CI/SfB

Date: April 2001

BRANZ
THE RESOURCE CENTRE FOR BUILDING EXCELLENCE

CONFERENCE PAPER

No. 82 (2001)

Researchers Working With Building Surveyors

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Presented at the 'New Approaches For a New Era', 10th Australasian Conference of Australian Institute of Building Surveyors, Surfers Paradise, Queensland, November 12-15, 2000

This work reported here was funded by the Building Research Levy.

SUPPORTED BY THE BUILDING RESEARCH LEVY

ISSN: 0111-7505

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1 Introduction

It is appropriate in the year of the Olympics in Australia to reflect on the slogan that underpins the Olympic movement – "Citius, Altius, Fortius" (faster, higher, stronger) – and the way that it also reflects the expectations of customers of our sector. Whether the demand is coming from the customers who are commissioning buildings, from the people who are creating buildings, or from the building product suppliers, there is an expectation that the performance of the built environment, just as that of the athletes of the world, will get 'better' – however we, or the customers of the building industry, want to define that. But whatever the definition is, it implies change from today, and 'change' means 'risk'.

Virtually every country has a building code, and Australia is no exception. I suggest to you that the role of the building surveyor is an important one, in balancing risk against potential benefit on behalf of the community, and that the research community also has potentially the same goal – to devise solutions which mean buildings are more cost effective, or delivered more quickly, or have healthier indoor environments, or address society's emerging expectations about sustainability. I suggest then that there is scope for the building surveyor and the researcher to work very closely together to the same end.

Why do I suggest this commonality of purpose? Every building control decision has in it an element of 'politics' – "the art of the possible", as someone once defined. No code system can exist without a sound knowledge base, which cannot exist without the efforts of researchers, or at least of codifiers of facts. But few decisions (and almost none of the hard ones) need to be made in the instances where the facts are exactly as laid out in the code. Almost every time a crucial decision about acceptability of a product or system needs to be made, there is some small difference from the "deemed to satisfy" documents. This is especially so if there is a desire to use a new material, or an old material in a new way, or deliver a characteristic of the building (such as an egress route in fire) in a new way.

Then the building surveyor needs to know where the risk lies in the departure from the previously known – and that sensitivity analysis is where I believe the researcher can make considerable contribution to the work of the building surveyor, in letting him or her understand clearly the risk that arises. However, the researcher is not at present being asked to assist with this. Every time a researcher is alerted to a gap in the knowledge base, they have an opportunity to devise ways to fill it. It is therefore very useful to researchers to be contacted by building surveyors, either over the phone regarding specific issues, or through organisations like your institute formally drawing research organisations' attention to these gaps.

There is another strong reason for the researcher to want to work with the building surveyor, in my view, and that is in developing an understanding of how a building surveyor thinks about an issue. The best research in the world has no value if it is never used. A researcher may come up with a totally new solution to a building problem – one that the existing standards never envisaged – which faces extreme barriers to implementation simply because it cannot fit to the existing "deemed to satisfy" or "approved" solutions. The researcher's work is wasted if this technology transfer work is not carried out.

I'd like in this paper to elaborate on some of the above points.

2. Concerns about sustainability

A new citizens' voice is pushing for more attention to 'sustainability', in a direction that at present has little coverage in building codes. People recognise that there is a limit to the resources which we can apply. They also recognise that the construction sector is an underpinning element in every economy in the world, no matter how developed, and that it therefore is a key industry in which the 'sustainability' issues of energy and resource conservation must be addressed.

There is a range of estimates – from 30 to 50% – of the amount of energy usage in OECD countries that is associated with operation of the built environment. Many less-developed countries are making rapid strides toward industrialisation and their contribution to global energy use will inevitably rise. The consequences for CO_2 generation, and therefore contribution to global warming, are likely to be significant.

There are regions of the world where supplies of potable water can be assured only with difficulty. There are also concerns about the extent to which virgin forest is being cut and not replaced, and about the continued availability of some metals. So there is a strong movement sweeping the world toward 'sustainability' – toward design of built environments which use less resource, especially of water and energy (including transport energy to convey residents to their place of work), and toward more use in materials selection by the building and construction sector of the principles of 'reduce, re-use, or re-cycle'.

The themes of 'sustainability' and 'energy' and 'environment' are very popular in research at present. There are millions of dollars being poured into investigations in these areas, even though there may be minimal control requirements – yet – on them. There is extensive scope for researchers to work with the building control community to temper the zeal of the enthusiasts – some might describe them as extremists, even – to ensure that when the codes are written, their requirements have a basis in fact, and in likely measurable impact, and have an element of achievability rather than being based on pure idealism.

3. Customer expectation

But setting aside these emerging trends, in the conventional building procurement world we can see common threads emerge in exercises carried out in many countries regarding what the expectations are for the industry in the 21st century – see for example, Wright et al (1995) and Snell et al (1999) regarding USA, Tupamaki (1997) regarding Europe, the Egan report in the UK[1], the Construction Industry Development Board (2000) regarding Malaysia, and NSW Government (1997) and the National Building and Construction Committee Report[2] regarding Australia.

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[1] See http://www.construction.detr.gov.uk/cis/rethink/index.htm
[2] See http://www.isr.gov.au/industry/building/NatBACC.pdf

We can thus encapsulate the expectations that exist among all those who are seeking greater innovation in building and construction, as in Table 1. These expectations place pressures on all in the planning and production chain – not least those responsible for making sure that code requirements are met as these innovations are introduced. How can researchers, and people like them, help with this?

Table 1: Some expectations from innovation

- Faster delivery
- Zero defects
- Reduced operating and maintenance costs
- Greater durability and flexibility
- Greater building user productivity and comfort
- Fewer building-caused illnesses and injuries to occupants
- Fewer illnesses and injuries incurred by workers in the construction industry
- Greater consideration of sustainability of energy and water use
- Better materials utilisation, leading to less waste and pollution

4. CIB and its scope of action

Given my role as President of CIB – The International Council for Research and Innovation in Building and Construction[3] – it is probably not surprising that I should say that researchers can offer a lot to assist in this area.

To help convey an appreciation of this, it is necessary to provide a little background on CIB and its activities. CIB was established in 1953, with 43 initial members, by far the majority from Europe, but has since developed into a worldwide network of over 5000 experts from about 500 member organisations active in the research community, in industry or in education, with a permanent Secretariat based in Rotterdam.

The members cooperate and exchange information in over 50 CIB Commissions. Amongst the CIB member organisations we can now find almost all the major national building research institutes in the world, as well as many other types of organisations in the building and construction sector who have since joined us. And although within the CIB programme considerable attention is still given to technical topics, which originally dominated the work programme, there are now also activities focused on topics like organisation and management, economics of building, legal and procurement practices, urban planning and building control systems.

This structure means that there is a huge network of experts from a wide range of countries with experience of subject matter in most of the areas covered by building codes. Table 2 lists some of the Working Commissions and Task Groups that are of relevance to building control issues.

These Working Commissions and Task Groups initiate projects for research and development and information exchange, organise meetings and produce publications, such as proceedings of meetings, scientific or technical analyses and international state-of-the-art reports. The emphasis is on transferring research results to those who can best apply them, wherever in the world they may be.

[3] see the CIB Home page at http://www.cibworld.nl/

Table 2: CIB Working Commissions and Task Groups with work of direct relevance to building controls

WC/TG	Title	2001 meeting in Wellington?
TG25	Facade systems and technologies	Yes
TG36	Quality assurance	Yes
TG37	Performance-based building regulatory systems	Yes
TG42	Performance criteria of buildings for health and comfort	Yes
W14	Fire	Yes
W40	Heat and moisture transfer in buildings	Yes
W51	Acoustics	
W60	Performance concept in building	Yes
W62	Water supply and drainage	
W67	Energy conservation in the built environment	Yes
W80	Prediction of service life of building materials and components	Yes
W83	Roofing materials and systems	
W84	Building non-handicapping environments	
W85	Structural serviceability	Yes
W94	Design for durability	Yes

Many of these groups will, as shown in Table 2, hold meetings during the 15th triennial CIB World Building Congress: Performance in Product and Practice, which will be held in Wellington, New Zealand in April 2001[4]. Different technical streams in next year's Congress, which will mix people from this wide range of backgrounds, will address the topics of client expectations of performance and how this performance might be measured, delivery of projects by high-performance teams, innovations to improve performance, and (probably of special importance for this audience) performance-based building controls.

We have been trying to expand the base of membership, because the technology transfer that I referred to, and the learning by researchers about how others such as building surveyors think about issues, is facilitated by having the researchers and others work together in a group. There has been some success in this, with around a third of the membership coming now from outside the research institutes and universities. Standards committees serve a similar purpose at a national level and sometimes at an international level. But CIB has tended to work at the 'prestandardisation' stage, providing reports which identify from our international base the issues that might fruitfully be addressed in standards or other control documents, and how different countries have done this.

Very good examples of this have been reports by Task Group 11 on analysis of building regulations in countries where the performance-based approach has been applied, (the UK, New Zealand, Australia, Canada, the Netherlands, Spain, Sweden and the USA) and the results of a detailed survey of building regulatory systems in general in these and other countries (Oleszkiewicz, 1997), and Working Commission 82 on a comparison of visions of sustainable construction from a number of countries (Bourdeau 1998), and CIB's Agenda 21 setting out the perceived research agenda for increased sustainability of construction (CIB, 1999).

[4] see http://www.branz.org.nz/cib/

5. Overcoming the barriers to introduction of innovations

Seaden (1996) wrote at length about the economic barriers to development and application of innovations in the sector, and CIB Task Group 35 is presently completing a state-of-the-art report on “Innovation Systems in Construction”, which will provide views from many countries on the systems by which new ideas are introduced to the sector, and the impediments to their introduction. This report will be discussed at the CIB Congress next year and at a separate conference in Canada in June 2001.

I was privileged to have a leadership role in the “Buildings and Facilities” stream of the Civil Engineering Research Foundation (CERF) conference “Moving Innovations into Practice for a Sustainable Future Construction Sector”[5] held in Washington in September. A number of barriers to getting innovations applied were identified, and a number of desirable practices were proposed to get around these barriers.

There was a general view amongst participants in the buildings and facilities stream that there were two key strategies required:

- Clear creation of ‘market pull’, by provision of reliable information to potential users about the benefits that might be expected. It was recognised that third party statements, such as are obtained in Appraisal or Agrement certification systems were crucial in enhancing the credibility of this information
- Creating a legislative environment which was supportive of, rather than resistant to, the introduction of new products and processes. It was suggested that this needs to extend to government funding support of innovation processes and demonstration projects in which the new products or processes were applied, and – probably of most importance to this audience – the need for code systems expressed in performance rather than prescriptive terms.

A number of human factors come into play when new ideas are introduced in our sector. People are always wary of, and usually resistant to, innovation, which in the building and construction sector is usually incremental, which means that it is often slow to permeate the industry. This is driven by a reluctance on the part of the huge majority of customers to have an ‘experimental’ building delivered to them. Their reluctance is justified when one considers the extent of, for example, weathertightness problems which seem to occur with supposedly established systems, let alone when an incompletely-thought-through innovative cladding system is introduced.

Yet changes must be introduced, if we are to achieve the desirable outcomes that are listed in Table 1, and as the building control systems are broadened in coverage to more fully address energy and environmental issues in response to public concerns about sustainability. People will look to introduce innovative solutions to problems, and some established products, designs or practices will no longer meet the code requirements. We can anticipate very real tension between the ‘public good’ which the building control official will be asked to enforce and the ‘private good’ of the product or system principal. Hence the need for systems for third party opinions, ‘demonstration projects’, and the provision of reliable information that were identified at the CERF conference, as essential aids to delivery of a better built environment. The researcher is well placed to assist in these.

[5] see http://www.cenet.org/

5.1 Third-party evaluation systems.

Every system must be used for a first time and, unless the 'approvals' system is extremely conservative, there will be some failures. Therefore processes need to be in place to ensure that innovative building solutions which are not going to work are identified, and stopped in their tracks, and those solutions which have value are implemented as widely as appropriate. These administrative processes should provide efficient and easily accessible routes for ideas to be evaluated and if desirable introduced. Agrement and Appraisals are key processes adopted in many countries to deal with these evaluations. The World Federation of Technical Assessment Organisations (WFTAO[6]) has been established to share ideas on how innovative ideas should be evaluated, and to try to avoid requirements for expensive duplicate re-evaluations of innovations in each country.

There are 25 members of WFTAO, from 21 countries. Many of these are national building research agencies – such as IRC in Canada, CSTB in France, CSIRO in Australia, CSIR in South Africa and BRANZ in New Zealand. Others are from traditional product evaluation agencies, including ICBO in USA.

There are two aspects whereby this type of network is of direct benefit to building surveyors. The first is related to the arrival of products from other countries, as an effect of globalisation. Despite the desires of the World Trade Organisation[7] to outlaw "Technical Barriers to Trade", such barriers do still exist, making the inter-organisational networks like WFTAO extremely important. One of the ideas which WFTAO have been considering is a 'World Technical Assessment' (WTA), whereby a product/system which was being sold internationally would also be assessed internationally by members of the WFTAO network. There is already a European analogue of this, and this is likely to be the foundation for developing the WTA concept.

Yet even when these third party assessments are available, it is essential that local knowledge is applied. While every country can learn from every other, every country also has its own climatic, geological, and social characteristics which may make an innovation which is a raging success in one country a sorry failure in another. This is one of the issues that is going to make the WTA concept a challenging one to develop.

The second aspect is the assessment of innovative products for which there is no standard. A good current example is the use of fuel cells for delivery of power and heating to buildings, for which commercial units are now available in North America. Fuel cell standards in place today, do not cover the full range of available or anticipated technologies, nor are there any criteria in the model codes to cover their installation and integration with the building or facilities with which they are associated. NES[8] is near to releasing for public review a protocol for evaluating the performance of fuel cell products against the US building codes. How would the average building surveyor begin to assess the criteria that would be needed for allowing such a product to be used, and then provide the relevant assessment and grant approval? Returning to more mundane issues, what about assessment of methodologies claimed to provide termite control? What does a building surveyor look for to assure themselves of the efficacy for long-term use where Appraisals don't exist? It is in such innovative systems that Agrement or Appraisal systems come into their own, because their staff are trained to do nothing but these evaluation exercises.

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[6] See http://www.nrc.ca/wftao/about.html
[7] See http://www.oecd.org/ech/seattle/issues.htm
[8] http://www.nateval.org/index.html

5.2 Code structure effects

An issue that loomed large at the CERF conference as a major barrier to use of solutions which meet customer expectations of greater cost-effectiveness, safety and/or productivity was the systems used for regulation of the built environment. By specifying requirements in prescriptive terms, countries can define exactly how their built environment will be created, in terms of products and processes. This is the traditional nature of building codes. While they provided certainty of the nature of the resulting building and its performance, in most formats such codes made innovative ideas very hard to introduce except by changing the code itself.

In contrast, codes using a performance-based description of requirements allow the expected outcomes to be defined, but leave the means of attaining them to the ingenuity of the design and construction team. It is usual for these codes to set minimum requirements for achieving society's expectations of safety and health from the built environment. These may be exceeded if the customer wishes. It has also been usual in jurisdictions where performance-based codes have been introduced to have a set of prescriptive documents as well which, if followed, will meet the code requirements. The difference from the codes composed solely of prescriptive requirements is that using the 'approved' methods is not mandatory in these performance-based systems.

It will be obvious from this description that 'performance-based' codes should inhibit innovation less. But the barriers are not totally removed. There are many systems which have served the public and the industry well for tens, if not hundreds, of years, under prescriptive codes. Introduction of performance-based codes forces the realisation that there are many aspects of the performance of these traditional systems which we do not completely understand. For example, the structural engineering community has had a considerable detective task in working out the reasons that timber frame structures work better as a whole frame than would be predicted from the sum of the individual components of the framing system (e.g. Deam and Beattie 1997). (And since this talk is about the cooperation involving researchers, we should be honest and admit that researchers are not just being altruistic in desiring the spread of performance-based codes, even though it does 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.)

There can therefore be difficulties if the requirement is to demonstrate "equivalence" of new solutions to the old ones, as a means of having the innovative idea approved. Long-established systems may significantly exceed the minimum performance that is required, and setting 'equivalence' to the old system as the standard to be met for new ideas may therefore undermine the concept of establishing a performance-based code. This particularly applies where the building code does not use specific numbers as the basis for code requirements. I invite you to consider how to interpret – when presented with an innovative system which is not covered by the Deemed to Satisfy documents - the words or terms "adequate" or "acceptable" or "undue" which occur in the Building Code of Australia Volume 2 at the performance requirement level. Do these not provide fruitful room for debate and argument? Or does the innovator simply not bother to innovate?

Finally, proving that an innovative system will attain the required performance levels is based on having approved verification methods, such as proof by particular tests or calculation methods. These verification methods are often difficult to develop. Application of verification methods to innovative systems may be too expensive unless the savings that can be attained by using the innovation are very great. Thus, performance-based codes are not without difficulties of their own.

A corollary is that the people who are administering the building controls system must be well trained, and able to respond creatively to innovative ideas. There is no point in someone devising a new means of delivering a durable, cost efficient building if the person who is responsible for allowing its construction to proceed is dominated by a manual of "Approved" or "Acceptable" or "Deemed to satisfy" Solutions.

5.3 Fire engineering as an example of researchers helping with understanding code needs

It is at these sorts of points that the researchers can perhaps step in to help, and consideration of fire engineering issues is a good example to use. CIB Working Commission W14: Fire, which has 60-70 nominal participants from over 30 countries, has had an ambitious plan of work (Duncan 1999) which has been hampered by lack of funding – a common problem all around the world for research in the building and construction sector. Some of the elements of this work plan which should materially assist building surveyors were:

- <u>Preparing a guidance document on a rational fire safety engineering approach to fire resistance in buildings.</u> Fire resistance has traditionally been assessed by measuring the performance of the building cell components in standard tests. Increased understanding of fire, and the development of fire safety engineering as a special profession, have created possibilities for a more flexible approach to fire resistance.

- <u>Building and occupant characterisation in FSE guides.</u> Modern fire safety design of buildings must take account of both the physical building and its occupants. In a nutshell, what and who will be in the building when fire begins? This project, led from USA, will review building and occupant characteristics in Fire Safety Engineering Guides internationally.

- <u>Compendium of statements of objectives and functional requirements of fire-related building controls.</u> An early step to obtaining some globalisation of fire engineering solutions will be to identify what the requirements are in different countries, and understand any valid reasons for difference. Understanding this will teach us each about the real rationale of our own code, as well as those of others. This is a theme which is being addressed by several CIB groups outside the fire area, as well.

- <u>Databases to support risk-informed performance-based fire safety engineering.</u> This project aims to identify and collect frequency, probability, and reliability data for use in risk, uncertainty and reliability analyses, and publish a compilation of it.

- <u>Compendium of reference cases for validating the performance of models.</u> W14 has previously run an extensive round robin on fire growth and smoke movement models. The blind simulations highlighted not only possible problems with the models but, especially, potentially serious problems in the capability of the users. This project aims to improve the quality of the models and their use by providing a set of reference cases, which can be used both by the model developers and the engineers using the models..

- Guidance document on rational fire safety engineering approach to fire safety in historic buildings. There is always a dilemma in deciding how to balance retention of the character and appearance of buildings of significant historical or architectural value with delivering the level of fire safety which society has come to expect from its built environment. This project aims to produce a guidance document for practising engineers and those responsible for the management of historic buildings on the use of a fire safety engineering approach in such buildings.

Other activities being promoted by W14 have included:

- A guidance document on protection of disabled people against fire.
- A methodology to move some Japanese research findings on exit design into international documents, perhaps through ISO TC92.

The work plan originally adopted in 1999 was for the appearance of publicly available documents on many of the above issues by late 2001. These documents should provide a much sounder basis for assessment of provisions for safety of occupants from fires in buildings, by showing all involved the large range of potential approaches that might be applied, and potential sources of information on their effectiveness.

Fire engineering is also a good example of how the issue described earlier of research providing tools for assessing and managing risk to help the building surveyor profession. The concept of 'Fire Opinions' allows the experience of experienced fire testing staff to provide soundly-based technical opinions on the consequences of slight changes in the materials or hardware systems used in fire resistance constructions. For every BRANZ fire test that is carried out, somewhere around five fire opinions are written. Obviously, this type of experience is not held by every building surveyor. But for almost a decade there have been tools for assessing, for instance, the likely fire resistance of framed structures (Collier 1991), and BRANZ plans to place on its web page shortly accessible Windows-based software which will provide this sort of assessment, which has been derived from our research programmes at BRANZ.

5.4 Industry fragmentation effects

It might be felt from the comments above that getting the code right is the only thing that stands between us and an innovative consumer-satisfying built environment, and this of course would be wrong (though the code structure is an important issue, as the CERF conference discussed). A second key barrier is the need to train a fragmented industry in the correct use of new products or systems. The task of teaching the precise details of correct product use to every person – or even every enterprise – when the average enterprise size is less than five employees is daunting. Information technology may eventually provide us with the key for delivering precise instructions to the person on the building site, but we are years away from this yet.

In societies where resort to legal action is commonplace, the preparedness of a manufacturer to supply an innovative material to an untrained person is becoming restricted. The olden-days concept of a builder who took responsibility for the realisation of the whole building, using just his team, is almost gone. More often now, the builder manages a complex matrix of small contractors who are specialists in one aspect of the trade, and move on to work with other matrices as soon as their role in the project is complete. Maintaining a 'learning organization' whereby all of the intersections between trades operate smoothly on a new project without re-training of elements of the new matrix becomes difficult in such environments.

This second type of barrier to introduction of innovation is made worse by two other issues:

- Customers (especially those who are not professional property portfolio managers) do not necessarily know what is required, and so look to their 'expert' advisers. Often these will include the building surveyor, even if that advisory role is not sought!
- Innovations which are more sophisticated often have less room for error in how they are used. Examples are high-performance concretes and stainless steels. These are routinely used in the building and construction sector, are more costly than the mass materials they replaced, are extremely cost-effective when used appropriately, but must be installed and maintained more carefully than the materials they replaced if they are to achieve these benefits. A decade ago there was a warning from a major building materials manufacturer in Australia (Kean 1990) about this: "*As performance is pushed further and further out, so the need for narrower and narrower performance limits becomes critical. … As designs are pushed to the limit, quality control and maintenance become critical elements in the construction and life of the structure.*"

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Inevitably, this means that when consent for use of an innovation is given, it is essential that it is tagged appropriately to ensure that the innovation is used correctly. This is another instance where third party evaluation can be helpful, in ensuring that the technical literature provided with the product is accurate and appropriate for providing guidance on critical points to users.

6. Final comment, and conclusions

We should not necessarily see as a problem the tensions between those who have new ideas and wish to push the boundaries, and those whose job it is to provide the assurance for the community that it has a safe and healthy built environment. These tensions can be very healthy if they press us toward a commonly-agreed future. But as we move through the 21st century, we will need to ensure that we work cooperatively, by pooling all the available expertise (whether new ideas from the innovators, local knowledge held by the building surveyor, or international research or product performance knowledge through bodies such as CIB and WFTAO and the like), to ensure that we get the best possible built environment.

It is inevitable that the building and construction sector will seek innovation, to retain market edge and in response to customer demand. Building surveyors and research organisations can cooperate closely in making sure that useful innovations are allowed to proceed and that ones which are potential failures are recognised and prevented. They can work together too to ensure that building code systems, which exist to address health and safety and (increasingly) environmental issues, do not create barriers to a better built environment. Further, there are important potential inputs to the advancement of knowledge from the experience which building surveyors will develop in seeing how products and systems work in their local built environment, which are of value to the researcher if systematic feedback formats can be created.

There are accessible entry points to the research and product evaluation networks such as CIB and WFTAO through local research organisations. Everyone benefits – the researchers in understanding the context in which their ideas are being applied, and the building surveyors in understanding better the limitations which they should place on approvals – if there is close cooperation between all of us.

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8. Acknowledgement

The preparation of this paper was paid for by the Building Research Levy administered by BRANZ.