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INNOVATION AND BUILDING CONTROLS

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INNOVATION AND BUILDING CONTROLS.

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Abstract

The paper considers the effect of the building control system on the introduction of innovations. The requirements of a system for efficient innovation are discussed, including the 'performance-concept' base, which is designed in part to accomodate technical change.

The control system developed by the Scandinavian countries offers considerable potential and could be implemented in the current Review of Building Controls. The theoretical base and practical progress achieved with this system is reviewed.

Final comments will indicate how the new system allows for easier introduction of innovation by designers and how, commensurate with this greater designer freedom, there is an increase in designer responsibility.

1. INTRODUCTION

The principle objective of this paper is to introduce a system of building control that is currently being advocated for use in New Zealand. This system is identified in various ways but is perhaps best expressed as a 'performance based' system of control. It utilises the concept of performance which can be traced back to a style of thought that was used in the 1930s in the aircraft industry. It has been developed for the building industry by countries in North America, Europe and Scandanavia since the 1960s, and arose due to a need to accommodate new materials, products, methods or systems, i.e innovations, in a world which had for so long been used to a basic set of simple materials: wood, brick, steel and stone. The performance concept has wide application to many aspects of the industry but it has found a particular value in the field of building controls.

Innovation and engineers are partners. Innovation can come in many guises but this paper considers the type of innovation that can be described as the use of existing materials or methods in different ways, the development of new products, methods or systems, or the use of new materials. Many innovations associated with buildings are examined by the Building Research Association of New Zealand's Appraisal Division. BRANZ knows from experience shared with engineers how difficult it can be at times to understand the intent of building control requirements and the frustrations of the restrictive nature of much of the current system of control.

2. THE OPTIONS FOR AN INNOVATOR

Faced with the development of innovation for the building industry, be it a new method, new material, building system or building product, the engineer has two immediate options before him. The first is to 'go it alone' with test and development work. The second is to develop and test in conjunction with the BRANZ Appraisal system. (Any person with a new or innovative building product or system can enter into a contract with the Association to evaluate the product or system with a view to issuing an Appraisal Certificate).

The former route means that having established the pedigree and acceptability of the innovation in his own mind, the engineer has to approach each local authority for permission to use the innovation in its area. The BRANZ Appraisal route has the advantages that the innovation has been examined and checked by an independent organisation whose Appraisal Certificate (a formal technically-based favourable opinion) concerning the innovation is usually accepted by all local authorities in the country. It provides a complementary system to the national standards process. The third way, or some would argue the next stage, in obtaining a seal of approval for an innovation, is to have the innovation recognised as a national standard. However a standard is usually written when a product or system is proven and accepted.

3. THE PRESENT OBSTACLES

The common end point of the development and acceptance process referred to above is the building control system represented immediately by the local authority bylaws based on NZS 1900, the Model Building Bylaw system (1,2,3) produced by the Standards Association of New Zealand (SANZ), and by Government Acts, Regulations and statutory rules.

The total current system of building control in New Zealand has been descibed by Professor Helen Tippett and co-workers in a series of Victoria University School of Architecture research reports (4,5,6,7). These reports were funded under contract by the Ministry of Works and Development and by BRANZ. In brief the work has shown that controls affecting building either directly or indirectly and to varying degrees are comprised of 68 Acts and 66 Regulations administered by 19 Government departments who produce at least 250 documents for the control of buildings within their jurisdiction. Further there is the Model Building Bylaw NZS 1900 Chapters 1-11 and associated means of compliance Standards and the variations to the model building bylaw introduced by approximately one third of the 231 Local Authorities. These variations are usually made to account for conditions peculiar to a locality e.g. Rotorua, special local requirements, or to cover some aspect considered missing in the model bylaw. Finally there are other 'documents of authority' produced by organisations such as BRANZ, NZ Concrete Research Association, NZ National Society for Earthquake Engineering, industry etc, which are effectively used as controls by many local authorities.

The building control system is diverse and complicated. It has 'grown like Topsy' and this in itself is the subject of adverse comment and the attention of the current Review of Planning and Building Controls (8). Three other comments on the system which are frequently heard are concerned with the system's inability to cope adequately with innovation. The first relates to the inclusion of technical matters in the law and the difficulty involved in changing the law in order to accommodate innovation. This problem was raised by and related to New Zealand by Dr E.H.Hitchcock in the early 1970s who subsequently researched and published a thesis in 1979 (9). The second relates to the prevention of innovation by the prescriptive nature of the controls, and the third points out the absence of statements describing the intent of the controls.

Embodied in the controls is the traditional approach to legislation which describes only the tried and tested materials, products, methods of construction etc that were available at the time the control was written. As a consequence of this approach equally satisfactory alternative materials, products, methods etc, developed since are excluded. Examples of <u>prescriptive requirements</u> are:

1) Agricultural Workers Accommodation Regulations 1963.
   Reg 5: - - 'floor shall consist of close clamped tongue and grooved flooring boards or other approved .... free ventilating space of not less than 150 mm between the underside of every joist, sleeper-plate, stringer, or bearer................

2) Spray coating Regulations 1962.
Reg 8: - - all windows wire or reinforced glass in metal frames.

This type of control has the advantages of precision, of being readily understood, of being easily checked for compliance and is totally self-contained. On the other hand its serious disadvantage is that it provides for no alternatives and there is no basis for an alternative since its purpose is unknown. Techniques become fixed and design stereotyped (10).

In recent years SANZ has recognised this problem and has introduced its 'other materials and proprietary products' type clauses to the Model Building Bylaw. These clauses effectively pass judgement on the acceptability of alternative materials, products, methods etc to the local authority Engineer or other person appointed by the Council to control the erection of buildings.

Though making life a little easier for the innovator this type of clause does not remove a fundamental problem of the prescriptive system i.e., where the intent of a control is not stated or where a minimum level of acceptability is not indicated then it becomes impossible for the Engineer to apply his discretionary powers when assessing a new product. The problem applies equally to these involved in developing an innovation.

A common way out of the problem is to compare the properties of the new with the properties of the old-checking that the new in all essential properties is as good as the old, i.e. a test for equivalency. The problem with this approach however is that no one is sure that the properties of the old system are necessary and, if they are, whether they are just adequate for the purpose or in fact are excessive. Material properties are a further factor. Properties of one material necessary for its intrinsic quality may not be the required properties of an alternative material that will be performing the same function.

4. A WAY FORWARD

In order to assess new products on their own merits, rather than compare with what was done yesterday, it is necessary first to consider the function that a product must fulfill and the stresses to which it may be exposed. An example of such a statement is the following:

> A non-load bearing exterior wall must provide a safe physical boundary to a room. The wall must have such strength and rigidity that it can stand up to continuous effects of wind (wind pressure and suction) as well as wind gusts, without apparent deformations and damage occurring or lack of sturdiness being noticed. The wall must have such strength and rigidity that it can be subjected to persons leaning or falling against it without any obvious damage occurring or any lack of sturdiness being noticed (11).

This type of control statement often referred to as a 'functional statement', is purely qualitative in approach. It allows the innovator the freedom to attain the desired ends with a variety of different techniques, and it will also accommodate future developments. However it has several disadvantages. There are disadvantages of obscure meaning, of having implied requirements which will probably be found elsewhere e.g. in 'deemed to satisfy' documents, or by satisfying a nominated agent, and this in turn means that a high level of knowledge and skill in the subject by the control system is required in order that it may judge acceptability of an innovation (10).

The functional statement is however a necessary precursor to another type of statement, the 'performance statement,' which is quantitative. For the wall example given above we have:

a) The wall has sufficient rigidity with respect to a horizontal linear load of 500 N/m if the measured deformation does not exceed 10 mm, and the stress curve gives an even, almost rectilinear curve. Permanent deformations should also be less than 2mm.

b) The wall has sufficient strength as regards "soft" impact if no damage, such as cracks for example, occur at an impact of 120 Nm, and no permanent deformations, such as fractures, for example, occur after impact of 240 Nm (11).

These performance statements allow assessment of a product's (the wall's) 'fitness for purpose' to be made. Use of such statements in a building control system will provide a self contained, precise and readily understood requirement. The requirement is easily checked for compliance (given requisite instrumentation). By leaving the means of achieving the performance level optional, the control does not impede the development of design, or the use of innovation in materials, methods, systems, products etc, (10).

This type of control does however require a resonable degree of technical competence on behalf of the controllers and users. It also requires suitable test facilities to be available.

For each performance level set there should be a 'validation technique' for checking acceptability of an innovation. The technique used should ideally be a universal test or calculation method. But where these are not available then tests or calculations backed by informed judgement can suffice.

This quantification of a functional requirement is an essential key to an effective performance based system of building control. The levels of performance set must have regard to user requirements and therefore should be based on studies of these requirements. Whether the final levels set should be minimum levels commensurate with human needs, or whether they should be levels regarded as currently acceptable to society is open to discussion. Many properties that are quantified will require the element of risk to be assessed and safety factors decided. Clearly this level of risk must be formulated first by society or its representatives, the politicians, making informed judgement based on informed technical data. Risk must also be related to cost considerations. Techniques for cost benefit and risk evaluation will require development.

5. THE HIERACHY OF REQUIREMENTS

Consideration of the types of statement discussed above show that they form a natural hierarchy: functional requirements, performance requirements, and validation techniques. These statements are the centre of a performance based building control system. Two aspects are missing for a complete, integral system.

The first follows from a sociometrical or political decision defining the parameters that a building control system must control i.e. the aims of the control system. If questioned, many people today would reply that obviously the health and safety of the occupants of a building are the major concerns - with perhaps as a national requirement the need to conserve energy. However it was not so long ago that protection of property was a prime concern and many of the requirements of our current control system are written with this as the prerequisite. Many requirements also reflect a desire for consumer protection and have nothing to do with health and safety. Welfare, amenity, comfort, water conservation, preservation of building stock etc are other parameters which could all be advanced as being necessary for a building controls system to regulate.

Having defined the aims of the system it then becomes possible to make an overall statement of the properties of a building that must be regarded as important from the point of view of society and its individual members.

For example if one of the aims of the control system is for the provision of adequate standards of safety, then the safety section of the control will provide general statements of intent covering such things as safety and load, structural design, protection against fire collapse, explosion, protection against accident: e.g. for safety and load:

> Building structures shall be designed to withstand normal static and dynamic stresses (12).

This then leads to a subdivision of structural requirements and to a series of functional statements for different components of a building, one of which is the non-load bearing exterior wall example given previously.

The second missing part of the total system concerns recognition of traditional methods of construction. These may be included by supplementing performance level statements by reference to prescriptive guiding documents which meet the intent of the functional statements and performance levels.

The total resulting hierarchy of statements, with new examples (13), is summarized below. (The example is given in fuller detail in the Appendix to this paper.)

TYPES OF CONTROL

Overall Statement	"PROVIDE A SUITABLE SOUND ENVIRONMENT".
Functional Statement	"INCLUDE ADEQUATE IMPACT SOUND ATTENTUATION".
Performance Statement	"AN IMPACT SOUND ATTENTUATION OF 58dB IS REQUIRED".
Validation Technique	"USE (XXX) METHOD OF TEST (OR CALCULATION)".
Prescriptive Statement	EITHER: "THIS PRESCRIPTIVE (YYY) HAS BEEN TESTED AND COMPLIES". OR: NO VALIDATION METHODS EXISTS BUT THIS PRESCRIPTION (ZZZ) IS DEEMED TO COMPLY.

This type of system, with modifications, has been in use in Canada, Europe and Scandinavia since the early 1960's. The UK is changing its current system based on functional statements to one based on performance statements, and Australia has also adopted the performance concept. A performance based system of building control is currently being advocated for use in New Zealand by the Review of Planning and Building Controls (8). Standards Association of New Zealand is developing the concepts for its own use through its Building Bylaw Study Group.

6. PROPERTIES OF THE SYSTEM

(a) Strengths

With respect to the objections raised against the existing system earlier it can now be seen that the performance based system:

1) Allows for separation of the legal requirements from technical. The law need only concern itself with the top two or three layers of the hierarchy. Technical solutions can be named in law as 'means of compliance' but still be outside the law, thus allowing for easy change.

   These solutions may now be illustrated with consequent advantages to understanding the control (14).

2) Removes the inhibiting effects of the prescriptive nature of controls.

3) States the intent of the controls.

With these bars to innovation removed the introduction of innovation becomes easier. This type of control system allows for easier applicaion and easier review of control requirements. Work at SANZ committee level would be facilitated by knowing what a control is intended to do. Concerns for intrinsic risk levels and costs, and likely acceptance by society will be eased considerably by the guiding functional and performance statements.

Through its Appraisal work BRANZ has recognised the problems, shortcomings and frustration of the present system of control, and is of the opinion that a change to any performance based system that has a logical hierarchial progression of statements, such as described above, is necessary.

The performance based system should also ease constraints on design and the designer should be able to take better advantage of the freedom to interpret and comply with the intent of a control statement. Innovation in design should become possible. Commensurate with these increased freedoms of innovation and design there will arise an increase in responsibilities for care during the design process, and for adequate proof of innovation when required. Contractual procedures, responsibilities, insurance and liabilities of designers may change or require clarification if the technical basis of 'fitness for purpose' is the sole or major basis for design. Also innovators and designers have a responsibility to use the system otherwise the alternative prescriptive means of compliance will once again become regarded as the only way to meet the controls.

(b) Limitations

It must be stressed that, based on overseas experience, the introduction of a performance based system of building control will not be an immediate panacea for our problems. The system has to be understood, worked with and developed. A lot can be learnt from overseas experience but essentially New Zealanders will have to experience it for themselves.

Some aspects of the control system are difficult to write in performance terms. In these cases prescriptive statements may be the only way to describe a particular control. The blend of performance and prescription will develop and be modified with experience.

The small size of New Zealand's population will almost certainly be a limiting factor in the development of universal validation techniques and in supporting diverse test equipment which will only be used at the innovation proving stage. The economics and financing of such equipment may be too expensive. In place there may be a need to use the equivalency technique of relating the new to the proven, or to rely on the expert judgement of a new system based on ad hoc testing. The background work for the setting of performance levels, the user requirement studies, the development or evaluation of cost-risk, cost-benefit techniques has to be supported. Probably, there will be a need to be pragmatic and accept compromises initially and eliminate these compromises as the knowledge base grows.

One thing that has become clear is that a central agency is required to organise this new building control system and its development. Overview of requirements, coordination of resources, access to the politicians, needs to be the responsibility of one organisation. Such an organisation is the Building Industry Commission recommended by the Review of Planning and Building Controls (8).

7. CONCLUSIONS

This paper tries to show that one of the major complaints regarding our current building control system is that the controls inhibit innovation and adoption of new techniques, the reason for this being that they are prescriptive, are a mixture of legal and technical requirements, and do not state the intent (aim) of the control. The combined effect has the tendency towards preserving existing techniques. To overcome this a building control system is outlined that will allow innovation. This system logically needs a clear identification of types of control statements arranged in a logical hierarchical order with explicit performance levels.

There needs to be a range of documents in addition to those produced by SANZ which can be used to show compliance with the performance requirements of such a performance based control system. These must be applicable to innovation and be acceptable.

There will be problems because of a lack of resources in the setting up of a complete performance based building code. Some performance levels, validation techniques may have to be temporarily substituted by prescriptive equivalents or other means.

Direction of this work by a central agency would appear to be a necessary requisite.

Finally a shift to a performance based control system and the use of 'fitness for purpose' justifications will increase innovators and designers resonsibilities and may affect the current situation concerning insurance, liability and contractual procedures.

APPENDIX A

Example of hierarchial set of statements taken from the Scandanavian control system (13). The example covers only the field of impact sound level in residential buildings and there only the floor structure in rooms in adjacent dwellings.

Overall Statement (Duty)

A Building shall be planned and constructed in such a way that a sound climate satisfactory for the user's comfort and health be obtained and maintained in each single room.

Functional Statement (Properties)

A building shall be planned and constructed in such a way that the propagation of annoying impact sounds be hampered to the extent the activity in the building makes it necessary. Furthermore, speaking must be perceived in a satisfactory way in each single room.

Performance Statement (Performance level)

In single-family houses adjacent to each other, floors shall be constructed in such a manner that impact sound level index in rooms in adjacent dwellings (excepting bathrooms, lavatories, storage rooms and the like) does not exceed 58 dB.

Validation Techniques

The requirements for satisfactory sound insulation are verified by the following test methods:

Impact sound transmission in buildings shall be measured by means of the methods prescribed by ISO/R 140. For the measurements 1/3 octave band filters with preferred frequencies from 100 to 3150 Hz according to ISO/R 266 shall be used.

Measurements of impact sound transmission level shall be evaluated according to the methods of ISO/R 717.

Prescriptive Statement

(Examples of construction techniques are given, well illustrated, with the measured performance recorded).

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