somewhat amorphous; it was temporarily placed into a middle-ground between art and science, while increasing study was devoted to analysing the process of architectural creativity.

Following the best analytical traditions, early in these studies, models of the design process were developed. Groupings and sub-groupings varied from model to model, but almost all of the notable studies acknowledged that design included the following aspects:
Initiation: recognition and definition of the problem
Preparation: collection and analysis of information relevant to the problem
Proposal: synthesis of collected information into an appropriate solution(s)
Evaluation: weighing the relative success of a proposed solution
Action: manifestation or, or response to, an accepted solution.

These analytical studies of the design process were relatively straightforward, and their results correlated to a large degree with earlier investigation into related aspects of intellectual problem solving. Made confident by their ability to so easily isolate the readily discernable components of the design process, investigators set about attempting to disassemble the components. Their almost total failure to succeed revealed several inherent characteristics of the design process.

Design does not progress at a uniform, or even definable rate. Although every aspect of a particular design problem would be subjected to each of the five requisite processes, aspects, even when directly related to each other, went through at different rates; some aspects required numerous more 'cycles' than others, and not every aspect of a problem emerged with a similar degree of resolution. Inadvertantly, in their attempts to fragment the architectural design process, investigators had merely reaffirmed its holistic nature. A design problem could indeed be broken into a set of discrete sub-problems, and each of these in turn could be tackled according to the five-part process. There could be no guarantee, however, that the sub-problems could any longer be solved in a mutually interactive manner, nor could the designer be sure that the isolated sub-solutions would cohere into a unified compound
solution. Architects were warned about the danger of misinterpreting this holistic quality: "Designers have tended to fall into the trap of expecting an optimum solution to a total problem to be the sum of optimum solutions to its sub-problems, regardless of the fact that the sub-problems are highly independent."³

(Some design researchers, intent on perfecting their own models of the design process, completely missed comprehending the holistic nature of design. Others chose to ignore this inherent resistance to conform to linear aggregate modelling, and opted to pursue their analytic methods at a more sophisticated level. Some recognized the non-linear aspects of traditional design approaches but interpreted it to mean that design was only a much more complex example of straightforward Cartesian logic. They too chose to pursue their initial investigations using more rigorous techniques. Generally, all of these initial efforts graduated to the use of elaborate computer programs and mathematical analogs, none of which helped change the non-linear characteristics of the design process.)

A second, almost immediately apparent characteristic of architectural design was that in a complex design problem, as soon as the problem was fragmented into sub-problems, the nature of the initial problem changed. And, no matter how simple the sub-problems became, at some point, they invoked the Proposal phase of the solution process, and this phase simply defied objective explanation. None of the investigators could satisfactorily explain in scientific terms how the human designer synthesized collected data into a unique and successful solution. (And, since they couldn't explain it, there was little chance for scientifically duplicating it.) Some chose merely to say that the Proposal system defied explanation using existing investigative methods, but others were less re-
to confess the validity to the traditional architectural belief that design was grounded primarily in an innate, unexplainable subjective intuition. At its core, design was essentially a heuristic process.

A third stumbling block also prevented scientific methods from adequately analysing and duplicating the intuitive design process. In a complex design problem, the solution processes for each of the sub-problems are mutually interactive and overlapping. However, within even a simple, one-step sub-problem, the five aspects of the individual solution process are also mutually interactive and overlapping. Not only do the different issues with the overall design process interact -- and this interaction proceeds at a non-uniform, non-definable rate -- but within any one element of the process, the five aspects of the solution method are also interacting at a non-determinate, continuously changing rate.

For example, while a designer is sketching a speculative answer to some minor detail of a design problem -- the placement of a window perhaps -- part of his brain might very well be evaluating the applicability of the solution to surrounding factors, even as the solution is being drawn, while another part of his brain is already reaching ahead, reacting to this evaluation and beginning to investigate positive or negative ramifications of the still incomplete solution. In other words, at no single instant of time is the designer fully engaged by any single aspect of the design process. Initiation, Preparation, Proposal, Evaluation, and Action all occur continuously; only their relative weight changes. (In scientific terms, the sum of the five aspects must always equal a constant, but no aspect can ever equal zero.)

Thus, the fundamental error of rational design analysis was the attempt to either rationalize or disre-
gard the role of the subconscious mind during the creative process. What cannot be analysed cannot be rationalized and therefore cannot be applied in a purely logical construct. On the other hand, however, because an element of a process cannot be understood, it cannot simply be disregarded. If the rational model was to work, it had to include all the elements of design intellectation; if it didn't include all the elements, it couldn't attain the same intellectual quality, whatever advantages it might hold in other respects.

Much of the work in design analysis was undertaken with the hope that computers could be used to relieve the architect of the burdens of increasing complexity in design issues. In many ways, the 'answers' supplied by design research were geared more towards this anticipated computer application than towards the true nature of human design processes. As has been described, most analysts based their work on the presumption that architectural design was a divided, linear process.

It was assumed that rational design would proceed characteristically by decomposing the problem into its elements, adding an information content to each of the elements, then synthesizing a solution by some more or less rational procedure which may or may not include an 'intuitive' leap.4

Bill Hillier, the author of this statement, spent a great deal of time studying the failure of such computer modelling, and he goes on to demonstrate that this 'analysis/synthesis' model is based less on observation of the actual operation of skilled designers than on the application of misunderstood scientific theory to a badly misunderstood process of creation.

In their eagerness to apply computers to architectural design, analysts forgot to get a correct and complete
description of the process they sought to improve/replace.

The analysis/synthesis model is . . . fallacious and unlife-like at a very fundamental level. In real life, complex problems are solved by having some pre-existing theoretical or quasi-theoretical cognitive map which acts as a kind of plan for finding a route through undifferentiated problem material. In engineering, the cognitive map takes the form of calculation rules; in architecture, where no rules of rationality have yet been proposed, it more often than not takes the form of a previous example of a built solution to a particular problem.5

In other words, what the architect or designer brings to the design problem -- something no computer can begin to understand, analyse, or duplicate -- is of crucial and critical importance to its successful resolution.

The role of pre-existing notions in the solution of complex problems is paramount. In real life, the essential sequence is more like Cognitive Map/Conjectural Solution/Analytic Testing, followed by a process of hardware finalization.6

What Hillier attempts to show is that the reality of architectural design is almost the diametric opposite of the theoretical models. The model approaches a problem with a 'clean slate' and absorbs only that information which is pertinent to the particular problem; in this way, it is supposed to arrive at the 'best' solution to an idiosyncratic situation. The designer, on the other hand, approaches a problem with some idea of the solution already in mind. The pre-solution is tested with respect to the constraints imposed by the particular situation, and design proceeds, not as some inventive process of creating virginal ideas, but as an iterative process of modifying previously successful approaches to meet and solve newly specific needs and problems.
Of the numerous failures to rationalize the design process, only a few fully admitted their lack of success, and fewer still took the time to investigate the reasons. Guy Weinzapfel, an early advocate of computerization, was one who did investigate his failure, and writing about one of his creations, IMAGE, he admits that although he and his associates had developed an "extensible vocabulary of form descriptors" and a "valuable interactive design assistant," the program never came close to realizing some of the initial expectations held for it.

Even the strongpoints of the finished failure were of dubious utility. Weinzapfel feels that even if the system had met all of its initial goals, his work during the development of the system had taught him that IMAGE "may still fail to help many architects."

He presents two specific reasons:

First, the nature of architectural design is not well understood. How people design -- how they solve problems -- has never been fully explored. To create a tool to aid that process has been an especially difficult task since we could never know exactly what goals were most appropriate.

Second, by the very act of assisting a designer, IMAGE, as well as any other tool, changes his process. The very function we sought to assist is transformed by our intervention. Our objective is shifted.

This understanding came only after IMAGE had been designed and built and tested. The tests themselves resulted in failure, yet the revealed further insight into the human process of design. IMAGE was tested in a variety of settings: student design studios; a university planning office; a professional architectural firm.

In each of these settings, very startling results occurred.
Both the students and the professionals found IMAGE's constraint vocabulary interesting and workable. They were all able to develop descriptions of their design objectives using this vocabulary. But, having developed the problem descriptions, they all surrendered the generation of solutions to the computer... In a very real sense, the toylike nature of the machine captured them all.8

Weinzapfel feels that this dilemma was an overriding characteristic of all attempts at computerization. Fascinated by the new process, designers lose their instinctive awareness of design. A certain intellectual restraint is demanded for the successful use of such computer aids, a restraint often found only in talented designers with years of professional experience. And, as Weinzapfel learned, these designers would have nothing to do with computerization; indeed, they stood to gain nothing from their use.

This dilemma is endemic to all computer aided design. The people who have the least respect for machines--who would stick to their own capabilities--shun the computer. We are left with those who are so intrigued by the invention that they want it to do everything...9

Weinzapfel also investigated other failures besides his own, and his findings more than verified the lessons he had learned personally changing his impression that architectural intuition could be duplicated by computer. His conclusions in 1975, were, in part, based on observation of the work of another researcher, Adel Foz of MIT, work which verified Hillier's earlier notion that design cannot be adequately analyzed or duplicated primarily because of the intangibles that each human designer brings to his work.

(Foz's) work showed that experienced designers often begin their search for solutions by applying design ideas that they have previously experienced. They quickly sketch those designs, testing them and modifying them incrementally where they fail to meet a new problem's criteria.
This research showed that since these ideas are drawn from the designer's experience, it is most important that he be in close touch with that experience --with his head, if you will. Also, because of the way designers mentally structure information, a single perceived notion can trigger a network of associated design ideas so that complete concepts can be retrieved at once. 10

As the research didn't prove, but clearly indicated, the computer cannot meet these essential criteria with respect to the design process. Within architecture, therefore, it is limited at best to an ancillary role, a role that paradoxically diminishes as the designer's own innate abilities strengthen. Not only is design essentially an intuitive process, the greater the intuition --ie. the undefinable 'leap'-- the better.

Most of the investigators studying the nature of the design process discovered that their findings had little applicability to the practicing profession. Those who had created new models for design had trouble convincing the profession of the validity of the new methods (if indeed, the methods even worked), and if the researchers succeeded in getting someone to attempt to apply the rationalized models, the models generally proved far inferior to the traditionally accepted intuitive approaches.

However, the knowledge, or information, generated by these analytical studies did stir up some interest if not acceptance within the profession. One of the most perceptive of these investigators was Horst Rittel of the University of California at Berkeley. He realized that many designers were defensive about the 'softness' of their intellectual methods, but he justified the designers' self-image by pointing out that design was indeed very different from traditional Cartesian thought processes. He spent a great deal of time and effort in-
vestigating various forms of cognition, and he came up with a number of findings. Most of the problems in science and engineering are 'tame' problems: they are close-ended, often have a single optimal solution, and are amenable to analytic methods of investigation as well as experimental duplication. On the other hand, nearly all the problems faced by a practicing architect were what Rittel termed 'wicked' problems: essentially, they had no single solution, and one could only hope to approach a reasonable level of optimization to be considered successful.

Whereas most design investigators had approached their work with the hope of deriving a methodological approach which would guarantee the success of a particular design process, Rittel's investigations concluded that no such methodology could possibly exist; it is simply extraneous to the very nature of realistic architectural design problems. Instead of proposing a misleading 'counter' methodology, Rittel devoted his time to more clearly defining the characteristics of the architectural problem itself.

1. **Wicked problems have no definitive formulation.**
   Whenever a formulation is attempted, additional questions are posed and more information is required.

2. **Every formulation of a Wicked problem corresponds to a formulation of the solution and vice versa.**
   How one formulates the problem will depend on how one is attempting to solve it. Thus, the formulation of the problem is in itself a problem.

3. **Every Wicked problem is essentially unique.**
   No two problems are identical and no solutions can be directly copied. There will always exist some way in which they differ.

4. **Every Wicked problem is a symptom of another Wicked problem.**
   Resolution of a problem is itself a problem for
which the original problem was but a symptom. Every problem should be considered to be the symptom of a higher order problem. Thus, there is no 'proper' entry level from which a problem can be attacked.

5. A Wicked problem can have numerous explanations.

How one explains the causes of a problem will depend on one's worldview, and there can be no objective arbiter of these various Weltanschauung.

6. Wicked problems have no stopping rule.

The worthiness of a solution is a function of its consequences. Yet the consequences go on into the future; thus, a solution can always be improved upon. A designer stops designing only when he or she has run out of resources, time or patience.

7. The solution to a Wicked problem can never be true or false--it can only be good or bad.

The criteria for assessing a solution cannot be a function of a predetermined set of goals, but rather must rest on the consequences of the solution. Since many of the consequences go into the future and are unforeseen, a solution can only be judged on the basis of values (goodness and badness) and not on the basis of facts (trueness and falseness).

8. The solution to a Wicked problem has no immediate or ultimate test.

Since many of the consequences of a solution are unforeseen, no test could ever be invented to take all possible consequences into consideration.

9. Wicked problems have an inexhaustible list of admissible operations.

Since Wicked problems are inherently open-ended, there can be no objective set of rules for developing a plan for their solution.

10. Every Wicked problem is a one-shot operation.

The consequence of every implemented solution can never be completely undone. Thus, there is no room for trial-and-error, nor is there any room for immediate experimentation.

11. The resolver of a Wicked problem has no right to be wrong.

Unlike science where findings can often be refuted as part of the scientific process, in a Wicked problem, the resolver will be held responsible for the consequences of his or her actions.
Rittel's findings appeared only slowly, spread out over time. And, despite the implications of his work, little was done in response, by either designers or research. Designers didn't respond because they distrusted the vehicle from which Rittel produced his findings. Research didn't respond because Rittel's findings, by and large, contradicted many of the notions researchers held about architectural design. The methods and attitudes inculcated at the outset of the research movement have remained the watchwords for organized inquiry ever since. That these attitudes are often inaccurate or simply incorrect has been demonstrated not only by Rittel's findings, but by the singular failure of research findings to productively benefit the design profession.

As yet, no effective liaison between research and design has been established precisely because of the erroneous notions researchers hold about the design process, and the misinformed judgements designers have made about the worth of organized investigation. These obstacles cannot be overcome without a thorough reassessment of the development of architectural investigation over the past years. In order to understand what organized inquiry in architecture should be, one must begin by understanding what it is, and has been.
Existing Notions of Architectural Inquiry

Only recently has a movement begun from within the design professions to initiate an organized form of architectural investigation. The majority of the 'architectural research' that has occurred over the past twenty five years had its origins outside the fields of architecture or design. Much of this work was motivated by imprecise or simply erroneous interpretations of design, the architectural practice, and research itself. For some, design investigation was seen as a vehicle for personal promotion or professional recognition. For others, architecture was seen as the subject but not the focus of investigation; researchers explored the field on their terms, with little interest in improving it. Finally, a great deal of this analytic scrutiny only masqueraded as 'scientific inquiry'; slipshod, imprecise, or blatantly fallacious methods were used and the 'findings' cloaked in a veil of scientific veracity. Generally, the results of an investigation -- valid or not -- were incomprehensible to the practicing professional, and were consequently disregarded as nonsense and a waste of time. When, in fact, the profession did try to apply some of these research data, the results were almost invariably less than desirable.

One of the first of the modern wave of architectural investigators to make a name for himself was Christopher Alexander; the title of the introductory chapter from his seminal work, Notes on the Synthesis of Form, summarizes the fundamental misconception behind much of the research that has occurred in recent years. "The Need for Rationality" sounded both authoritative and promising, and in the face of increasing criticism for its irrational -- ie. non-objective -- nature, architecture did indeed, in
the beginning of the 1960s, seem to be in dire need of some imposed ordering. Too often, however, the desire to inculcate regularity and order overshadowed any desire to actually improve the existing system of practice. Very few researchers, even during the earliest phases of the movement towards 'rationalization' stopped to consider the relation of their work to the time-tested principles that underwrote all acts of designing the human environment. Instead, tradition was simply cast aside as obsolete and invalid. (One must remember that it is within architectural tradition to suddenly decide that architectural tradition is meaningless. It has happened before, with similar consequences.) Many felt that they were heralding a new 'up to date' approach to environmental design. Rather than explore convention for possible validity, they opted to work from the radical and ultimately insupportable notion that the creation of a humanly effective environment was merely a matter of science: the results of thorough analytical investigation combined systematically in a logical, linear aggregation.

Not only was the assessment of the problem erroneous --architecture did not need imposed rationalization so much as it needed a thorough housecleaning-- but the general understanding of architectural purpose was usually overly simplistic as well. "The ultimate object of design is form." From this single statement, the first sentence in Alexander's book, many design researchers went out to totally revise the environmental design process, revealing in the act, a single-minded tenacity that was as appropriate to constructive change as the similarly tenacious attitude that architecture is purely art. The thing that the profession least needed and most often received was the imposition of single-minded approaches from external sources.

Finally, in this imposition of external methods and
attitudes under the guise of 'research,' architecture has been misled by inadequate, incomplete, or merely wrong notions about the nature of research and organized inquiry. Once systematic investigation was seen as a potential asset to design -- and generally it was seen this way only by those without design experience -- researchers proceeded to don the trappings of hard science without bothering to learn the essential meanings, insights, or nuances of the scientific method. Nor did they question the propriety of their actions; the assumption of the scientific methods of analysis and synthesis were not based on any scientific evidence of their validity to architectural problems. Non-designers, chancing upon the failings of the profession and becoming aware of a concomitant non-scientific bent within the field, simply presumed that the two observations were related. Architecture was experiencing difficulty in meeting its responsibilities, and architecture, by and large, in non-rational. Ergo, the solution lies in imposed rationalization. (Ironically enough, in proceeding with this presumption, the investigators violated one of the fundamentals of the order which they were attempting to install; they created their hypotheses without examining their subject and then attempted to alter the subject to fit the hypotheses.

(It is even more ironic that, just as the movement to rationalize the traditionally intuitive, non-scientific field of design began, many leading scientists were starting to reveal the non-rational aspects of their own professions. As shown in works by such men as Karl Popper, Michael Polanyi, and Thomas Kuhn, there is far more intuition, speculation, subjectivity, personal illogic, and pure luck involved in science than most people would ever guess. In 1962, Polanyi attempted to describe some
of these 'unaccountable elements of science':

I shall speak of the contributions made to scientific thought by acts of personal judgement which cannot be replaced by the operation of specific reasoning. I shall try to show that such tacit operations play a decisive part not only in the discovery, but in the very holding of scientific knowledge.¹

What he tried to show was that merely comprehending science demands some element of personal judgement and intuition, yet, two years later, Christopher Alexander was hailed for his 'solution' to architectural difficulties when he wrote that "the intuitive resolution of contemporary design problems lies beyond a single individual's grasp" and used this as a foundation for removing intuition and human judgement entirely from the process of environmental design.²

A number of the specialists who initiated studies into architecture during the 1960s saw design merely as a vehicle for their personal investigative interests. Amongst mathematicians and systems scientists, design was used as the subject for experiments in cognitive modelling and for the development of complex mathematical analogs of human intellectual processes. Amongst behaviourists, design was seen as the ideal situation for evaluating the effects of deliberate environmental change on individuals and social groups. Anthropologists saw architectural design as having a formative influence on people and society; physiologists were interested in the ramifications of architectural decisions on physical activity and stress; ecologists were interested in the relationship between the natural and man-made environments. Even business and finance had interests in architecture; manufacturers sought ways of improving the products they offered to consumers, while economic analysts were extremely
interested in the role of design and construction within a nation's economy. Government agencies were interested in improving the quality of construction, especially for low-income housing, and myriads of special interest groups -- foundations, health care agencies, corporations, etc.-- had their own incentives for initiating organized research activities into architecture and related fields. Over the past twenty five years, a host of social and physical scientists have used architecture, as a whole or in part, as the subject for their particular research investigations, and while the majority of these investigations did not have the improvement of architecture as their goal, nearly all these efforts were lumped under the single title, 'architectural research.'

The myriads of data that were collected did have some minor benefits which eventually trickled down to the average practitioner. Most of those who studied the design professions, however, had little concern for the architectural utility of their work; design and the environment were merely means of furthering personal interests and ambitions. Geoffrey Broadbent commented on these researchers, in retrospect:

Clearly these sciences differ greatly in scope, methods, and aims. They differ greatly in degree of rigour and the extent to which they can help the designer with positive results. Many of them, in any case, are still embryo sciences, anxious above all to establish their respectability as true sciences... difficulties arise because some of their practitioners seem far more anxious to demonstrate their grasp of methodology than to produce results which are usable in design. They collect large quantities of data and submit it to minute analysis, without stopping to think what their analyses are for.³

Even those researchers who approached their work
with a sincere interest in improving the quality of architecture and design often found that a lack of understanding of architecture, research, or both, prevented them from having any significant effect on the design processes or products. In 1965, Peter Manning, an architect who had started one of the first organized building research units in Britain, published an article, "Hard Facts on Research," in which he attempted to convince the profession of the necessity of systematic investigation and knowledge production, akin to scientific research.

We are beginning to realize that in a time of change and rapidly developing technologies, it is no longer possible to depend solely on experience as a guide to dealing with new situations. Architecture's tradition of being a practice-based profession has to give way to what is for us a new idea of being a research-based one.

Manning did not make the error of many in assuming that human intuition was no longer capable of comprehending the complexity of environmental issues. He did, however, misinterpret the purpose and utility of systematic investigation into architectural concerns. Like many others, he presumed that tradition alone prevented architects from enforcing an objective rigour on their working processes. Despite his architectural training, he presumed that the application of scientific methods to architectural problems would automatically lead to more successful solutions. And, like many of his fellow researchers, he held somewhat imprecise conceptions of the nature of these rationalizing influences.

The goals of architectural research, as he saw them, were to "provide a foundation of knowledge for decisions which hitherto have necessarily been based on human judgement." But, once again, the validity of attempting
to categorize sensitive sociological, aesthetic, psychological, physiological, and environmental issues from a clinically objective standpoint is never questioned. Manning and his fellow researchers worked from the view that had been promulgated by Baumgarten over two hundred years earlier: human judgement was inferior to objective logic. While the designer would still be able to manipulate increasing complexity with some degree of success, many felt that intuitive approaches would become less and less valid as time went on. Judgement, therefore, had to be replaced with objectivity; value decisions had to be replaced with factual decisions. Understanding --a solely human capability-- was to be replaced with objective documentation; intuition was to be usurped by information. Subjective 'knowing,' hitherto the foundation of architectural decision making, had to be replaced by objective fact. No matter what.

No one stopped to discover if all the proposed rationalization could indeed by achieved. Everyone assumed that it could, and that it hadn't been done previously because architecture, being practice-based instead of knowledge-based, had never bothered to develop an organized research methodology. Enormous high hopes were held out for scientific methods; once they had been grafted onto the design process, all of the problems handcuffing the architectural profession would be removed.

Manning's schema is clearly based on scientific prototypes:

Research entails the establishment of theories and principles through systemic study... it is a form of practice, but one which is more high-powered and critical, more objective and less subjective than usual. Research is not the assembly and re-presentation of already existing knowledge... Least of all is it preparation for design...
Research, therefore, during these early phases, was seen as tangential to practice, but essentially distinct and isolable. The architectural researcher owed his existence to the design profession, but he would be able to defend this existence through the production of knowledge. In theory, such a relationship seemed workable, but no one ever bothered to address the issue of the suitability of architectural 'knowledge' for application into architectural design. Traditionally, architecture has awarded value on the basis of products; the designer was judged by his buildings. To this, however, research was an addendum in keeping with design 'theory': the justification is implicit in the work itself. As with science, the mere production of knowledge was seen to be good.

Enormous fallacies became apparent as soon as this view began to become accepted. The philosophical validity of the production of knowledge can be set aside for the moment, for far greater problems arose. Architecture, unlike science, has no objective criteria for judgement, hence, it has no way of determining what is or is not 'knowledge' except in some limited and isolated cases (which are therefore inappropriate for generalization). Traditionally, 'knowledge' in architecture comes through experience or direct transition; 'learning' is revealed through application. Whereas the sciences had developed from the Cartesian dictum --"I think therefore I am"-- and theory, properly comprehended, can be considered as understanding, the architectural tradition is more properly summarized in Heidegger's statement: "one can only know what one discovers." Pure 'knowledge' without empirical justification has little buying power within the design professions.

It is precisely for this reason that architecture never developed a scientific form of research. The
complexity of issues the architect must deal with, the interdependence and non-rationality of these issues, and the need for production rather than mere 'knowledge' all shaped the way architectural processes developed. The assumption that arose during the '60s and '70s, and which is still widely held, that one can simply appropriate the methods and traditions of science -- an entirely different intellectual discipline, with different ends, means, and methods -- in order to create a meaningful entity, 'architectural research,' was both simplistic and misguided.

Not surprisingly, architectural research as it has unfolded over the past twenty five years has brought little tangible success to the profession, despite the proliferation of 'knowledge' produced. It is true, as many researchers complained, that the profession is historicist and tradition-bound, and is extremely slow to accept innovation and change (of any but the traditional kind). On the other hand, researchers have seldom been whole-heartedly dedicated to improving professional practices, and usually made little effort to present their findings -- valid or not -- in a form that was comprehensible to the intended audience. Many, in fact, did relatively little to secure any type of working contact with the profession they ostensibly were studying.

Most often, the investigators in an architectural research project were solicited from outside the profession, usually through sheer need; architects simply did not have the abilities, understanding, or interests necessary for many types of investigative work. Without architectural direction or focus, however, many projects quickly devolved into pedantic exercises; researchers attempted to solve problems "that are interesting" rather than deal with issues of concern to the practitioner.
Until very recently, the profession itself, has regarded most investigative efforts as an imposition, decrying these efforts as worthless and inappropriate, yet, at the same time, denying any responsibility for improving that propriety.

If research in architecture depended entirely upon architects then it would be a non-starter. For all the projects reported in the first twelve issues of 'Research in Progress' only about one-fifth of the total number is being carried out by architects . . . the sheer bulk of the work on which the future of architecture depends is being initiated, undertaken, concluded and interpreted by non-architects, mainly scientists and engineers. But, because they are unlikely to appreciate the whole context in which their work will ultimately be used, non-architects are unlikely to be the most suitable people to initiate building research.

(It is worth noting that a great deal of the research Manning spoke of was actually the systematic investigation of building technology, building materials, and construction methods, rather than architecture, per se. This is one of the most objective of all aspects of architecture, and the one with the longest history of organized inquiry, extending back to the beginning of this century at least, when the British founded their first Building Research Station. Yet, Manning notes that only a small percentage of the people doing this essential work --and it is only a small percentage of the work that could be done-- were designers, and because of this, a great deal of the results of the work are inapplicable to actual design needs. This dichotomy is even more serious in the 'softer', less-knowable areas of architecture.)
The characteristics of pure research and architecture are generally different. A fundamental trait of classical inquiry is its open-ended nature; studying one problem leads to the discovery of related problems, the solution of which leads to still further inquiry. Where knowledge itself is seen as an acceptable product, such open-ended inquiries can be termed beneficial. Architecture, however, despite the definitely open-ended nature of design, must deal with closed problems; sooner or later, design must end and building commence. The very best buildings are often those which make themselves amenable to continued change and development, for there can be no such thing as a static 'solution' to a design problem, but every architect knows that he will be forced, at some point, to commit himself to decisions upon which further decisions must be based, and whose ultimate rationale is subjective.

It is the tenuous nature of such decisions, and the burden of personal responsibility that they place on the designer --as well as the very real degree of difficulty entailed in resolving them-- that lent credence to many initial efforts to introduce computers into the design process. Basic insecurity was one of the reasons that the design professions tolerated attempts to rationalize their processes. Beneath their intuitive surity was a very real insecurity; architects, like everyone else, wanted to be sure that their decisions were 'correct' and the computer, as promoted to the profession, was seen as a potential means of guaranteeing such 'correctness.'

Rather quickly, however, the profession discovered that it would have to continue relying on subjective intuition as its sole guarantee of propriety. In a revealing article describing his transition from a 'believer' to a 'non-believer' in computer-aided design,
Vladimir Bazjanac explains the illusion held forth to the profession by computer advocates.

Perhaps the most disturbing discovery . . . was the realization that designers did not need those 'precise' and 'reliable' predictions of performance to make their decisions after all. All they were really asking for were some order-of-magnitude figures which could be arrived at just as effectively by employing simple, handicraft models . . . What they expected from the computer model was credibility, not precision. They were basically looking for a mechanism to which they could transfer the responsibility of making guesses when they felt uneasy about making them themselves. 8

In other words, both the advocates of computer-aided design and its intended recipients held erroneous beliefs about its nature. Advocates felt that the computer could be used to thoroughly rationalize the design process; designers, on the other hand, simply wanted it to verify their own judgement. The former goal is impossible; the latter, by and large, unnecessary. Bazjanac used his own experience as an attempt to verify the claim that architects have not been able to use the products of many recent research projects simply because these products were not necessary. The competence of an architect cannot be dramatically improved merely through the indiscriminate application of research findings. Good designers design well; bad designers design poorly. In each case, ability far more than computer-aids, research data, or even 'knowledge' is essential to success.

Bazjanac does feel that the computer, like many other modern innovations, can find some useful application within the design repertoire. He feels, however, that finding an appropriate niche for what the computer can do well is a far more useful subject for research talents than the attempt to force both the computer and the designer
to adapt to intrinsically inappropriate situations.

Architects are rightfully wary of intrusions into their domain, and this suspicion increases when they are unable to understand the nature of a new tool, device, or method. Therefore, before they will accept and be able to fruitfully use the products of organized research efforts, architects must feel that they have some intuitive understanding for these products. This is not to imply that an architect must have a degree in engineering in order to accept structural analyses, nor must one have a degree in physics in order to appreciate the benefits of physical models to test heat flow, acoustics, or lighting conditions. Indeed, many architects would be hard pressed to explain the fundamentals and principles underlying many of the decisions they make and methods they use --this, in itself, is not necessarily a beneficial position, but it is one that is inherent in design practice-- but accept these traditional beliefs on historic faith rather than objective verification. Within this context, therefore, new methods, products, and processes are also subjected to intuitive rather than objective touchstones, which makes their assimilation doubly difficult if they are described, presented, and designed in terms foreign to the design profession.

A dilemma begins to emerge. Architecture, a profession whose success depends on its products, is slow to accept innovation from outside its conventional realms. At the same time, inspiration for innovation is not going to come from within the design profession; or, innovation will come only at a rate that is far too slow to meet increasing needs. Architects have proven that they are not the best people to initiate,
carry out, or implement organized research activities. Nor are they appropriate for applying the products of external research investigators. At the same time, however, they resent the intrusion of external researchers who, in any event, seldom know enough about design, architecture, or the built environment to effectively apply their own work.

What has resulted from this conflict of interests, priorities, methodologies and intellectual attitudes is simply a stalemate. Researchers continue their investigations primarily for their own purposes, and architects tolerate them as long as no one attempts to upset the status quo. As Peter Manning related in a second article written ten years after his first piece on architectural research, "the overwhelming evidence about the products of architectural research is that they are not applied."9

The stalemate has often reached a level where the propriety of the research for application into the design practice no longer becomes an issue. The overwhelming issue devolves to communication; the primary obstacle to be cleared away in paving the path for effective architectural investigation is the crisis in communication between research and design. Currently, the aims, methods, and ideologies of researchers and designers are distinctly different, and very often they don't even speak the same language. There is some common understanding however; the designers feel that the researchers don't understand the nature of architectural design -- and many don't -- while the researchers feel that designers refuse to step down from their traditional positions -- and many do. Neither side is making any moves towards eradicating these communication failures. In some respects, as the two sides become more entrenched, the gaps are widening, and each side can point to the failure of initial appli-
cations as justification for further disdain.

Clearly, some effort must be made to break down the barriers which have arisen between research and design. The failure to communicate, however, cannot be remedied simply by working to dissolve readily apparent frictions. Improved communications will work only when the two parties concerned are speaking towards the same goal. As one observer of the situation has noted, "the problems of integration . . . hinge around definition of subject matter rather than around difficulties in communication." He goes on to clarify his argument:

Belief in a solution of the problem of integrated design through 'better communications' is equivalent to the idea that Esperanto might solve the problem of war or bridge the gap between rich and poor nations. Communications are vital, of course, but good communications is more a matter of agreeing what you are talking about rather than improving the quality of the message.

With respect to architectural research, agreement and quality improvement are both necessary, but only in that order. And, the burden for the former must fall on the designers, not the researchers. Architecture must take the lead in establishing an appropriate form of architectural investigation, a job that would be made easier if it began with a thorough investigation of its historical means for and attitudes towards design research.

Although architecture as a profession has never been distinguished for a tradition in technological innovation, in their own way, designers and builders have been continuously adapting, innovating, inventing, and discovering new ways of resolving old and new problems. Many times, the technological breakthrough at the base
of architectural innovation had to be imported from engineering, science, industry, or elsewhere. What followed the initial adoption of a new technology, process, material, or means has never followed any rigorous or systematic format, but it can, in a way, be called architectural 'research' although they have never been recognized as such, nor have they been taken as anything but a pertinent and imperative ancillary to architectural design.

In its own way, therefore, architecture does, in fact, have a research tradition. It is so carefully and seamlessly integrated into the design tradition, however, that it has been extremely hard to isolate and identify as a separate entity. Essentially, there is no justification for importing a research methodology -- let alone an inappropriate one -- from external sources. Importation should occur on a selective basis, only after the design profession has investigated the merits of its own research tradition, and has agreed upon the goals for a future investigative format.
Energy Conscious Design:
A Case Study in Architectural Research

The interest in architectural research and the interest in energy conscious architecture both arrived in America during the 1960s, with the former preceeding the latter by about five years. Neither interest was generated from within the mainstream of the design professions. As seen, interest in research generally came from non-designers; interest in energy conscious building sprang initially from ecologists, environmentalists, and others in the 'back to the earth' movement and was eagerly followed up by design students and recent university graduates who developed an informal, but highly effective 'grass roots' approach to the issues of energy efficient architecture.

The Arab oil embargo of the early '70s brought energy consciousness to the attention of both the design profession and architectural investigators. Both began to devote a great deal of time, money, and effort on the subject, but neither seemed to achieve the same degree of success and propriety produced by their 'grass roots' forbears. In many ways, the union of professional concerns and organized research talent only muddied the waters which had apparently been beginning to clear. Through empirical studies, intuitive design methods, attentive observation, and word-of-mouth communication, the grass roots movement had managed to solve many of the pertinent issues of energy conscious design, long before organized efforts and monies were brought to bear. Certainly, many of the issues involved in small scale, residential design were brought to a high degree of resolution without the use of sophisticated research techniques. And, at best, most of this sophisticated
investigation merely managed to verify the validity of the heuristic methods which had evolved from the 'grass roots' approach.

Energy conscious design is an appropriately timely subject for a case study. Much of the support for energy research came from the government, a source which has become increasingly restricted. When enormous amounts of work are being done in a particular field, some quality is bound to trickle down and have a widespread beneficial effect. Some of the work done by energy researchers during the past fifteen years has, indeed, instituted change in the general architectural practice, but a great deal of work has been wasted. When research support becomes scarce, as energy funding has become, it is essential that work that does get done is both useful and usable; a great deal of our past energy studies were neither.

Finally, the needs and concerns of the architectural profession with respect to energy use in buildings has changed over time. Small residential projects are no longer the primary concern; the methods and techniques developed for these buildings must be adapted or replaced to meet current needs. How well the profession is able to respond to the existing challenges of energy efficient design will depend, to a great extent, on the relationship between design and investigation. New knowledge is needed to resolve new issues; a critical examination of past efforts to link energy research with energy design may give valuable insights towards creating a more energy efficient future.
Energy conscious designers attempt to create human environments which meet all of the traditionally recognized architectural concerns and which also make frugal use of non-renewable energy sources. Twenty years ago, an interest in energy efficient architecture was limited to a small number of ideological designers, scientists, engineers, and 'back to the earth' supporters. Today, energy is one of the most widely discussed topics in environmental design, and energy has been of paramount concern to architectural investigators over the past decade. Some of the research into energy efficient building grew from architects' personal design problems, but to a large extent organized energy investigation has been underwritten by the design profession and the construction industry who have, for the first time, actively sought the advice and assistance of outside technical experts. Yet, despite the apparent concern for increasing the architectural knowledge base with regard to energy, little of this organized research activity has had any large-scale effect. That the energy efficiency of the built environment in America has improved somewhat over the past fifteen years is due far more to a common sense reaction to economic pressure than to the results of any form of organized research activity.

Many of the advances in our general knowledge of energy use in buildings have come about, not as the result of original research efforts, but simply through 'surveying': compiling and clarifying the known wisdom about energy from other eras and cultures. Although some of this 'surveying' was done as part of organized research efforts, most of it took place on a small scale, grass roots basis, requiring minimal amounts of money or special technical ability. High-cost, well equipped research efforts, on the other hand, have not contributed nearly
so much as these 'indigenous' studies.

To some extent, the failure of organized research efforts to make a substantial contribution to general architectural practice can be blamed on the nature of a capitalist economy: knowledge will seldom be applied until it is monetarily profitable to do so. Yet, in the same respect, any form of architectural research must be concerned with economic viability; high priced, esoteric 'solutions' are not really solutions as all.

To a greater extent, however, research into energy has been troubled by the same problems, errors, and misconceptions that have plagued as aspects of organized architectural knowledge production. Despite its support from the design professions, energy research has never derived from any specific architectural concern. Projects have been undertaken with little knowledge of what has gone before them, or in what direction they are headed. Enormous amounts of time and money have been spent in 'after the fact' verification of traditional design methods and intuitive practices. Energy investigation has been little concerned with the institutional and organizational structure of the architectural and construction professions, and has often proceeded on the blind assumption that everything research turned up could be easily converted into actual practice. Energy research, like a great deal of the architectural inquiry that preceeded it, has failed to focus on the practical, pragmatic, and essential --if mundane-- issues of energy conscious design. Instead, in keeping with an inappropriate penchant for 'pure' research, money and effort have been directed towards issues regarded as scientifically or personally interesting, stimulating, or challenging, with only a secondary regard for the applicability of the expected results.
Even as the furor about the Arab oil embargo was subsiding, two forms of recognizable inquiry were being conducted with respect to energy use in buildings. With the support of government grants, high priced equipment and facilities, scientists and engineers, many of whom came directly from research in areas such as physics, chemistry, or materials science, began to initiate projects studying environmental energy consumption. These researchers usually proceeded in the traditional scientific manner, isolating their areas of concern and rationally analysing specific problems. In this respect, notable advances could be said to have been made. Mechanical equipment was re-designed; materials were improved; building systems and components were made more efficient. Myriads of technical data were produced, and numerous standards were set as touchstones for testing the efficiency of the new products. Sunlight was measured in Btu/sf-hr-year; comfort was measured in terms of radiation, air movement, humidity and temperature; building quality was discussed in terms of "solar heating fractions." Computers, despite their historically poor record with the design professions, played an integral role in these research efforts, compiling data, generating statistics, comparing systems, and even producing their own versions of 'energy efficient buildings.'

At the same time, a far less rigorous or well-defined type of investigation was occurring within the design and building professions themselves. The researchers in question were generally architects and builders with realistic problems to solve, no tradition in objective inquiry, but a keen interest in their work. Relying on their design training, common sense, and historical references, these designers and builders began to compile large amounts of useful information about energy efficient architecture. They seldom looked for
'new' solutions to 'new' problems. Instead, recognizing their own limitations and abilities, and realizing that the problems they were encountering had been encountered by many others before them, they began their work by looking for references from previous examples.

As opposed to organized research, work of this second type received little support or publicity. Most of it was conducted by individual investigators who worked on their own, in isolation, with little awareness of similar efforts being done by others. Many of these investigators did not consider themselves 'researchers'; they saw their work as a necessary adjunct to responsible design. Seen in this light, however, although they worked hard, they made little effort to inculcate rigor into the work process, and documentation was often poor. Although a great deal of work was done, throughout the country, the development of a common body of information was, of necessity, slow and poorly coordinated.

A great deal of redundancy occurred in this grass roots approach to research, but at the same time, as more and more work was done, a noticeable 'regionalism' began to develop with respect to energy conscious design. The respect for location which had been a trademark of architecture for thousands of years, and had endured in more remote areas well into the twentieth century, once again was seen in the products of small-scale attempts at energy efficient building. Solar houses in New England were distinct from solar houses in New Mexico and each, in turn, differed from solar homes in Colorado or Minnesota. Left on their own, with realistic problems to resolve, designers and builders, through their own abilities and efforts, managed to create a style of design which not only solved many of the immediate problems of energy usage, but were 'truer' to the ideals of architecture than a great number of far more prestigious
and highly acclaimed works.

Occasionally, students in one of the major schools of architecture would initiate a personal investigation into energy conscious design, and the results -- uninhibited by professional experience or external 'logic' -- were often extremely innovative, and occasionally very useful. In 1973, Bruce Anderson, of MIT, did his Masters thesis on the fundamentals of solar design, doing a great deal of library work and information research in order to assess this burgeoning aspect of architecture. Following his graduation, he continued this work and in 1976, he published The Solar Home Book, which almost immediately became very popular throughout the country.

Anderson's book was one of the first publications which could be usefully employed by an architect or serious designer, but which was interesting and understandable for the average citizen. In presenting usable information in a readable format, Anderson overcame one of the primary stumbling blocks affecting both organized and small-scale research efforts. His book was particularly useful because it began to tap the resources of this latter type of investigative development, presenting some of the wisdom and acumen of the grass roots solar designers who had been developing their abilities long before the oil embargo brought energy into the public spotlight. After the 1972 crisis, a number of books had appeared on the market promoting the efforts of these hitherto unknown designers and builders, and many of the early energy conscious designs were featured in popular magazines such as Handyman, Popular Mechanics, and Popular Science, but for the most part, such publicity was useless to anyone seriously interested in learning about energy conscious design. 'Articles' usually consisted of a large number of photographs and sketches with a minimum of words. These, in turn, were generally quotes from owners
or builders, explaining their ideological reasons for building the way they did.

Early publications of this vein carried little technical information had very little academic value. Anderson's book, on the other hand, and a handful of others like it, began to examine early energy conscious buildings-in detail, and tried to explain in a subjective yet rigorous way how and why the buildings functioned. As opposed to highly technical publications from organized research efforts, numbers played an ancillary role in these guides; instead, diagrams, photographs, and other graphic devices appropriate to an architectural audience were used to discuss and analyze important features.

Despite the effect of work such as Anderson's towards unifying the conceptual strengths of the regional, grass roots design work, with the onset of highly organized scientific and technical research, many of the regional characteristics began to diminish, crushed beneath the weight of organized efficiency. Researchers working in large government or university facilities came from all parts of the country and all types of intellectual backgrounds. They focussed, not on designs, but on isolated aspects of specific problems, and they had little knowledge of regional concerns. These workers were used to dealing with the universal objectivity of science. Many worked amidst national or international organizations, and most relied heavily on outside assistance and consultation. They tackled problems in energy as discrete units, and few saw any connection between the work at hand and its final application in the built environment.

As with architects, these researchers had their own language and means of communication. Researchers published far more widely than designers did, but only
within their own fraternity; few non-researchers knew of, or had access to, these publications, and those designers who managed to come across research documentation related to energy conscious design often found the reports dull and incomprehensible and of little potential use.

Research in energy resurrected the problem of finding an appropriate use for the computer within the traditional architectural design process. During the early phases of energy conscious design, there had been a considerable interest in highly-technical solutions: active solar systems, mechanical systems, heat pumps, solar water chillers, and the like. Experience quickly showed, however, that these devices were usually inappropriate for true energy conservation, and the early 1970s saw more and more designers turning towards passive, 'designed', rather than built, solutions to energy concerns. Passive design, however, demanded a very keen design intuition. Such buildings had very little about their design that could be subject to objective verification; most passive designs evolved solely from the designer's 'sense' of what was appropriate, which systems would work most effectively, and what size various elements should be.

While a great deal of organized research never made the transition from 'active' to 'passive' solutions, those researchers who did generally began by attempting to circumvent the empirical and subjective nature of passive design. They spent long hours trying to develop mathematical analogs and computer programs to simulate the performance of passive buildings. As with computer applications in non-energy areas, it was hoped that analogs and programs would reduce the inherent uncertainties of passive design. The traditional dictum, "the proof is in the pudding," applied in an overwhelming way to energy
conscious design work; there was almost no way of checking the validity of a designer's intuition until his design was built, and once a building was completed little could be done to rectify design errors.

As in other areas of architecture, the computer was offered to the energy conscious designer as a means of alleviating doubts about design decisions. With the computer's power of prediction, design would no longer carry subjective implications; it would simply be a matter of selecting those performance predictions which guaranteed the highest efficiency.

The prototype computer programs were extremely sophisticated, long, and difficult to use. They had to be developed through careful analysis of the performance of hundreds of completed designs, and through the systematic comparison of the collected performance results. Investigators had to begin their work by monitoring passive buildings scattered across the United States. Measurement techniques were not well advanced, nor were they universally accepted. Correlations had to be made to adjust for measurement discrepancies, and further correction factors had to be used to compensate for climatic differences, differences in system design, building size and type, and variations in use schedules. In choosing to use the computer, researchers were forced to follow methods which suited its characteristics. Rigorous data collection was essential to the validity of any work that followed, yet from the outset, data collection was far from precise, rigorous, or well organized. Nevertheless, results from data surveys were mapped and compared, and from the graphic outputs, sophisticated mathematical analogs were developed which would theoretically be able to simulate the performance of any desired organization of variables.
Almost from its inception, this type of research was plagued with difficulties. Data collection was often crude and imprecise, and correction factors had to be worked into computer programs right from the outset. The initial analogs derived from the collected data often gave performance predictions which contradicted further measured data from actual built examples. Additional correction factors had to be worked into the analogs to compensate for these unexplainable discrepancies. Furthermore, researchers soon discovered that a great many of the factors pertinent to effective passive design simply could not be measured quantifiably. The way an owner used a building dramatically affected design performance, yet there was no way for writing such an idiosyncratic variable into a computer program. Weather data could indeed be measured, but the accuracy and propriety of these measurements fell dramatically as one moved further and further away from the handful of certified meteorological data stations scattered throughout the country. Local climate conditions were crucial aspects of passive design, but there was no way that a generalized computer program could account for such details.

To counteract these inaccuracies, computer analysts were forced to make important decisions. Should they simply drop the non-objective aspects entirely from the analog, thereby invalidating a large part of its already suspect veracity, or should another correction factor be installed? Dropping aspects severely limited the applicability of an analog, but additional correction indices reduced the validity of any predicted estimate.

Despite considerable difficulty, a number of researchers were able to develop computer models which seemed to have some ability to predict the performance of a limited number of passive design types. At the very
least, the new analogs were able to digest statistical information about existing designs and produce 'predictions' that bore some resemblance to empirical monitoring. A major drawback, however, was that these initial simulation models were almost impossible for anyone but their creators to use or understand, and their creators very seldom had more than a minimal grasp of essential issues about architecture, design, or energy use in buildings. In addition, these initial programs demanded elaborate and expensive equipment as well as skilled programmers; sophisticated computers and adequate skill to operate them were necessary for even the simplest simulations, and any one of a myriad of minor errors -- in the program or the programming-- could destroy the validity of a simulation.

Passive design research, therefore, entered a second phase in which the original simulation programs --defects and all-- were refined for a more general and useful application. This often meant that many of the variables which the researchers had labored so hard to include in the programs had to be dramatically reduced or abandoned all together. In their stripped-down form, the new programs also had a reduced applicability, and stringent limitations accompanied all of the simulation results.

The development of many computer simulation programs travelled in a full circle. After several years of first working to increase the sophistication and reliability of the program and then working to simply this program into a usable format, researchers arrived with a product which was neither accurate nor applicable. For example, in 1978, J. Douglas Balcomb, a physicist and one of the first scientists to begin working with passive prediction modelling, published a paper describing the "Solar Load Ratio" modelling system. The beauty of the new system,
it was claimed, was that no sophisticated computers or programming skills were required. Any designer could use the SLR method; all that was needed was basic mathematics, pencil, paper, and a set of pre-measured graphs and instructions.

On first appearances, the SLR methods seemed to be too good to be true; it was everything the designer could have hoped for. Determining the performance of a passive system required only about an hour of time and no special skills; every designer would be able to fit such an analysis into his program, and the results would give an accurate assessment of the quality of his system design.

Behind the initial appearances, however, were an enormous number of constraints. The graphs were only applicable to two types of passive design -- mass walls and water walls-- and the graphs were not very useful for hybrid designs which used more than one type of system. The SLR method was designed to use nationally available weather data, data which often contained inaccuracies, and which, as explained, often didn't bear the least resemblance to site-specific conditions. Finally, the method dramatically simplified many of the variables involved in passive design, and the four or five pertinent variables which were incorporated into the final equations were further compressed into a single function. By the time that all the limitations had been tabulated, the SLR method had a built in 'error' that was so large as to totally invalidate its utility for realistic design problems.

This, however, did not stop people from using the new method. Unfamiliar in any way with solar design principles, but under increasing public and professional pressure, a large number of designers and builders began to rely on the SLR method and similar simplified calculation
procedures as a 'crutch' to lend support to some extremely risky design decisions. Where these new design tools did not lend themselves to a particular feature of a design, designers 'improvised' using 'exchange values' to modify different designs into water wall or mass wall buildings. Where data was missing, further improvisations were made. By the time that many designers were through bastardizing the methods, they bore no resemblance to the rigorous scientific formulae from which they had begun, but the predictions they produced were still regarded as accurate and correct.

Balcomb had intended that his method be used as an assessment tool during design development. Once the architect had selected a passive system and had begun to integrate his design around it, the SLR method could give him a fairly simple way of assessing the relative merit of various design decisions. Changes could be made and the effects weighed against the original design. For example, if a designer determines that one type of mass wall will give a 40% solar heating fraction and another will produce 50% passive heating, if everything else is equal, the second design can be presumed to be more efficient than the first. How much more efficient was difficult to predict, and almost impossible to verify; in any event, Balcomb and other creators of design tools were more interested in the relative accuracy of their creations than the objective accuracy.

Many designers were ignorant of the limitations of most passive design tools, or simply chose to ignore them. But, used incorrectly, these limitations became glaringly apparent. Designs based on improperly used methods, when built, often ran into severe operational difficulties such as overheating, large temperature swings, uncomfortable interior conditions, and even reduced energy efficiency.
By 1980, when Balcomb published an improved version of the SLR method, a great many architects and designers considered the issue moot; none would use any of the analogs, computer programs, or hand calculation methods. Those who had previously relied on such tools had been discouraged by their inaccuracy, while many felt that these aids were actually an imposition into the design process. For the time they took and the effort they demanded, the results they yielded were negligible. While researchers interpreted this rejection as a sign that more sophistication was required, the designers understood its significance: energy conscious design was still a matter of informed intuition.

However, even the architects agreed that informed intuition did not demand a completely naive approach to every design problem. Many designers were extremely interested in developing energy conscious 'rules of thumb': simple mathematical relationships or formulae which could give any designer a bit of a grasp of a particular design issue. (An example of a rule of thumb might be that the optimal tilt for a solar collector for year round use is equal to the latitude plus 15°.) Many of these rules were the products of direct observation. As such, they were a form of design intuition put into writing.

Still, these rules of thumb also suffered from misuse and abuse. One designer's intuition doesn't always agree with another's. A rule of thumb for one type of design in one type of location or climate might be entirely inappropriate for another type of building or another climate. In other words, designers not only had to have an intuitive awareness in order to formulate useful rules, they also had to have an intuitive feel for the propriety of using such tools. Often, however, in their desire to substantiate some aspect of their design heuristic, these designers/researchers lost an essential facet of their
intuition.

Rules of thumb were formulated about all aspects of passive design: system sizing, heat gain, temperature swings, insolation levels, lighting, overall system efficiency. Many of these rules were very crude and highly subjective. Those which attempted to correlate a number variables, of necessity, neglected many of the essential factors. Other rules focussed only on two variables, but were still able to delimit only crude relationships. At best, rules of thumb could be said to clarify, not define, essential relationships found in passive design. Experienced designers were well aware that design variables --and the number and importance of these change from building to building-- cannot simply be isolated, developed, and re-integrated to create an effective design product. Entire systems must be developed coherently, with a simultaneous concern about all aspects and variables. These designers found the rules of thumb interesting and appropriate, but not very helpful.

Inexperienced designers, however, often fell prey to the disarming simplicity of the new rules. They forgot many of the overriding constraints affecting the formulae, or ignored the idiosyncratic factors which affected the propriety and utility of the rules. In some cases, the rules of thumb were 'modified' to fit a particular design need, with the results of the modified formula used to justify a design decision. In other cases, designs were actually modified to fit a particular rule of thumb; inexperienced designers figured that since the rule described a verified situation, if their design agreed with the rule's criteria, they would achieve the predicted levels of performance. Once again, propriety and utility were neglected in the desire to have some tangible justification for design decisions. Unfortunately, those designers who
did place a lot of weight on rules of thumb soon
discovered that any justification the rules seemed to
afford was purely artificial; a mathematical relation
simply could not take the place of a well-developed,
empirically grounded intuition.

In 1979, Edward Mazria, an architect, passive
designer and educator from New Mexico, published The
Passive Solar Energy Book, in which he attempted to
walk a fine line between ambiguity and rigidity. The
book contained 26 'patterns' for passive solar design;
the patterns were deliberately general, to avoid an air
of technical certainty, but Mazria used specific buildings
as examples to illustrate his points and highlight passive
was as comprehensive and informative a passive design
'manual' as could have appeared at that time. (We have
since learned a great deal about the state of the art,
and many of Mazria's points have subsequently been up-
dated.) Still, many designers misinterpreted the utility
of the book, using it more as a crutch than an aid. Some
assumed that the 'patterns' were guaranteed performance
predictions; others merely copied directly from the
built examples Mazria included in the book. The Passive
Solar Energy Book, however, did clarify a lot of issues
that passive designers had been attempting to deal with,
but didn't attempt to impose limiting technical mis-
information. The book was particularly useful as a text
for design students who wanted to learn the principles
and concepts of passive solar design, for in many ways,
it represented a case history of the development of
Mazria's own personal design intuition.

The Passive Solar Energy Book is also a good ex-
ample of the benefits deriving from a symbiotic under-
standing of both architectural design and technical in-
vestigation. A great deal of Mazria's personal work involved the research of such non-designers as Balcomb and others computer advocates and technical experts. As an architect, however, Mazria was in a superior position to many designers in that he was able to both understand this technical work and also realize its limitations. He knew that Balcomb's work and other work like it was not the answer to passive solar design, and he also realized that the original formats for this work were particularly inappropriate for an architectural audience. His personal development included a lot of time and effort devoted to translating the usable elements of computer methodologies and hand calculation techniques into an appropriate form for designers and architects. This development was later used as the basis for The Passive Solar Energy Book, and as such, the book represents a fine example for emulation.

Despite their varying degrees of success, books and work such as those done by Mazria, Balcomb, and Anderson were similar in their attempt to translate technical research information into a form suited to an architectural audience. Such attempts, however, were part of a very small collection. The vast majority of the energy research from the '70s and early '80s has never crossed out of the realm of science, engineering, and technology. Every month, numerous journals have been filled with reports from workers conducting investigations into energy and related fields, and many of these reports contain information that has some bearing on contemporary architectural concerns. Little of this information, however, ever gets translated into an architectural format, or ever appears in architectural publication or building trade journals. Ignoring the question of propriety --ie. was the work that was done potentially useful?-- an enormous
communications gap exists between those responsible for producing knowledge about energy use in buildings, and those who must use this knowledge. Most attempts to bridge this gap have merely tried to 'water down' the research information, in the mistaken assumption that this would render it more palatable, and hence, more usable for the design profession. As witnessed by the lack of success of 'design tools', hand calculation methods, and 'rules of thumb, this 'watering down' process has benefited neither design nor research.

Research, even under current conditions, can be an enormous asset to architectural design practice, and design, once it has established a working relationship with technical investigation, can provide myriads of useful areas for research to explore. An effective symbiosis, however, in unlikely to come about if the status quo is maintained. Instead, changes, simple, but significant, must be made if research and design are to meet their current needs and future goals.
Architectural Research:
Current Needs and Future Goals

The problems which prompted the initiation of architectural research still exist today. Indeed, in many respects, the complexity of designing an effective human environment has increased over the past twenty five years, while the benefits to be gained from organized investigation have not enabled the designer to keep pace. Research, however, despite its numerous failings has done several significant things for design. Primarily, it has publically clarified something that most designers always knew: architectural design is not a pure science, nor is it amenable to the ways of pure science; the indiscriminate imposition of scientific methods and attitudes is not the way to improve the process of creating the built environment.

As a discipline grounded in the need for assimilating --not merely 'knowing'-- information, architecture, of necessity, has been able to develop appropriate methods for learning, and for applying this knowledge to practice. The fundamentals of architectural intuition --investigation, assimilation, application-- are as appropriate today as they have ever been. The increased complexity of the modern design problem merits changes in the organization of the design process, but not in the process itself. We must look to investigate, understand, and update the tried-and-true fundamentals of architecture rather than forsake them for foreign impositions. Science and ordered rationalism must play an essential, if deferential, part in this revivification of the architectural design process. Properly understood, research and organized investigation will be a major force in remodelling the traditionally
appropriate methods and practices to meet new challenges.

Historically, architecture has progressed through trends and movements; twenty years can witness a total revolution in professionally acknowledged needs, motivations, and direction. The fact that some members of today's design profession feel a need to objectively explore the architectural knowledge base and to discover new and appropriate methods for adding to this base is no guarantee that their sentiments will be advocated throughout the profession or that anyone will advocate them in twenty years time. Indeed, the twenty plus years of investigative failure witnessed by the profession have caused many formerly unbiased designers to believe that organized research has little application to or place in architecture. As one strong advocate of design research ruefully admits, "There has been a definite trend away from research of late. Interests in it seem to follow the same pendulum swing as other interests in architecture, and research does seem to be on the decline."\(^1\)

Nevertheless, research in architecture does exist, and most professionals seem to recognize that organized investigation is a identifiable, if not integrated, appreciated or valued aspect of the environmental design mechanism. That most professionals are not quite sure what exactly architectural research encompasses is not totally bad.

Ten years ago you would hear us arguing whether or not architectural research existed. There is no longer any need to spend time debating whether or not there is such a thing as architectural research: there is. It means a lot of different things to different people, but that's all for the good; it's one of the strengths of an emerging discipline.\(^2\)
Thus, a new understanding of architecture seems to be emerging which takes into account the separation of essential functions. Traditionally, investigator and designer were one and the same. Although the architect generally began his career with a long period of investigation --ie. education or apprenticeship-- and moved only later towards a design emphasis, no designer ever totally relinquishes his role as researcher. As one architect expressed it, "whenever I observe, I am doing research." Still, once a designer's formal training has been completed, time devoted to the discovery of knowledge is given over to the application of discovered knowledge.

Traditionally, this arrangement could work, because design problems needn't be overly complex --they could be as complex as the designer desired-- and the requisite knowledge base for competence was not overwhelming. Today, however, the extent of existing architectural information (which is still insufficient) and the complexity of all but the most rudimentary design problems overpower the ability of all but the most extraordinary individual to successfully internalize. In this respect, Christopher Alexander's perceptions were correct, but the solution seems to lie, not in a new concept of design, but in an organized delegation of traditional responsibilities and a thorough integration of the delegated elements. Architecture must shift from its traditional stance as a collection of related, but essentially self-sufficient and distinct, individuals, to an integrated network of interrelated talents and abilities. (Not only must the profession as a whole agree to accept the presence of non-architects fulfilling specific investigative and technical tasks, but each professional must, to some extent, adapt his or her conception of
architecture to include organized investigation and the systematic extension of the architectural knowledge base. In some instances, this adaptation may mean nothing more than the willingness to trust the veracity of research data and use that data; in other cases, a design professional may choose to forsake some aspect of design in order to concentrate on research and the organized development of the professional knowledge base.)

Therefore, if this burgeoning area of deliberate architectural inquiry is to play a meaningful role in re-establishing trained design talents to their traditional role in the environmental design process, a primary emphasis at this time must be given to defining the role of research within the architectural framework. For too long, extremely viable methods of architectural inquiry and investigation have suffered for lack of definition, or from ambiguous positioning within the design process. At the same time, however, a definition of architectural research must not impose artificial constraints which would stifle its effectiveness. Research has established itself as an entity within design; its next role is to clarify its position.

Broadly stated, this position might be defined as "an organized method for adding to the professional architectural knowledge base." No attempt should be made to qualify the word 'organized' except with respect to the final outcome of a research investigation. The methodology for discovery need not follow a prescribed format; organization is more essential in the ends than in the means. Where the actual investigation may proceed along less than scientifically rigorous terms, the documentation and presentation of research findings should follow an organized logic readily amenable to the design professions. The methods by which knowledge is produced
need not follow an objectively rigorous format where such a format is impossible or inappropriate, but always, if research is to be effective for the entire profession, the selected format or methodology must be rigorously documented, allowing the reader to evaluate the relative merits of the enclosed data.

An important distinction has often been drawn between design and research. Researchers, it is said, are interested in novelty: in doing things differently or in a new way. Designers, on the other hand, are not responsible for newness so much as for improvement; their goal is not to do something differently but to do it well. The definitions, however, are not mutually exclusive. Obviously, novelty alone cannot guarantee improvement, and very often it results in the opposite. (One of the constant complaints used against organized architectural research is that its overriding interest in producing the new destroys the designer's ability to internalize and improve the old.) However, even within the traditional framework, improvement, if not actually entailing new materials, methods, or processes, implies, in the least, a new attitude of a different way of thinking about a problem. Research, therefore, cannot be defined as mere physical novelty; an investigation leading to a new way of approaching traditional problems using traditional means can indeed form as essential aspect of architectural research.

Thus seen, architectural research cannot delimit itself by proscribing an 'official' research methodology. No single methodology is valid for the myriad of areas involved in environmental design, and the notion of a single 'correct' approach to investigation immediately closes the door to any other methods, methods which may prove, upon application, to be considerably more effective than the officially designated procedure.
However, organized research as a systematic means of adding to the professionally recognized knowledge base will not be able to emerge as a viable entity within the design professions if it simply allows that any one method of inquiry is as valid as any other with respect to idiosyncratic criteria. Although circumstances make every separate inquiry into areas of architectural concern unique, and appropriate methods for evaluating one area --ie. technology-- may be completely unacceptable when studying other areas --ie. behavioral patterns-- architectural investigation, as an integral facet of the total architectural process, must encompass some strong unifying and organizing element. Since this element cannot be found in the investigative methodology, it must be embodied in the documentation and evaluation of the unique research methods and their products.

The objectivity of scientific investigation simply cannot be made effective in architectural research and exploration. Architecture is not a pure science, nor is it appropriately defined as 'applied science.' The logic and methods of science, therefore, cannot be assumed to work for architectural purposes. Correctly done, scientific research involves a number of inherent constraints designed to achieve the goals of objectivity: isolation of problems, analytic dis-integration of a particular problem, isolation of factors within that problem, clear definition of variables, isolated manipulation of variables, uniformity of environment, experimental duplication. Investigation of man-environment relationships simply cannot adhere to these criteria, and to impose such constraints incorrectly, or in part, destroys their validity as objective devices.

As opposed to scientific investigation which uses a proscribed methodology to assure universal validity
to its research findings, architectural inquiry cannot even attempt at such uniformity or objectivity. It can, and must, assume a high degree of organization and universal utility through the rigid and thorough analysis and documentation of the investigative technique as well as its results. In other words, for architectural clarity, both the products and the processes of any particular inquiry must be thoroughly explained. Since architecture cannot be divorced from its context, the products of an investigation similarly cannot be properly expressed without their context. The methodology of an investigation may be ad hoc, subjective, and totally non-quantified; the results can still be valid and useful as long as the circumstances affecting the creation of these results are readily available to anyone examining them.

Rather than hiding behind a veil of inappropriate and incomprehensible scientific methodology, or disappearing into a cloud of aesthetic or sociological mystification, the production of architecturally usable information must return to a level of organized common sense. Once a question has been formulated, investigative methodologies should be selected for their propriety to the issues at hand; the reasons for the selection should be made explicit, and the process and products of the investigation rigorously documented. Whereas scientific inquiry deliberately attempts to be value free, architectural research must be deliberately hermeneutic: nothing can be taken as neutral, therefore the values attached to everything must be thoroughly defined. Since it can't be value free, architectural knowledge must be valuable.

Even as efforts are being made to clarify the nature of architectural research, designers and researchers must also begin to delimit the types and focus of this
aspect of the design process. Primarily, research can fall into one of two categories: research for architecture, and research in architecture. Although the two are by no means exclusive, the former implies investigation into how buildings and environments function; the latter investigates how architecture—the people, institutions, attitudes, processes—function. The first investigates substantive areas such as technologies, materials, building systems, physiology, etc. The latter looks at the social, organizational, institutional and intellectual frameworks within which architecture takes place. (Discovering new ways of designing energy efficient office buildings would be an example of research for architecture; investigating how students assimilate knowledge within design school curricula would be an example of research in architecture; overlap would occur when the results of these two investigations were used to create a design course which effectively transmits the principles of energy efficient design to students in school.)

Several implications arise from these efforts to clarify the role and nature of architectural research. As opposed to more classical definitions, architectural investigation need not demand novelty as a product, and novelty certainly should not be held as the most desirable goal. The primary motives of architectural investigation should be improving some aspect of the professional practice, adding to the general fund of architectural knowledge, increasing the profession's understanding of itself.

Clearly, therefore, this understanding of architectural research demands certain special characteristics of those who make the integration and assimilation of such research their primary concern. And, after consideration of extant professional structures, it becomes clear that
talents requisite for these new professionals come neither from the design tradition nor from the research tradition. Since both these traditions are so firmly established, and neither alone nor in conjunction has managed an effective solution to problems in environmental design, the meaningful development of architectural research demands the creation of a third type of professional: one whose primary obligations are towards the creation of a harmonious relationship between those attempting to create knowledge, and those attempting to apply it.

Efforts have been made in the past to validate architectural research by smudging the educational distinctions between researchers and designers. Architecture students have been asked to take courses in basic sciences or methodology; researchers are offered survey courses in environmental concerns. By and large, such efforts have been futile (adding fuel to the fight to abandon the notion of architectural research) and have left no one satisfied. While researchers and designers may share many talents and concerns, their primary professional purposes and intellectual attitudes are dissimilar. Given these dissimilarities, it is not surprising that an effective interaction does not emerge spontaneously from merely physical or professional proximity between research and design; instead, a third professional is required, to nurture and facilitate this essential interaction.

An intermediary position between research and design does not imply that a 'facilitator' must encompass all the knowledge and abilities essential to both. Indeed, it is the inability of one person to do this that justifies the creation of this third professional. In-
stead, a solid intellectual background enhanced by a thorough familiarity with the professional concerns and methodologies of both research and design are far more important than any specific scientific or architectural talent. A facilitator must develop a keen intellectual comprehension of each field, and a less rigorous procedural competence as well. However, the facilitator is not used to usurp the traditional responsibilities of designer or researcher. Rather his duty, in an era when investigation and application can no longer be practically embodied in a single professional, is to establish an effective symbiosis between the production and application of knowledge: to integrate the results of investigation with the needs of design, and to direct investigation in a manner most effective to the design community.

(Contemporary design practice increasingly resembles corporate management; a central design 'team' deals with the general issues related to a particular project and farms out specific problems to a series of technical consultants. Often, only a handful of project participants are aware of the overall scope or ultimate goals of a project; perhaps only one or two can describe the interrelationship amongst the various vital participants in the design effort. Although the corporate approach is an answer to the increasing complexity and magnitude of modern design problems, it reveals none of the harmony and integration that derived from an individual approach, or even that of a small-scale 'workshop' or studio.

Whatever the approach, an effective architectural design process must include the collection of information and the synthesis of this information into an appropriate finished product. The individual approach (or the unified studio) integrates both of these functions into a harmonious process. Corporate design, on the other hand, isolates these aspects, attempting to
partial processes; researchers and consultants collect pertinent information while designers and other consultants attempt to synthesize it. Dichotomies between the methods of approach, misunderstandings, or simple lack of communication between the two facets of the design process reveal themselves as errors and omissions in the finished product --ie. the built environment.)

A primary professional responsibility for facilitators, therefore, must be the re-integration of the professional design practice. Since no single individual can assume responsibility for assembling all the necessary components of the architectural process into a finished work, the facilitator must assume a responsibility which hitherto has simply been allowed to 'slip through the cracks': orchestrating the interaction of the participants in a design effort. In a sense, facilitators must be designers; they must assume responsibility for designing the process of design. A macroscopic outlook is essential; given the proper overview, a facilitator can harmonize the necessary research talents and sources with the requisite design skills and abilities to achieve a given --and fully expressed-- end. If design by team is necessarily dictated by the size and complexity of today's design projects (as well as economic, social, and professional structures), then the facilitator would work to change the inherent linearity of this approach into a more suitable and satisfying integrated harmony.

To function effectively under such responsibilities, the facilitator must be fluent and adept with the languages and methodologies of both research and design. Ideally, the facilitator will have the intellectual background to permit an adequate understanding of two dissimilar mental attitudes: the open-ended, dilated approach of the designer, and the close-ended, focussed perspective of the scientist or researcher. The former
embodies a primarily synthetic approach to problem solving, whereas the latter relies heavily on analysis. The facilitator must be capable of understanding the implications of both.

Communications becomes an essential concern for the facilitator, and eradication of the somewhat artificial barriers between research and design caused by lack of a common language. The facilitator must be able to convert the technical language of the researcher --equations, graphs, mathematics, and idiosyncratic professional 'jargon'-- into everyday verbal expression, but more importantly, into the visual language of the design professional. This process must work in reverse as well; the facilitator must be able to clarify and explain the doodles, sketches, and diagrams of the designer into a meaningful directive for information gatherers.

Communications is so essential to the integration of research and design --and has proven to be such a major stumbling block thus far-- that this aspect of the facilitators' professional responsibility can, in itself, be a fitting subject for substantial investigation. It is often stated that architects and designers think 'visually,' but what, in fact, does this truism mean, and what does it entail for the relationship between designers and other professionals (or clients)? If architects think visually, research consultants think scientifically or in terms of technical 'jargon,' and the client --to whom ultimate responsibility must be directed-- thinks in everyday English, how can there be an effective means of communication? At times, the facilitator must act as a physical translator, mediating personally between concerned parties. At other times, the facilitator would simply attempt to devise an effective communication system that didn't demand personal presence. The entire area
of professionally related communications would fall into the facilitators' purview, and as such, provides an immediate subject for considerable investigation.

Facilitators must also have an understanding of the overall relationship between research and design; he or she must be responsible for investigating the utility and applicability of architectural investigation. The facilitator must take some professional responsibility for propelling research in directions similar to those of immediate concern to the design profession. Research cannot simply be undertaken on an ad hoc, 'it looks interesting' basis. Rather, the facilitator must assume responsibility for observing the changes and developments in the design profession (many of which reflect changes and developments in society) and for translating this immanent needs into productive and appropriate research investigations. The facilitator must not only know the extent of the architectural knowledge base, he or she must know the limitations, and must work to fill in those areas of primary concern.

As mediators of the research/design interaction, facilitators must take advantage of their unique position in order to realize the potential of using actual design work as a form of architectural investigation. Initial steps in this direction have proven enormously successful and productive, and a primary responsibility for a facilitator would involve the furthering of this trend.

In an article discussing the relationship between energy research and design, Bob Shibley describes the benefits of using the design process to inculcate and test the products of architectural research, and to further this research as well. Shibley arrived at the idea of
using design as a means of advancing knowledge about energy after considering the three generic types of problems involved in energy research and architectural design.

Simple problems lend themselves to either/or solution. They have an empirical base and can generally be resolved through direct investigation. However, with respect to design,

These problems tend to fall under the purview of physics and engineering much more easily than architecture. Architects are not by nature or training, 'simple' problem solvers. Architectural research is not the simple exercise of empirical science. 4

However, certain aspects of energy use in buildings can be successfully broken into a series of simple problems, which can be 'solved' using straight forward empirical approaches. Other elements of energy research, however, are disorganized complex problems, and...

... deal with rational more than empirical ways of knowing or understanding. The disorganized complex problem is a multi-variable one, where each variable operates somewhat independent of all the others. It is often difficult or extremely expensive to measure all variables, but rational predictions based on statistical probabilities are frequently used. 5

As might be deduced from such a description, such problems lend themselves to investigation and analysis via computer, and the prevalence of such problems in energy research is one reason why computers have played such a large role in this aspect of architectural investigation. Still, as Shibley describes, disorganized complex problems are not the most common form of architectural concern.
The simulations of building performance based on complex computer codes can inform the architect of tradeoffs during design, but the development of the probability models and computer codes falls more closely into the categories of statistics and computer science than architecture. The rational method of inquiry used in disorganized complex problem solving appears to deal with relationships, but actually modifies one variable at a time while holding all others constant.6

Architects, on the other hand, even with the information supplied through empirical or rational research methods, must deal with organized complex problems. These include a large number of interdependent, or related, variables, and do not lend themselves to solution through the isolation or manipulation of a single variable. Indeed, as most designers know, it is rare that one of the major parameters in a design problem can be successfully isolated from its related context.

Once an essential base of empirical and rational research data existed about energy use in buildings, designers were still faced with the problem of integrating this data into the design process. In order to deal with this type of organized complexity, Shibley and the others turned not to research methods, but to the tried and true design process itself. Once the energy problems had been solved, integration of research data became the main problem.

It is precisely in such 'application' that the limitations of our science based methods constrain us. Our end goal in architecture/energy inquiry is not application but integration with the economic, functional, behavioral, symbolic, social, ecological, and engineering frames of reference which come to bare (sic) on the art and science of building. In integration (organized complex problem solving) we find design to be our best method of inquiry and architecture to be our best discipline.7
Surprising as it may seem, the meaningful development of architectural inquiry might insist that design play an essential part; in seeking to optimize a dis-integrated traditional process, architecture might actually succeed in re-integrating itself. Based on his experience in using the design process itself as a means of translating research data to designers and as a means of furthering actual research knowledge, Shibley fully advocates the use of scientific and technical abilities to add to the architectural knowledge base, but also believes that this knowledge will only be made meaningful if designers themselves participate in its assimilation.

The opportunity is to use such experience to acquire an appreciation of the unique confluence of concerns that occur when people build. It may not result in the ability to generalize except in so far as real building experience informs the scientist among us of what problems can be disaggregated and better understood through simple or disorganized complex problem solving.

In informing judgement about what is real, the empirical and rational methods of science serve us well... Informing judgements about how such reality is valued and what action should be taken requires design.
The development of an effective conjunction between architectural design and architectural investigation must commence with a thorough investigation of both design and research within the architectural framework. This is a task for which a facilitator would be ideally suited; it requires knowledge of both fields and a macroscopic view of the overall inquiry/integration problem. A great deal of research has already been done with respect to architectural issues and architecture itself. Facilitators could begin their work by determining the extent of the current knowledge base, discovering a successful means for organizing this knowledge into a format usable by both designer and outside investigator, and selecting ways for evaluating the relative 'worth' of already available knowledge and information.

Several issues should be addressed initially:

1. What are the various issues of concern in architecture today, and how much can be said to be 'known' about these issues? Of that which is considered knowledge, how much can be attributed to systematic development, how much to tradition, and how much to plain hearsay or speculation?

2. How can the available sources of knowledge be organized for optimal utility to both architect and investigator? A Sweets catalog is not a particularly useful source for a serious researcher, while a designer might experience considerable difficulty drawing any usable conclusions from a basic technical treatise.

3. Once this body of knowledge has been outlined and organized, how does one begin to evaluate its relative utility? Rigorously detailed investigation might lead to meaningless results while knowledge with no foundation other than personal intuition might be crit-
ical to a designer's success. Evaluation cannot be based on outward appearance, nor simply accepted on faith. Facilitators must develop an effective means for judging the validity of that which appears under the name of architectural knowledge, working with professionals from within design and from without in order to qualify the utility of the architectural knowledge base.

In the course of addressing these primary issues, facilitators and people who view themselves in a role of integrating research and design within the architectural professions can fill a number of specific positions:

1. **Liaisons between designers and researchers.**

   A meaningful system of architectural inquiry can develop only if there is an effective connection between the production of knowledge and its integration into the design process, and hence into the built environment. Designers cannot keep abreast of all the changes and developments occurring in the field, nor can they develop the requisite intuitive sense for those aspects of their work which they encounter only peripherally. One cannot assume that widespread publication or a new process, technique, material or approach will guarantee its adoption into common practice; innovations and new ideas must be gently worked into the designer's repertoire. Since responsibility for this 'working in', this transition from information to application, is assumed by neither research or design specifically, the facilitator plays a vital role. Bob Shibley gives a thorough description of one method of successfully working research knowledge into the designers' domain through a series of interactive design reviews:

   This interactive review process allowed design teams the opportunity to consult with nationally recognized
technical experts. Each team participated in a series of reviews which monitored project progress and provided design assistance.

Group schematic reviews became forums where designers informally exchanged ideas among themselves and technical experts.

Interim reviews provided additional assistance at the request of the design teams.

Final design reviews assessed projects and documentation which had been rigorously maintained throughout the design phase.

A number of pre-conditions were established to facilitate the transfer of information during these reviews and to inform all participants of their role within the review process:

1. The review teams did not interfere between the client and the designer.
2. Both reviewers and designers were still learning.
3. The reviews were conducted in a manner consistent with the tenets of peer review rather than a superior/subordinate exchange.
4. The physical settings for the reviews were conducive to the review tasks.
5. Technical monitors followed the projects throughout the design process to assure technical and documentation assistance was available for the evolving designs.
6. Comments were offered at a time when the project was still in schematic design.

Shibley summarized his reports on the experience with a critical assessment, "In the absence of intuitive knowledge, a framework was established for design professionals to learn from one another." To learn from one another, and to learn from outside technical and research personnel. Such frameworks are crucial to the future development of architecture, and facilitating personnel are essential if more frameworks
such as these are to be established. Most professional settings do not lend themselves to intramural learning, and the existing nature of the profession often hinders the unplanned development of such interrelated settings. Since intuition can only develop over time, through the combination of learning and application, and the increasing complexity of ends and means dictates that fewer designers will have the time, ability, or conditions necessary for developing effective intuitive comprehension, the design process must intentionally assume some of the characteristics of a learning and investigative process as well. Working together, designers can compensate for individual weaknesses. In coordination with technical support, designers can actually overcome some of these weaknesses and improve their personal design abilities. The cooperation of both designers and researchers are essential if such joint efforts are to succeed, yet the coordinating influence of a trained and knowledgeable intermediary -- the facilitator -- is equally vital to the success of such operations.

2. Liaisons between researchers and design.

In the first situation, facilitators act to enhance the ability of the designer to carry out his professional responsibilities. By determining what aspects of architecture need further investigation and beginning to organize efforts to undertake that investigation, facilitators can enhance the role of the architectural research specialist. Facilitators can assume responsibility for coordinating the relationship between those with specific architectural questions -- manufacturers, project sponsors, government agencies, professional organizations, other researchers -- and the investigative talents capable of providing adequate solutions.
Architectural tradition is filled with ingenious answers to tough problems, answers born from ad hoc desperation or intuitive gut reaction to a critical issue. As both design and construction processes grow more complex and demand more coordination, such ingenuity is increasingly unable to provide appropriate or lasting solutions. Facilitators must work to provide a much needed link between existing architectural problems and potential solutions.

3. **Documentation.**

Through their intellectual background and their professional responsibilities, facilitators will find themselves in the unique position of having an overview of whole segments of the environmental design profession, if not the entirety. As such, they will be the most qualified members of that profession to assume a responsibility which has been historically weak: the organization and dissemination of knowledge. Included in the work that facilitators must undertake is establishing an accurate account of the existing knowledge base, and developing a system for integrating new findings into that base.

This aspect of the facilitator's work should not be confused with architectural journalism, although writing and publishing will be extremely useful ways of disseminating pertinent information. Whereas a great many journals and books are devoted to opinion, theory, and subjective analysis of works or philosophies, documentation done by facilitators would be more encyclopedic, aiming at a comprehensive, systematic overview of extant architectural knowledge. Besides recording past knowledge and seeking sources for new findings, facilitators could be of service by establishing methods for documenting ongoing interactions between research and design, or for
effectively documenting existing design products. Every project that gets built, every purposeful manipulation of the built environment, is a potential subject for rigorous documentation. Facilitators could add immeasurably to the professional knowledge base, merely by coordinating, directing, and compiling such documentation. More than mere journalists, facilitators would function as coordinators and librarians, directing the documentation of pertinent aspects of design and research, establishing references from which the designer or research specialist can draw information, and developing new and better means of bringing information directly to those who can most benefit from it.

4. Education.

Architecture traditionally has a checkered academic history. Even today, many of the teachers in our schools of architecture are practitioners who regard teaching as a supplement to actual professional work. Most do have considerable concern for their didactic responsibilities, but few have the training or intellectual background demanded of academics in every other discipline. Although there are numerous talented designers within the ranks of architectural education, there are very few trained educators. The ability to design does not automatically grant the ability to convey design knowledge, and as a tradition grounded as much in practice as in knowledge, the ability to convey knowledge to a student is far more essential to a teacher than the ability to actively use that knowledge. Cognition without application is merely under-utilized; application without cognition, however, is useless within an academic atmosphere.

If an investigative tradition and a respect for research is to be inculcated into the design profession, exposure must begin when the designers begin their education. Teachers, therefore, must themselves be aware
of the nature of architectural inquiry, and must work to translate an investigative attitude into their teaching. With a general overview of the entire scope of architecture, a more refined awareness of the nature of both research and design, and, perhaps, a specific aptitude in one area of design or investigation, a facilitator can carry the ideal credentials for a serious architectural educator.

Most architecture schools in America exist within a university context. Traditionally, a university is dedicated to three specific goals: education, service, research. (The dissemination, application, and production of knowledge.) Schools of architecture often fall far short of meeting the last two standards, however; the most oft-cited reason is architecture's practice-based tradition. As that tradition changes to include research and the systematic production and dissemination of knowledge, the education of architects and the context for that education -- i.e., the school of architecture -- will have to adapt to include these new dimensions. The architecture teacher as part-time practitioner, part-time professor will necessarily give way to a professional with a full-time commitment to the three academic ideals: education, investigation, and public service. Facilitators, with their abilities to comprehend many aspects of design, their ability to participate in research, and their ability to communicate effectively will have all the talents requisite for future architectural educators and, as such, can fill vital roles and perform necessary services in our schools of architecture.

Schools of architecture, especially those set within a university context, stand to play an increasingly
important role in the future of architecture. Not only will their importance as the setting for higher education increase, especially as this education becomes more and more vital to effective performance in the design profession, but schools also provide the ideal settings for major facilities dedicated to producing, documenting, and disseminating knowledge about architecture.

Architectural research currently takes place under the most fragmented and haphazard of conditions. A variety of sponsors -- the government, private, public and professional groups, industry, higher education -- promote architectural investigation, and each has established its own facilities and collected its own personnel. There is very little coordination amongst these various operations, and while their spheres of concern may be similar and are certainly related, no effective element has been established to organize these efforts towards a mutually beneficial goal. And, if architectural research is to make viable and necessary contributions to the profession, it is precisely this type of organized network which must begin to appear.

Universities which currently include schools of architecture present the best potential locations for research facilities. Within a school of design, there is an immediate connection amongst students, academics, researchers (to the extent that they already exist), and practitioners. Students represent the future of the profession; if that future includes research, research must be a part of the students' educational background. And, even if a student is certain to dedicate his or her career almost exclusively to design, practical experience in organized investigation will still form a valuable part of a well-rounded education.

Academics are responsible for the effective education
of the students; if education includes investigation, the academics must have access to such work. Practical research experience cannot help but to enhance an instructor's didactic abilities, and creating research facilities within schools of architecture will also improve the chances for achieving effective research results. Currently, a great deal of architectural investigation is undertaken on a part-time basis by academics, many of whom are inconvenienced and forced to relinquish teaching duties because of poor proximity between schools and research facilities. And, while the traditional tendency to avoid research within the schools of design is sure to diminish due to administrative and organizational pressures, the availability of appropriate facilities within the university setting is certain to increase faculty participation in research.

Schools of architecture traditionally attempt to maintain their ties with the practicing profession, through publications, continuing education classes, workshops, and similar programs. Establishing viable and valued research facilities within the university context will increase the connection between university and profession, to the benefit of both.

Universities are optimal locations for research for pragmatic reasons as well. Schools of architecture generally exist in conjunction with a wide range of other academic facilities. Within the university context, architecture research would be able to make use of established facilities -- engineering workshops, science labs, a wide variety of libraries, museums, and archives. In addition to their wealth of physical resources, universities also present enormous potential in terms of trained personnel. Isolated research efforts cannot call
necessary talents, especially if these talents are on the periphery of a particular investigation's concerns, without entailing considerable difficulty and expense. Within a university setting, however, information about even the most esoteric aspects of a particular project and the personnel to help understand that information are far more accessible.

At present, a great deal of publication and information processing takes place within the schools of architecture. Establishing research centers within these schools permits researchers to employ already established communications networks to their benefit. The more established the network, the more valuable it is a means of disseminating information between researchers and between research and the profession.

Finally, the diversity of the university context is in keeping with the diversity of issues involved in environmental design. Conducting research in a university setting exposes the researchers to a variety of external inputs and feedback mechanisms. Even if a project becomes extremely focussed, its context amongst myriads of related architectural investigations would help provide the project with an appropriate frame of reference. Projects in a variety of separate but related concerns occurring side by side would enable all the participants to maintain a proper perspective as to the utility and meaning of their work, a perspective which is essential if the products of these investigative efforts are to prove beneficial to the overall field of architecture.
Conclusion

The increasing complexity of architectural issues and concerns does not invalidate traditional methods of design; in fact, the increasing wealth of materials, processes, and techniques makes a sound design intuition more imperative than ever before. Intuition, however, can spring only from knowledge. The real problem facing the design profession, therefore, is not the failure of design, but the lack of a system for establishing, verifying, and disseminating knowledge.

Organized architectural research can help solve this problem. And, despite the difficulties that efforts in architectural inquiry have encountered during the past twenty-five years of semi-organization, research must now be considered as an officially acknowledged and accepted branch of the design process. More organization is needed, however, and both the ends and means of architectural investigation must be more clearly expressed. The role of research must be made known, and its benefits demonstrated. Students must be educated to overcome traditional biases against organized systems of inquiry. Despite its overwhelming potential, research will improve design only if it is understood and accepted.

Because the nature of systematic investigation and the nature of environmental synthesis imply different intellectual attitudes and methods, neither research nor design will profit from attempts to turn investigators into designers or to turn architects into research scientists. Where definite interests for interrelation between the two disciplines exist, efforts should be made to promote a symbiosis, but if organized research is to become a truly integral aspect of the architectural process, a third type of professional must emerge to assume responsibility for effecting this integration.
This third professional -- the facilitator -- will act as a catalyst between research and design, allowing them to interact and mutually enhance each other. In addition to the essential role of promoting the development of a design/research interaction, facilitators will have to fill other important positions in architecture today: education, community service and public relations, documentation, and professional communications.

The framework for an effective system of architectural investigation already exists; the burden now is on the more traditional elements of the design professions to develop that framework and begin supplying the necessary infill.
At most, this thesis gives only a brief overview of an extremely complex and integral aspect of the architectural profession. Organized research is making slow advances into the traditional concepts of architectural design, progress which could be thwarted by blind organizational disdain, or conversely, through blind adherence to erroneous notions about research. While an appropriate method and form for architectural research must develop of its own, over time, the profession must do its best to guide that development in a positive way.

I have tried to touch on some of the issues affecting the role of research within architectural design. I firmly believe that research is essential to the future viability of the design profession, but at best, this thesis only points to some of the critical issues. Each of these could be greatly expanded, and all must be explored in depth. My hypothesis at the end is only that, a piece of intellectual speculation based, not so much on experience as on a brief survey of the design profession. My goal in writing this thesis was to create a personal framework with which to begin a more detailed examination of architectural research, especially with respect to architectural technology. My goal now is to take this intellectual outline and begin filling in some of the many areas left blank or incomplete.

My initial 'research' has yielded a hypothesis; now it is time to begin examining the validity of that conclusion more fully.
FOOTNOTES

I  An Introduction to the Problem

1 Honnikman, Basil, Ph.D. Department of Architecture, University of Miami, Coral Gables, Florida. Presentation at the 1982 ACSA Annual Conference, Quebec City, Quebec. April, 1982.

2 Ibid.


FOOTNOTES

II The Professional Tradition


III The Nature of Architectural Design


2Ibid. pp. 158-163.


5Ibid. p. 115.

6Ibid. p. 115.


8Ibid. p. 97.

9Ibid. p. 98.

10Ibid. p. 100.

FOOTNOTES

IV Existing Notions of Architectural Inquiry


5 Ibid. p. 192.

6 Ibid. p. 192.

7 Ibid. p. 194.


11 Ibid. p. 111.
FOOTNOTES

VI Architectural Research: Current Needs and Future Goals

1 Honnikman, Basil. op cit.

2 Catanese, Anthony J. Presentation at the ACSA Annual Conference. April 1982, Quebec City, Quebec.


5 Ibid, p. 6.


7 Ibid, p. 7.

8 Ibid, p. 10.

9 Ibid, p. 11.

10 Ibid, pp. 11-12.

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