Translation of Research into Practice

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ABSTRACT

It is difficult to introduce new concepts to the building industry. Innovation must be approved by:

the designer
the owner
the lending authority
the insuring body
the design code
the building regulations

The preferred approach to secure early acceptance of innovation is to submit the concept to the professional committee responsible for the design code. Endorsement by that committee can be used to secure the several approvals but incorporation in the appropriate design code can lead directly to incorporation in regulations and thus assure the other approvals. Once the concept is incorporated in a design code or the regulations it will almost certainly be incorporated in the curriculum of educational establishments.

KEYWORDS

Innovation, lending authority, insuring body, design code, building regulations, high-speed sprinklers, steel, concrete, restraint, education, research.

INTRODUCTION

Research workers in all countries are often frustrated by what is seen as an inordinately long time before the findings of successful research projects are adopted in everyday practice. It is probably true in most industries but it is certainly true in the building industry where my experience lies.

Those who have given the matter only passing thought probably accept human reluctance to accept change as the explanation. Certainly the building industry is not renowned for its rapid acceptance of innovation, no matter how well the merit may have been demonstrated and proven.

Those who have given the matter more thought explain it as a failure in communication. The practitioner does not study scientific journals where research results are publicised and busy practitioners are not able to attend research seminars or to undertake post graduate extension courses.

It is my experience that whereas the above two explanations are partially correct, the real explanation lies elsewhere.

CONSTRAINTS WITHIN THE BUILDING INDUSTRY

No matter how eager a designer may be to employ a new technique he is obliged to work within certain constraints. The principal constraint is that he must inform the owner of any intention to be innovative and obtain the owner's consent. No matter how adventurous the owner may be, he in turn may have to obtain the consent of the lending authority through which he is funding the project and secure the approval of the insurance body which is or will be underwriting the project. After these approvals have been obtained local building regulations have to be complied with and these almost invariably require compliance with the relevant design codes. I can cite a classic example of the ease with which research can be translated into practice if some of the foregoing constraints can be eliminated.

In 1971 - 72 the Fire Research Station carried out full-scale tests on fire in high-racked storage at the research facility at Cardington. These experiments demonstrated that fire would spread vertically to involve material above a conventional sprinkler head mounted within the storage rack before that head would be brought into operation by heat from the fire. Further testing demonstrated that a linewire detector could be arranged in the rack to operate sprinkler heads electrically and selectively to confine the fire at its level of outbreak.[1] The Experimental Building Station in Australia is a national building research laboratory attached to the Department of Housing and Construction. This Department is responsible for all federal government building and is probably the largest design and construction authority in the southern hemisphere. The department has to secure its client department's approval before any innovation but it is not necessarily subject to the other constraints. In 1972 the department was designing a high-racked storage building for the Royal Australian Air Force. The strategic importance of the stores required a high level of security and fire safety. A small section of the proposed racking was erected at the EBS and by means of real fires the performance of in-rack sprinkler systems to the latest insurance codes and the new high-speed system were demonstrated. The superiority of the new system was established clearly. The new system, incorporating a computer to monitor continuously the continuity of all electrical circuits and the status of all valves and the pressures in the hydraulic systems, was installed in the multi-million dollar store. Shortly afterward similar systems were incorporated in three large stores for another Australian government instrumentality. After 10 years experience the operators of these four complexes have full confidence in the system but international insurance bodies have not given approval so no commercial enterprise requiring insurance cover has been able to adopt the system. Without support from the insurance industry it cannot be introduced into national codes as full consensus is normally required before existing codes are altered or new codes are adopted.

HOW RESEARCH CAN MEET THE CONSTRAINTS

The constraints upon the practitioner's introduction of change have been identified as -

1. Approval of the building owner
2. Approval of the lending authority
3. Approval of the insuring body
4. Acceptance within the appropriate design code
5. Incorporation within building regulations

1. Approval of the building owner

Few building owners welcome innovation for the sake of innovation and most adopt the attitude that they would prefer to follow up on someone else's success. The experiences of the De Haviland and Boeing companies with their Comet and 707 respectively are well known and understood. To secure the approval of the owner the practitioner has to produce a cost/benefit analysis showing a balance clearly in favour of the innovation. If the balance can be expressed in monetary terms it is more likely to succeed. Successful practitioners are experienced in such activities and normally do not require assistance from the research worker responsible for conceiving the innovation.

2. Approval of the lending authority

The lending authority is normally concerned about the retention of the monetary value of the asset, at least throughout the mortgage period. Accordingly, lending authorities have a conservative approach to innovation in any form. Here the practitioner may need to call upon the research worker for data accumulated during the development program to produce a forecast of the soundness and durability of the innovation to offset the lending authority's complete lack of past experience with the innovation. If the matter is highly technical the lending authority may refuse approval until the body responsible for the design code has examined and approved the innovation. That is, acceptance under constraint number two is frequently conditional upon compliance with constraint number four.

3. Approval of the insuring body

As insurance is based on past experience this industry's reaction to any proposed innovation is cautious in the extreme. Some of the larger industry groups such as the Fire Offices Committee and the Factory Mutual Corporation have their own research laboratories and thus have access to professional expertise in evaluating the merit of particular innovations. In many cases an innovator will have to accept increased insurance costs and in some cases coverage may only be granted if the innovative owner has sufficient other insurance business to offset the feared increase in risk. In these latter cases compliance of the innovation with constraint number four makes the innovation more digestible but not necessarily more attractive or palatable.

4. Acceptance within the appropriate design code

Although listed as number four, acceptance in a design code is probably the most important constraint to be met before an innovation will be widely accepted in practice. No practitioner will risk his professional standing by employing an innovation that is forbidden by the design code but the more talented practitioner will be prepared to use an innovation which he approves personally but which is not specifically approved by the design code. The less talented practitioner works within the provisions of the code as it embodies the procedures in which he was instructed in his undergraduate days. Any subsequent modifications have been examined and approved by a committee comprising the brighter and more experienced of his fellow practitioners together with academics and other industry representatives. Once an innovation has been incorporated in the design code it virtually ceases to be an innovation. The average practitioner is not concerned with the history of its derivation and does not wish to study the matter in depth to develop a full understanding of its underlying theory. He wishes to have the code nominate the technique and the bounds within which he may use the innovation in his practice. Therein lies the biggest delay in the translation from research into practice.

Most research workers believe their task is completed once they have succeeded in having a paper describing a new research finding accepted for publication in a leading scientific journal. In most cases this is all that their laboratory or institution requires of them. Indeed it is on the basis of such publications that promotion and their future professional career is based. If the research institute sees potential for exploitation by industry it may seek to establish a licensing arrangement to give a particular firm exclusive rights to develop the research finding into a marketable commodity. Otherwise the finding may languish in the literature until an applied research worker at another institute or commercial research laboratory sees a potential for its application in particular problems. The applied research worker explores the application both theoretically and experimentally to determine the factors that limit its safe application to particular problems. Publication of this information eventually provides the basis for incorporation in the design code. The contribution of the second worker is often more important than that of the primary worker and usually requires a much longer gestation period.

However, not all research follows the foregoing pattern. I would like to summarize the history of a research undertaking that has evolved over some thirty years and in which many of us here at this First International Symposium on Fire Safety Science have played largely unco-ordinated roles of varying importance.

In the late 1950's several research workers became concerned about the significance of results that were emerging from tests on structural elements carried out at the Northbrook laboratories of Underwriters Laboratories Inc. Studies to explain these results revealed a serious lack of information about the properties of structural steels at temperatures significantly above ambient.

Indeed in 1960 the definitive work on the relation between yield strength and temperature of structural steel was that of Lea[2] published in the early 1920's. To correct this a joint project was undertaken between the Buildings Research Establishment and the Fire Research Station in the United Kingdom[3] and a project was undertaken by the United States Steel Corporation in the U.S.A.[4] An EBS approach to the research laboratories of the steel industry in Australia at that time was rebuffed and suitable information on Australian steels did not become available until the 1970's[5].

The explanation for the test results from ULI was found to be the very high forces of restraint that could be generated during tests on specimens of steel and reinforced concrete held within the very strong specimen - containing frames that had been built for use at Northbrook when the facilities were transferred from Chicago. This highlighted the need for a better definition of the standard fire resistance test for use internationally and ISO/TC92 began work on what ultimately became ISO 834.[6] The Portland Cement Association developed a test facility at Skokie capable of controlling the magnitude and direction of forces of restraint at the boundaries of test specimens. The findings from this facility lead to ULI adopting the practice of publishing separate ratings for restrained and unrestrained structures.[7] Work at P.C.A. Laboratories[8] and at Universities in Sweden[9] and Germany[10] produced detailed information on material properties at high temperatures.

The Federation Internationale de la Precontrainte established a Commission on Fire Resistance which assembled the research information relevant to concrete structures and this panel of international experts drew up a set of guidelines for practising structural engineers designing concrete structures to possess nominated levels of fire resistance[11]. Later national committees produced guidance documents for the design of reinforced concrete structures in United Kingdom[12] and U.S.A.[13]

The foregoing is an example of the general recognition of an area of ignorance and the conduct of independent research programs to produce knowledge to overcome that ignorance. The position now achieved is that the professional associations have prepared the basis for national design codes for the design of fire resisting structures of steel and of concrete. In many countries the movement seems to have stalled at that point and difficulty is being encountered in coping with the next of the constraints.

5. Incorporation within building regulations

In Scandinavian countries there does not appear to be as much difficulty in securing legal acceptance of technical innovations as there is in other countries. Scandinavian countries have for some time accepted buildings that have been individually designed to match the severity of fire that the designing engineer has calculated to be probable for that building.

Most countries still adhere to the system of regulating fire safety in buildings by grouping buildings into classes according to usage and assuming that each class represents one level of potential fire severity. Buildings in each class are required to incorporate a common set of active and passive fire safety features that is varied according to the height and the floor area of the building. The writers of the building regulations have the option of incorporating detailed design requirements in the building regulation document or of specifying a level of performance and requiring compliance with the provisions of a separate nominated design code.

Fortunately in Australia the committee responsible for the drafting of the Australian Model Uniform Building Code has selected the second of these options. The AMUBC nominates the level of performance and requires compliance with the provisions of the appropriate national standard for design and installation produced by the Standards Association of Australia. The Association's standards are drafted by committees representing the appropriate technical and community interests and a representative of the building regulations committee serves on any standards committee responsible for drafting a standard that may be called up in the regulations. This assures appropriate liaison between the two groups. National standards produced by the SAA have no legal status unless they are specifically called up in a regulation.

The SAA Committees responsible for the steel structures code and for the concrete structures code have accepted that fire, like wind and earthquake, is a loading condition that the designer should consider in producing his design. Accordingly an appropriate section on design for fire will be incorporated in the 1985 editions of these standards and should thus become part of the AMUBC.

This system has committees of appropriate technical experts drafting technical standards and leaves the building regulations committee to concentrate on the moral, social and economic considerations that determine the desirable minimum quality of buildings. The system makes it possible for research findings to be considered by the relevant technical committee of SAA, for the national standard to be modified as appropriate and then become part of building regulations. The progress from SAA standard to building regulations is not automatic as the regulating committee has to approve the modified standard. Because of the system of representation on the standards committee a significant delay is unlikely provided that issue of the revised standard is harmonised with the review of regulations. One factor that has to be observed carefully is that standards must be expressed in mandatory rather than advisory terms if they are to be passed into law. While this may seem an editorial matter it does involve the technical committee in consideration of those design matters to be defined as obligatory and those to be expressed as desirable. The technical committee drafting the standard is best qualified to do this.

If the second option is followed the process becomes more involved. In February 1981 American Concrete Institute Committee 216 published a guide for determining the fire endurance of concrete elements.[13] The guide represents an excellent and detailed treatment of the subject but is not in a form suitable for adoption in building regulations. Had that ACI committee of experts co-opted representatives from building code authorities to prepare a companion document suitable for incorporation in building codes the matter would have been dealt with expeditiously and the U.S.A. would have had common rules for fire-resisting concrete structures. Instead the system requires each of the code authorities to form its own ad hoc committee to prepare its own rules. The duplication of the work undertaken by the Ad Hoc Committee on Calculated Fire Resistance of the Southern Building Code Congress[14] by each of the several other code authorities represents a major effort and very likely will have resulted in a lack of uniformity throughout the country.

INTRODUCING RESEARCH THROUGH EDUCATION

At post-graduate seminars, extension courses and conferences organised by fire protection associations, fire research workers are afforded the opportunity to outline progress with fire research to industry. Practitioners attending the seminars and courses are interested in learning techniques or other developments that can be applied in their practice. They are interested in learning the background and basis for changes that are being made in design codes or regulations but they are not interested greatly in research that has not yet reached that stage of advancement.

I have studied the professional backgrounds of attendants at regional and national conferences organised by the Australian Fire Protection Association. The majority of attendants are from the fire protection industry itself and the remainder are federal, state or local government officials or fire safety officers from large commercial or industrial undertakings. When questioned, the average architect or engineer will reply that he cannot spare the time to attend such functions but that he would like to be able to do so.

The Australian Model Uniform Building Code, wherever practical, calls up standards and codes of the SAA to express its requirements in the various building fields. Fire safety is a comparatively young science and because there is no SAA fire safety code the regulations devote a lot of attention to detailed fire safety provisions. Tertiary institutions such as the New South Wales Institute of Technology have introduced extension courses to acquaint building inspectors and practitioners with the intent of and background to these new regulations. Schools of Engineering and Architecture are including similar instruction in their undergraduate courses.

The overall picture shows clearly that the average practitioner and educationist becomes really interested when new concepts are introduced by design codes or by regulation. Until that stage is reached they are not interested.

CONCLUSION

Most industries, and certainly the building industry, are so structured that it is difficult for an individual designer to attempt to introduce a practice that is seen to be a major innovation. Consequently it is difficult for a major research advance to be introduced to practice by individual effort. The preferred approach is to submit the research findings to a national professional committee for appraisal. If the work can be incorporated in a design code it can then progress to incorporation in regulations. Once this is achieved it will be incorporated in the curriculum of educational institutions. Figure 1 is a schematice diagram of the procedure that must be followed with an individual attempt to be innovative and Figure 2 outlines the preferred approach through national design codes.

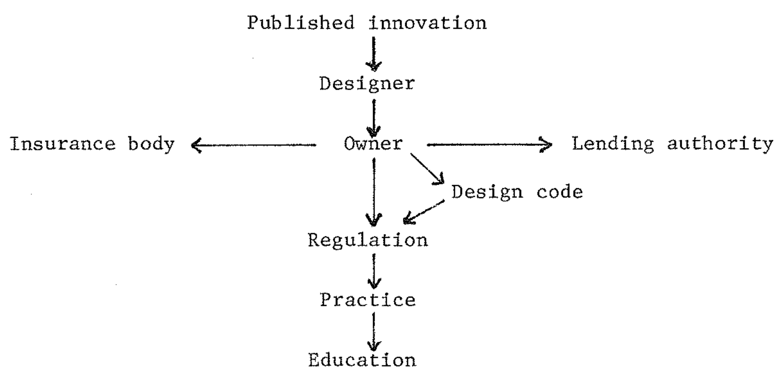

Figure 1 INDIVIDUAL EFFORT

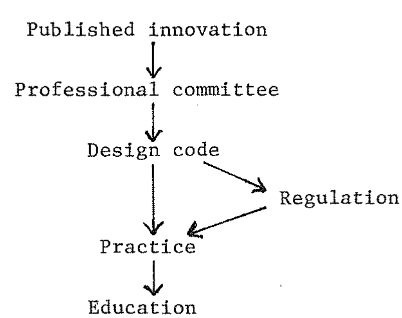

Figure 2 DESIGN CODE APPROACH

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