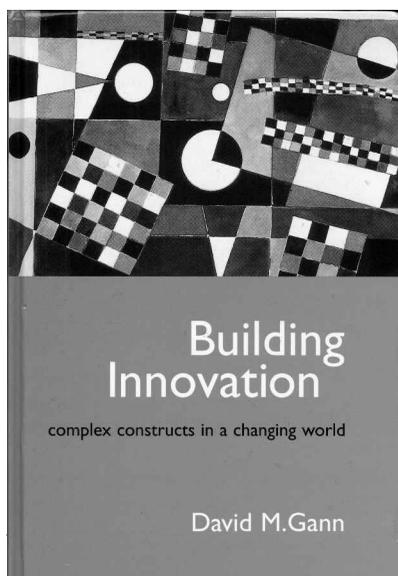


# How does innovation link to research?

## Building Innovation, Complex Constructs in a Changing World

David M. Gann

Thomas Telford Publishing, London, 2000, ISBN 0-7277-2596-3



alone imply we should have high expectations, and *Building Innovation* does not disappoint. It is undoubtedly a worthy addition to the literature on innovation in construction.

In practice, there are very few equivalent sources. As Chris Freeman writes in this book's preface, innovation and technical change in the construction industry have received little attention from economists and historians. The industry has a reputation for being resistant to change and, unlike some other sectors, it is not driven by research and innovation. Nevertheless, what *Building Innovation* clearly shows is the substantial transformation of both technological and managerial practices in the industry over the last two centuries.

Part 1 of the book takes a historical view and charts technological changes in the industry from the middle of the nineteenth century to the middle of the twentieth – broadly Banham's first machine age. Craft traditions were gradually replaced – or overlaid – by industrialized techniques related to the use of iron, steel and glass in buildings. Building sites changed gradually from places where craftsmen shaped local indigenous materials into a building, to places with greater and greater degrees of mechanization in the assembly of pre-fabricated components transported from afar and assembled on site. Both designers of buildings and manufacturers of products were implicated in these innovations. There were pressures from the demand side, such as the programme to provide 'Homes for Heroes' after World War I, as well as the need for new building types. From the supply side, economies of scale

arose from standardization and prefabrication, while the growth of lifts and other mechanical services enabled buildings to become higher and larger. Much of this is well known territory, but Gann tells the story competently and concisely.

Part 2 looks at innovations in the digital age, from about 1960. Again, both demand and supply sides drove innovation. On the demand side there were pressures for innovative buildings to support the 'information society' – to house the computing, software, micro-electronics and telecommunications industries, as well as for offices to support the growing financial services sector. Typically such buildings needed to provide large floor-plates, adaptable cabling systems, and the ability to cope with periodic changes in working patterns and organizational structures, including hot-desking. The servicing of buildings grew in importance, not only as occupants came to expect higher standards of comfort, but also as the buildings themselves became deeper in plan and increasingly contained heat-emitting equipment. On the supply side, intelligence could be built into products and services within buildings – digital control systems that contributed to building security and fire protection, operated heating, ventilation and air conditioning, and adjusted artificial lighting.

In some cases innovation originated within, as it were, the construction industry. For example, 'smart structures' enabled buildings to respond to wind- or earthquake-induced movement by dampening oscillations. But most of the technical innovations came from manufacturers of products, components and systems. The 'intelligent building' concept

David Gann occupies a unique position in construction research. Based at the Science Policy Research Unit (SPRU) at the University of Sussex, he holds the Innovative Manufacturing Initiative/Royal Academy of Engineering Chair in Innovative Manufacturing. The construction industry, notorious for its comparative lack of interest in research, is therefore extremely fortunate to have a research champion linked into strategic and policy level research at such an institution. Gann is responsible for the Programme on Innovation in the Built Environment, and has built up a research team at SPRU with a portfolio of construction-related research projects. *Building Innovation* is not the first book he has published in this area, but it is the most substantial and, as he suggests in the Acknowledgements, it draws on 12 years of research into the subject. These factors

was marketed in the US by telecommunications companies, although in Britain it was consultant-led and in Japan demand-driven by owner-occupiers. Both markets and technologies were immature initially and suffered from a lack of common standards. Nor did users understand fully the potential benefits. However, by the early 1990s, integrated building management systems were emerging that could control HVAC, fire and security systems, while telecommunication networks dealt with communications and data processing. The convergence of these two systems is imminent although there are barriers to be overcome, including the demands this would place on already-stretched systems designers, lack of demand from organizations where the functions themselves have not yet converged, and the incompatibilities and lack of inter-connectivity between sub-systems.

As both the fabric and services of buildings increasingly became assemblies of high-value engineered components and systems, so prime contractors offering project management skills to co-ordinate a large number of specialist subcontractors emerged to replace traditional general builders with their in-house building skills and craftsmanship. New procurement routes, forms of contract and financial arrangements emerged to enable risk to be better managed, and to ensure the successful delivery of increasingly complex products.

Even the activity of design was transformed by information and communication technologies. Initially engineers and designers used CAD and similar computer based tools for calculation and simulation, and project management within organizations. Later, electronic exchange of data between organizations was introduced. Increasingly, project data developed by various participants could be stored and communicated electronically across a wide range of project participants throughout the process from early project planning to operation, maintenance, and facilities management. Document management allowed all participants access to all relevant documents on a project. More radically, all participants worked on a common model which grew in complexity and sophistication as the project proceeded from inception to completion and operation. The goal of a single project model emerged from this process. Inter-operability between systems remains a substantial barrier, not

least as proprietary software is constantly changing. As processing power increased rapidly, visualization and virtual reality modelling helped clients to envisage possibilities.

Part 3 focuses on contemporary innovation, specifically on the drivers behind technological change in the construction industry, and the barriers that held the industry back. In part it takes a historical approach, and rehearses the role of the UK's Building Research Establishment (BRE) and the contribution of academics like Marion Bowley and Ducio Turin. Technical innovation continued to take place mostly in the R&D departments of component manufacturers. This also accounted for the majority of investment in research in the industry. Although in the decades immediately after World War II, UK construction firms invested in research, the industry was badly hit by the recession of the early 1990s and spending on R&D went into decline. In part, the shortfall was made up by government which increasingly funded construction research in the universities, particularly in departments of the newer disciplines of building and construction management. But Gann's most telling contrast is with the R&D spending on Japan, where the commitment to research and expenditure in the industry both started, and remained, far higher.

As local authority building programmes in the UK were reduced and then disappeared, and as government moved away from direct commissioning of buildings as products towards buying facilities as a service, the government-owned BRE was perceived as an anomalous left-over from a previous age, and privatized. This helped to precipitate some big questions about research – specifically why and for whom was building and construction research being carried out. As Britain climbed out of recession, and with the election of a new government, some of these questions were answered. There was a continuing need for research into health and safety issues, into energy efficiency to support international commitments on climate change, and to support regulations, codes and standards. But there was also a determination within government that the industry should move beyond its adversarial, fragmented and inefficient practices, towards a leaner and better organized industry, more attuned to the needs of its customers.

Research was identified as having the potential to contribute to these ambitions. Research programmes introduced by the Engineering and Physical Sciences Research Council (EPSRC) and the Department of the Environment, Transport and the Regions (DETR) supported business process research, in part to emulate the re-engineering of such processes that was considered to have occurred in manufacturing in the previous decade. Here Gann draws on the literature of innovation in fast moving research-intensive sectors such as semi-conductors to compare them with construction and identify what lessons can be learned, if any.

Gann suggests that understanding the supply network is necessary but insufficient to improve the quality and cost and user-friendliness of buildings. Instead he identifies in his penultimate chapter five areas that need to be addressed:

- (1) How technical change influences and is influenced by the relationship between three broad parties – component suppliers, building designers, and constructors
- (2) The relationship between producers and users, and how user needs are articulated in ways which would help producers to respond to them
- (3) the role of government and the regulatory environment
- (4) The processes by which know-how is acquired, stored and passed on
- (5) The delivery of buildings which are considered as integrated products.

The final chapter is about managing innovation in project-based firms, and the competencies, strategies, capabilities and skills that are required. In contrast to most of the rest of the book which is about technical innovation, this deals with managerial changes. Gann recommends firms to appoint an innovation champion to devise an innovation strategy and to act as a focus for organizational learning, knowledge management, and liaison with government agencies, research and technology organizations and universities. He describes the central role that governments have in promoting and supporting innovation in the production of the built environment, particularly where

there is evidence of market failure, as well as via the regulatory framework. On the question of professional institutions, Gann is aware of the valuable role they play in maintaining and disseminating professional knowledge, but critical of their defence of their traditional territory and their antagonism towards interdisciplinary practices and emerging specialisms. As the machine age and the digital age give way to the bio-molecular age, Gann suggests the palette of materials and products will enlarge. Furthermore, in combination with the needs of ecological awareness and sustainable development, this enlarged palette will create additional demands on a sector whose reputation for planning and innovation is comparatively poor. In closing, Gann identifies the challenge facing the construction industry: to study how to retain the ability for maintaining the existing building stock from the machine and digital ages; while also developing the new interdisciplinary and integrative capabilities that are required to deliver inspirational buildings for a healthy, prosperous and civilized twenty-first century.

Who is *Building Innovation* targeted at? The most obvious audience is undergraduates and, more particularly, postgraduates in construction, to whom it will introduce a very wide range of issues to which they have had little, if any, exposure. For students of inno-

vation in other sectors it will undoubtedly provide an excellent overview of innovation in construction, in a way no other single publication has achieved. Its appeal to those working in the industry is less certain. The historical perspective is certainly engaging and provides a valuable background to the current position facing the industry. However, with the exception of the section on the appointment and activities of an innovation champion, it contains few practical recommendations for the industry to operationalize.

Does this book make a clear case for the construction industry to invest more in research? Does it identify research-based innovations and report on their impact? Unfortunately it does neither. Although a limited research agenda is set out in chapter 7 (see the five bullet points above), this is always treated at a very high level. The book's consistently top-down view of innovation is accompanied by a narrow range of detailed examples to provide sufficient supporting evidence. Although the book is a call to arms endorsing the need for research in construction to continue and indeed to expand, it presents very little detailed evidence to justify its exhortations. What, for example, has been the impact in Japan of a much higher level of investment in research? For those UK construction firms that have invested heavily in research, what benefit did they

gain? What are the main strengths and directions of current construction research, particularly into the industry's business processes, and what have been the effects on practice? If there is any disappointment with *Building Innovation* it is its failure to engage with this level of detail. This is not a book that could be given to government or industry as clear evidence justifying an expansion of construction research. Nor does the book's essentially descriptive historical and contemporary narrative provide many pointers about what needs to be done by the academic research base to support the industry.

This is not to deny, however, that it is a remarkable book. Gann is equally comfortable writing about technical, economic, managerial or policy related issues, at ease with historical or contemporary material, and draws not just on UK experience, but on the position in Europe, Japan and, to a lesser extent, the USA. *Building Innovation* will undoubtedly stand as a landmark achievement for its documentation of innovation in the construction sector for many years to come.

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