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Major Bridge Projects from the Point of View of Owners

Projets de ponts importants du point de vue du maître de l'ouvrage

Wichtige Brückenbauprojekte vom Standpunkt des Bauherren gesehen

E.K. TIMBY

Member of Advisory Board

Howard Needles Tammen & Bergendoff

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SUMMARY

This theme paper departs from the strictly technical aspects of structural engineering to examine societal and political influences which control vital phases of the creation of a major bridge project. Emphasis is placed on the need to improve communications, and thereby confidence and understanding, between the three principal groups involved: government, the public and technology. Return to realistic attitudes with respect to cause and effect, and cost vs benefit, is considered long overdue.

RESUME

Ce rapport s'éloigne des aspects strictement techniques du génie civil pour étudier les influences sociales et politiques qui gouvernent les phases critiques dans les projets de ponts importants. Le besoin d'une amélioration dans la communication est souligné, une telle amélioration menant à un climat de confiance entre les trois groupes intéressés: autorités, public et techniciens.

ZUSAMMENFASSUNG

Dieses Referat verlässt die rein technischen Aspekte des Ingenieurwesens, um soziale und politische Einflüsse zu studieren, welche bei grösseren Brückenbauprojekten auftreten. Die Notwendigkeit, Kontakte zu verbessern, wird betont, da dadurch mehr Vertrauen und Verständnis zwischen den drei betroffenen Gruppen: Behörde, Öffentlichkeit und den Technikern entsteht.



Editorial Preface

On the occasion of the IABSE's Symposium "BRIDGES" 1979 in Zurich, Elmer K. Timby, USA (Honorary member of IABSE) presented a theme paper which despite its restriction to "Bridge Projects from the point of view of owners" led to the discussion of some very valuable points and to a deeper insight into the relations between engineers, constructors, owners and the general public.

Mr. Timby's theme paper was also the basis for written comments by six prominent engineers from the USA. We had the opportunity to study these papers and found their content most worthy of being brought to the attention of the members of IABSE. As these comments relate to a large extent to the theme paper, we found it appropriate also to reprint the latter without any alterations. The comments however have been shortened with respect to introductory remarks in order to avoid duplications.

The Editorial Committee of IABSE expresses its sincere appreciation of Elmer K. Timby's various valuable contributions to the activity of IABSE including this paper. It also thanks the authors of the comments for their active participation in the discussions.

Prof. J. Schneider
Secretary of the Technical Committee
of IABSE

The problems requiring action and decisions by a future Owner of a proposed major bridge project are typically related to the specifics of why, where, what, when, who and how. The Owner, usually an arm of government, frequently has little if any meaningful experience in such specifics as they relate socio-economic service benefits, engineering theory and practice, costs, and environmental impacts of the project. Also, there are often existing restrictions and controls formulated in years past by legislators, administrators and regulators under political initiative and pressure without any anticipation of the project at hand.

To further define the basis of discussion, the reader is referred to the August 1969 Report of the Institution of Structural Engineers, entitled "Aims of Structural Design," for an excellent presentation of factors, processes, philosophy and relationships relevant to the subject. The following brief quotations therefrom are significant here:

"Design is an art concerned with the adequate. Its history shows a perpetual extension and refinement of the knowledge of what is needed of a structure and how these needs may be satisfied at least expense of human effort and wealth.".....

"The structure must fulfill its intended functions must be safe (and) must be of least cost.".....

"Design starts with the appreciation of the client's (owner's) requirements; this is the critical stage in the process and calls for the closest collaboration between the client and the designer. Not every client knows exactly what he needs; many are unaware of what structural engineering can provide.".....

"The works of the structural engineer are of major consequence to society, which can and should define the functional standards of building.".....

It is observed that "safety" and "least cost" are often at odds with each other, requiring the designer to make a calculated judgment as to cost vs. benefits based on his accumulated knowledge and experience. In the words of a multinational company in the construction field: "There are no simple solutions; only intelligent choices." Of course, choices are not limited to technological matters. Many of them relate to definition of functions to be served, to location of structure as a compromise between function, environment and cost, and to a variety of ancillary considerations -- such as aesthetics, cultural impact, and economic consequences. Numerous instances can be cited to demonstrate that a major bridge has critically influenced the culture and economy of an entire political entity.

The "cost" of a major bridge is defined as including operation, maintenance, amortization and demolition charges throughout the life of the structure as well as the initial cost of planning, design, right-of-way and construction; plus the added totally unproductive costs of delays and extra work caused by lack of prompt and firm decisions by the owner, and by interference by possibly well-intentioned but uninformed and/or misinformed segments of society and government. Such delays in providing a needed structure deprive society of needed services and also represent additional tangible costs, and not infrequently double or triple the initial cost at the same time. By the same token, service functions provided have value to the public and to a degree offset cost as broadly defined above.

Contrary to certain political, environmental, ecological, egalitarian, and news media pronouncements, the creation of a needed major bridge is a serious matter, can be analyzed rationally, and is an achievement of great importance.



It meets not only a service function for society but also, perhaps as importantly, will inspire those in other cultures to dream great dreams and to challenge the impossible. Such a design should never be entrusted to those whose credentials are limited to the production of impressive renderings or to the offering of the lowest fee.

Experience in the USA has not included significant use, with respect to bridges, of competitive designs nor of tenders for design plus construction. In each case, only one competitor wins. The costs for all other participants must be recovered by them from the owner conducting the competition or from owners of future projects. For a major bridge project, such costs can be very substantial.

On the other hand, there have been recent attempts by government to force competitive bids for design, suggesting various euphoric procedures whereby experience and capability would be given priority. The real purpose of such suggestions is, of course, not to provide better structures from the owner's point of view but rather to relieve the owner (government in this case) from having to make difficult qualitative judgments. Such attempts overlook the fact that in the case of a major bridge there is no basis for bidding to accomplish the design because there is no existing specific definition of the work to be done. Such a procedure is a farce unless the owner has already completed extensive planning, preliminary investigations and feasibility studies. Even then, it fails to serve the owner adequately. Further, if a designer has already worked closely with the owner throughout such first steps, and has performed that work satisfactorily at reasonable cost, then he is quite likely better qualified to continue with the design than another designer of equal or even better ability but unfamiliar with the owner and his project.

The cheapest bid for design, whether by novice or qualified professional, logically will contemplate over-design to assure safety, and will leave many design details to be completed by the construction contractor. The resultant direct increase in construction cost of structure, vague drawings and specifications, and inevitable requests for extra payments by contractors will most likely be in excess of any savings in design costs. In addition, there is no room to be innovative and no incentive to serve the owner properly.

Some persons prefer to think in terms of numbers rather than in philosophical manner. For them, an experienced owner of major projects, who has supervised millions of dollars (US) worth of design and construction, has commented on this subject. In his opinion:

- a) the construction cost is usually 10 to 20 times the cost of adequate design engineering;
- b) the variation in cost from the cheapest to the best design engineering is usually no more than 10%; and
- c) the ratio of potential construction cost increases vs. engineering savings is probably at least 100 to 1.

Then too, it should be appreciated that, from the point of view of the owner who must operate and maintain a major bridge, no bridge is better than its details. The owner may learn too late that it is very important: to have appropriate details for clearances and moving elements; to have adequate cover over reinforcing steel; to have quick and adequate drainage, in particular if salt is used; to be able to readily accomplish cleaning and painting or, better yet, to need none if the bridge crosses heavily traveled roadways;

to have adequate safety features and traffic controls; to be able to easily redirect traffic and clear lanes in case of accident or needed repairs. Such items are the result of careful and complete design, drawings and specifications. They are not a part of short-cut procedures. They are not highly technical; and are given greater emphasis by designers who also have experience in construction and operation.

It is appropriate to ask the question:

What can be learned from experience in the USA that will assist owners in obtaining better major bridge projects for their publics? There are two major aspects to be considered: improvement of knowledge with respect to theoretical planning, design, available materials and methods of construction; improvements in the ways and means of identifying and evaluating needed structures and then utilizing the foregoing knowledge correctly and expeditiously. First, the record will be examined in certain important aspects.

In the USA the improvement of knowledge and its wide publication have been progressing nicely and promise to continue to do so. The ways and means of utilizing that knowledge to identify and construct needed projects has been deteriorating seriously and will be the aspect discussed herein. A few reasons for that choice will be given.

About 25 years ago a state in the USA enacted legislation authorizing a very large highway project, passing through some rural and many highly developed urban governmental jurisdictions. Serious planning and preliminaries were started immediately. Twenty-two months later the project had been designed, financed, constructed within the budget, and fully opened to traffic. It has been one of the most useful and successful projects ever created. It is now greatly expanded, as the original design had anticipated, and is providing tremendously important service to the public. It illustrates beautifully what can be done when government, the public and technology act cooperatively and responsibly in productive and straightforward manner under adequate authority. Today things are different. Why? Several reasons will be cited.

Several years ago Rachel Carson published "Silent Spring."..... The book immediately became a best seller. Clubs were formed all over the USA to prevent engineers from covering the nation with concrete, to prevent industry from making air unfit to breathe and water unfit for use, and to prevent natural resources from being used. It was reported that during the following year members of the U. S. Congress introduced over 3,000 pieces of legislation intended to support the stated aims of those constituents. Nothing happened to most of the bills but the uproar continued and some of them became significant legislation for which new large bureaucratic agencies had, of course, to be created. Today it should be carefully noted that:

- a) There had certainly been some improper actions and policies which warranted intelligent correction;
- b) The surge of public opinion, resulting legislation, plus ensuing administration and regulation largely ignored established relations between cause and effect, ignored essential aspects of costs in comparison with benefits, multiplied the elapsed time between conception and completion of projects; and
- c) The current result is typified by many needed public works projects being delayed for years or being killed, by a major contribution to inflation through multiplied costs, and by substantial roadblocks to our fundamental energy problem.



For example, in one such case, one new piece of legislation was designed to control purity of streams and waterways. The new agency promulgated numerous rules and regulations (interpretation of legislation follows legislation as surely as day follows night). Then the new agency turned to an old agency, which has for decades had other responsibilities for many of those same waterways, for review of the requests and newly required environmental impact statements (EIS) plus recommendation for action thereon by the new agency. It is understood that during the first year of such divided responsibility: the old agency received approximately 11,000 requests and EIS's (some being up to 5 feet thick); reviewed and forwarded recommendations on about one-half of them to the new agency; and that the new agency took action on twenty-two. A bridge over a waterway must pass through these procedures.

It is to be emphasized that the creation of a major bridge is not limited to technological capabilities. As a matter of fact, the real decision makers in such a project are NOT the engineers. Such critical decisions as whether or not the project will go forward, what functions it will serve, where and when it will be built, how it will be financed, what zoning regulations and building codes will govern, and who will administer and design the project are made, and rightly so, by elected or appointed governmental officials often having little, if any, technical knowledge or experience.

It is, therefore, self-evident that the successful and timely creation of a major bridge project requires complete cooperation, trust and respect between those decision makers on the one hand and the engineers on the other hand. The public, those persons who both pay the cost and receive benefit from the services to be provided by the completed project, is a very interested third party and should be represented in the planning and preliminary studies. Each of these three groups has its own background, its own experience and desires, its own priorities, and its own brand of logic.

Without in any way making a judgment that any of the following should be done, it can be noted that in the fifty-year history of IABSE, being celebrated this year, the design profession and the materials, equipment and construction industries have made advances which now make it technologically possible to span the English Channel, the Strait of Gibraltar, the Store Baelte and the Stretto Messina. Each project has been under discussion time and again. None have gone ahead because the decision makers have not acted favorably; and it may be a long time before they do if the ideas and attitudes now prevailing in the USA spread over the rest of the world.

More specifically and in more common dimensions, there are today in the highway systems of the USA and in urban areas near great rivers (most big cities grew up along rivers) tens of thousands of bridges designed 50 to 75 years ago for far lesser loads and traffic densities than they now are forced to carry. Upgrading and replacements are proceeding at a snail's pace. Probably little will be done to update essential links in transportation vital to commerce and industry until after several failures occur. The designers will be blamed, the politicians will rush to the rescue (particularly if an election is near), and the public will be hurt. WHY? Certainly not because of lack of technical design ability, construction skill, nor concern for least cost!

The basic reason for this essential non-existence of progress is a fundamental lack of meaningful communications -- and therefore understanding, respect and trust -- between those same three groups -- government, public and technology. Organizations such as IABSE are as responsible for that lack as anyone else, perhaps even more so, because they alone know how to do the job as well as the consequences of not doing it. Correction of the situation is vital.

Misguided policies and isms are strangling needed public works in the USA; minor as well as major bridges, flood control projects, water purification and sewage treatment plants, transportation projects, power generating plants and all other facilities which distinguish a developed nation from an undeveloped one. It is vital to correct the misunderstandings of related causes and effects; and of the current unrealistic limitations being imposed by a few on the qualities of living for the many. It is vital to broaden the understandings of the responsibilities and limitations of governmental agencies. It is vital to broaden the understandings of capabilities and limitations of technology as regards costs, benefits and economic health which flow from appropriate utilization of technology.

It is vital to develop mutual trust and respect for each group's problems, needs and capabilities so that all can work together constructively as a team. What has been done in the past is truly considerable. What can be accomplished in the future with meaningful cooperation would be unbelievable. The answer to how owners could obtain better major bridge projects would become self-evident to all concerned.

During this present exercise of examining where we have been as an aid to better performance where we are going, it is to be noted that the design profession has not been above reproach in the USA. It has espoused the sound virtues of selection on the basis of demonstrated ability and experience, as demonstrated by prior performance and satisfied clients, followed by negotiation of a fair and reasonable compensation BUT it has done precious little to provide an adequate environment and public support for the public officials required to make such really difficult decisions. Recognition of that important shortcoming is long overdue.

A considerable number of other elements hindering progress can be distilled from experience in the USA in recent years. Of first importance is the fact the three principal groups involved -- government, the public and technology -- do not speak the same language. The situation is analogous to that of three men -- one speaking only Chinese, one speaking only Greek, one speaking only Arabic -- attempting to discuss a complex problem and reach intelligent decisions. The resultant lack of communication precludes intelligent progress. Whether he is right or wrong, the dominant one will control and the other two have no basis for understanding nor meaningful comment. They will be confused and unhappy.

None of the three groups is perfect; each has its shortcomings and difficulties. Each tends to concentrate on and to present in the mass media (which prefer the negative) the faults of the other two. For example, a group of structural designers will usually discuss the difficulties they see with clients or with their public rather than address themselves to ways and means whereby they might better understand the problems faced by such groups; and thereby improve cooperation with them.

There are certain innate difficulties. For example, elected or appointed officials and legislators come from a wide variety of backgrounds. A large proportion of them hold office for relatively short terms -- say 2 to 4 years -- and during that period their primary concern becomes re-election or re-appointment. Re-election or re-appointment definitely are not determined by how well they handle major bridge or other public works projects; unless they have made a scandalous mess of one. It is evident that, under the circumstances, such individuals cannot become experts; also that the problem of establishing communications, understanding and respect between the three groups is an endless one.



Among the design professionals there are all degrees of training, experience and capability. It must be so. Various individuals will always be beginning their profession, well established in it, or too old to function effectively. There is also, fortunately, keen competition and laudable ambition for achievement. The design profession is still striving to devise better format and methods for fostering this essential growth and, simultaneously, providing owners with better procedures for selecting designers in the best interest of the owners. Only recently did IABSE actively recognize the need for this growth and revise its by-laws to encourage it.

Perhaps the most poignant difficulty is that each of the three groups is composed of humans. Among humans there are always a few conniving power-hungry grasping and dishonest individuals whose actions, when they become known, are widely publicized under the principle that "No news is good news" which has been translated into "Only bad news is news." As a result, neither Government nor the engineering profession fully trust each other; and the public questions the integrity of both.

The basic problem is fundamentally no different than that faced by a continuing private corporation with respect to maintaining effective and efficient management. But it is much more difficult by reason of the lack of coherence between groups exercising various significant aspects of control, and because of their inadequate understandings of factors which determine need, excellence and cost. There is no concise profit and loss statement by which to measure progress definitively.

A technological problem worth mentioning is the difficulty of obtaining financial support for timely specific project research for improvement of design and construction, two closely related factors, for a major bridge. The bridge will most likely be a one-time, large and unique operation requiring very substantial capital investment. It will usually be under discussion for decades. However, final decisions as to type, location and capacity are customarily not reached until money for construction is assured. There is then no inclination on the part of the owners to allocate time to research. One example will be cited.

Nearly 50 years ago the writer participated in a university research project which constructed and then studied a structural model of a suspension bridge of modest size to investigate the accuracy of design theories. The work done demonstrated that additional research on a broader scale would be of appreciable value. Attempts were made to organize and finance an appropriate series of research projects in cooperation with government and related industries. The attempts were unsuccessful. Then a suspension bridge collapsed. Too much extrapolation of design experience had, by necessity, replaced research. Immediately government, the only owner of large suspension bridges, sponsored numerous investigations and finally the needed research.

The public always pays for any and all public works projects regardless of the method of financing. In perspective, it is inevitable that to many if not most individuals, the near-term increase in taxes, tolls or other charges will loom larger than the long-term future availability of any improved or new service function. It is also true that today, even in democracies, questions placed before the public are decided by organized minorities making deals with one or the other of more or less inert larger groups who concede to the minority point of view in exchange for an I.O.U.

Limited space now calls for a summary which should then be followed by suggestion as to how governmental owners can obtain better major bridge projects, when needed, at least cost.

It should by now be understood by the reader that, in the opinion of the writer, the environment for accomplishing that objective has deteriorated in substantial manner in recent years. The public is being deprived of needed projects. Those being built must run vicious gauntlets, again and again, of uninformed questioning, unfounded criticism, and of cost multiplying delays. The public is paying and paying. Firstly, far too much for the study and planning costs of the projects which are killed by the devastating powers of obstruction and negation. Secondly, far too much for those which do survive. Thirdly, by reason of the delays in creating needed service functions. And, fourthly, because of the real contribution made to inflation by the items just now mentioned. Public works financing forms a substantial portion of governmental budgets; and taxes to support governmental budgets are a major portion of the cost of living. In practically every developed nation today more than one-half of average income is devoted to payment of taxes.

Our engineering friends in other national groups may feel they do not have the problems mentioned here. It is reasonably certain that at least some do, that in time more will, and that even now it is probably only a question of form and size of the problem and not whether one exists. It is urgently recommended that IABSE avoid complaining about anti-technological sentiment and energetically attempt to establish better ways and means for mutual communications and understandings between the public, government and technology. No other solution appears feasible within the existing environment.

For those who may doubt feasibility of such an attempt, it can be recalled that the Offshore Technology Conference has a ten-year history of attracting annually from widely diverse disciplines and cultures as many as 65,000 persons. Also, at the 1977 International Conference in Paris, sponsored by UNESCO and organized by the IABSE supported Council on Tall Buildings and Urban Habitat, about half of the attendees were public officials. Another form of successful communication is represented by The Road Information Program (TRIP), the very effective public relations effort of the roadbuilding industry in the USA that consistently generates excellent and informative front-page newspaper coverage and editorial comment of road needs and how to satisfy them, as well as the costs of not doing so.

Any effective program to improve communications in the area of public works must convey its messages in language clearly understandable by all concerned. It must be persistent, tolerant, and dedicated to the public good. It must be broadly organized and widely supported.

The most effective messages will be those so presented that the reader will come to think they were his ideas in the first place. The information must be delineated in a manner designed to constructively instruct, rather than set out in a manner designed to emphasize the cleverness of the author. It must reach all interested parties; not just those who are already informed believers.

These design criteria may make the assignment seem difficult; but not impossible. What major bridge has not been characterized by similar terms? IABSE is a can-do organization. The public good which can result from increased intelligent USE of technology quite possibly exceeds that which can result from improving



technology. Creating technology is only an exercise. It must be used to become valuable. A philosopher once opined that a bridge is as important as a printing press because it also provides communications for people and their needs.

A structural engineer needs to be more conscious that he is also a member of the public and a citizen of government with accompanying non-technical responsibilities in both categories. One of the better definitions of an engineer is "A person who, by reason of training and experience, can utilize the materials and forces of Nature for the benefit of mankind at a cost mankind can afford to pay."

It will be observed that this paper has been limited to discussion of principles. It should be until those principles have been agreed to and formalized by all parties concerned, i.e. representatives of government, the public and technology. Before a major bridge project reaches the design-and-construct stage a definitive master plan should be refined from comparison of reasonable alternates in the light of all known factors. Similarly the "subsurface" conditions and the "forces" to be brought to bear by the "superstructure" should be thoroughly investigated before the design of the substructure is undertaken. During such developments it must be remembered that a major bridge is designed one member at a time; and that laboratory testing is a useful procedure.

From the IABSE point of view, a part of any approach must be the strict realization that no international organization can go into any individual nation and be effective in the matters here discussed. The role of the international organization must be to collect all applicable experience from each of its national groups, correlate and digest that experience, and then produce methods, procedures, publications and other supplements to aid a definitive program under the cognizance of the national group in each nation. In such manner, and by continuing to exchange experiences through the international organization, each national group can make two plus two of its efforts add to more than four. It isn't necessary that each national group invent the wheel! Nevertheless, they must put their shoulder to their wheel if they want it to turn and progress in their nation.

Irrevocable laws of Nature are the basis for scientific research, technological applications and human progress. If owners are to create better major bridges to fulfill their potential role in the future, it is essential that engineers as well as society in general regain the urge to improve qualities of living by their own cooperative efforts. IABSE should start with correcting known non-technical deficiencies within its own profession. The next step should be to assist the public and the decision makers in the application of established Natural laws of cause and effect; and in application of experience, judgment and rational analysis in evaluating costs and benefits.

Excellence in technology is necessary but is not sufficient to permit bridge designers and owners to serve their public in adequate manner.

Comments on the preceding theme paper
“Major Bridge Projects from the Point of View of Owners”
were received from

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|---|---------|
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Discussion by E. Montford FUCIK

There is no doubt that there has been a dramatic increase in the time needed to plan, obtain permits, design and construct a large public project in the United States such as a bridge, highway or dam, when compared with just a few years ago. The author has identified the reasons for this increase, and this discussor agrees that the requirements for Environmental Impact Statements have been perhaps the major factor in lengthening the time requirements, and also agrees that timely completion of a project requires trust, cooperation and respect between the public officials responsible for the project, the engineers and the public at large. However, it is questioned as to whether any major improvement in the timing can be achieved in the near future.

It is this writer's opinion that there has been vast change in the attitude of the general public toward elected and appointed public officials, and this change is reflected in an almost complete lack of trust by the general public of any statement or action of a public official. There has also been a change in the viewpoint of the public as to how they should attempt to influence public officials and public policy. Today, in the U.S. almost any group, no matter how large or small, will mount an organized and antagonistic protest against any idea or policy with which they do not agree. Rather than trying to understand the reasons behind such an idea or policy, and then discussing their objections with the agency, public or private, involved, the objecting group mounts a vociferous, adversary type protest, often insisting that the entire project be abandoned. It will take a major change in the attitude of the public on these matters before any reduction in timing can be achieved. And this change cannot be achieved by engineers alone, but must come from a major shift in public opinion.

It should be observed, of course, that there are a number of reasons for the public being so suspicious of the actions of public officials. Probably the genesis of this distrust was the Vietnam War. However, there still are occasions when the veracity of public officials, and also of some executives of large, privately owned corporations, has to be questioned. For instance, the problem of payments by corporations to public officials both outside and inside the U.S. to obtain business has recently come to light, and the public's trust has been further eroded. More recently, the problem of the malfunction of the Three Mile Island Nuclear Plant in Pennsylvania, and the DC-10 aircraft engine problems have raised doubts in the mind of the public. These problems have been magnified by the way the information media, press, radio and television, have handled them, but the basic fact remains that these incidents have caused further damage to the image of public and private officials.

This discussor agrees that IABSE should indeed undertake a program like the one suggested by the author, as such action is an essential first step in winning back the trust of the public. We engineers should be aware, however, that the road back may be long and arduous.

Discussion by Frederick J. CLARKE

Mr. Timby discusses the continuing problems of the methods of selection of engineering consultants for planning and design of major projects. Two schools of thought have not been reconciled in the United States. The school to which most engineers subscribe believes strongly that selection should be made on the basis of qualifications to be followed by negotiation of a fair price. The opposing school believes very strongly in price competition among prequalified consultants. These opposing views are common on international projects. Mr. Timby puts forth a persuasive position for the selection on the basis of qualification, resting his views (with which I agree) on the points that engineering is a small percentage of the total cost of a project, and that there must be sufficient latitude for thorough examination of alternatives to produce an economical design which best meets all of the requirements of the public.

In the United States, we have had little success in convincing some of our political leaders that there is a strong parallel in the procedures used in selecting other professionals such as lawyers, doctors, and accountants. I am always reminded of the caption of a cartoon showing an astronaut in a spaceship saying, "It gives me great satisfaction to realize that this ship was designed by the lowest bidder."

The other major point in Mr. Timby's article which is of great interest to me is his discussion of the relationships among engineers, political leaders and the public at large. Mr. Timby's paper points out very clearly the situation which engineers face in planning major projects which will have substantial impacts on the economy and the environment. The engineer becomes impatient in these situations because he faces repeatedly the same type of problems with different projects and clients. The bridge design firm over 20 or 25 years may encounter similar problems in 50 or 60 parts of the world.

The public agency, acting as the client for the engineer, may have only one major project in the lifetime of the staff of the agency. To the staff, the project is unique and requires their concentration for a matter of several years. A public agency will have the broad background of the requirements and will usually be an advocate for successful prosecution of the project. The public agency will be impatient of the delays forced upon the engineers and will be even more impatient with the lack of recognition of need by the political leaders and the public at large. Quite often the public agency ends in an adversary role with the public at large.

To the public at large, a major project such as a bridge across a large stream is a once in a lifetime project. Groups of the public and individuals usually first consider a project from a personal point of view as they examine the adverse effects and later may consider the beneficial effects. Problems for the engineer arise from the situation where those who benefit are a different group from those who are adversely affected. Experience



on major projects has indicated that we can expect little open public support for a project, since those who will benefit operate expecting the public agency to advance the benefits. Supporters have a feeling that the right solution will prevail. On the other side, those who are adversely affected for many differing reasons will join together in their common objection without regard to the differences in their reasons for objecting. We find curious marriages of environmental groups and commercial interests taking strong positions against projects. Our laws appear to foster such coalitions. These coalitions, tailored to the specific project, disband when a project is completed or stopped.

The engineer and planner has a difficult role. He can explain, quantify where appropriate, answer questions, but cannot alone satisfy the objections of those who are adversely affected. Answering their single purpose objections to their satisfaction is often impossible to the point that a political solution is required.

We have found that open planning is the best device for assuring the concerned public that their view points have been considered. Open planning is time-consuming and may not always be successful. In the United States, open planning is encouraged and in some cases mandated by law. It has made the job of the engineer more difficult and more comprehensive in that he is required to consider the social disciplines as well as the physical sciences in his solutions to problems.

Unfortunately, we have also found that it may take a crisis to ensure action on a particular problem crying for an engineering solution. The crisis can take many forms--a disaster such as a flood, serious accident, intolerable sanitary conditions or a severe decline of the economy of a region. As planners and engineers we seek to avoid the crises through a logical and orderly planning process to arrive at economical and sound solutions.

I am uncertain that we will reach the point of Utopia where planning decisions are so easily made. We will have to content with the concerns and emotions of those who are vitally interested in the project but whose views may be markedly different from those of the project planners and the owner.

Discussion by Eugene J. PELTIER

Mr. Timby could just as well have titled his paper "The Hazards and Pitfalls in the Birth of a Structure", particularly during this time of supersensitivity about the environment.

The cost of constructing a major public works project is perhaps less than 45 percent of the project's life-cycle cost. The owner is indeed shortsighted if he selects his project designer on the basis of least cost. The fee for designing the structure will not vary by more than 2 percentage points between the "best-qualified" and the "least-qualified" designer, whereas the life-cycle cost between the resulting two designs could vary from 10 to 30 percentage points. The lesson here is to select the best-qualified designer available for the particular project.

I was Chief of Civil Engineering and Chief of the Bureau of Yards and Docks, U.S. Navy (New Facilities Engineering Command) from 1957 to 1962. While Chief of the Bureau, over two billion dollars worth of public works construction was completed. Engineering design consultants for this work were always selected on the basis of "bestqualified" for the particular project at that particular time. As a result of both this policy and negotiation for equitable fees, I am convinced we obtained optimum designs and complete drawings and specifications; these resulted in good bids and minimum change orders during construction.

While I was President and Chief Executive Officer of Sverdrup & Parcel, a major consulting engineering-architect-planning firm in the United States, the firm was selected in 1971 to do a preliminary design of a major underwater highway crossing in the Commonwealth of Virginia. In addition to the preliminary designs for the tunnel crossing and locating the approach routes through densely populated areas, we had to prepare a complicated environmental impact statement.

Now, after eight years (1979) we are negotiating the fee for the final design of the underwater portion of the project. We presently estimate the project will be open to traffic in 1984, and the final cost will be over \$ 400 million! This contrasts with Timby's experience of 25 years ago when he designed and built a major trafficway in 22 months. A similar tunnel project of a larger scope in the same general area was designed by Sverdrup & Parcel and built in about four years' time in the early 1960's. Not all the delays can be attributed to federal and state regulations requiring environmental studies and to other citizen-protection laws and regulations.

No doubt there were abuses of the environment in times past, and legislation to protect the environment was necessary and right. However, the Clean Water Act of 1972 was the springboard for many ecological organizations to mobilize and demand consideration for their views. This, in itself, was acceptable. Along with the legitimate criticism, however, crackpots also appeared whose only mission was to stop everything. Their objections (with little or no technical, ecological, or environmental background) were unfortunately given the same weight in our courts as those of the most qualified experts in the field.



There is evidence the pendulum is swinging back to center even in the "age of the environment". However, it is wishful thinking to believe we will ever return to the conditions of the 1950's and 1960's. We must adjust our approach to planning projects, and take these added roadblocks into consideration. Organizations such as the IABSE must help if we are going to be able to continue constructing public works projects. Otherwise, regulations will drive the costs of needed public works projects to ridiculously high levels, and we will be priced out of the market.

Discussion by William W. MOORE

Mr. Timby's paper is particularly significant because it stresses the importance of non-technical as well as technical issues in the design and construction of major bridge projects and other engineering works.

I would like to emphasize Mr. Timby's point that the "design starts with the appreciation of the client's (owner's) requirements...". A problem which is frequently not recognized by the design engineer (and sometimes not even by the public agency which represents the client) is that the users of public works projects are comprised of various elements of the general public. Frequently, people in the organization representing the client do not fully appreciate the desires of the various elements of the public to be served. It is an unfortunately justified criticism of the engineering profession that many engineers have failed to recognize that significant elements of the public may have different desires and values than the engineer himself may have. Thus, the design engineers must learn that they cannot impose their particular standards and values upon their clients. As an alternative, they should think carefully about alternative choices available and do their best to communicate to their client and to the various publics to be served a full understanding of the costs and consequences of the choices that must be made in the development of plans for an important project. It does not take undue imagination to recognize that all people who want automobile transportation do not choose a pick-up truck. Some people do, but others prefer the comfort of a Cadillac or a Mercedes. Thus, the engineer should not assume that all other parties to be served by his project will make the same choices that he would. A great many of the currently popular public opinions which Mr. Timby mentioned having received tremendous attention have been over-emphasized since the publication of Rachel Carson's "Silent Spring". Many of these opinions are quite uniformed or unconcerned about the need for economic viability and for the economic well being of people who are to be served by a particular project.

For example, if an alternative bridge location might preserve particular areas of recreational or social importance, while being somewhat more expensive, that choice should be made with the appreciation and input of the people who are going to reap the benefits and pay the costs of the particular project. All too frequently costly delays in decision-making are caused by people who will not pay the costs of creating the project. Sometimes these people are well informed, sometimes poorly informed, and sometimes they are motivated by selfish purposes. In any case, it is the public that pays - not the protestors. The public will pay either the cost of the final project or the cost of doing without it, and they should understand this and the cost of delayed decisions. The attainment of this balance of choices requires a far higher degree of communication ability and communication effort on the part of the design engineers and of the organizations representing the public client than has been usually evident in the past. Both the public agencies and the design engineers have too often been guilty of "tunnel vision" or "single purpose" decision-making. If the engineering and design professions fail to develop the needed degree of "listening ability" and communicative skills, they will be relegated to the position of technicians hired to implement particular technical projects on which the major decisions are made by people who are far less capable of evaluating the costs and consequences of the different choices available. Thus, there is a very heavy responsibility upon the engineering and design professions to develop the needed abilities to listen and to communicate with the various public sectors who will be influenced by their choices of design and by the products of their creative efforts.



It is of major importance to the publics that are served by engineering projects and to the engineers themselves that more effective and better means of reaching critical decisions are developed. These decisions include whether or not to create a certain project and, if so, under what constraints. As Mr. Timby has pointed out, the costs of undue delays in the decision-making process can increase the costs of a needed project by as much as 100 per cent or more. By contrast, the additional costs of making provisions for reasonable environmental and social concerns usually can be accommodated with a relatively modest cost increase - if the decision-making can be reasonable and expeditious. The costs of no decision or unduly delayed decisions due to confused facts and misunderstandings are just too large a cost for the public to afford.

Discussion by Douglas B. FUGATE

The paper presented by Mr. Timby offers valuable comments and suggestions on how governmental agencies in the USA, which are to become owners of large vehicular bridges, may improve creation of such structures and incidentally other public works projects.

The writer feels qualified to offer a discussion in view of many years of representing the Commonwealth of Virginia, the owner of a vast highway system, as Commissioner of Highways and Transportation responsible for planning, financing, constructing, maintaining, and operating many large vehicular bridges over the waterways of Virginia. Many of the bridges were constructed through toll financing. The writer has also held office as president of the American Association of State Highway and Transportation Officials and is an honorary member of the American Society of Civil Engineers.

The paper offers cogent reasons for noncompetitive selection of design engineers on the basis of the owner's judgment as to experience and capability. I agree with this policy completely, except that as owner-representative in a large state having many state-based engineering firms, I found it desirable to give preference to these firms whenever completely satisfied they were competent of carrying out the required design.

The paper refers to recent attempts by government to force competitive bids for design. There are two reasons for this desire for competitive bidding. The first is a wish on the part of the governmental owner-representative to escape the difficult task of selection when he may be under political pressure by advocates of engineers less qualified than those dictated by his best judgment. My close association with legislative bodies convinces me that there is a second and far more important reason for the trend toward competitive bidding. This is the demonstrated absence in far too many instances of complete integrity on the part of the public official and the engineer in negotiating a noncompetitive contract for engineering services. Each exposure of kickbacks or other more sophisticated forms of graft fuels the demand for competitive bidding. The remedy, I think, is for the engineering profession to increase its vigilance over ethics to the point that the design engineer would first not seek engineering assignment through any form of political influence, and second would not only refuse to participate in any improper fee arrangement, but would also feel obligated to denounce a public official who made an improper proposal.

The need to develop complete cooperation, trust, and respect among the decision makers (elected and appointed government officials), the engineers, and the public is emphasized. I would add that there must also be developed a spirit of compromise among these three groups and all of their subdivisions, sufficient determination and momentum for creation of the project to overcome obstacles, and in the final analysis the fortitude to overcome those who continue to adamantly oppose the best reasoned and majority-supported solution. This is a large order indeed!

The outstanding difficulties in trying to accomplish this three-group process of developing cooperation, trust, and respect in the USA are, first, the federal government which because of partial federal funding has a veto over almost all public works projects carried out by state and local governments, and second, the public, which, as has often



been said, is not a unity but a number of publics having different goals, aspirations, or, in some instances, a determination that under no circumstances shall the project be created. If several governmental jurisdictions are involved, the good of the total population of a region may become secondary to the individual interests of the several governmental units.

One may ask why, after the three-group approach has developed a majority public consensus acceptable to the responsible state or regional authority in the USA which is to own and operate the project, the owner does not proceed to a final decision based upon its best judgment for the majority of the citizens. The answer is that after the owner has reached such final decision, the federal government, because of financial participation and environmental laws and policies, has veto power over the decision. Thus in far too many instances the three-group approach fails because the federal government supports the minority dissidents.

I detect a note of optimism in the movement for an amendment to the USA Constitution requiring a balanced budget. If the federal government were prohibited from deficit spending, much of the control and financing of public works projects would have to be returned to the state and local governments. With a balanced budget requirement and sensible interpretation of the environmental laws, the USA might someday lift the strangulation of public works projects so well described in the Timby paper. In the meanwhile, let other countries take warning by what is happening in the USA.

Discussion by William J. MILLER, Jr.

This discussion is offered by an individual who represents a governmental agency and has been associated with governmental agencies at the State level or at the bi-State level for more than forty years.

There is and must be a different attitude concerning projects when they are considered from the point of view of an agency of government as contrasted to the point of view of a consultant who desires to perform the services for the project. On the one hand, the governmental agency or group may be advancing the project for so-called "political" reasons. It may be advanced to create an attitude for "good things in the future" or repay political debts. In many instances, the project may merely be an idea which should not yet be given serious consideration, a trial balloon - so to speak.

In contrast, once the idea has been advanced and appeared in print, many consultants accept the scheme as one which is really being seriously considered. They therefore immediately indicate their interest and attempt to obtain the assignment. Many times, these conditions lead to a chain of events which are not in the best interest of the engineers or the governmental entity. In some cases proponents and opponents of a given project come forth to challenge or defend it. In other cases, the governmental agency is led to select consultants to advance the project or in some cases to recommend that they be rejected. The selection of the firm, often because of expressed political interests becomes a selection which is frequently based on non-engineering or other considerations. All in all these conditions relate to additional cost and obviously to delay.

Unfortunately, these events have been repeated on projects many times over. They will continue to occur. As a general result the mass media and the public in general frequently become cynical about the process which is used by governmental agencies in advancing projects to the construction stage. There is cynicism in the acceptability of the project, the costs which are advanced and the selection of engineers and other staff for the project and other details most of which relate to prior experiences.

There are instances, however, where projects were advanced on a technical, scientific and competent basis. It seems that these projects should be singled out and exploited. These should be the basis under which future good projects are advanced.

Mr. Timby provides a telling comment when he says that "IABSE should start with correcting known non-essential technical differences within its own industry". One way would be to actively promote the projects which have been handled well.



Closing Statements by Elmer K. Timby

taken from his oral presentation of the theme paper at the
IABSE Symposium "BRIDGES" 1979, Zürich

I am pleased that several distinguished engineers having extensive and most responsible experience in the subject have taken the time and made the effort to submit written comments on this theme. Their comments enhance and add substance to this consideration of procedures with respect to large public works projects. This is of significant value inasmuch as public works projects have a major impact on national economic health; and represent a substantial portion of local as well as national budgetary expenditures and therefore tax burdens.

Structural engineers have a very real responsibility to initiate, and to pursue with diligence, ways and means of creating and maintaining effective avenues of communications. Three principal groups of people are involved: the decision makers of the owners; the public, which pays the cost of major bridge projects and benefits from the services thereby provided; and the structural engineering professionals. It is essential that each group develop mutual respect for and confidence in the other two. A prerequisite is that all three groups participate in meaningful discussions, using terminology understandable by the others, and do so in timely manner.

The creation of such a rapport and homogeneity of purpose will be no small task. It will be impeded by existing differing short term objectives, lack of understanding, and creditability gaps between the groups; plus the perpetual efforts of the mass media to emphasize the negative while ignoring the positive. But, let us recall that no major bridge project was ever easy to create. Engineers are often in a struggle to improve what has been provided by Nature. And like a major bridge project worthy of development, the potential benefits of the improved communications far exceed the cost in human effort and natural resources.

Every meal starts with the first bite; every journey begins with the first step; and each is apt to be more successful if adequate preparations precede the beginning. Included early in those preparations is a decision on the desired end result.

IABSE, as an international organization, could collect and analyze experiences of national groups and from such data formulate suggested programs to be carried out by national groups, acting singly or together, for the purpose of organizing discussion forums. Participants and attendees at forums should include: government leaders, legislators, administrators and regulators from various levels; economists, businessmen, bankers and tax experts; representatives of the public; and representatives from the various technical fields involved. Individual forums could deal with large national programs or with specific projects. The results could be applicable to all public works - not just bridges - and could be particularly helpful to the needs of the developing countries.

The group discussion of each sector's problems by all sectors could improve communication, develop cooperation and save vast amounts of time and money thus bringing benefits to many people.

To achieve such objectives will require following up such forum discussions with the leverage of publication of summaries of the proceedings, written in form to support all parties in their common purpose of serving the socio-economic, cultural and quality-of-living aspects of people. And of course, these publications would need to be given wide distribution to all levels of government, industry, the public and technology.

Having defined the objective, the first step should be for IABSE to place its own house in order. Inasmuch as the time for this presentation is limited, certain possibilities for progress in the indicated direction will be stated but not discussed.

- (A) Programs of the various units (national groups, working commissions, task groups) of IABSE could place more emphasis on the aspects of applying technology to create useful service functions as contrasted to the historical concentration on perfecting or improving the theoretical. Technology is useful only when it is applied effectively.
- (B) We learn from experience; and failures are the best teacher. IABSE national groups could organize from time to time symposia, each concentrating on a notable project and including consideration of the aspects of the public, the government, and the financing; as well as technology discussed in terms understandable by the other interests. The purpose of each discussion should be to demonstrate how the public interest will be or was served by the procedures which are being proposed or had been followed.
- (C) IABSE units could organize joint meetings (with non-technical groups, say Rotary, Kiwanis, or Chamber of Commerce) for exploration of recurring difficult aspects of major bridge projects. Subjects to be discussed could include:
 - 1. Specific prior research for a major project
 - 2. Timing a project to minimize costs and maximize benefits
 - 3. Planning for future increase in capacity
 - 4. Financing
 - 5. Alternate locations and types of project
 - 6. Effects of lack of decisions and changes in design and construction on schedules and costs
 - 7. Costs to the public of a needed project which is not made available
 - 8. Values of proper operation and maintenance
 - 9. Evaluating the benefits to the public resulting from a major bridge
 - 10. The true costs of environmental protection carried to extremes
 - 11. The true cost of continuing obsolete bridges in use
 - 12. Advantages of function accruing to major bridges from long-range land use and transportation planning

During the course of a few years, such exercises should serve to broaden the thinking and interests of IABSE members, should attract more attention from government and the public to IABSE activities, and should provide a foundation of experience upon which to build.



Great contrasts exist between situations affecting major projects today and fifty years ago when IABSE was founded. For example, today:

- a national economy depends upon the world economy
- the fates of developed and of developing nations are intertwined
- communications spread contentious news around the world instantly
- transportation is an essential ingredient in interchanging food, shelter, clothing, and survival between all peoples.

Progress in our profession must recognize and adapt to such developments.

Each major profession in the world, and engineering is one, was created by society to meet one of its specific needs. Fortunately, in the past, society has exhibited the wisdom of granting those professionals the respect and confidence necessary to increase and to apply their knowledge. As in the case with freedom in its broad sense, such professional privilege must be defended.

The primary activity of the professional engineer is to utilize the materials and forces of Nature for the benefit of mankind. To do so he must work with people. He must not shirk his participative role in dealing with people in matters which are the fruits of technology but which do not require a knowledge of the technical for effective use by the public. It is this type of communication and negotiation that is under discussion.

A failure to construct a needed major bridge usually results from an impasse caused by one of the parties involved trying to extend its authority beyond reasonable limits. These obstructionists gather strength from a wide variety of compulsive activists who take full advantage of the fact that it is far easier to question some facet of a proposition than it is to prove every possible aspect of it. This is devastating to the professional engineer because, by necessity, he must always compromise the ideal to arrive at an intelligent choice for his solution.

There is in the United States today, and tomorrow there will be around the world, a time of prevastive self-interest, self-indulgence and over-indulgence of minorities identifying themselves as protectors of the environment, preservers of natural resources, and advocates of the public interest. Costs and benefits are ignored; as is the fact that resources, including the environment, are of value to the public only when used intelligently. The engineering profession must effectively offer its own proven methods for achieving solutions for application to social and economic problems instead of remaining in a defensive position against narrow opinion and half truth. Our profession can no longer continue to be characterized as an adversary of government and society, particularly in the province of public works.

IABSE should do its best to provide the advantages of efficient application of its own technological expertise to the solution of the relevant problems everywhere. The logical methods by which the engineer has been successful in developing his technology should now be applied to their useful application. Engineers should seriously undertake that responsibility. Society has an urgent need to know the facts.