THE POTENTIAL FOR COMMONALITY IN ARCHITECTURAL AND ENGINEERING DESIGN

by

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Thesis submitted to the faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

MASTER

in

Architecture

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June 1982

Blacksburg, Virginia

ACKNOWLEDGMENTS

My father who taught me the art of engineering, and my mother who taught me the ability to recognize beauty.

Cathy, for her patience in overcoming the inconveniences of graduate school.

The faculty of Virginia Tech with whom I have been associated over the past two years.

Rachel for her dedication and skill in typing this work.

TABLE OF CONTENTS

INTRODUCTION

This work is based upon the belief that there could be a common basis of understanding and communication between architects and engineers. The motivation for its undertaking in an observation that an unnecessary spirit of animosity often exists between architects and engineers in both academic circles and professional practice. I feel that this atmosphere is often at cross purposes with the creation of a quality environment.

As a practicing civil and structural engineer, I have worked with architects on numerous projects. I noticed a recurring behavior pattern in these contacts. When I made suggestions regarding technical aspects, I was often unquestioned regarding my statements. However, once a suggestion was made regarding traditionally non-technical aspects, an atmosphere of mind-your-own business was generated. As an engineer, one was expected to be a technician and not a co-designer. Many other engineers with whom I had contact reported similar situations. Some found entertainment by making technical pronouncements in jest to architects. These statements were often followed with unquestioned acceptance. I realized that engineers could design much of a building without an architect's intervention. Mechanical engineers were even more influential in this practice than structural engineers. I began to wonder who the architect of those jobs was. One structural engineer remarked that our job was to take the architects "cartoons and make them work."

Many architects with whom I have worked remarked upon the deficiencies of engineers. Comments were often made regarding the dullness, cultural backwardness, and insensitivity of engineers. One architect remarked that only an architect could design a building. Engineers were too stupid for the task. This argument was also echoed in the comments of architectural faculty. Often I heard complaints that the architect's work was "butchered". In general, I found that contacts between architects and engineers are often characterized by feelings of mutual frustration.

Who is the loser in these situations? Ultimately, it is the client. The resources for building are getting harder to obtain, and the client has a right to expect the most out of his building dollars. An effective working relationship between the architect and engineer is an insurance that the best building will be produced with the available resources. To achieve this relationship, a dialogue must exist between designers to explore their work's possibilities. Buildings are atypical of most designed products in that site considerations and client requirements are often unique for each project. In a sense, the building designer must "reinvent the wheel" on every project. To do this requires that a design situation be viewed from as many sides as possible. However, this approach assumes that a common language exists between the involved parties. This aspect is often absent.

A timely reason for encouraging this commonality of concerns is today's building market. According to some statistics, less than 25% of the buildings that are constructed in the United States involve participation by architects. As a believer that architecture can provide a quality environment, I find this disturbing. I also believe that a way out of this situation would be for the professions to provide new approaches to design problems.

There exists a growing need for an architecture that responds to changing values regarding the environment. However, this architecture will perhaps be more dependent upon technology than that of the present. New designs will be found that include the ability of technology to deal with new types of problems. A dialogue should be established between the architect and engineer.

In this work, the similarities and differences of architecture and engineering are first addressed. These two professions originated from a common background, but were directed toward separate concerns. By tracing their evolution, an understanding can be gained regarding their present nature and behavior.

The second section deals with problems in the contemporary design professions. The influences identified in the first part are shown to be contributory to problems in architecture and engineering. In the case of the civil engineer and the freeway, the effects of a purely technical approach to planning and design problems are noted. The architect's need to be conversant with technology is also explored.

In the final section, the possible responses of the design professions to the environmental issue is explored. Also, proposals for creating a commonality of concerns between architects and engineers are presented.

The hope is that this work could serve as a point of departure for future changes. As an aspiring architect, I would prefer to see the two professions more in concert than dischord.

CHAPTER ONE

COMMONALITY AND DIFFERENTIATION IN ARCHITECTURAL AND ENGINEERING DESIGN

What is it that spearates an architect from an engineer? Does this differentiation lie in training, type of work, utilitarian concerns? Frank Lloyd Wright is considered by many to have been a major American Architect. However, Wright received formal university training in civil engineering. A similar problem exists when one tries to state whether bridges are engineering or architecture. The Brooklyn Bridge and T.Y. Lin's work have become viewed by some as being architecture. What of Buckminster Fuller's work? Is it engineering or architecture? Some argue that only the engineer's work is designed to be utilitarian. However, in Sullivan's motto "form follows function" utility can be viewed as integral with the form that an object assumes. A similar problem exists if one argues that what the engineer designs is intended to be economical. This would imply that the office buildings designed by architects are divorced from economic concerns. If this were true, the architect would have difficulty finding a client.

It is not surprising that a distinction between architects and engineers is somewhat elusive. Until the 17th century, the architect and engineer were often one in the same person. A certain level of this commonality has persisted to the present. Nevertheless, the majority of architects and engineers in today's society are somehow separate.

What differentiation does exist is a set of distinct attitudes, concerns and abilities that is a legacy of the past few centuries. This chapter will attempt to delineate the evolution of this differentiation as a response to the needs of past societies for the designer's work.

From a historical perspective, it is often difficult to distinguish between the architect and the engineer. An example of this was the Roman architectus. In his work, The Ten Books of Architecture, Vitruvius delineates the concerns of architecture in the Roman Empire. As Vitruvius stated:

> "The parts of architecture itself are three: Building, clock making, mechanics."[1]

Under this definition, the architect was versed in the design of public buildings, public works projects, military fortifications, and machinery. By today's standards, this would make the architect a combination of structural, civil, and mechanical engineer, as well as architect. The architectural profession is still concerned with these fields. However, the engineering aspects of contemporary architecture are often performed by consultants.

The first departure from the traditional practice of architecture occurred during the Italian Renaissance. Prior to this time, the element of craftsmanship in architecture was integral with design. Most architects were trained through apprenticeship in the building trades. This experience gave the architect a basis for deciding what could and could not be built. During the 15th century, a distinction was made between the artist and the craftsman. As Flemming noted, this distinction was based upon the artist becoming drawn to explore the theoretical aspects of his work.

> "It was not enough for an artist to create works of art. He had to know the theory of art and the place of art in the intellectual atmosphere of the period."[2]

This theoretical attitude towards art influenced architecture. At that time many architects disassociated themselves from the craftsman tradition, and began to present themselves as practitioners of a liberal art.[3] A practice of "disegno" arose in which the architect concentrated on drawing, geometry and perspective.[4] These tools of design were also those that were being developed in painting and sculpture. As to the status of the craftsman, Alberti, a leading figure in the creation of the new architecture, stated:

> "An architect is not a carpenter or joiner... the manual worker being no more than an instrument to the architect, who by sure and wonderful skill and method is able to complete his work."[5]

The design of buildings without a "hands-on" knowledge of building materials and techniques was to have a lasting influence upon architecture. One consequence was the creation of a tradition of dispute between the architect-engineer and the building trades.[6] Another consequence was the elevation in social status of the profession.[7] At this point in time, the architect and engineer had not separated. Alberti's theoretical view of architecture was based largely upon the work of Vitruvius.[8] Throughout the 16th century, architects such as Da Vinci, Fontana, and Michaelangelo[9] worked on military and public works projects, as well as buildings. The primary contribution of the Renaissance to architecture was the identification of the architect as an artist.

The first separation of architecture and engineering occurred in 17th Century France. Colbert, Finance Minister to Louis XIV, persuaded the monarch to establish training academies for architects and engineers.[10] While the academy system of education was not new[11], the French were the first to separate architects and engineers into two distinct groups. The reasons for this dealt with the military needs of the empire. The French army needed a group of designers to devise military fortifications, and build bridges and roads for troop movements. In 1675, the Corps de Genie was established.[12] This institution was to serve as a prototype for the establishment of state-run military engineering academies.

The Corps was notable for another reason. Under this institution, the traditional role of public works projects designer began to be transferred from the architect to another party. When the Corps was reorganized as the Ecole Des Ponts et Chausses[13], the engineer became differentiated from the architect by virtue of the projects that they worked on. From this point onward, public works became the concern of civil engineers.

Architectural training at the Academie de L'Archtiecture followed the emphasis on 'Disegno' established in the Renaissance. The monarch was developing the preeminent national and cultural power in Europe. In deference to this, the King desired that the buildings of the state reflect the position of France in European culture. To this end, the academy was established in response to the King's desire that "the most exact and correct rules [of architecture] be publicly taught."[14] At this time, the Italians were felt to be the leading practitioners of architecture. Realizing this, the academy used the Italian model of architectural theorization as the basis for its practices.

The French architectural profession was tightly controlled by the monarch. The King dictated the standards of training, as well as the awarding of commissions.[15] In many respects the architect and engineer pursued similar ends in society. The buildings of the state were as much public works projects as were roads and harbors. However, the emphasis on architectural education was different from that of the engineers. The academy for architects stressed the aesthetic concerns of architecture. "When the academy met for the first time in 1672, the main topic of discussion was a definition of beauty in architecture."[16] On the other hand, the engineers received training in physics and mathematics.[17] The outcome of this separation of educational practices was to have a widening impact on the concerns of architecture and engineering.

The Industrial Revolution in England served to widen the gap between the practices of architecture and engineering. Since the Renaissance, the craftsman had been separated from the architect. In 18th century England, no institutions existed for the training of engineers.[18] The civil engineers who built the transportation and commercial infrastructure of the Industrial Revolution were predominantly craftsmen and members of the working trades.[19] By definition, what these craftsmen produced could not be considered as being art. Another factor which distinguished these engineers from the architects was their social and economic status in society. As Smiles noted in his 1874 work Lives of the Engineers:

> "The educated classes of the last century regarded with contempt mechanical men and mechanical subjects."[20]

The educated classes were either the aristocracy or the upper middle class. To these people, the engineer was, as a tradesman, a lower member of society. On the other hand, architecture carried with it the image of respectability. According to Jenkins, few english architects of the late 18th century served an apprenticeship in the building trades.[21] On the contrary, architecture was practiced as a "gentleman's art" by either the aristocracy or the learned artist. The Italian tradition of architecture as art has been introduced into England by Jones in the early 17th century.[22] Jenkins gives a description of architectural considerations in the 18th century:

> "The complications of modern services and structural techniques were unknown; the building industry was made up of highly trained tradesmen who...had mastered the materials in which they worked; and, with a knowledge of rules...and the orders of architecture...an intelligent and sensitive man could design...an elevation. Convenience in plan...seems to have been a minor consideration when weighed against the requirements of taste."[23]

This tradition, along with the attitude toward utility, shaped 19th century English architecture.

Whereas the French empire had separated the architect and the engineer by the needs of the state for public works, England separated the two designers through attitudes toward utility and beauty. By the mid-19th century, many of England's public works projects has been financed and constructed by the private sector.[24] This included railways and canals. The private sector was also responsible for the construction of the commercial and industrial facilities of the time. The private client differed from the state in his value placed upon utility and economics. For this reason, the industrial client turned to the civil engineer to design the means of production and internal commerce.[25] The engineer was concerned primarily with technical considerations. As engineers were associated with the building trades, issues of beauty were often overlooked. Architects, such a Pugin or Ruskin, viewed the engineer's work as ugly and lacking any sensitivity to accepted cannons of taste. An attitude developed that what was beautiful was somehow exempt from being useful. In some respects, this attitude reflected the relative social position of architects and engineers as much as it reflected the utilitarian versus artistic considerations.

The emergence of Romanticism in the late 18th century was also influential in widening the distinction between architecture and engineering. Romantics viewed the industrial age as an extension of the mechanistic world view of the Enlightenment.[26] Believing that the human condition could only be improved through spiritual means, the romantics opposed the materialist society of the Industrial Revolution.[27] Romanticism, as a moralistic transformer of society, found one outlet in the arts. As architecture had, since the Renaissance, proclaimed itself as a liberal art, Romantic thought became a preoccupation of architecture. One outlet of Romantic architecture was the belief that the replication of a preindustrial environment would cause a intensification of spiritual values in society. Chief among the proponents of this view was Pugin.[28] In 1837, Pugin's work Contrasts, stated that there was a connection between spiritual values and architecture. Ruskin, believing in the Romantic view of art, stated that bad art would produce bad men.[29] Many Romantics saw the industrial age as degenerate, avaricious, and unconcerned with beauty. Architecture became opposed to the mechanical forms of the railways and factory system. This had the effect of labeling the engineer's work as being morally tainted. Other effects of this attitude were to discourage architectural involvement in the building projects of industry and limit experimentation with the construction materials utilized by engineers.[30]

By the late 19th century, architecture and engineering became distinct, individual disciplines. Engineering was directed toward public works projects for government and the production facilities for industry. Architecture dealt almost exclusively with buildings for individuals, the government, and commerce.[31] When the engineer worked on building projects, he was subordinate to the architect. In public works projects, the engineer was the prime professional. With respect to architecture, this role of the engineer as a subordinate was to have implications. Turnor defined the relative roles of the architect and building engineer in the late 19th century:

> "The architect's work consisted in designing beautiful buildings in such a way that they shall be readily constructionable; the engineer's in constructing them as efficiently as possible while taking no thought for their aesthetic effect."[32]

In the 19th century, the dichotomy between beauty and utility largely defined architecture and engineering. Regarding public works projects, Turnor saw them to belong exclusively to engineering. Bridges, he stated, could not be architecture because:

> "They were designed soley to fulfill a practical purpose without any intention of producing an aesthetic effect. For there lies the distinction between architecture and engineering."[33]

This attitude is a reflection of the Renaissance belief that the craftsman is subordinate to the architect. Nineteenth century engineering was associated with the building crafts, and was directed toward utilitarian ends. An implication of the architect's attitude toward engineering was to promote the belief that architecture should not be considered with utility. Ruskin, in his work <u>The Seven Lamps of Architecture</u>, stated his anti-utilitarian beliefs:

> "...No one would call the laws architectural which determine the position of a bastion. But if to the stone facing of that bastion is added an unnecessary feature, that is architecture."[34]

However, this belief of architecture was to be challenged.

In the late 19th century, the attitude of western society toward industrialization was optimistic. The machine brought an increased standard of living, greater convenience, and more wealth to society. As a reflection of the more progressive spirit of the times, public expositions were held in which a nation could display its industrial might. The London Exposition of 1851 was notable in that it was housed in a prefabricated glass and iron structure of unprecedented dimensions. Archictectural critics found the unornamented structure that evoked engineering technology to be disquieting. Ruskin stated:

> "True archtiecture does not admit iron as a constructive material."[35]

However, the Crystal Palace was a public building, and represented the positive social attitude toward technology. This attitude was revealed again in 1889 at the Paris Exposition. Eiffel, a railway engineer, designed the monumental symbol for the event. His tower received harsh criticism from the artist community.[36] However, the Eiffel tower came to be regarded as a "symbol of French Supremacy in the art of Civilization."[37] A common denominator of the Crystal Palace and the Eiffel Tower is that they became symbols of their age. Being an industrial age, it was somehow appropriate that engineers designed its monuments. Regardless of the Romantic view, the public came to regard some of the engineer's work as the representative symbols of the 19th century. This situation caused problems for the architect. Ferriday noted that many architects felt threatened:

> "As the century progressed a gulf grew between the 'structural science and the building art'...In the second half of the century, architects tended to regard the engineer as a dangerous rival rather than a collaborator."[38]

The beginnings of a unification of architecture and engineering took place in America. Following the Civil War, American business grew at a rapid rate.[39] Cities began to become more compact with the increasing economy. As a response to rising land costs, it became necessary to build taller buildings. The skyscrapers of Chicago in the 1880's became the first integration of industrial age building engineering and architecture. Chief among the Architects of the Chicago School was Louis Sullivan. The influence of Sullivan's work of European architecture was that a building should not be evaluated in terms of appearance. Rather, the form of a building should reflect its purpose.[40] Sullivan's beliefs, popularly interpreted as "form follows function", were influential in attempting to reconcile the dichotomy between beauty and utility.

Engineering changed considerably by the beginning of the 20th century. The only formal training for engineers in the early 19th century was through military institutions. In 1824, the United States established the U.S. Army Corps of Engineers.[41] This group became the primary designers of major public works projects in 19th century America. Engineers who worked for industry were either self-educated or trained on the job. With the exception of France, this was a common situation for industrial nations. In 1794, the French established the

Ecole Polytecnnique.[42] By 1870 similar institutions were established in Germany, Switzerland, and the United States.[43] England was conspicuous in its continued reliance upon the apprentice system for technical education.[44] The object of these technical institutions was to train students in mathematics, the physical sciences, and industrial techniques. In many respects, these institutions were instrumental in the furtherance of industrial development.

Aside from the establishment of formal engineering education, industry had another effect on engineering. The civil engineer of the 18th century was distinct from the military engineer only in the projects that he undertook. By the early 20th century, civilian engineering spawned mechanical, chemical, electrical, and industrial engineering. Industry's demands for specialized technologists, coupled with the increasing inventory of technique, resulted in an internal specialization. Even civil engineering had developed specialities in transportation, hydraulics, structures, and other fields. The architectural and structural engineers who dealt with architects comprised a small percentage of the total field of engineering.

The early 20th century witnessed changes in the 19th century dichotomy between beauty and utility in architecture. Loos, in his 1908 work, Ornament and Crime, stated:

> "The evolution of culture marches with the elimination of ornament from useful objects."[45]

This attitude served to further discourage ornamentation of buildings for the sake of artistic effects. Another attitude was an optimism of society with technology. Many equated technological process with cultural process. As a result, symbols of the past were discarded as being not representative of the "new" age. Boccioni, a futurist artist, reflected the disenchantment with the past, and an optimism in the future.

> "...The era of the great mechanized individuals has begun, and all the rest is paleontology."[46]

The effect of these attitudes was to remove the 19th century practice of associating symbols of the past with what was considered beautiful. In the evolving view of architecture, what was useful could also be viewed as beautiful. As the engineer's work was considered useful, its forms could be considered as being elements of a new aesthetic. Le Corbousier stated the relationship between the engineer's forms and the modernist architect.

> "...The engineers of today have use of primary elements and by coordinating them in accordance with the rules, provoke in us architectural emotions, and thus make the work of man ring in unison with the universal order."[47]

By adopting the engineer's forms, the architect sought to place his art in the mainstream of the industrial culture. With the modernist, the 19th century issue of beauty and utility was partially resolved.

Another development which affected architecture in the early 20th century was the team approach to design. With the increasing sophistication of building systems and technology, it was difficult for the architect to gain an in-depth knowledge of all the factors involved in building. This situation was similar to the expansion of technical knowledge in 19th century engineering that led to specialization. With this sophistication, the architect became more a manager of design than an authority in every contributing factor. The age of the individual is design was drawing to a close. As industrial engineer Taylor noted the trend toward specialization in society:

> "The time is fast going by for the great personal or individual achievement... and the time is coming when all the great things will be done by the cooperation of many men in which every man performs that function for which he is best suited."[48]

The engineer had adapted to this role in the 19th century. In Layton's view,[49] the American engineer had always been a bureaucrat. However, this presented problems for the architect. Since the Renaissance tradition held that the artist was the individual author of his work.[50] This was less pronounced in the architect, as he depended upon craftsman to execute his work. However, the specialization in design meant that the architect had to share design decisions with his consulting engineers. This approach was effective only when the architect knew enough about technology to make reasonable judgements. The level and intensity of how much technology that the architect should know is a topic that still remains controversial.[51]

An emerging trend that effected both architecture and engineering in the 20th century was the changing client. Before the Industrial Revolution, the architect and engineer had worked for either a powerful individual or the state. As Jenkins noted:

> "In the 18th century the architect's employer was almost invariably the individual patron; in the 19th century his employer was the collective client- a committee, local council, or board of directors."[52]

Engineers designing public works projects felt the change in the client. Except for military organizations such as the Corps of Engineers, the civil engineer found himself employed by local governments who represented sometimes conflicting needs for public works. Engineers in industry were primarily employees of the corporations who were expected to be loyal to the company.[53] One problem that often arose was the degree of responsibility that the architect and engineer owed to both the legal client and the user. As Fitch noted:

> "In modern America the architect's real client is less and less his legal client. [The real client is] the people that the architect no longer sees. He deals with their agents--those corporate or institutional entities who commission the projects.... It cannot be assumed that these corporate or institutional clients...are always to be relied upon to represent the best interests of the consuming public."[54]

The Engineer's problems with client responsibility were addressed by Layton. Although engineers state that their primary professional objective is to serve the public,[55] Layton notes:

> "The role of the engineer as it has evolved in America has been a patchwork of compromises between professionalism and organizational loyalty."[56]

This problem has become more pronounced with the widening number of different people who use the designer's work.

Architects and engineers face similar problems from the perspective of increased sophistication of knowledge and the problem of client differentiation. One cannot necessarily state that the engineer is more specialized than the architect. Many architectural firms specialize in one type of building design, such as office buildings or hospitals. A point of differentiation might be found in attitudes of the two designers.

Peter Stringer's 1970 study on architectural and engineering student's attitudes[57] revealed some significant information. Regarding the subject of creativity, Stringer notes:

> "Although [architectural students] do not feel strongly that only new and original solutions to design problems will satisfy them, this characteristic is strongly denied by engineering students."[58]

With respect to working in groups, engineers are:

> "More likely to disclaim the notion that they prefer working alone to collaborating in a team."[59]

Another conclusion of Stringer's study refers to an attitude toward society:

> "The architecture students put more store by their responsibility to society in comparison to engineering students, whereas the latter feel a relatively greater responsibility to the profession."[60]

The picture that emerges from these observations indicates a distinction between architects and engineers. Architects could be characterized as less inclined to work in groups, more inclined to seek new solutions, and conceive their primary concerns to be directed toward social issues. On the other hand, engineers would appear to be team workers who seek the utilitarian approach, as opposed to the novel approach. This picture could be substantiated from past involvements and concerns of the architect and engineer. Romantic art and architecture was somewhat directed toward social goals. Bannam saw this tradition continued in the modernists work.[61] On the other hand, many engineers saw their work as benefiting industry, and thus society.[62] As to the group work preferences of engineers, most public works and industrial projects have been of such as scale that one person would have difficulty mastering all of the intricacies.

At this point in time, only a few criteria exist to differentiate the architect from the engineer. The first of these is the difference in training and knowledge of the two groups. Since the establishment of technical schools, engineering education has been directed toward mathematics and quantifiable models of the physical world. Architectural education has included some of the technological approach. However, it has been directed primarily to design concerns that extend beyond technology. Another method of differentiation is the type of projects with which the architect and engineer are involved, as well as their relative responsibilities. On public works and industrial projects, the engineers usually are the managers and designers. On building projects, architects are the managers and primary designers. Engineers serve in the role of consultants and contributory designers. A third method of differentiation is the attitudes of the two groups toward their profession and society. According to Stringer's study, engineers are more oriented toward their own group. Architects tend to be concerned with social issues over group issues.

The effect of this differentiation between designers can be seen in contemporary professional problems.

CHAPTER TWO

PROBLEMS IN CONTEMPORARY ARCHITECTURE AND ENGINEERING

The training that most engineers receive is directed toward viewing design problems as technical in nature. When the range of design concerns extends beyond those of technique, the engineer will sometimes adopt a Procrustean approach. What does not conform with the technical models is discarded or ignored. This behavior is not malicious in nature. Rather, it is a reflection of the specialization of concerns in engineering.

One example of the engineer's approach to design problems was the urban freeway. In this situation the freeway was viewed as a structural and civil engineering problem. As a result of the controversies surrounding its implementation, the full range of design issues involved in the freeway was revealed.

The freeway was intended to solve a problem in transportation. In the early 20th century, expanding cities experienced problems with traffic congestion. Street systems that had been laid out in an era of pedestrian and horse-drawn traffic were inundated by the automobile. By 1924, the number of cars on the existing national road system exceeded 17 million.[63] To cope with this problem, public works engineers of the time:

> "widened old roads, . . .set speed limits on them, . . .and put up thousands of traffic lights."[64]

This approach was not sufficient to keep pace with the rising number of vehicles on the roads.

One solution proposed to the problem of the automobile and the crowded streets was to build new road systems. In the 1938 World's Fair, the General Motors exhibit displayed an amazingly prophetic vision of the shape of automobile transportation systems today. Using the model of the railroad, designers proposed the construction of a separate transportation system for the automobile. The G. M. exhibit portrayed the shape of the system to be a multi-laned, high-speed, divided expressway.[65] Similar roads had been constructed as parkways, and were successful in providing the motorist with a pleasurable driving experience. It was thought that this experience could be extended to everyday travel.

The proposed effects of a national system of high-speed freeways were portrayed as being beneficial to all in society. However, Bel Geddes' 1940 work, Magic Motorways, saw the implications of the new highway on the city:

> "People will see that if roads are designed specifically for their traffic, then whole cities ought to be designed specifically for the business of cities. It is not the business of cities to serve as residential centers. With an adequate highway system to transport them back and forth, families could be moved 30 to 50 miles away from their place of work."[66]

This view of the decentralized city was also a concern of urban planners of the time. According to Jacobs, in her work The Death and Life of

Great American Cities, there existed a group of planners who desired to:

> "decentralize great cities, thin them out and disperse their populations into smaller, separated cities, or better yet, towns."[67]

As Jacobs notes, the views of these planners were represented in the architectural schools and legislatures of the times.[68] In many respects, the freeway was an integral part of this planning concept. Transportation was viewed by some as having planning implications.

The Interstate Highway System was initiated in 1957 when Congress voted to appropriate funds for construction.[69] As this project was to be a public works project of both the state and federal government, the design of the roads was put into the hands of civil engineers. State highway departments were entrusted with the planning, design, and construction supervision of the freeways. At this time, highway planning and design was concerned with issues of construction costs and traffic flow volumes. Few departments had any expertise in urban planning and design.

From its inception, the freeway was thought by its designers to be a technical problem. A review of the national AASHO design manual[70] shows that the only references to non-technical concerns dealt with the visual character of the road as viewed by the driver. Mumford questioned this approach in his work, The Highway and the City:

> "What's transportation for? This is a question that highway engineers apparently never ask themselves.. . .To increase the number of cars, to enable motorists to go long distances, to more places, at higher speeds, has become an end in itself."[71]

Halprin saw the engineer as being unable to deal with the complexity of the urban environment. Due to their technical outlook they were:

> "inadequately trained, unfortunately selected, and poorly educated. . .with limited outlooks. . ."[72]

Frequently, the operational characteristics of the road, such as grades and curvature radii, dictated the location of the alignment. To lower construction costs, areas were chosen that had relatively low assessed property values.

The result of these practices was a disrupted urban environment. McHarg, in the work <u>Design with Nature</u>, saw the engineer as competent to deal with the technical issues of highway design, but unable to deal with the human and urban design aspects of highways:

> "[The Engineer's] competence is not the design of highways, merely of the structures that compose them."[73]

The highway engineer had "layed waste to woods, streams, parks, and. . . neighborhoods"[74] in the design and construction of his works. A further indication of the inadequacy of the engineer's approach to the design problems of the freeway was that they did not live up to the original expectations. A cycle was noted in which the construction of roads generated volumes of traffic that made the road non-operational.[75] A cycle was put into motion where the road construction programs were in competition with an ever-increasing traffic volume. A third problem with the roads was an increased generation of air pollution from automobile exhausts. To many, the engineer's work was environmentally destructive and a failure at solving transportation problems.[76]

Another dimension of the highway problem concerned the client. As projects of this magnitude were often beyond the means of individuals, the government was frequently the client. An additional reason for government involvement was that traditionally the building of public works projects was an improvement shared by all in society. Since the French establishment of the Ecole de Ponts et Chausses, state-supported road building projects were perceived to be engineering concerns. In a representative democracy, the government created problems as a client for the engineer. It was assumed that serving the interests of the government was equal to serving the interests of the public. However, major forces effecting legislative decisions were neither elected nor responsive to public influence. Robinson referred to this group as the highway lobby:

> "Lobbyists are employed by all the groups which comprise the Highway Establishment. As long as their operations are in the open, they serve a useful purpose by providing our lawmaker with facts. Unfortunately, they have many means of less publicized coercion not open to the private citizen."[77]

Representatives of this group included automobile manufacturers, oil companies, and construction materials suppliers.[78] By influencing the government, who was the highway engineer's legal employer, these lobbyists became a client of the engineer. Often, the demands of governmental organizations were opposed to the values of the public. The end result of this situation was to expose the engineer to public criticism.

Public reaction against the highway took many forms. Legal actions were brought against highway projects to halt construction.[79] The Highway Trust Fund, a method of financing the Interstate System, was attacked by citizens' groups. Increased emphasis was placed upon integrated transit systems and mass transit alternatives. The Federal Aid Highway Act of 1970 made citizen review of planning and design mandatory. The organization representing state highway officials, AASHO, was critical of these actions and their economic consequences. Its chairman, Alfred Johnson, commented:

> "The relocation assistance, your double hearings, your environment, your conservation, your urban designs, your equal opportunity--those are things that cost money. And a lot of these costs are for cosmetics."[80]

However, he also admitted that the urban freeway was a mistake. "As far as I'm concerned, we should just forget them."[81] These comments reflected both the severity of the public reaction, and the engineer's response to it.

In many respects, the highway controversy was an education for the civil engineer. In his thinking, the highway was a transportation project, and dealt with technical issues. As the Commissioner of Public Works in New Hampshire stated in 1974:

> "Twenty-five years ago, it was a relatively simple matter to get a highway project underway. Once the need was recognized. . . we proceeded with the layout and the construction with maximum utility and an optimum cost

> benefit ratio as principle guidelines. Present day concerns cover a great deal broader area."[82]

To deal with the broader concerns of public works design, some engineering educators suggested an increased emphasis upon "non-technical" subjects in the training process. Schaumberg viewed the engineer's emphasis upon technical solutions as the major factor in creating works that did not respond to public needs.

> "Since the role of the practicing engineer is supposed to enhance the welfare and well-being of society, how can the engineer without a sound base of human sensitivity and social values determine whether his work achieves the goal? The student who is unwilling or unable to hold the human dimension with technological understanding. . .will be content to receive problems as 'given' and then proceed to determine meticulously and efficiently how, how much, and how fast."[83]

In the case of the freeway, how, how much, and how fast were the responses of the civil engineer to the transportation problem. The concerns of urban planning and design were discarded. The political structure that served as the client inhibited direct contact with the public. However, it could be argued that this did not exempt the engineer from considering the social effects of his work. The overspecialization of concerns had the effect of creating hostility between the technologist and the public.

How could this problem have been avoided? Both Halprin and Robinson saw a solution in the changing of the academic training for engineers. As Robinson viewed the problem, the curricula of study was the culprit:

> "There is little or no room in [the engineering student's] curricula for literature, philosophy, art appreciation, or even political science. By any reasonable academic standards, he is not an educated man, but a technician."[84]

Halprin saw this re-emphasis as instrumental in creating "broad gauge" people to deal with environmental design problems.

Many in the civil engineering profession acknowledged this view of broadened education leads to broadened awareness and concerns. However, the profession sees the primary problem in the relationship between their group, the political client, and the public. As Musprait stated, in his paper "The Challenge for Engineering":

> "The greatest need today is to reconcile technical decision making with political decision making."[85]

Thus, many in the engineering profession continue to view their work as technical in nature. The problem is seen as political in nature. By participating in the political process, some engineers see the public benefit as being served.

> "[A problem is] the civil engineer's lack of participation in the processes that decide the fate of his and the public's well being."[86]

If the engineer does gain increased participation in the political process, what will be the shape of the resultant environment? This question was not addressed in the professional literature that was reviewed.

The engineer as a political and social power was an image that held great promise for some in the past. Veblen[87] argued that the engineer should inherit the leadership of industry by virtue of his abilities and capability to better serve social needs. However, society and its economy encompass far wider concerns than technical and economic issues. The built environment of the freeway gives an indication of the limits of technology. If the engineer is to achieve his role as the designer for the public good, his concerns will have to be broadened. Engineering must become a liberal art.

Many architects in today's society are being placed in an uncomfortable position. With the increasing sophistication of building technology and systems, architects often find their work designed by their consulting engineers. The team approach to building design was intended to allow the architect to manage the work of his consultants. However, this approach can become problematic if the architect does not comprehend the implications of separate technological decisions on the entirety of the project. The architect's primary role is often to create order through management of his consultants. If this order is not established, the building engineers will often make decisions only in reference to their specialties. To avoid this occurrence, the architect must manage the input of individuals who possess a greater knowledge of their specialties than he does.

Under these conditions, who designs buildings? According to the AIA Handbook, if the architect uses in-house consultants, engineering is assumed to account for at least half of the fees in the construction document phase.[88] In some construction projects, the costs for engineering-related work can exceed 60% of the total project cost. If the engineer's work comprises such a great proportion of a project, what is the architect's role in design? According to the AIA, one of the architect's roles with respect to the client is to accept responsibility for the engineer's work:

> "Since the engineer or consultant acts as the architect's agent, the architect assumes primary responsibility to the owner for the accuracy and completeness of the work performed by him."[89]

Not only does the architect have to understand technology in order to manage design; he must also accept legal responsibility for the engineer's work.

A tension has often been created between the architect's need to understand technology and his traditional role and training. In the 19th century, the dichotomy of beauty in art and utility in technology created an atmosphere of architecture becoming "structural camouflage".[90] In the Chicago School, this tension was partially reconciled. The predominate building type of this group of designers, the skyscraper, demonstrated an accommodation of architecture and technique. The skyscraper was as much a work of engineering as it was architecture.

The skyscraper evolved from a number of different influences. Wolf Von Echardt saw technical developments as being highly influential in the origin of the skyscraper:

> "The Industrial Revolution had presented [architects] with steel, glass, central heating, and electric light. Otis had invented a device to keep elevators from plunging. Eiffel had built his tower with construction methods he developed for railway bridges."[91]

Along with these developments, other factors came into play. Rising land costs created the need to maximize the use of property. An increase in commerce and industry brought both the demand for increasing space and the wealth to finance construction.

The prototype of the skyscraper was constructed by architect-engineer Jenny in 1884. The Home Insurance Building deemphasized the wall as a structural element by utilizing a 10-story iron frame to carry gravity loads. It was also notable in that Jenny was trained in a French technical school, and was previously exposed to iron framing in industrial facilities.[92] The transference of building technology from public works and industrial structures to architecture was a process that was to continue through Gropius and the modernists.

A further development in the skyscraper came with the work of Sullivan. As Cowdit viewed Sullivan's work, he saw it as an attempt to create a "mature civil architecture out of the technical means and utilitarian demands of the age."[93] As to the nature of the new architecture, Cowdit said:

> "What [Sullivan] was trying to articulate was some kind of complex psychological reaction to the new structural techniques. As symbols the buildings and celebrations of the new technological virtuosity. . .it is an expression of the awareness of a new kind of power."[94]

Sullivan formed a partnership with structural engineer Adler. As Hilberseimer noted,

> "This collaboration made it possible for [Sullivan] to realize his architectural concept."[95]

Another development in architecture that was highly influenced by structural potentialities was the glass-walled skyscraper. Van de Rohe's designs for a concrete-framed building with a glass curtain wall explored the potentials of the new technology. Contrary to the New York school of classical revivalism, Van de Rohe did not attempt to conceal the structure of his works. Rather, he:

> "made technology his point of departure . . .and sought a close relationship between technology and architecture."[96]

In Van de Rohe's work, the expression of structure became the foundation of an architecture that sought to deal with building problems of the time.

The glass-walled skyscraper has been criticized by many as being anti-art, dehumanizing, and environmentally questionable. Even the designers of these works sometimes agree. Owings, a partner in the firm that designed the tallest building in the world, stated:

> "Skyscrapers tend to dehumanize the area in which they are raised."[97]

Many architects are seeking to adapt the necessary buildings of commerce to a better understanding of human concerns in architecture. Some have joined in the current fashion of berating technology and the structural forms of the modernists. However, it becomes difficult to jettison a history of the close interaction of technology and architecture. If the skyscraper is to be made in a more desirable image, the participation of the engineer in the design process will be essential.

If modern technology has such a large influence upon the design of buildings, it would be assumed that architects would be relatively conversant with engineering. However, there are indications that this is not the case. Regarding the technological education of the architect, the August 1981 issue of Architectural Record held a forum to examine its emphases and depth. One of the educators remarked:

> "Architecture is really a fragmented profession. Architects work with consultants who are in a separate firm, do separate work, and who all have to be coordinated. The schools are set up in the same way. We teach in a fragmented way. It's easier to teach concepts in isolation--but it may not be the best way."[98]

The architect and engineer are separated in an academic environment. This separation continues largely throughout the professionals' careers. It would appear that a closer contact at this point would develop mutual understanding of the nature of both architectural and engineering concerns.

Aside from a separate educational system, architects and engineers are influenced by attitudes within their professions. One of the participants in the Architectural Record forum noted:

> "Architecture is really moving in very pluralistic ways, and certainly part of the current thought in architecture is very antitechnological. Many of our leading thinkers and most influential architects today are not at all concerned with engineering, but rather with architecture as art."[99]

Fitch noted an attitude of the post-modern architects in which:

> "Social responsibility and functional efficiency are ridiculed as irrelevant qualities in architecture."[100]

Architect Conklin saw the reason for this swift changing attitude in architecture:

> "For a long time, one of the givens, the goals, of architecture was to give expression to technology. That seems to be changing as we see more designs

> intended to express something else--
> a relationship to history, or a special
> image."[101]

It would appear as though current attitudes in architecture are being directed away from an involvement with technology. One direction that this trend could follow is a return to the 19th century attitude of art versus technology. It is interesting to note that the 19th century attitude diminished only after a rapid pace of technological developments was viewed by society as being beneficial. At present, there exists an uncertainty about the continued developments and effects of technology. However, this trend may not last indefinitely.

What does the architect's attitude toward experimentation with form reveal about their possible future? Historian Melko has observed what can happen when old forms break down:

> "New forms will eventually replace
> those that have broken down. But in
> a world conditioned by the old, it
> is difficult to distinguish between
> what represents a genuinely successful
> discovery of forms. . .and what are
> simply desperate, meaningless, and
> blind experiments.. . .It may not be
> the artist, but the engineer or the
> craftsman. . .who develops the appro-
> priate forms."[102]

By this observation, the present experimentation in architecture may result in the engineer assuming the role of architect. This possibility is all the more realizable when one considers the influence that today's building engineers exert over the design process. An anti-technological approach to architectural design could have the effect of placing all but issues of appearance in the hands of other professionals. On the other hand, the architect who is conversant with engineering can actively participate in, as well as manage, the design process.

CHAPTER THREE

POTENTIALITIES AND PROPOSALS

A major problem that faces our society deals with the interconnected issues of resources and the environment. Its dimensions encompass international and national politics, social attitudes, economics, and human values.

The 19th century saw the rise of a group of industrial nations that consumed large quantities of natural resources, produced manufactured goods, and exported their surpluses to the now-industrial nations. In return, the non-industrial nations would slip raw materials back to the industrial nations. This type of system had the effect of concentrating capital in the industrial nations, and discouraging development of locally owned industry in the Third World. However, political and economic trends of the past half century have weakened this system. Many nations in the Third World are becoming independent of direct political control by foreign governments, raising the price of exported raw materials, and developing their own industrial base. Competition in world markets has had the effect of favoring those nations with large quantities of either natural or labor resources. As a result, the "haves" and the "have nots" are becoming redefined.

The international political situation in today's world is in part a reflection of who has the resources and their allegiences to political alliances. In the Third World, resource-rich countries have maintained close alliances with the industrialized nations. However, some of these countries have concentrated their economies upon "modernization" of their infastructure to the exclusion of meeting the basic needs of their populace. As domestic discontent grows, the government will often seek to repress political challenges. In some cases, the results of these practices has been an overthrow of the existing government and a re-alliance with other powers. The American economy imports large quantities of raw materials from many of these countries.

The United States, in many respects, is the most privileged nation in the history of the world. In this country, 6% of the world's population consumes 35% of the globally marketed resources and energy. Political freedom is greater in this country than anywhere else. Our economic system has produced freedom of movement, freedom from the elements, freedom from hunger for most of the population, and freedom inherent in a long life span. However, political history has shown the consequences of a society's economy being radically altered. In Germany during the 1930s, the desire to be free of a failing economy ushered in an infamous political regime. It is to the credit of this nation that our self-government tradition survived the 1930 depression. However, this does not guarantee that the forces that will sacrifice freedom for security will be defeated if another economic disruption occurs. In a world economy, the political systems of other nations have a great effect on our own economic and political structure.

A society rarely accepts the diminution of privilege without resisting. The living standard of industrialized trade is showing signs of erosion. This has had the effect of producing stresses within our society. The proximity of the time between the old state of affairs and the present situation has had the result of heightening these stresses. Signs of uncertainty are reflected in the rise of absolutist philosophies, nationalistic political systems, and a paranoic defense policy. One of the major domestic political problems is the method of enforcing a status quo in the light of a changing global economy and political order.

Another emerging problem is the issue of the environment. McHarg[103] saw one aspect of western culture to be a war with nature. As long as nature was formidable by virtue of its power, man's manipulations were relatively inconsequential. With the Industrial Revolution, man's command of the new technology increased his ability to significantly alter nature. However, the old urge of dominance was not replaced by a respect for what man could control. Western culture had not developed an environmental ethic based upon understanding and respecting the natural environment. The 18th century attitude towards nature as being separate from man and subject to his manipulation has remained. This attitude allowed for the development of the modern economy and technical sophistication. However, science has reached the point where the end results of past actions are becoming realized.

It is difficult to separate the resource and environmental issues. In a biological sense, man is an organism that is subject to the resources and climate that the environment affords. An organism develops a pattern of behavior to respond to its environment. In human societies, this behavior is sometimes referred to as a lifestyle. It was a belief of many in the 19th century that a change in the environment would cause a change in one's behavior. With respect to material needs and human behavior, I believe that this view of environmental determinism is valid. Our accessibility to resources has created a certain set of attitudes about the environment. As this accessibility changes, our attitudes will change. The problem becomes one of time. How fast can an established set of attitudes respond to a changing social and natural environment? What form will this adaptation take?

Contemporary America has grown up with a lifestyle based upon consumption of ever-increasing quantities of goods and resources. The national economy is founded upon continual growth and expansion. However, what happens when these resources to which we are accustomed begin to be depleted? Some economists state that we will find substitutes for materials that are in short supply. In the past, energy sources were shifted from one source to another when economy and availability dictated. This view does not immediately address the time the changeover takes or the social consequences of such a change. Nor, does it view the existence of world-wide resources as a closed system. It may be that fusion power will be developed to solve energy problems. It may also be that relatively common elements will be substituted for existing scarce materials. However, experience has shown that technical advancements have often been made at the expense of the natural environment. The technical breakthrough approach will be beneficial only if technologists can come to any understanding of how their work effects the social and natural environments.

At this point the designer enters the picture. Architects and engineers have, for the past few centuries, designed the infastructure for a resource-consuming society. Their work made possible and encouraged its growth. The designer also possesses a means for introducing society to an alternate form.

The designer is a unique individual in society. At various times and in various ways, the designer has provided for man's material needs of necessity and convenience. There are two basic ways of achieving this. One way has been for the designer to understand social needs, and respond to them. This approach assumes that the needs have been predetermined. The designer acts in the role of a skillful technician. The other way is when the designer's work both created and satisfied a need or desire that society had not previously articulated. In this role, the designer acts as an advocate of his work. Many have stated that the builder and engineer are representatives of the first group. Architects are frequently associated with the second. However, the impact of technology upon our society has increasingly placed the engineer in the second group. This aspect of design also places the architect and engineer in a position of influence in creating an image of an environmentally conscious society.

The search for an image of the environmentally conscious society is already underway. Architect Geddes sees its roots in the changing relationship between technology and the environment:

> "In the early phase of modern architecture. . .the resources of nature seemed limitless. Energy and power were expressed. Now a fundamental shift in values has occurred. Nature is seen as fragile and limited in resources. It is something to be nurtured. . . .When nature is seen thus. . .it becomes the primary source material for architecture."[104]

Malcolm Wells has advocated and constructed buildings that were generated by considerations of the natural environment. Wright's design for Broadcast City was, in part, a statement about man's relationship with nature. In the work of Downing, there existed a tradition of this type in America over a century ago. What happened in the meantime was the impact of industrialization.

The core of an environmentally conscious design is not the rejection of technology. If anything, the role of the designer will be to find a ground for reconciling the interaction of technology and the environment. This would express the advantages of living with less resources by virtue of our skill at adapting technology to human needs. We possess the skill to build machines. What is needed now is the skill to adapt them to our intended goals.

What could be done to achieve this? The education of the consulting engineer must begin to include an emphasis upon architectural and urban design, as well as the social sciences. A problem with engineering education is that the subject is seen as an abstract entity in itself. There is little understanding of who utilizes the structures that the engineer designs, or what effect those structures have upon the human environment. Nor is there an understanding of what the architect desires or seeks when he designs. In order for the team approach to be successful, the parties must possess some understanding of their relationship to the entire effort. For the engineer's relationship to the public to be improved, an understanding of who the public is should be gained and held in mind throughout the design process. On the other side of the coin, the architect should receive an increased contact with his future consultants through the educational process. Part of the architect's training should include an increased emphasis upon the basics of technology.

To achieve this goal of commonality of concerns, the educational institutions for designers should be modified. It would be undesirable to found a new set of institutions. Rather, the curricula of architecture and civil engineering should be redirected. At least one year of coursework should be common to both architectural and engineering students. The freshman year would be preferable as it acts as a foundation for the subsequent studies. Along with this foundation, courses should be taught in subsequent years that bring architecture and engineering students together in design and planning situations. The intention is not to make the architect into an engineer, or visa versa. Realizing that the work of engineers has had a large impact upon that of architects, landscape architects, and urban designers, the development of a grounds for future communication should be established. It is not suggested that an entirely new discipline be established. This would serve to compound the problem of specialization and professional jurisdiction.

The common topics taught in this curricula option should be: history of architecture and technology, a design laboratory sequence, and an introduction to the environmental sciences. Subsequent to this common training, engineers should receive more courses in the social sciences. The intention would be to develop a mutual respect for the views of each party towards design, develop a respect for and sense the potentialities of the natural environment, and seek to bring the social dimension into design. It would also be desirable to bring both the practicing professionals and the general public into the educational environment to add an understanding of the complexity of the issues involved and to discourage artificiality of concerns. A mechanism for this exists in the design jury system of criticism. However, it should be extended to the earlier stages of the project through a workshop or seminar system. One problem in today's professions is that public input is not often sought until the project is already "firmed up".

The problems with this proposal are formidable. Concerns of academic and professional accreditation would require the traditional number of credits for degree completion to be increased. However, a responsive designer is as important to society as a doctor or lawyer. Both of these fields have formal training periods longer than either architects or engineers. Another problem is tradition. The professionals have been trained in the present form for over a half century. A sudden change is likely to cause resistance and uncertainty. In this case, the proof of the approach would be the work of the graduates.

Another recommendation is the establishment of institutions to conduct research into the interactions of the built environment, and the natural and social environments. These organizations already exist to some extent. Their role in the educational process and in serving the community should be encouraged. As this type of work would be in the public interest, it is assumed that government funding for such research could be secured. Their work could also be funded on a contract basis by undertaking private research work. Many design firms do not presently possess the financial resources to do this type of work. The need for such an institution is that a great deal of our existing infastructure may have to be modified in the near future. This organization could act as an adjunct to the designer by identifying desirable alternatives based upon research into the problem.

Educational institutions could also serve two other roles: provision of means of apprenticeship for students, and serving as a an point of public access to design services. These roles are mutually beneficial. Much education in design schools deals with simulations of problems. Public access to design services is often limited by economic concerns. By acting as a public service, these institutions could act as a method of confirming the validity of design concepts through the implementation of proposals.

REFERENCES

[1] Friedrich Klemm, A History of Western Technology, (Scribners:New York, 1959), p. 45.

[2] William Fleming, Arts and Ideas, (Holt, Rinehart and Winston:New York), p. 267.

[3] Spiro Kostoff, The Architect, (Oxford Univ.:New York, 1977), p. 125.

[4] Ibid., p. 135

[5] Ibid., p. 98.

[6] Ibid., p. 130.

[7] Ibid, p. 112.

[8] Klemm, op. cit., p. 112.

[9] Gosta Sandstrom, Man the Builder, (McGraw-Hill: New York, 1970), p. 190.

[10] Ibid., p. 194.

[11] Donald Egbert, The Beaux-Arts Tradition in French Architecture, (Princeton Univ. Pres:Princeton, 1980), p. 18.

[12] Sandstrom, op. cit., p. 194.

[13] Ibid., p. 195.

[14] Kostoff, op. cit., p. 176.

[15] Ibid., p. 177.

[16] Idem.

[17] Sandstrom, op. cit., p. 195.

[18] Idem.

[19] Samuel Smiles, The Lives of the Engineers, Vol. I, (Murray:London, 1874), p. XVI.

[20] Idem.

[21]Frank Jenkins, Architect and Patron, (Oxford:London, 1961), p. 63.

[22]Ibid., p. 42.

[23]Ibid., p. 47.

[24]Smiles, op. cit., p. XX.

[25]Jenkins, op. cit., p. 111.

[26]Paul Solomon, History and Human Nature, (Harcourt, Brace:New York, 1979), p. 32.

[27]Fleming, op. cit., p. 470.

[28]David Watkin, Morality and Architecture, (Clarendon:Oxford, 1977), p. 17.

[29]Reginald Turnor, Nineteenth Century Architecture in Britain, (Batsford:London), p. 73.

[30]Fleming, op. cit., p. 470.

[31]Jenkins, op. cit., p. 191.

[32]Turnor, op. cit., p. 27.

[33]Ibid., p. 30.

[34]Ibid., p. 75.

[35]John Gloag, Victorian Taste, (Black:London, 1962), p. 130.

[36]David McCullough, The Path Between the Seas, (Simon and Schuster:New York, 1977), p. 195.

[37]Idem.

[38]Peter Ferriday, Victorian Architecture, (Lippincott:Philadelpha, 1964), p. 45.

[39]Joseph Bensman, The New American Society, (Quadrangle:Chicago, 1971), p. 33.

[40]Fleming, op. cit., p. 534.

[41]Daniel Mazmanian, Can Organizations Change? (Brookings:Wasington, 1979), p. 8.

[42]Fleming, op. cit., p. 470.

[43]Sandstrom, op. cit., p. 195.

[44]Idem.

[45]Reyner Banhan, Theory and Design in the First Machine Age, (Praeger:New York, 1960), p. 94.

[46]Ibid., p. 102.

[47]Ibid., p. 225.

[48]Laurence Holland, Who Designs America?, (Anchor: Garden City), p. 77.

[49]Edwin Layton, "Science, Business, and the American Engineer," ed. Perrucci, The Engineer and the Social System, (Wiley, New York), p. 52.

[50]Fleming, op. cit., p. 261.

[51]"The Engineering Education of the Architect", The Engineer and the Social System, (Wiley:New York), p. 52.

[52]Jenkins, op. cit., p. 188.

[53]Layton, op. cit., p. 54.

[54]James Fitch "The Profession of Architecture", ed. Lynn, The Professions of America, (Riverside:Cambridge, 1965), p. 236.

[55]American Society of Civil Engineers, Code of Ethics.

[56]Layton, op. cit., p. 54.

[57]Peter Stringer, "The Professional Self-Images of Architecture and Engineering Students", ART, (Nov., 1970), p. 25.

[58]Ibid., p. 27.

[59]Idem.

[60]Ibid., p. 28.

[61]Banham, op. cit.

[62]Layton, op. cit., p. 53.

[63]Norman Bel Geddes, *Magic Motorways*, (Random House:New York, 1940), p. 29.

[64]*Idem*.

[65]*Ibid.*, p. 236.

[66]*Ibid.*, p. 292.

[67]Jane Jacobs, *The Death and Life of Great American Cities*, (Vintage:New York, 1967), p. 20.

[68]*Ibid.*, p. 27.

[69]Lewis Mumford, *The Highway and the City*, (Mentor:NewYork, 1963), p. 244.

[70]American Association of State Highway Officials, *A Policy on Geometric Design of Urban Highway*, 1965, ed.

[71]Mumford, *op. cit.*, p. 246.

[72]Lawrence Halprin, *Notebooks 1959-1971*, (MIT Press:Cambridge, 1973), p. 157.

[73]Ian McHarg, *Design with Nature*, (Doubleday:Garden City, 1971), p. 32.

[74]Mumford, *op. cit.*, p. 247.

[75]*Ibid.*, p. 248.

[76]*Ibid.*, p. 256.

[77]John Robinson, *HIghways and Our Environment*, (McGraw-Hill:New York, 1971), p. 291.

[78]*Ibid.*, p. 320.

[79]*Fortune*, (July, 1971), p. 124.

[80]*Ibid.*, p. 125.

[81]*Idem*.

[82]*Assessment of Resources and Needs in Highway Technology Education*, (ASCE:New York, 1975), p. 2.

[83]Frank Schaumburg, "Engineering--as if People Mattered", *Civil Engineering*, (Oct. 1981), p. 56.

[84]Robinson, *op. cit.*, p. 293.

[85]Murray Mospratt, "The Challenge for Engineering", *ASCE Journal of Professional Activities*, (Oct. 1978), p. 243.

[86]James Van Beveren, "Engineer's Role in Environmental Issues," *ASCE Journal of Professional Activities*, (April, 1976), p. 171.

[87]Robert Heilbroner, *The Worldly Philosophers*, (Simon and Schuster:New York, 1980), p. 232.

[88]"Project Procedures", Chap. 11, *Architects Handbook of Professional Practice*, (AIA: Washington, 1969), p. 5.

[89]"Interprofessional Agreements", Chap. 10, *Architects Handbook of Professional Practice*, (AIA:Washington, 1975), p. 4.

[90]Turnor, *op. cit.*, p. 27.

[91]Wolf Von Eckardt, "Too Many Buildings in Too Small a Space," *AIA Journal*, (March, 1982), p. 102.

[92]Carl Condit, *American Building Art, The 19th Century*, (Oxford:New York: 1960), p. 52.

[93]*Ibid.*, p. 272.

[94]*Ibid.*, p. 273.

[95]Ludwig Hilberseimer, *Contemporary Architecture* (Theobald:Chicago, 1964), p. 97.

[96]*Ibid.*, p. 138.

[97]Von Eckardt, *op. cit.*, p. 102.

[98]"The Engineering Education of the Architect", *op. cit.*, p. 84.

[99]*Ibid.*, p. 83.

[100]James Fitch, "A Funny Thing Happened....", *AIA Journal*, (Jan. 1980), p. 68.

[101]"The Engineering Education of the Architect", *op. cit.*, p. 89.

[102] Matthew Melko, The Nature of Civilizations, (Porter Sargent:1969), p. 65.

[103] McHarg, Ibid., p. 67.

[104] Robert Geddes, "What Next?", AIA Journal, (Mid-May, 1980), p. 193.

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THE POTENTIAL FOR COMMONALITY IN

ARCHITECTURAL AND ENGINEERING

by

Joseph Showers

(ABSTRACT)

Architecture and engineering are two professions whose concerns are often contradictory and in conflict. This situation has sometimes impaired the professions in responding to the client's needs. The encouragement of a commonality of concerns could act to enrich the quality of each profession's work.

The origins of the problem lie in the past attitudes, social roles, and training of designers. These aspects were a response to past social stimuli and have continued to today. While an alteration of social roles would be problemmatic, the training process and attitudes of the professions are possible grounds for change. Educational institutions could play a major role in this redirection of concerns.

A need for encouraging commonality of concerns lies in the designer's potential role in addressing environmental issues. The relationship between the built enviornment and life-style could be utilized in encouraging a more environmentally conscious society. This goal could be realized if architects and engineers understood the strength of design protentialities afforded by a commonality of concerns.