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SESSION II

DISCUSSION (1st part)

October 6, 1982 - Afternoon

Chairman: H. WERNER (Federal Republic of Germany)

R.W. HOWARD - A question of predicting the future, having tried in the project I mentioned this morning. We are trying to do just that and it is relatively easy to say what will happen in the future, but to say when it will happen and when it will be widely used in industry is much more difficult thing, I think. For instance, the pictures you showed of that building at Cornell campus were done in 1969 with 3D color modelling. Well I think there are probably very few people in this room who used color graphics in 1969, or perhaps even in 1979. Colorgraphic display - I think hardly any - appeared on a large scale in Europe in the last year or so and the time lag between advanced research and the things, even becoming available on the market before being widely used in practice, is quite long. To take up one point of your question for future workstation specification, the flat interactive display. Again it will come, the technology is there and provides small displays and,in rather specialist research environments, but certainly we felt it would still be very much an advanced research tool in the more sophisticated user environment and within five years in Europe. I would like to know if these things are used in practice in the States at the present time ,or what stage of research they are in, because ergonomically they would help the design of workstations, but I think their appearance in the engineers' offices on a large scale is some way off.

D.P. GREENBERG - I am not exactly sure of what your question is. I think there are two things that you said. One is related to the development of flat interactive screens. Currently, to my knowledge, there are a number of companies which have perfected these capabilities for displaying a reliable 256 by 256 flat panel. The technological difficulties increase beyond that, but it makes no difference, as it is not a difficult task to combine those elements. You could really put together four 256 by 256 panels and have the resolution which you currently have in television. Westinghouse and Xerox and I am not sure which japanese firms are working on this and have already shown these products. Most of them have been in black and white because it is apparently quite difficult to be able to get the inert gases for the blue color. With respect at how much this has been used in the architecture and engineering profession,it hasn't! You are absolutely correct. In fact very few firms are even using computer aided design in architecture although they certainly are in engineering. Most companies justify their initial plunge into this field on the basis of the economics of the drafting system. However, from my point of view, the real difficulty is the fact that we are approaching the problem too traditionally and that's perhaps why a lot of those systems are not being used. One of the major problems, at least in teaching students in architecture and in engineering, is trying to make sure they understand the three-dimensionality of the problem. There are a lot of students who think they understand, but have difficulties of just visualizing three dimensions. If we would talk of working in three dimensions at the start, I would feel that these systems would be used much more heavily.

And the last comment of course is the economics. That has been too expensive.

W.R. HAAS - First of all I would like to admit that I felt a little bit as if I was acting in the computer middle ages when I heard you talking. I have two questions. At the beginning you showed us the structure of your computing center; you had a VAX in the center and you have attached PDP 11/44. How did you manage to get this real time speed in your program? What did you do on the PDP 11/44? What was done on the VAX? Did you use any attached hardware or didn't you use it?

D.P. GREENBERG - That's a good question. When you are dealing with computer graphics, the basic problem is first to define a three dimensional model. Once you have a numerical description of the three dimensional model, the ability to generate perspective images, to rotate it, to dynamically zoom in and out of it is a very simple problem. In fact all graphic display manufacturers in the next three years will be implementing this capability in either hardware or microcode. Once you have the model, it is easy to do manipulations. The difficulty is, if you have a time sharing computer, you must pay attention to those needs. Particularly when there are fifteen other users. You cannot get the response you need, so the logical solution is to offload the timesharing computer by placing as much intelligence to the user stations. We looked around in 1977 and there were no intelligent graphic stations at that time,so we bought our 11/34s or 11/44s, threw away the DEC operating system,and bought some vector display devices from Evans and Sutherland and some color frame buffers, we put in our own graphic software and our own intelligent operating system, that were unique for our graphic environment. Then what you do is to describe your object geometrically and the user can do all manipulations which you saw: all the rotations, perspectives, zooming in and out, even some editing changes. The VAX computer doesn't know anything about it and only when you change the geometric description or the topology of the object, do we have to go back and make sure that we update our database. Does that answer your question?

W.R. HAAS - The first part, but not the second part whenever you used any attached hardware or retrocessor.

D.P. GREENBERG - I am already "biting off more than I can chew" in terms of what we can develop our laboratory and so I made the subject decision that we would only use commercially available hardware. We have not modified any hardware and I do not have a floating point array processor to help with the computation.

J. BLAAUWENDRAAD - I have a question which is connected to the last one. I got the impression that you could achieve the results because you did not decide to make it hardware independent. What about that point?

D.P. GREENBERG - I think that is true. This is very definitely hardware dependent. We had only certain types of devices which were in the laboratory and clearly our software was designed to run on those pieces of hardware most efficiently. Your comment is correct.

J. BLAAUWENDRAAD - A next question is: what possibilities do you see to spread it in building industry in the future? How can you reach the situation that others use it a lot of times, so they try it?

D.P. GREENBERG - It is a very valid question. Let me go back first to one of my original statements. What I tried to show today was the result of a research laboratory, and it's really experimental. The approaches, which we use or used, I believe are the correct approaches for dealing with interactive three dimensional graphics and I believe that the manufacturers now are coming to the same decision. I have had a good fortune in the United States, I guess, to be able to work with a number of the manufacturers, so I feel fearly secure on that statement. They will be microcoding lots of these operations in their own pieces of equipment. The ability for rotation, for perspective transformations, for zooming in and out will all be part of the hardware and will not be software code any more. Even hidden line operations will be part of the hardware. That may be two years off but it will be part of the hardware. Thus, the ideas will move into the profession but it will not move in by taking software which is developed at a university. I don't mean to say that everything we have done is correct. One of the major contributions is that we have been able to tell manufacturers what we did wrong. I am not showing any of that.

H. WERNER - Can I give a short comment on this? Last week I attended a seminar on GKS (Graphical Kernel System) at Darmstadt. Up to now, there are several installations of this graphical Kernel system on several types of hardware. Just one example: in Berlin a program for representing three dimensional models has been developed on top of GKS. It was brought to Darmstadt on a tape and there it was installed on a quite different hardware in less than one hour. This is the main advantage of such a standardized graphics system. The transmission of developments from one computer to an other will cause less problems.

H. WAGTER - One of the conclusions of your talk is that hardware is going to be very cheap, hardly free, storage is also free. This gives me the impression that hardware suppliers are preparing their own funeral now. What is your reaction to this? There is a tendency, I guess, in Europe that software firms and hardware firms are combining and doing efforts to keep their combination expensive to share incomes.

D.P. GREENBERG - My personal opinion is that your observations are very astute. You are right. The hardware manufacturers are beginning to recognize that the cost of the equipment is going to be so small that that's not where they are going to make their profits. During the last year or two they seem to have made the major recognition that most of their profit is going to be having software which runs on their systems. If you start to examine some of the recent strategies of hardware manufacturers such as merging with software companies, or subcontracting software development to software companies, or more importantly trying to get an installed-user base, so that it makes very difficult for users to change manufacturers. That's all a strategy which assumes that software is going to be the only expensive portion.

E. ANDERHEGGEN - Because the software is so much expensive than hardware, what could you suggest in order to reduce software development costs? I am thinking about two things. First: some programming language better than Fortran, which is a very old theme of discussion. Second: may be some brute force approach to the problem of modelling, for instance the octrees approach,which was studied

I think at Renselear. It requires a heavy lot of data to describe a model, but a much simplier software. Could you comment on this?

D.P. GREENBERG - I think so, but they are really two separate questions. The first one relates to how does one try and reduce the enormous software costs which would be necessary. I wish I had an answer to that, I don't know. If you find the solution I would love to hear it. With respect to brute force approach,I don't think that we would find those approaches to be very satisfactory in the future. All the brute force approaches which you would see are really based down to the resolution of the display. They can get away with a lot graphycally in term of 512 by 512 displays. You can even get away a lot in terms of 1000 by 1000 displays, but that's not sufficient for engineering data. You may use those approaches, but only for display and not for modelling. That's my own personal opinion.

SESSION II

DISCUSSION (2nd part)

October 7, 1982 - Morning

Chairman: H. WERNER (Federal Republic of Germany)

H. WERNER - Are there any questions to Prof. Shimada on his theme "Safety Inspection Systems on Existing Structures"?

D.D. PFAFFINGER - In your last example you showed the experimental determination of the cross-correlation of the structural response between X and Y direction, if I understand correctly. The question is: did you also perform similar investigations on the cross-correlations of earthquake excitations?

S. SHIMADA - Yes, in every case of experimental measurement and whenever the data are prepared in computer readable data.

D.D.PFAFFINGER - Therefore you could certainly run earthquake recordings through the same procedure and determinate the spacial correlations between earthquake excitation components. The question is if you also considered that type of problems.

S. SHIMADA - Yes, the same problem, but unfortunately we can not take the data from an actual earthquake and we obtain data from the random information from the excitation induced by heavy duty trucks; for earthquake analysis it is necessary to obtain the earthquake data at the site of the structure (but it is always difficult). So we extract the data from the ground and the structure motion, by using several apparatuses, such as shaking machines. Usually we get the shaking from heavy duty trucks moving around the structures.

G. KRUISMAN - Mr. Shimada, you are studying the dynamic behaviour of existing structures. Is the reason purely scientific knowledge generation, in order to be able to make better designs in the future, or are there other incentives to do so? For instance: expected heavier earthquakes in the near future, or higher demands for new regulations, or other reasons? What is the exact reason you look at existing structures? It seems to be longstanding practice to built something and to leave it there until it is damaged.

S. SHIMADA - I tell you some of the comments and could you please correct my answer? I am much interested in the design of structures and also in verifying the capacity of the designed structure to resist actual loading. This research has been extended in getting in site data. I found that portable inspection systems should be convenient for the use of field inspection. I found several parts of very dangerous structures. Sometimes the structures were destroyed by our prospects and some of the structures are coming to loose their capacity. I am thinking of the systems to be used under construction work, since many failures occur in the construction work. I am now trying to built a very handy and conveninent system for field workers, to test the safety of the members at the construction-site; because, you know, we can get some safety by beating something, but unfortunately the failures occur at very low frequency,that can never be felt by human sense. So some kind of strong devices are required. An other example is found by testing the soil capacity to bear the weight of the structure. Unfortunately we have many claims for soft foundations on which structures sometimes set unfavourably. But,by the test of the ground motion, we can find some unfavourable soil state.

J.T.P. YAO - I noticed the very small amplitude in your test data. I just wonder what kind of noise-signal ratio you had and whether and how you filtered such noise-polluted data before you analyzed them.

S. SHIMADA - It depends on the system set up and on the equipments used for the error correction method. The noises have the tendency of some spectra, we compare these noises and can extract them from the original data. The random waves are very fruitful data for me, because they have many frequency elements. The noises have some typical frequencies which can be identified by interactivity and some of the very strange properties of the sensors is also extracted. So, by comparison of the various data, we can get the correct data and properties from the random waves.

H. PIRCHER - This is not a question, it is a short comment. Near the town I leave, 15 years ago a bridge was built and one year ago there was political decision to change the line of the motorway and to blast the bridge. Before blasting it, it was decided to make some experiments. A vibration test and a calculation of vibration were carried out and there were some differences in the results. After blasting we could see that there was one zone in the bridge where the injection in a part of the prestressing cables was not good. I don't know details about it but I think this is interesting in this context.

S. SHIMADA - Much interesting, and we are gathering many such vibration data and, if possible, would you send these data to my address?

H. BALDAUF - The construction industry is said to be a conservative industry.

I think the main reason for this is that we are largely concerned with individual rather than mass production. If one has mass production, as with prefabricated elements, then there is an impressive array of examples,as Mr. Haas showed yesterday. As for individual products, if well described modules, like continuous beams, slabs in highways, are being considered, there also exist adequate examples for graphic design. It becomes difficult, however, if we look at the concrete industry and try to include the dimensioning process in graphical design. Furthermore, we have to cope with the National Codes for dimensioning and you know the difficulties which can arise when these codes and their philosophy are changed. In the past we had to throw away programs because of these changes, but it is unthinkable to have to replace graphical design programs for this reason. What we need are methods with a very high flexibility, methods which will suffice for 80/90% of graphical design and be capable of being adapted to the reminder by hand. Otherwise I believe the development of these programs will become too expensive. I have a further question. You said that for graphical design it is necessary to have a complete 3-D description of the building. For the calculation we need a model of this construction. You also said it is necessary to separate the calculation model from the graphical description, or perhaps I did not understand you correctly. Could you make some comments on this please?

P.J. PAHL - Let me start with the comments on the construction industry which you made at the beginning. I think you emphasized the point which I really tried to make. The point is that there are very special properties of the construction industry which one must take into account when planning developments and estimating the market for a particular development. The area of application for most of our work is not standardized. I am not aware at the moment of any development which has the flexibility addressed by you in the first part of your statement. The problem lies in the interelationship between the geometric model and the functional model in structural engineering. That is the peculiarity of structural engineering. We cannot simply describe the geometry without describing other properties as well. Both the size of the problems we have to solve and the volume of the software we need to obtain the necessary flexibility are a problem which, at the moment, we are not capable of handling even in principle. Computer graphics is for the construction industry essentially an area of research and not an area of development or application. This contrasts strongly with graphics support for finite element work.

H. WAGTER - In your paper you present a state of the art of all the programs you know. You also mentioned that those programs are fairly standardized on certain aspects. It has always been my impression that not even the size of the manuals has been standardized. Could you explain a little bit more what you mean with standardized in this respect? And the second thing I wanted to ask is: you are talking about disappearance of drawing boards at the engineering offices and I think in your story you are using the drawing just as a communication mean for people who are making actually building. What do you think of the role of that drawing? Is it just a representation of the model you are working with? Because I think that is the field in which the drawing board might disappear.

P.J. PAHL - Let me go first to the question of standardization. In my paper, there was no reference to similarity in implementation. There is a similarity in the type of functions which are made available, not in the methods by which they are made available. I agree with you that there are very large differences in implementation. This is demonstrated by some of the points made yesterday in connection with accuracy and size problems. I can give you another example in that area. If you look at a perspective of a steel structure and compare the dimension of a flange with the dimension of the building as a whole, you realize the accuracy problems we have with most of the perspective drawing programs. So I fully agree with you that the method by which we implement is not yet standardized, but I think that the kind of problems we have to solve are fairly standardized.

The second question concerns the drawing board. I think one should first put the question: is drawing the appropriate mean of communication in computer environment? At least at our universities, I see the problem that many students can no longer draw. They can analyze very well, they can handle programs, provide them with input and look at the output, but they are loosing the conceptual facility because they loose the ability to visualize structural behaviour and structural details. I do not anticipate that drawing will be replaced to a very large extent because we are using computers. The problem I see is that of the discrepancy between the speed of development in numerical analysis and that processing, and the lack of speed in the development of graphical computer applications. I did not want to make the point that the drawing board cannot be replaced; on the countrary, I want to make the point that we have to be very careful how we replace the drawing board.

J.P. RAMMANT - I have two questions. You said that one of the topics in research is that we should keep the data management ourside the application software. Now, the question is: are the current available database management syustems suitable or will they suite it to cover our technical databases, or should we redesign databases? Then I come back to your comment. Should not that be included in the application software? The second question is: does it make any sense to do draughting on its own in the construction industry? Should drafting not always be connected to design?

P.J. PAHL - There were two aspects of database management. The first aspect is the managing of design variants. That is a problem which one can handle in the application program if only the basic decisions "Yes, I use the variant; no, I do not use the variant" are made in the application program and a database management system is called to make all of the modifications required to either retain or to reject the data of the alternative. Then the database management is a considerable help to the application program developer. The second aspect is that of distributed databases: the problem of lending a part of a dataset to a workstation and reintegrating the modified data in a central project file. This problem also is one which potentially one could solve, at the application level, but I would like to put the question wether it is not more reasonable to solve it at the level of the database management.

The second question refers to the connection between drafting and design. If one tries to start with drafting after the design has been completed and to input the data in that phase, most of the economy of computer drafting is lost. Design and drafting must use the same dataset. In that connection, let us look at the traditional ways of describing structures on drawings. We find that they are not complete: there is a great deal of information, which is implied and not explicitly shown on the drawing. It is anticipated that whoever is going to interpret that drawing will make deductions and judgements. If the information is to be processed on the computer, that information must be made explicit. In this respect, there are big differences between the way structural and architectural drawings are prepared on one hand and the way in which mechanical drawings are prepared on the other hand.

P. LENGYEL - I would like to put you two questions. The first one concerns the traditionality of building industry and your very bad experiences about automated drawing in design offices. The obvious arises: which will be the proper way to go ahead? An answer might make use of the contractor being very strict to the standards. Don't you have the feeling that CAD is always used in places, where the national standards allow to do so? Moreover, if there is such a standard - for the application of CAD - included in the standards of engineering, then it promotes automated graphics, too. I would appreciate your comments on this. The second question refers to your comment about finite element drafting, saying that here you have to get all the stresses in an order of points, so as to be able to make a drawing. My question is: why?

P.J. PAHL - Let me start with the second question. Many of the algorithms that are used to draw isolines, use interpolating functions within finite elements. To use the algorithms, one requires nodal values of the variables. We also are interested in the values of stresses on the surface of a body. Normally that requires nodal stress values. We obtain the nodal stresses by beating the computed displacements of a normal displacement analysis, as imposed displacements in a mixed model (principle of Hellinger-Reissner). Using compatible element stress variations, we then compute the stress values directly at the nodes. Instead of computing the displacements by differentiation within the elements, we compute them with the same accuracy as the displacements at the nodes.
Concerning your first question, that of introducing symbolism to as large a degree as possible in graphics: if one uses standard reinforcement shapes, and if that standard changes, that it is not a big problem, because usually programs are designed in such a way that non-standard shapes can be incorporated. This simplifies the adjustment to a new standard. The problem lies not so much with the standards, but with flexible digital models for structures. This seems to me to be the problem: the appropriate structural data for drafting.

S.J. FENVES - I don't know yet if this is going to be a comment or a question. It seems to me that there is one thing that you left out of your presentation, and that is that, in structural engineering, we have a multiplicity of symbols for the same things, and, at various stages of our thinking, we have different symbols-images of the objects we are dealing with. Now, it depends whether you are an optimist or a pessimist. If you are a pessimist, you get the impression that this complicates the problem even beyond the rather negative picture that you presented. If you are an optimist, this may be a way out, because, as we develop our specification of a structural model at early stages of design, we can get by with very simple symbols. It is only at later stages of the design that we flesh out these symbols with more and more information. Your example of the perspective display is a good example. At the level of showing the perspective of a building, you don't care about the detailed dimensions of a wideflange beam; all you need is a very simple representation of an object that stands as a column. It is very late in the design process that things like flange dimensions, etc. enter. My colleagues in architecture, who are dealing exclusively with geometric modelling, cannot understand that a center line dimension and a few functional properties, such as moment of inertia, are perfectly adequate models of a beam until a very late stage of design. It seems to me that this kind of thinking may be the way out of the dilemma that you posed.

H. WERNER - I would like to stop the discussion on this topic and pass over to the next topic, to the presentation of Prof. Okukawa "The application of sensor technology and computer use for setting a large caisson on the sea bed".

M. FANELLI - I was very much interested in your presentation Prof. Okukawa. There is one point that was not clear to me. You essentially monitored the different quantities about the positions of the caisson, the force of the different winches and the status of the water flooding the various compartments, and then you got information on which to base the next move of the controlling apparatus. How was the forecast of the next motion of the caisson evaluated? Was there a model of the equations of motion of the caisson, implemented in your computer system that predicted the next step and compared the prediction with the observed position and took corrective actions or what? It seems to me that it would be natural, once you have a computer system, to incorporate such a predictive model of the actions, that you take on your controlling system, into your overall controlling system. And then another question. As long as I understood it, the actual operation of the controls, such as the winches and pumps, was manual. Did you ever consider making it automatic, based on the information and the processing done by the computer?

A. OKUKAWA - For your two questions, perhaps, you will have the same answers. The part of the next following operation in these controlling systems should be depending on the operators and the director. There is no estimation for the next following operation, because the conditions of the contruction site are very changeable, then complete automation system is not applicable.

S. SHIMADA - I can help him for his answer. Perhaps the computer program has no dynamic programs forecasting the movements. I think the manager, or director, controls the pump pressure.

M. FANELLI - Can I make another comment or another question? It seems to me that to try to incorporate in your computer system a situation like this, the equation of motion of the caisson in order to forecast the next movement and the effect of the operations that you are going to effect on the controlling apparatus, would be beneficial to the stability of the operation. Moreover, such a model would be very helpful in simulating offline the performance of the system and to train your operator. Is it clear?

A. OKUKAWA - Such system, that satisfies all conditions of the construction site, will be perhaps cast very expensively. For the purpose of training, before the final setting of the caisson is done, the workers are examined on an other site like the actual construction site, I think.

H. WERNER - Are there other questions on this topic? So, we pass over to the next two topics. Are there any question to Mr. Steiger or to Dr. Nuti on "Optimum design methods" or on "A computer program for the analysis and design of prestressed concrete structures"?

G. SCHMIDT-GOENNER - I have a question to Mr. Steiger. I think I got the main thought of your presentation that not always the cheapest single element will give the cheapest global solution, but I think the main problem may be to get realistic prices for the single member in connection to the whole. You understand what I mean. It may be quite an other thing,if you have the same beam for example in a thousand members or in ten members, and now you try to get the cheapest solution. If you use this member only once, you will have an other price as if you use it, may be, a thousand times just even if it is not the cheapest, or not the lightest as in your example. So I think that it will be a very big invent if you get all these decisions a man normally does , when he is planning and calculating for his construction,in a computer program.

F. STEIGER - You are quite right. You can never extimate in the situation of a designer, who is not the man who has to build the construction, he is not employed in the company, in a building company. In our example, we made a case study and all these objectives you mentioned have been examples based on these objectives. The results have been obtained inserting realistic figures for materials and equipment prices of summer 1981. The question that a beam is more cheap if you can make a hundred or thousands of the same type, is right and it is the task of the decision maker to give an upper and lower level of these prices, including this special case naturally. We can never estimate exactly the prices. Yesterday I talked about a method to evaluate these upper and lower limits and so come to a result.