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Symposium 1979 BRIDGES. Panel Discussion: Mission for the Future

Colloque 1979 PONTS. Table ronde: Mission pour l'avenir

Symposium 1979 BRÜCKEN. Podiumsgespräch: Aufgaben für die Zukunft

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SUMMARY

The fourth session of the IABSE Symposium 1979 on BRIDGES was conducted in the form of a panel discussion under the chaimanship of Professor R. Walther of the Swiss Federal Institute of Technology, Lausanne. Two aspects of the theme, "Missions for the Future", were treated in the discussion, the transcripts of which are gathered in these "Proceedings":

- Education of Future Engineers
- Systems of Competition and Tendering

The papers delivered in the other three sessions of the Symposium BRIDGES (Past and Future Trends / From the First Ideas to the Project / Construction, Performance, Renwal) are contained in the Symposium Report (AK 32) which can be ordered through the Secretariat.

RÉSUMÉ

La quatrième séance du colloque 1979 de l'AIPC sur les PONTS fut l'objet d'une table ronde, présidée par le Professeur R. Walther, EPF Lausanne. Deux aspects du thème «Missions pour l'avenir»:

- Formation des futurs ingénieurs
- Genres de concours et d'appels d'offres

furent traités au cours de cette table ronde et font l'objet de ce Mémoire.

Les contributions aux trois autres séances du colloque PONTS (Du passé vers l'avenir / De l'idée initiale jusqu'au projet / Construction, performance, rénovation) sont contenues dans le Rapport du Colloque, AK 32, qui peut être commandé au Secrétariat de l'AIPC.

ZUSAMMENFASSUNG

Die vierte Sitzung des IVBH-Symposiums 1979 über BRÜCKEN war Gegenstand eines Gesprächs am runden Tisch unter dem Vorsitz von Professor R. Walther von der ETH Lausanne. Zwei Aspekte des Themas „Aufgaben für die Zukunft" wurden anlässlich dieses Gesprächs am runden Tisch behandelt, welches nun in dieser Abhandlung zusammengefasst ist:

- Ausbildung zukünftiger Ingenieure
- Wettbewerbs- und Ausschreibungsverfahren

Die Beiträge zu den drei weiteren Sitzungen des Symposiums BRÜCKEN (Rückblick und Ausblick / Von der Idee zum Projekt / Bau, Bewährung, Erneuerung) sind im Symposiumsbericht (AK 32) enthalten und können beim Sekretariat der IVBH bestellt werden.

PANEL DISCUSSION

SYMPOSIUM "BRIDGES", ZURICH, SEPTEMBER 20 - 22, 1979

CHAIRMAN (R. WALTHER, Swiss Federal Inst. of Technology, Lausanne, Switzerland)

During the past two days we have heard many enlightening talks by eminent engineers about technical, aesthetic and other aspects of the wonderful art of bridge building. The panel members and myself do not propose any further discussion on these topics, which in any case would probably only be a faint echo of what has already been said. We thus propose a discussion under the very general heading

MISSIONS OF THE FUTURE

incorporating the following theses:

1. Education of future bridge engineers
2. Systems of competition and tendering
3. Political and socio-economical aspects
4. Specifications (Codes).

We will treat one topic at a time, first of all, by asking the panel members to express their views on the point in question and then to open the discussion to the floor, whereupon, if time permits, other subjects might be taken up if the audience so wishes.

The discussion of the panel members will be conducted in the most international language, that is bad English. I hope that Dr. Brown and Prof. Galambos will forgive me this diatribe, since for the former, distinguished Oxford English is his mother tongue, whereas the latter has spent the better part of his life in the USA, thus speaking something which vaguely resembles English (as they advertise in Zurich's shops: English spoken - American understood).

As regards the floor discussion, the three official languages of the symposium may be used.

Before beginning the discussion, I would briefly like to introduce the panel members:

Prof. Dr. H. Siebke, from the German Federal Republic, Ministerialrat der Deutschen Bundesbahn.

Dr. W.C. Brown, from Great Britain, who is the chief bridge designer at Freeman Fox and Partners. He was very instrumental in the design of the Severn, Erskine, Humber and Bosphorus bridges.

Mr. C.J. Louw, from the Netherlands, a member of the board of management of Ballast Nedam, who works mainly in the Middle East, particularly in Saudi Arabia.

Prof. Dr. T.V. Galambos, Professor of Structural Engineering at Washington University in St. Louis, USA.

After this brief introduction, I would like to take up the first topic, that is:

THE EDUCATION OF FUTURE BRIDGE ENGINEERS

In my opinion, the most pressing problems for the future are not technical ones, but rather ecological ones. The fact is that, despite all the technical advances, many ugly bridges, which completely destroy the environment, are still being built.

This is particularly true of medium and small bridges, which make up the bulk of present day bridge construction.

It is my firm conviction that this unsatisfactory situation, amongst others, can only be improved by a better, more practice orientated education at university level.

In fact, many a young engineer, proudly clutching his degree, knows a great deal about the most modern, sophisticated computer analyses, but is barely able to read a plan, let alone to really design a bridge or a structure.

In a broader context, it seems very regrettable that, in these days of advanced technology and specialisation, the gap between the architect and the engineer has widened so. Such a gap was absolutely unknown in former times, when a bridge builder was engineer, architect, craftsman and artist at the same time.

We have already seen, during Professor Hart's talk, a good number of wonderful bridges built by our ancestors, without the use of a computer, or the knowledge of present day calculation techniques.

Now, after this brief introduction, I would like to open the discussion to the panel. May I first call upon Dr. Brown to express his view on the subject.

W.C. BROWN, Freeman Fox & Partners, London, England

Thank you Mr. Chairman and I will attempt to be brief, to give more time to participants speaking from the floor. I think the theme which runs through all this topic is "what do we really want?" What do we want from the bridge engineer of the future? What is our requirement and what is the objective? We should define the objective. Now speaking as a designer, it seems to me that, if any engineer is to be successful, he must first understand the behavioural function of his structure and he must be able to design. It doesn't necessarily mean that he has to be a creative designer but, before he can be a creative designer, he must understand the principles of design. The bridge engineer of the future need not be an expert in analysis, stresses, moments and shears in bridge elements. The computer can do that. But he must nevertheless have a good knowledge of mathematics. It is more important than ever that he understands how the structure works. This must become his second nature to him and he must be provided with a totally thorough feel for his subject. This is something which the universities can and should provide. He must know instinctively how relative stiffness, the proportion of various elements, influence the distribution of loads. Now this may all sound obvious but it is so often neglected by emphasizing the analytical processes alone. He must be trained to think objectively, critically and be able to transmit his ideas clearly. Our method of communication as engineers is primarily made through the engineering drawing i.e. until we find a better way. And sufficient emphasis and time must be devoted to this. The current trend in some countries to treat the need to use the drawing board as beneath the status of a professional engineer is in my opinion quite wrong. Designs are made on the drawing board, not on the calculation sheet or the computer. And the universities must never fail to realize this.

CHAIRMAN

Thank you very much Dr. Brown. And now Prof. Galambos who, being a professor, should know a little about the question in hand.

T.V. GALAMBOS, Washington University, St. Louis, MO., USA

Mr Chairman, Ladies and Gentlemen. It is dangerous to ask a professor to talk about professing because that's how he makes his living. So I'm going to talk only about good things: I think that a mature bridge engineer has to be a master of many subjects. How can he become that? Well this isn't magic. It's going to take a lot of work and time and it is going to be a lifelong process of learning, observation and experience. The start of this proficiency is the study at the university. The university education has failed if the person cannot improve himself by self-study afterwards. As I see it the function of university education is to give the young person a thorough grounding in the fundamentals of the sciences of engineering. The university must give an appreciation of how science, technology and society fit together. It must give him a thorough understanding of structural behaviour. And finally it must develop good work habits, independent study, honesty and integrity. So the university is here to give knowledge, understanding and character: to make a technically educated person. In the U.S. after four years an engineer is supposed to be this educated person. He is not an engineer and is not so recognized by law. He has to practise afterwards and his training is taking place in practice. And my feeling is that many of the things that my previous colleagues here have said will have to be acquired by training in the first employment. And the university has to make this understood. We do not know where the young person will go to work, what career he will take. We do not know what technology will be like in 30 years or in 20 years when this person will be on the top. So the university can educate. The first few years in the job can train and then further education has to be through continuing education and through the training within the company. Now, I see as mission for the future of the universities to do what we do all the time but do it much better. I think we must teach more dynamics, we must teach also more sociology and so on. But we must also bring in more of the design office into the classroom in the last few years. We have neglected this and I think this is going to be a serious problem if we do not bring the designer to interact with the students and the faculty. Finally I would like to say that one mission for us in the United States is to perhaps expand what is taking place in some universities where they have graduate schools of professional education and I think it would well be if one of these graduate schools could concentrate on bridge engineering. Thank you Mr. Chairman.

CHAIRMAN

May I now call upon Prof. Siebke to give his views. Prof. Siebke prefers to speak in German and, since a great majority of this audience speaks or understands German, I think it will be better for him to proceed in German rather than in "bad English".

H. SIEBKE, Deutsche Bundesbahnen, Frankfurt, Bundesrepublik Deutschland

Meine Herren, nehmen Sie dies vielleicht symbolisch. Es ist ja häufig so, dass Behörden - und ich vertrete hier die Behörden - Unternehmer und Wissenschaftler nicht in derselben Sprache sprechen.

Bei dieser Diskussion werde ich daran erinnert, dass der von mir sehr verehrte Professor Doeinck einmal sagte "Nun erziehen wir an den Studenten so viel herum und zum Schluss gibt es doch ganz vernünftige Ingenieure".

Ich meine, dass die Fähigkeit zur Abstraktion, aber ebenso die Fähigkeit zum entschlossenen initiativen Handeln von dem Ingenieur in seinem Berufsfeld verlangt wird. In der Bundesrepublik ist es heute leider nur noch über den Abschluss einer höheren Schule möglich zum Ingenieurwesen zu kommen. Früher genügte hierzu eine handwerkliche Ausbildung, ein Gesellenbrief, und damit wurde sehr viel praxisnahes Wissen in das Ingenieurwesen hineingetragen. Dies ist leider nicht mehr

möglich. Wir sollen der Vergangenheit nicht nachtrauern, müssen aber daran denken, dass dann die Hochschule diese Praxisnähe mit in die Ausbildung übernehmen muss. Ich meine, der kommende Ingenieur muss vor allem wissen, dass alles Zahlenwerk, alle Theorie nur eine modellhafte Abbildung der Wirklichkeit sein kann. Dieses Zahlenwerk kann Entscheidungen erleichtern aber niemals abnehmen.

CHAIRMAN

Thank you Prof. Siebke. Professor Louw?

C.J. LOUW, Ballast-Nedam Groep N.V., Riyadh, Saudi Arabia

Thank you Mr. Chairman. The profession of a structural engineer is to make things. He is just a craftsman, not less and not more. There is only one difference between a structural engineer and a craftsman, and that is that a structural engineer has a bigger toolkit. He has more tools at his disposal and two of them are important: one is that he has been trained in the application of science, the second is that he has, at least we hope so, a broader and a deeper education. But, although he has these two important tools extra, he is just a craftman who makes things. And in my opinion it's a task of the university to teach students in making use of their tools. But there is something which is in my opinion more important than that. And that is that we have to make the juniors enthusiastic when they are engaged, and maybe wild, about a new profession, a chosen profession. They will find new answers to old challenges. I think that all a successful professor has to do is to light a match which sets a lasting fire in the minds of his pupils, and that's enough.

CHAIRMAN

Thank you, Gentlemen. May I now open the discussion to the floor. There are three announced contributions. Firstly, Mr. Edem from Nigeria.

E. EDEM, Etteh Aro & Partners, Ibadam, Nigeria

Developing countries as always are hoping to make a break through in technological know-how without historical progress as has been the case in the developed world. The result is lack of the base from which young engineers can work. In international circles very little can be transferred in terms of technical information on bridge and other related projects. Furthermore, the state of construction in these countries is such that there is no technological transfer per se. From available data, the Third World has a good share of the world's structural monuments especially bridges. But the design, planning and execution of these projects have always been in the hands of engineers from the developed countries. All that is left in these countries is the finished product; a land mark structure. The solutions to design and construction problems in the project remain with the designers and contractors from the developed countries. The indigenous young bridge engineer has nothing to refer to. We have continued to remain consumers of developed world's technical efforts. The sad effect of this situation is that we make little or no contribution to technology. Technical education alone is not enough to remedy the situation.

Most of the major bridges in the developed world evolved from challenges posed by socio-economic circumstances and policies. For instance, while in Africa functional structures of any configuration could be accepted, in Europe, America and Asia aesthetics and sociological impact among other things help dictate the type and shape of the structure. The governments here have a lot to do in remedying

the problem, but usually lack of co-operation between the agencies responsible for the project and experts in the field thwart all efforts made by engineers for the better.

What the IABSE can do for developing countries is to hold some of their symposia in these countries. Let the local press, the populace and the government have the chance of seeing what exists outside their habitat. This would
- expose to government the need to invest in research and training of young engineers,
- educate the populace on the need for technological excellence and the necessity for trust, co-operation and respect between government, public and technology,
- create a forum for free discussion of the inadequacies of existing structures, thereby bridging the communication gap between the public, the engineer and the politician.

Technical training is basic, but public awareness creates challenges which in turn call for co-operation necessary for the research without which developing countries cannot cope. Know-how in design and construction of super bridge structures has become a national pride. Thus, these symposia in developing countries would make the developing world realise that indigenous engineers must be involved in the creation of these structures from decision making through design to project phasing and cost planning.

Consulting engineers in these countries too have a lot to do. In Nigeria today some consulting engineers are trying to create a DATA BANK. There is a sub-group assembling data on 50 major bridges with a view to high-lighting their design and construction as a guide to cost implications of future major bridges in the light of inflatation and present-day technology. Your symposia would bring governments to the aid of such groups.

Governmental co-operation is a must if we are to take off and public awareness would make government reluctant to approve of just anything bearing the name of a bridge. This is the situation which would create the challenge needed by the future bridge engineer in the developing world. He gets his on-the-job training tackling this challenging project using his technical know-how and zero-performance experience. Though the IABSE cannot as an international organization go into any country with the express intention of high lighting the inadequacies it can through the national chapters help in the campaign for public awareness and co-operation. She can also help collect, correlate and digest data from national groups and give guidelines for the peculiar cases of the developing countries.

CHAIRMAN

Thank you very much Mr. Edem. I don't think I have to comment on that, the applause from the audience seems to confirm your view. I, myself, have a clear conscience in this respect, as I have just spent a week in India discussing these very problems.

That now brings me to the next contribution, from Mr. Subba Rao from India. Mr. Subba Rao is the Managing Director of one of the biggest construction firms in India, Gammon Ltd.

T.N. SUBBA RAO, Gammon India Ltd, Bombay, India

On a subject like engineering education for future bridge engineers, the scope is not limited merely to bridge engineers but has a much wider coverage including the basic pattern of education prior to this course. However, I would like to confine myself to what has transpired during the earlier part of the Session and would suggest in what direction the future education of our bridge engineers should be aligned. What I saw this morning and during the previous Sessions, revealing the many bridge failures all over the world, conveys a very important message and that is, that structures well designed and detailed have an inherent capacity to sustain unbelievably much higher loads; this is essentially due to the fact that they have been designed using modern methods of structural analysis, better understanding of the material contributions and further have been well detailed and executed, to enable them to follow alternative ultimate strength paths to sustain themselves until the structure is reduced to a mechanism.

Somebody jokingly mentioned to me that structures have a habit of staying where they are despite the fact that they have been overloaded and cannot be held safe by a design check. I have witnessed many buildings in Bombay, India, wherein structures constructed almost fifty years ago, have revealed that the reinforcement has become completely corroded and brittle but the live loads from offices above continue to be supported. I am sure many of them have reached the point of instant failure and only require to be triggered by vibration settlement or any other reason to initiate collapse. One of the reasons for the higher load carrying capacity of structures which have revealed distress, may be due to the fact (and this was also emphasised by Mr. Brown) that very often good detailing greatly enhances the ultimate strength of the structure and delays brittle failure. This morning we saw the bridge in Vancouver which could take a hundred percent more load as normal traffic, essentially because of the fact that the engineers had a very good understanding of the behaviour and response of the structure and it had been well detailed on the drawing board.

It has been often emphasised that more than design and detailing, the engineer must have an intuitive understanding and feel the behaviour of a structure - in short, he should be a craftsman like the great engineers Freyssinet, Sinar and others who may not have been great mathematicians and qualificationwise engineers at all, but their understanding of the true behaviour of the structures and the material properties, enabled them to construct bridges which would last under even today's heavy loads. Drawing, it is said, is the language of an engineer and how many engineers today, exposed to computers and readymade solutions including drawings, have this message ingrained in them! This position requires correction, if the future of bridge engineering or for that matter structural engineering is to progress rapidly to meet the demands of today.

Very few contribute to the wellknown adage that 'Prevention is better than Cure' although everyone accepts it. The history of repairs to and maintenance of bridges and a proper instructional manual with logging data, is rarely available to practising engineers. This is also an area which requires to be inculcated at the graduate level or post-graduate specialisation level so that a student is aware of the consequences arising from poor maintenance of the works, both from a safety and national standpoint.

Especially in developing countries and possibly in even some of the developed ones, there is little interaction between post-graduate engineers and the consultant, contractor and public bodies involved in bridge and structural engineering. This

is one way of building up a good, observant and intuitive bridge engineer who has been exposed during his academic education, to the practical approach of design, construction and maintenance of structures.

Lastly, it is necessary that a structure at any place should be the pride of the people around and, as far as possible, during its construction, the people should be involved through audio-visual media or directly at the job site. This would not only make them aware of the important facets of the work but may kindle the interest of a probable future bridge engineer.

It is said that an engineer knows something of everything, but as he knows more and more he realizes he knows less and less and finally nothing of anything. I believe this ancient oriental adage which applies to every human activity, is more apt today, if engineering education is at all to shape the engineers of tomorrow to become more useful to society.

CHAIRMAN

Thank you Sir. I now call upon Mr. Javor from Czechoslovakia.

T. JAVOR, VUIS, Bratislava, CSSR

Wir haben heute sehr interessante Vorträge gehört, z.B. von Herrn Prof. Leonhardt über die ästhetische Gestaltung der Brücken, von Herrn Dr. Wittfoht über Bauverfahren im Brückenbau oder aber Vorträge über langfristiges Verhalten von Brücken und über Schadenfälle.

Ein junger Ingenieur braucht aber nicht nur theoretische Kenntnisse über statische Berechnungen und Baustoffe. Er braucht genauso auch eine spezielle Ausbildung über Methoden der Spannungsanalyse und der Qualitätskontrolle, über Messmethoden und zerstörungsfreie Prüfverfahren, über statische und dynamische Probebelastungen und über Ergebnisse der langfristigen Beobachtungen des Verhaltens von Brücken im Gebrauchszustand. Der junge Ingenieur, der erstmals auf eine Baustelle kommt, benötigt einfache und zuverlässige Prüfgeräte. Erst dann kann er selbständig und rasch die notwendigen Qualitätskontrollen durchführen, z.B. die Prüfung der Betongüte, die Prüfung von Spannkraftverlusten, Dehnungsmessungen, optische Fotostressmessungen der Spannungen sowie auch theoretische Messungen von Durchbiegungen, Verschiebungen und Senkungen. Selbstverständlich können die zahlreichen Forschungsinstitute mit verschiedenen spezialisierten, z.T. voll automatisierten Messanlagen helfen. Ein junger Ingenieur muss jedoch schon während seiner Studienzeit an der Technischen Hochschule zahlreiche Kenntnisse über Mess- und Prüfverfahren erwerben. Daneben ist der Austausch von Informationen über Messergebnisse und Erfahrungen mit bestimmten Prüfmethoden sehr wichtig. Diesem Zweck dienen Konferenzen, Zeitschriften und Fachbücher. Daneben wurden für einige spezielle Probleme verschiedene Fachkommissionen gebildet. Als Beispiel ist die RILEM (Réunion Internationale des Laboratoires d'Essais et de Recherches sur les Matériaux et les Constructions) zu erwähnen, und ich möchte dringend empfehlen, dass zwischen der IVBH und dem Komitee LTO 45 für langfristige Beobachtungen von Betonkonstruktionen eine enge Zusammenarbeit angestrebt wird.

In der Tschechoslowakei haben wir bereits ungefähr 20 Spannbetonbrücken während über 20 Jahren beobachtet. In diesen Methoden der Langzeitbeobachtung verfügen wir über gute Erfahrungen. Ueber das RILEM Komitee LTO 45 können wir neue Empfehlungen für technische Universitäten und Forschungsinstitute erarbeiten und damit auch jüngeren Bauingenieuren auf der Baustelle Arbeitshilfsmittel und eine verbesserte Weiterbildung zur Verfügung stellen.

In Ergänzung zum Diskussionsbeitrag eines Kollegen aus Nigeria möchte ich Sie darüber informieren, dass RILEM zur Zeit drei interessante Konferenzen in sogenannten Entwicklungsländern vorbereitet. Die erste Konferenz soll nächstes Jahr in Guatemala abgehalten werden, während die zweite in Afrika, und die dritte in Asien vorgesehen ist. Diese Konferenzen behandeln aktuelle Themen der Ingenieurausbildung in diesen Ländern. Damit sind die Konferenzen wichtige Gelegenheiten, um Erfahrungen über die zukünftige Ausbildung der Ingenieure auszutauschen.
Ich danke Ihnen für Ihre Aufmerksamkeit.

CHAIRMAN

Dankt Herrn Javor für seinen Beitrag.
Are there any other contributions from the floor? No. In that case, we will pass on to the second topic which could be quite a hot one

SYSTEMS OF COMPETITION AND TENDERING

I would just like to make one or two points. Firstly, Mr. Wex, for example, referred to the English System versus the European System. I would have preferred it if he had said "the English versus the Continental System", because I always consider that England is also a part of Europe, although this doesn't seem to be the case! Also, I didn't fully agree with Prof. Menn when he said that any system of competition leads to a good solution. This can be true, but in many cases, when I have been on a judges' panel for a bridge, we had to award the first prize to a design that we didn't like at all, simply because the cost was so much lower that we could do nothing to prevent it from winning. It wasn't the engineer's fault, he just fulfilled his task to produce a bridge at as low a cost as possible.

I would now like to ask Mr. Louw to give us his opinions. As you know, Mr Louw works mainly in the Middle East and so he knows a fair bit about international competition.

LOUW

Gentlemen, I believe in competition. Look at the animals and look at the plants. In the daily struggle they compete: for space, for food, for water, for some sunlight. And in doing so they train themselves for the holy task of the preservation of the species. The human animal is not different. He needs the fight, the competition just to survive. It keeps his muscles trained, his teeth sharp, and I pity those groups of colleagues who have no competition.

Tendering is a way of using competition in our trade and it is therefore a healthy way of doing.

Mr. Wex yesterday advocated the advantages of what he calls the British system, where the competition is limited to the pricing of the construction firms for the project only, and the project has already a completed design. I think that in a number of situations he is right. It is easy to give examples. But it is also easy to show the successes of the continental system. There the competition is between a combination of design and construction price. My left neighbour made the remark three minutes ago about it. I think that in general this system is the better one. The theme of this whole symposium is a warning against the danger of too much specialization. There is so much interaction between design and execution, between a result and the cost of the effort that our system has to stimu-

late the universal mind. No committee, no team, can beat the effectiveness of the single human mind.

I happen to live and to work in one of the rich oil countries, where a real hectic development is going on. The scale of the works over there and the circumstances under which the projects have to be realized are totally different from what we are used to here in the industrialized world. The necessary wild extrapolation shows clearly the weaknesses of the procedures we are used to apply. I can easily list a great number of serious mishaps, but I will resist the temptation.

I want to state however that it would be a great help if the designer, maybe an independant consultant, maybe a civil servant, also would be personally, financially responsible for the cost of the project.

Under the present FIDIC (Fédération Internationale des Ingénieurs-Conseils) ethics the consultant sells only an effort, and he does so practically risk-free. The interests of the client and the society are better served when all parties who have a real influence on the result are also responsible for the result financially. They have to be so, like Lloyds' underwriters, with life and good.

What we, as structural engineers, maybe as owners, maybe as designers, maybe as contractors sell to the society are projects, products, results. It is the result that counts, not our personal efforts. In modern terminology, it is the output not the input. Thank you.

CHAIRMAN

Thank you very much, Mr. Louw. May I now turn to Dr. Brown.

BROWN

Well, I understand and appreciate the point made by Mr. Louw. I think he would agree with me that it doesn't necessarily follow as a result of competition in this way. I want to make a point that there is plenty of competition within what he chooses to refer to as the British system. In fact, I think British bridge designers show that they compete very well with their continental colleagues when the opportunity arises. I think what must be understood is that the system grows up within the requirements of the country itself and the way in which the industry in that country is established. Now, the British and American system, whereby consulting engineers act in this intermediate role, that is between government and public bodies and contractor, has meant that there is a large amount of design expertise held by them. The role taken by government is one of strategic planning and that by the contractor: of manufacture and control of erection. A degree of specialization if you like, but it exists and has been developed over the last century. Any design competition therefore on any real scale must be between consulting engineers. Contractors alone are rarely in the position, as they may well be and are on the continent, to prepare alternatives unless the official design is particularly bad. They simply are not structured to that. The competition therefore is in tendering to the same design, but I would not like anyone to assume that under the British system contractors do not put forward their ideas, modifications, offer reductions of cost or variations or improvements which are always considered and accepted. And it is also true that consulting engineers do prepare alternative designs for contractors within the United Kingdom. This in fact is on the increase. One or two procedures have been established, which I think on the whole are unsatisfactory, and I am quite sure that our continental colleagues would agree with me, whereby a client permits a contractor design com-

petition, but first he asks "what are you going to produce? Let me see if I like the design which you might put forward." If it's something new and has not been in being for about 10 years, well he's not interested. I think that is a most retrograde step. It is understandable to a degree and perhaps that type of competition might extend to the continent but I think it would have serious disadvantages.

There is no question, to my mind, that the system in the United Kingdom has done well for the U.K. and does work satisfactorily. Provided you have good consulting engineers who know not only how to design good economical and good-looking bridges, but how to manufacture and erect them as well. And this is a point I would just like to make. You can establish design offices which simply produce a design for a contractor and the engineers and the designers who produce it never see the manufacture and they never see the erection. It is not considered to be part of their work. Now, in the English system, the engineer in fact has much greater responsibility than has been indicated. He is concerned with all stages. He analyzes the alternatives, he is responsible for the design, and he does in fact bear the burden of the design. He is responsible to his client for manufacture and erection. He does control the progress, he does control the rate of progress and the cost. He also controls the final settlement and is responsible for that. And if he fails, he will very soon go out of business.

CHAIRMAN

Thank you Dr. Brown. May I just say that it is by no means unique to the British System that the design engineer is also for the most part responsible for the execution of a project. In most cases on the continent, the design office is also charged with the supervision of the work. However, it is somewhat different with the German System, where the big contractors carry out the execution, as well as the design, the latter by means of alternative proposals (Sonderentwurf). The German System has the advantage that by this alternative competition, development has undoubtedly advanced very much. I do not really want to comment too much on that point myself, but the next panel member, Mr. Siebke, should certainly be able to contribute to this question.

SIEBKE

Meine Herren, ich glaube, wir erkennen eine sehr grosse Uebereinstimmung hinsichtlich der Ausbildung der Ingenieure, aber hinsichtlich der Vergabe und des Wettbewerbes unterscheiden wir zwischen britischem und kontinentalem System - ich möchte sagen, Kontinentalsystemen, denn wenn ich hierfür das System Bundesrepublik spreche, dann ist es bestimmt sehr unterschiedlich gegenüber dem französischen oder auch denen anderer Länder in Europa.

Ich möchte kurz noch einmal erinnern, wie in der Bundesrepublik der öffentliche Bauherr Brückenaufträge vergibt. Selbstverständlich muss der abzuschliessende Bauvertrag mit den Prinzipien des zivilen Rechtes übereinstimmen. Rein theoretisch könnte er mündlich abgeschlossen werden. In der Praxis wird aber ein solcher Bauvertrag immer schriftlich abgeschlossen. Er ist das Ergebnis einer öffentlichen Ausschreibung, einer beschränkten Ausschreibung, oder in besonderen Fällen eines privaten Verhandelns mit den Firmen. Für den öffentlichen Bauherrn sind Ausschreibungsregeln festgesetzt, die mit der Bauindustrie ausgehandelt wurden, um möglichst grosse Rechtssicherheit zu erlangen. Normalerweise wird vom Bauherrn ein Entwurf ausgearbeitet und dieser der Ausschreibung zugrunde gelegt. Hierzu gehört nicht nur eine ausführliche Baubeschreibung, sondern ein Leistungsverzeichnis, in dem die Mengen der benötigten Baustoffe aufgeführt sind. Diese Mengen,

mit den angebotenen Einheitspreisen multipliziert, ergeben aufsummiert die Auftragssumme. Alle Angebote werden zu einem bestimmten Termin öffentlich verkündet. Meist werden Sonderentwürfe zugelassen, die den geistigen Wettbewerb um das ganze Projekt herausfordern. Sehr häufig kommen diese Sonderangebote auch zum Zuge. Ich glaube, die Vorträge der vergangenen Tage haben gezeigt, dass sich der deutsche Brückenbau sehen lassen kann. Dem wirtschaftlichsten Angebot soll dann der Zuschlag erteilt werden, und hier meine ich liegt vor allem für die Zukunft in der Tat das Problem. Denn mit "wirtschaftlich" wird meistens oder doch häufig die geringste Angebotssumme verwechselt. Das Verfahren hat Vor- und Nachteile. Auf der einen Seite ist es transparent für die Oeffentlichkeit, dergegenüber der öffentliche Bauherr ja Rechenschaft ablegen muss. Auf der anderen Seite sind wir uns, glaube ich, alle einig, dass nicht alle Eigenschaften einer Brücke sich in den Baustoffmengen sinnvoll beschreiben lassen. Wirtschaftlichkeit hat nicht nur mit dem Angebotspreis, sondern auch mit der Lebensdauer, mit der Abschreibung und mit dem Unterhaltsaufwand zu tun, mit den Tragreserven und auch mit der Schönheit. Ich habe bemerkt, dass wenn in den vergangenen Tagen über Kosten gesprochen wurde, eigentlich immer nur die Ausgaben des Ersterwerbs gemeint waren. Unter Kosten im betriebswirtschaftlichen Sinne ist der Wertverzehr in der Zeiteinheit zu verstehen, d.h. Ausgaben geteilt durch Lebensdauer. Hier steht die Situation lange nicht so einheitlich und eindeutig vor uns. Ich meine, für die Zukunft müssen wir uns Bewertungsmassstäbe für Qualitäten und Funktionen eines Brückenbauwerkes erarbeiten, damit wir dann auch in unserem System zu besseren, funktionaleren Vergaberegeln kommen, die die Nachteile des bestehenden Systems vermeiden, und Vorteile anderer Systeme, die wir international gerne studieren wollen, mit aufnehmen.

CHAIRMAN

Danke Herr Professor Siebke. And now, briefly, Prof. Galambos.

GALAMBOS

Just two points of some impending clouds on the horizon. One is that it is required for public works in the US to obtain competitive bidding for engineering design services. The second point I would like to make is that it is possible for lay persons not involved in any responsible position in a project to enter into the decision-making process and mess up the works. And I think these are two signals on the horizon that are likely to result in poorer engineering projects than are now being made.

CHAIRMAN

Thank you Professor Galambos. I believe Dr. Brown would just like to make a brief comment.

BROWN

All I think what emerges from this is that for good designs you need good engineers. In different countries the good engineers are in different functions. In some cases they are with contractors, in other places they are with consulting engineers. You should use them wherever they are.

CHAIRMAN

Thank you for that very right remark, straight to the point.
And now, contributions from the floor. Mr. Wex, please.

B.P. WEX, Freeman Fox & Partners, London, England

Chairman, Ladies and Gentlemen. Dr. Walther, I think you ran into the same difficulty as I did. You speak of England and the Continent, I spoke of Britain and Europe. I thought they were both synonymous: England is part of Europe and Britain is part of the Continent.

The topic which is being considered, of course itself is a matter for a symposium and not for a few minutes' discussion. Dr. Brown summarised the British attitude, position and history very well and I have only one or two things that I would like to add.

Firstly, concerning Mr. Louw's remarks, I believe that for developing countries especially, the "British" system does have a lot to offer. In Europe, with its advanced societies, public authorities, well versed in technology and knowing what they want and contractors well versed in the way of working - the "European" system works effectively. In developing countries very often the client may not have the experience to know what he wants at a technical level and he may not have the resources or knowledge to ensure that he gets what he wants. In these circumstances he really needs somebody to guide and assist him. We like to see the "British" system ("English" system) as working in this role. With his adviser, the client can get from contractors the benefit of their construction expertise and thus have his interest best served.

I think it was Dr. Siebke who made the point that the cheapest job on first bid is not necessarily the one which is the best answer. That is expecially true of "Design and Build" jobs. All sorts of matters other than first cost are tremendously important - satisfactory function, fitness for purpose, maintenance, aesthetics and many other considerations. This is where in the "British" system the good consulting engineer (Dr. Brown has made this point amply clear - we are talking about good service from the consulting engineer) can help. He does not necessarily design for absolute minimum construction cost, he must consider all the criteria vital to the client's interest, of course including those which I have mentioned immediately above.

I do not want to take much more time because obviously lots of other people will wish to speak. Professor Galambos mentioned competitive bidding, upon fees, for consulting services. I think this can give the client the worst of all worlds. If I were a client I would be most unhappy to appoint an adviser in this way because I would fear that he was tailoring his efforts to fit the cut price fee, which he had been forced to tender to get the work, instead of using all reasonable efforts in the interests of my project.

CHAIRMAN

Thank you very much, Mr. Wex. I think we should stay with this interesting theme for a little while longer, even if it means dropping the remaining topics. Mr. Subba Rao, I believe you also wish to contribute.

SUBBA RAO

I thought I heard Mr. Brown say that the designs prepared by good engineers wherever they are, whether with contractor or consulting engineer, could be accepted, but then he is defending so much the British system of consultants and contractors

being apart, it should not lead one to conclude that the best engineers in Britain or elsewhere are only available with the consultants!

In a developing country like India, a great deal of progress in the concept, design and execution of bridges with a variety of shapes, including construction by cantilevered spans up to 130 m, application of prestressed concrete to shell structures, development of precast techniques for long span bridge structures using epoxy bonding media, have all been made possible because competitive tenders were adopted on contractor's design, and the consultant's role was limited to the establishment of basic parameters required to be adopted for the design of the bridge at a particular location. I believe this procedure is also in vogue in Germany and elsewhere in Europe and has led to many new forms of structures and new construction techniques, all utilising the contractor's specialised resources and engineering acumen and that this has avoided monotony and given expression to creative thinking in a most economical and aesthetically satisfying manner.

The Bosporus bridge and many of the suspension bridges have all been of one type, except perhaps that the use of the concrete pylon in preference to steel is becoming more common. These bridges have been designed by consultants and a contractor who has built up his resources on the first job secured would certainly have a lead on all others because he will have had the experience and the inputs required to make a competitive bid on the next job. If the field was open, perhaps alternative solutions would have emerged based on common parameters, and helped utilisation of contractor's resources to the maximum. Even if tenders have to be submitted on a consultant's design, it is my view that alternative proposals based on well defined parameters should also be invited, to arrive at the most economically satisfying solution for a particular location.

There was a remark that in Britain many contractors are now using consultants for their design. There is also the contrary development now that most of the contracting companies are forming consultancy divisions to give contractor-consultancy services, which service covers the entire range of assistance required by a prospective contractor including field practices, choice of equipment, methodology of construction, optimisation of inputs, cost control and several other functions. This approach is an important development and herein lies the opportunity for the pure consultant with contractor backing and the contractor with consultancy approach to fuse together to develop a new form of ethos, which may help the future engineer to come up with solutions revealing higher forms of intellectual expression as a part of his service to humanity.

CHAIRMAN

Dr. Brown, I believe you would like to briefly comment on this statement.

BROWN

First of all on the question of the big suspension bridges. In fact alternatives were permitted, but I want to make a point, which is very very interesting. I think this is a development of consultants and consultancy divisions of contractors, it is possible that before long we could see the development of more standardization and you could reach a stage in civil engineering not unlike the motor industry, when you have models and types prepared and you change them every year or every five years and the like. Now this may be a very good thing and it may not. I don't know, but I can see that this could develop out of the type of thing which you have in mind. You have standardization and you have progressive change, slow progressive change and these would be designs which are developed by experi-

ment as well as by conventional means. I think there's something to be said for this.

CHAIRMAN

Thank you Dr. Brown. We will stay with this topic as it seems to raise so much interest. Another contribution? May I ask you to give your name, Sir?

R. SHAMA, Consulting Engineer, Madrid, Spain

My name is Robert Shama and at the present time I am working in Spain as a Consulting Engineer. Having worked all over the world for more than forty years of which twentyfive on the contracting side and seventeen on the consulting side, and although the subject of Mr. Brown's intervention is very wide, I would wish to challenge two of his statements, the first one being that consultants produce better designs.

Well, I regret to say that I don't agree in any way with that point of view and in support of my opinion I would say that I have built three bridges - which in their day have been world records - and whose design had not been produced by consultants but by the contractor's engineers. I firmly believe that when a consultant designs a large bridge he has no particular challenge other than that of producing a good design, so what he does is put one of his best available engineers to work on the project; on the other hand when you have ten or twenty contractors "competing" for the construction of that bridge, each of them will entrust the corresponding study to his best team of engineers as a result of which the owner will receive a large number of different offers based on designs each better than the other one, as compared with only one design and one estimate as prepared by the consultants. On the other hand and since consultants cannot at any time employ all the engineers available in a particular field, by going only through the consultants one would be simply eliminating completely all the advantages of the private expertise of all the engineers employed by the contractors. The advantage of one solution over the other would seem obvious.

The second statement of Mr. Brown is that when as an owner's consultant he receives various offers for a particular job, he would throw out any offer using a system or a process which has not been used for ten years. In reply to that statement I would say that if that principle were to be the rule, then there would be no prestressed concrete in the United Kingdom today. In effect when I was sent to the Freyssinet Company in London in September 1939, we had to fight almost everybody to introduce prestressed concrete because most owners or consultants would answer "this system has not been used before". In spite of that and because there was a war on and because some consultants and owners were "receptive", we finally managed to prove that prestressed concrete worked and following several jobs in the U.K. I was sent to India where we built three large prestressed concrete hangar roofs - at the time also world records - which incidentally were designed by the contractors (J.C. Gammon Ltd.) and would not have been built had the principle of 10 years previous use of the process been applied! Thank you very much.

CHAIRMAN

Thank you very much. I would just like to add a word here. In Switzerland, the design costs represent about 10% of the total cost of construction, and if one has 20 designs, there is more money spent on design than on the bridge itself

(20 x 10%), and this is not a reasonable procedure either.
Dr. Tedesko, you wanted to contribute?

A. TEDESKO, Consulting Engineer, Bronxville, N.Y., USA

I should like to clarify something that may have been misunderstood. That's the question of awarding engineering contracts purely on the basis of fees. Thank God we're not yet that far in the United States, although this is being propagated by some politicians and lawyers. In the matter of lawyers: if I had committed a murder I certainly would not want to be represented by a lawyer chosen simply because he submitted the lowest fee.

CHAIRMAN

Thank you Dr. Tedesko. I fully agree with your point, but it has been mentioned that this tendering on design is done in the United States. It seems also that many bad examples have been copied here in Switzerland. We have had quite a lot of this development in Switzerland, because some state engineers wish to award the contract to the design with the lowest bid of the design fee, but I always tell them "if you are gravely ill and have to have an operation, and you first go bidding for the doctor with the lowest fee, then you will not get a very good service".

Dr. Brown, I believe you wanted to respond to a previous point.

BROWN

Yes, I think it's very important because either I haven't expressed myself correctly or I've been misunderstood. I simply quoted a system which has existed in the U.K. whereby a client said "I want to know before I allow you to compete, I want to know what your design is and I'm not interested unless it's been done bebefore". I strongly oppose that system. I'm very much against that system and I don't accept that system, but that has happened in a pseudo form of competition in the United Kingdom.

The other point is that what I said is that you get the best designs from the best engineers. In the United Kingdom, most of the best design engineers are with consulting engineers. Elsewhere that is not the case. We're in agreement I think.

CHAIRMAN

Right, we have another contribution from the floor. Would you please introduce yourself, Sir.

K. SRISKANDAN, Department of Transport, London, England

I would like to make two points. Firstly, we adopt the British system in the U.K. Department of Transport. However, in almost all cases, the tenderers are allowed to submit alternative tenders, provided they submit a bid for the official design. In this way, advantage can be taken of any economies that an experienced contractor may offer.

My second point is on statements made that the British system stifles innovation. In my experience this is not so. There have been many new ideas that have been used on our bridges and an outstanding example is of course the Severn Bridge on the M4 Motorway.

CHAIRMAN

I believe you would like to say something, Mr. Kerensky.

O.A. KERENSKY, Freeman Fox & Partners, London, England

For almost half of my life I have worked with contractors and the remainder with consultants. I can assure you that the contractor's design is usually aimed at cheapness. They have to design to beat competitors on price, whilst the consultant's designs are aimed at quality and optimum minimum cost, taking into account future maintenance. The cheapest is seldom best.

The competition between consultants is based on the quality of their advice, in the same way as it is between doctors, lawyers and other professional people. The consultants are, in fact, competing very strongly through their reputation, whereas contractors' cut-throat competition is by price.

A speaker claimed that package deal tenders may involve as many as 20 different designs, against one design by the consultant. First of all this is not true - a good consultant will make several designs for any major project in order to select what he considers to be the best and, secondly, as the Chairman has already mentioned, the very high cost of the 20 designs must be recovered eventually in the price of the tender, or lead to bankruptcies.

Dorman Long & Company once had a very strong competitive design department in London which was successful in securing a fair percentage of their tenders and yet became nearly bankrupt in 1934 and had to be shut down, with a few survivals transferred to Middlesbrough for more conventional work.

I want to emphasise what Dr. Brown said - much depends on the way the skills of a Nation have been built up and organised, but no matter what system is adopted the design work must be paid for. If consultants and contractors are to make up joint teams to produce competitive designs and tenders, finances must be found to pay for the abortive efforts, and these would have to come from the big firms with capital reserves or Government Departments and eventually, of course, from the Clients.

Finally I would like to comment on the remarks made by Mr. Subba Rao of Messrs. Gammon (India) Limited. It may be true that his firm has built many bridges based on their own designs, but my firm has been associated with Messrs. Braithwaites Burn & Jessop (BBJ) and Messrs. Gammon, in successful package deal tenders for three major bridges in India. Therefore it is not true to say that consulting engineers are not needed in India.

CHAIRMAN

Thank you very much. Dr. Siebke.

SIEBKE

Wir sprechen hier viel über die Ingenieure der Consulting-Büros, der beratenden Ingenieurbüros und der Firmen. Darf ich ein klein bisschen auch für die Verwaltung sprechen? Immerhin bin ich "Besitzer" von 25'000 Brücken und darin mani-

festiert sich manche Erfahrung, die glaube ich, bei den Consulting-Büros und den Firmen nicht in diesem Umfang vorhanden ist.

CHAIRMAN

Thank you. Another contribution from the floor?

G. GRATTESAT, Inspection générale des ouvrages d'art, Paris, France

Comme M. Siebke, je pense qu'il n'y a pas d'opposition à faire entre le système britannique et le système "continental", car en réalité il n'existe pas de système "continental": Il y a sur le Continent autant de systèmes que de pays et dans chaque pays plusieurs procédures différentes sont utilisées pour les appels d'offres. On ne peut donc pas définir les systèmes par leur caractère national.

Il ressort de la discussion que chaque pays semble estimer que son propre système est le meilleur et n'envisage pas d'en changer. Le problème à examiner est celui de la procédure à choisir pour les appels d'offres internationaux. C'est un problème qui se pose notamment au niveau de la Communauté Economique Européenne et qui soulève de sérieuses difficultés.

Pour le résoudre, il faudrait comparer les avantages et les inconvénients des différentes formules, sans leur appliquer une étiquette nationale, et rechercher la procédure la mieux adaptée suivant les cas, mais cela nécessiterait une trop longue discussion.

Je signale seulement qu'il existe en France pour tous les systèmes d'appels d'offres un personnage qui joue un rôle très important et qui s'appelle le "maître d'oeuvre". Il n'y a pas d'équivalent exact de ce terme en anglais, et c'est sans doute pourquoi le "maître d'oeuvre" n'est pas représenté à la table ronde.
M. Siebke vient d'y faire allusion en reppelant qu'il y a dans l'administration des ingénieurs capables de juger de manière objective les appels d'offres: cette objectivité est une condition essentielle à respecter quel que soit le système utilisé.

CHAIRMAN

Merci beaucoup, M. Grattesat. Je suis très content que vous ayez pris la parole; j'ai en effet toujours été un peu mal à l'aise du fait que l'on parle toujours de l'Angleterre et de l'Allemagne, alors qu'en vérité il y a 150 différents systèmes; même en Suisse on a les deux, trois, quatre ou cinq systèmes dont vous avez fait mention.
Is there anyone else who would like to contribute? Dr. Wittfoht.

H. WITTFOHT, Polensky & Zöllner, Frankfurt, Bundesrepublik Deutschland

What I have to say is not important but it's terrible (Laughter from the audience). It's not a question of good or bad consultants - we would prefer good consultants. But what happens in many parts of the world now is that the competition in the field of several contractors results only in giving the work to the cheapest. In comparison with other fields it means that in the field of car production everybody would buy the cheap car, Volkswagen for example. And all the others, like Mercedes, Rolls Royce or whatever it may be are bankrupt immediately. But this doesn't happen. Why? What's wrong with our profession?

CHAIRMAN

Thank you. Any more contributions?

B. CHAUDHURI, F.R. Harris, Brussels, Belgium

I would like to make just a small remark on Mr. Louw's comment that engineers are risk-free. We are not privileged like lawyers and doctors. If a post-mortem analysis of the structure failure finds the consulting liable, he will have to pay throughout his life. Thank you.

CHAIRMAN

Thank you very much.

D. RUFER, Ingenieurbüro Ruffer, Wiesbaden, Bundesrepublik Deutschland

Wir haben in dieser Diskussionsrunde drei Hauptinteressentengruppen herausstellen können:

1. Die Regierungsstellen, in der Regel als Bauherr
2. Die beratenden Ingenieure
3. Die ausführenden Bauunternehmen.

Ich habe das Gefühl, dass teilweise Gegensätze dargestellt wurden, die wegen der verschiedenen Verantwortung ganz natürlich erscheinen sollten. Aber was können wir als IVBH generell für diese Dinge tun, um unsere Grundgedanken von einer allgemeinen wirtschaftlichen Lösung durchzubringen? Es wird wichtig sein, dass die Ingenieure sich darum bemühen, in die gesellschaftliche Verantwortung zu gelangen. Dieses Problem scheint sich nicht nur auf Europa zu beschränken. Wenn wir dies erreichen können, dann können wir auch unsere Ziele vom wirtschaftlichen Bauen zum Wohle aller Bürger verwirklichen. Wenn wir dies nicht erreichen, werden wir immer wieder Interessentengruppen ausgesetzt sein, die unsere Gedanken nicht verstehen. Dies bedeutet, dass die heute diskutierten Dinge und die Wirtschaftlichkeit von Konstruktionen nur über den Weg eines grösseren Verantwortungsgefühles und über ein fachliches Hineingehen in die Verantwortung erreicht werden können.

CHAIRMAN

Thank you very much. I was just wondering how I could make some closing remarks, but you have taken care of that very nicely. You are very right in what you say and, in fact, your comments would have led us nicely into the next planned topic, "political and socio-economic aspects", but we have no time. Perhaps we can take it up at the next Congress.

Before I close, Messrs. Louw and Brown would just like to make some final remarks.

LOUW

I should like, Mr. Chairman, to answer the last remark, which is a very important one and I should like to say, I wish that the speaker were right: that our conscience is enough to bring us to the correct attitudes to our work and in our society. But in my short introduction I made the parallel with the animals and with the plants on purpose. There are forces in nature, and we are part of nature, which we cannot leave out without being penalized for it. And it is not true in

my opinion that consience only is enough to live and to work. We also need to make use of the primitive forces, like competition, like the fight, to be living people. And that is also the reason that I said that in my opinion a fee must not be the lowest one as in the example of the lawyer or the doctor, but a fee must be related to the result it brings and these primitive rules have been, in my opinion, valid for millions of years and we cannot leave them out in an artificial way just for ethical reasons. Thank you very much.

BROWN

I just want to say a further defence of the system which we have in England and I don't want to appear holier than thou. I just make the comment that the consulting engineer's fee is based on a percentage of the cost. We chose, in designing the Severn Bridge, not to simply transfer over the design from the Forth Bridge, but to prepare a completely new design. The cost of preparing that design was considerably more and the cost of construction was considerably less, and the fee is based on the cost of construction. That is professional integrity, that the client gets when he retains a consultant.

CHAIRMAN

Thank you, Gentlemen. Unfortunately, in spite of this very lively discussion I am forced to close the proceedings. I hope that this panel discussion of our Association has been a success and that we can take it up again in a future session.

Thank you very much indeed.