AN INTERNATIONAL AGENDA FOR BETTER CONSTRUCTION?

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1. Introduction.

The purpose of the proposed workshop is to discuss and develop a research agenda that will serve the National Science Foundation in its effort to guide the engineering research community involved in design and construction of capital facilities. But I believe that the context into which this research agenda needs to be placed is as important, or more so, than the research work itself. I have discussed in this paper a broad agenda which seems to me to be emerging, but have given more space to the issues of research system organisations, and to technology transfer, because the best research in the world will be useless if no-one implements it.

2. Research will need to be focussed to an agenda.

I discussed the concept of an international research agenda in a paper[1] for the Global Building Model In The Next Millennium Convention, held 12-15 April 1999 in Melbourne. I firmly believe that a "global" agenda of needs of customers of the building and construction sector is emerging, as shown in Table 1 (see next page). There have been studies in many countries now[2345] which have come up with slight variations on this theme. There are a huge number of "blue sky" ideas for research, but to achieve the uptake which was a concern of the CII/NSF workshop[6] is going to require that the research is focussed on an aspect of this agenda.

It will be immediately apparent in my categorisation of the driving forces for the agenda shown in the right-hand columns of Table 1 that physical sciences and engineering research on their own will not be enough. The building and construction industry, as a generalisation, has in the past paid scant attention to understanding its customers and their needs. Research on this will be essential. So too will responsiveness to societal demands regarding the environment, and research on the best organisation of the industry to deliver the benefits sought. Traditionally, all over the world, industry players have competed against one another, with considerable erosion of profit margins. It is not a supportive environment for testing new ideas if one either makes a windfall or goes bankrupt as a result of the trial!

3. Networks to achieve optimum results.

I also firmly believe that the path forward will be via networks of researchers. No one organisation can regard itself as having a monopoly on knowledge. Every nation's building and construction sector must continually identify ideas from other countries and integrate them with ideas which arise due to their own national characteristics - which may be related to social customs, local geography and climate, local cost-effective availability of materials, or other factors.

There is no doubt that some nations are ahead of others in different fields; for example design against earthquakes is probably better advanced in New Zealand, Japan or California than it is in Australia or most of Western Europe; and computer rendering techniques for building information are very advanced in Finland compared with many other parts of the world. But every nation can learn from any other. Networks such as CIB, with over 500 members in 59 countries, creating a network of over 5000 experts involved in the 56 CIB Working Commissions and Task Groups[7], provide integration of individual research efforts.

In this respect the research community does nothing different from the manufacturing sector. Companies such as USG or Bethlehem Steel have informal or formal technology sharing arrangements worldwide, sharing the innovations in technology and market niche development which each participating company unearths.

Table 1. A research agenda for the building and construction sector

		Driving forces to achieve target			
Target	Comment	New knowledge	Know the customer	Better industry structure	Controlled impact on environment
50% reduction in operation, maintenance and energy costs.	*Energy efficiency is squarely on the political agenda, and the industry has a choice of setting a target of its own, or of having one set for it by others.*	✓	✓	✓	✓
50% reduction in delivery time	*Time is money both for customers - especially if normal operations have had to be disrupted to allow the construction process to take place, or if funds have to be borrowed for a project to start - and for the industry.*	✓	✓	✓	
Zero defects	*This will rely on better use of existing information, and timely recognition of the need for, and delivery of, new knowledge.*	✓	✓	✓	
50% less waste and pollution	*Construction waste is a disproportionately large contributor of volume of landfills.*	✓		✓	✓
50% more durability and flexibility	*The building/structure must be able to deliver (with appropriate maintenance) its initial performance for a long period, and be adaptable to changed user need, because facilities usually last for many decades.*	✓	✓		✓
30 % increase in building user productivity and comfort.	*The annual salary costs of the occupants of a commercial/institutional building approach the capital cost of the building. Such improved productivity is a very important performance characteristic for most facilities.*	✓	✓		
50% fewer occupant related illnesses and injuries	*This will contribute to the productivity target; but is also a target in its own right.*	✓	✓		
50% fewer construction work injuries/illnesses.	*In many countries, there are a disproportionate number of deaths of construction workers at work. Sick or injured workers mean loss of team productivity, as well as personal loss.*	✓		✓	

4. Technology transfer, and "locking advances in".

As the CII/NSF workshop pointed out, ensuring that new knowledge reaches those who can use it, and that they then implement it, is also essential if the optimum benefits are to be attained. I see a key role

for this in the building control system, especially where well-devised performance-based codes can be introduced and used.

The issue is complex, but in simplistic terms we already have a problem with applying all the information which we have. Yet because of the economic driver for more information and innovation to be produced, we are going to have to find innovative ways of managing the process, rather than simply throwing up our hands and trying, Canute-like, to stem the tide of knowledge.

The fragmentation of the industry introduces potential communication difficulties in taking all those working in the industry to new levels of understanding of knowledge. We cannot raise the knowledge and performance levels of the workforce without retraining those already working in the industry. There are therefore issues both of rendering the information useable by those who need it, and then making sure that they know of its existence and apply it. Aided by the availability of electronic communication tools, there is no reason now why exact solutions to problems cannot be delivered right to the worker on site to allow the attainment of the specified requirement, in a format which is tailored to the level of understanding of the particular user - though we probably need more research on exactly how best to structure this.

Some question why so many building research organisations should continue to be required in this environment of existing information overload. Seaden[8] postulates a potential future of international research organisations, and there is no doubt that a pool of experts who possess specific information in energy efficiency of building services, for example, could effectively carry out all the research that was needed in all countries, from a base in one country. I cannot see this becoming the predominant pattern, though[9]. As long as a significant element of the building industry world-wide is focussed on delivery of shelter, using small- and medium-sized enterprises, it is logical that a local agency is required to provide a local point of contact for the industry, ensuring that new knowledge derived either locally or in another country is applied in a fashion that is sensible for the situation in that country. It is also logical that that local agency will need good links to other agencies.

The building controls regime is another potential key to technology transfer. Codes and Standards define the minimum levels of performance which are to be attained - whether in prescriptive or performance terms. So as we advance our knowledge base, we can use these controls to lock in the new required performance of the industry. Once the researcher has demonstrated the desirability of including new research findings to the satisfaction of the person(s) responsible for creating the control, and the new knowledge is embodied, those charged with supervising the controls are automatically enlisted in explaining the new knowledge to those who must use it in individual buildings. But this builds in a "reality check" for the researchers too; it ensures that the work which they are doing is attainable in practice, or it will not be incorporated and implemented. We can see a win-win here for the researchers and for the industry, by ensuring that the process of introduction of new ideas is also keeping the researchers in touch with real-world issues.

Performance-based codes seem to me to provide an easier avenue for incorporation of research findings, and easier acceptance of innovative thinking, than do prescriptive codes. "Performance basis" is a comfortable notion for scientists and engineers, who are constantly needing to work on fact-based issues. The introduction of performance codes forces the realisation that there is so much about the performance of prescribed items which we do not actually understand, so creating a need for more research, if the introduction of innovative ways of thinking about issues, and solving design needs, is to be facilitated. There have been long-term efforts in CIB, ISO, RILEM and ASTM, stretching back at least to 1972[10], and more recently from the Inter-jurisdictional Regulatory Collaboration Committee, to spread information about performance-based specification, but it is clear that there remains a lot of unresolved ground yet. An important task for the research community is to ensure that this fragmentation of interested bodies becomes a force for the good, by bringing the different interests to a synergistic result, rather than fostering duplication of effort and splintering of implementation.

CIB Task Group 11[11] compared the approaches of a number of countries toward performance specification, and identified that there are many gaps in understanding even this generic area, let alone the correct specification levels. A new CIB Task Group has been formed to take this further, and we are examining now the ability of CIB to compile a compendium of validated models of building performance, and a report on the economic benefits of using the performance approach to specification and control of building and construction projects, over the next two years. We hope that the CIB Congress[12] in Wellington in 2001 will be a key reporting point for bringing together the recent achievements and discussing them with the user community.

5. The vision that emerges.

And so for 2010, we need:

- An industry approach to delivery of the built environment, which involves enhanced training, technology and product innovation, but above all a focus on understanding what people want from their built environment and a determination to address these wants efficiently and cost-effectively. This will be underpinned by research and development of a knowledge base which allows innovative solutions to emerging problems.
- Industry companies collaborating to form clusters around core competencies, such as "natural hazards and risk control", "clean, green eco-construction" and "personal shelter", to allow the efficiencies of scale of activity to better emerge, and to enhance organisational learning.
- An improved regulatory system, performance-based and underpinned by research which provides justification for the quoted performance requirements.
- The research and knowledge bases required for this vision derived on an international basis by teams drawn from a range of countries, capitalising on the special information known to each team member.

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