MODELLING INNOVATION IN AEC: UNDERSTANDING THE FOURTH DIMENSION OF COMPETITION

P.W. Newton, Commonwealth Scientific and Industrial Research Organisation, Division of Building, Construction and Engineering, Melbourne

STATEMENT OF CHALLENGE/VISION

The AEC industries constitute a key sector in all advanced economies (as contributor to GDP). Yet it is a sector characterised as low in R&D intensity (R&D spend as per cent of turnover). A key study by Stoeckel and Quirk (1993), however, indicated that enhanced productivity in construction, more than in any other sector, would deliver highest gains to national economic growth. New growth theory, such as that being advanced by Professor Paul Romer at Stanford University, advocates that economic growth is spurred by productivity which in turn is underpinned by *innovation* and technological change.

The challenge that the AEC sector faces is how to accelerate innovation across a higher proportion of firms, not just leading edge users. Traditional economic theory suggests that in industries where inventions cannot be protected via patent, investment in innovation development (rather than innovation adoption) is low because good ideas leak and are copied which means that firms never recover the cost of developing the new ideas.

Comparative analyses of innovation across different industry sectors (OECD, 1997, p. 17) confirm that construction has very low direct R&D intensity – most firms acquire their technology in the marketplace via adoption.

New economic theory (viz. William Baumol), however, is suggesting that globalisation and higher levels of competition are requiring that innovation becomes *routine* for companies, especially those where international competition is growing (as in AEC Sector). Implementing new ideas faster will become a more potent weapon than price competition.

Indeed, innovation is now being advanced as the fourth dimension of competition, along with cost, quality and time. The latter have gained more rapid acceptance within AEC industries, given the relative ease with which their key concepts can be defined, understood and measured.

OUTLINE OF PROPOSED RESEARCH

Management policies, whose purpose it is to influence innovation, whether based within public or private realm, need to be able to draw upon appropriate theory, empirical data, computational tools, benchmarks, etc., to guide their programs of investment. This is particularly acute in an era of rapid technological and economic change where there are mixed messages linking innovation and outcome. Cooper and Merrill (1997, p. 2) explain the challenge thus:

> '…progress in developing a theoretical understanding of innovation has been hampered by difficulties in measuring and evaluating its outputs as determinants of industrial performance and economic growth. As a consequence, it is uncertain how to capture changes in a volatile industrial environment that gives off mixed signals. For example,

> on the one hand, US industrial firms appear to be cutting back on long-term research and the infrastructure to support it. On the other hand, the competitive performance of much of US industry appears to have improved significantly in recent years. [Also], because of the distance between the language and decisions of policy makers and the language and practical constraints of analysts and statisticians, it is no simple matter to determine what information is relevant to policy.'

Major initiatives have commenced in the USA (National Research Council – see Cooper and Merrill, 1997), Europe (see OECD, 1997) and Australia (DISR, 1999) to gain new insight into innovation and economic performance at firm, region and national levels.

A program of research is proposed designed to fully specify and empirically explore the following, simplified linked model of innovation (as applied to the AEC sector):

Innovation:

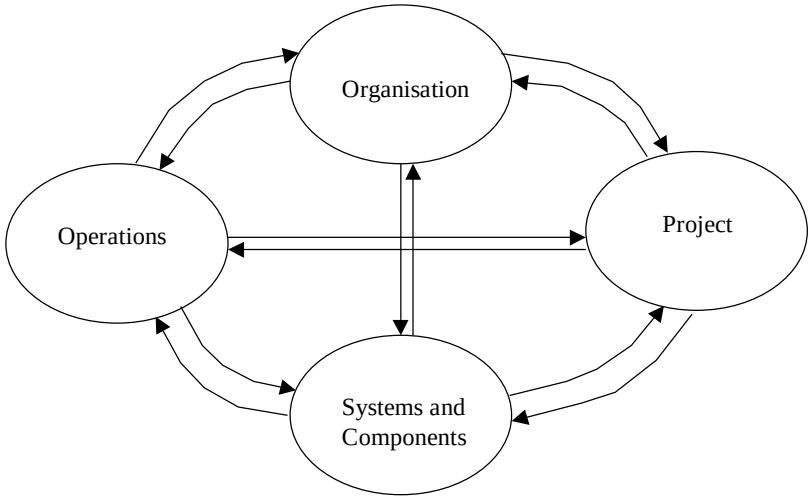
The innovation literature contains two alternative definitions of innovation, broadly corresponding to the difference between a buyer and a seller in a market.

- one definition, corresponding to the seller, is the creation of a technology (invention) and then diffusing it through a population of adopters;
- the other definition, corresponding to the buyer, is the adoption of a novel technology by an organisation (irrespective of how novel it is to the rest of the population).

These two alternative definitions are presented because it is important to emphasise that the vast majority of innovation occurs through the *adoption* of existing technologies, often with minor modification, and not through invention. On the other hand, technology developers who commercialise their innovations successfully can often capture large returns. The development of dramatically new technologies (radical innovation) is less common, but needs to be incorporated in this model.

Innovativeness:

Innovativeness is an organisation's (or person's) capacity to innovate. An organisation may be highly innovative, but may choose not to innovate (because it is not strategically appropriate or there are few opportunities). Similarly, an organisation with low innovativeness, which attempts many innovations, will probably fail in those attempts (because it attempts inappropriate innovations or fails to implement the ones it attempts).



Four domains for innovation

Outcomes

Innovation can occur in any one of these four domains. In the organisational domain, we might imagine innovations to increase innovativeness (e.g. introduction of a total quality management program, setting up an office in an emerging market) or to facilitate some other objective (e.g. introduction of computer aided drafting to increase overall efficiency). Alternatively, there could be a set of self-managed teams which include production workers, or as a virtual project organisation. There might be innovations in systems (e.g. on site microwave curing of concrete panels or components (e.g. novel funding regimes, new polymer adhesives, high emissivity windows, plastic nails, energy storage). Finally, there might be innovations in operations and maintenance (e.g. remote sensors, hybrid ventilation, etc.).

Within this framework the objective is to establish robust conceptual models capable of mapping the innovation process as applied to: new product development (viz. composite materials); new process development (e.g. real time code checking during design using expert systems); new projects (i.e., the combination of innovative products and processes in a building or infrastructure); and identify key indicators of the innovation process in each domain capable of use by policy-makers and/or individual firms.

ABOUT THE PROPOSER

- Dr. Peter Newton is Chief Research Scientist within CSIRO Division of Building, Construction and Engineering, Australia's national research organisation, headquartered in Melbourne with approximately 300 staff. At CSIRO he provides strategic direction to the program of research related to Infrastructure Systems Engineering. He is also Co-Director of the Australian Housing and Urban Research Institute.
- In the 1980s he pioneered research in application of microcomputers in planning and design (viz: *Desktop Planning*, Hargreen, 1988).
- Between 1991 and June 1993 he and his research team developed and demonstrated the first commercial broadband application of real time concurrent collaborative CAD

engineering. In 1995 he published *Networking Spatial Information Systems* (Wiley, London) to more broadly promote the emerging field of networked computing.

- Since 1983 he has been Coordinator of CIB W72 organising six international workshops and publishing all proceedings as commercial publications.
- Currently he is coordinating, for the Federal Government, a Cooperative Research Centre for *IT in Construction*.
- Since gaining his PhD at the University of Canterbury in 1977, Dr. Newton has published widely, co-authoring or co-editing more than 15 books and 100 refereed papers.
- In the past 12 months he has made key invited presentations at national conferences (viz: Invited Speaker to RAIA National Building Services Conferences, Melbourne, April 1999 "Networking Practitioners, Projects and Properties"; Invited Speaker to Royal Australian Planning Institute (RAPI) Conference - Planning in the Information Age, Brisbane, December 1998 "The Emerging Telematic City"; Invited Speaker to Department of Industry, Science and Tourism's 'Building for Growth' Conference, Sydney, May 1998 "Diffusion of IT in the Building and Construction Industry"; Invited Speaker to Royal Australian Planning Institute's National Congress, Brisbane, July 1998 "Technological Change, Urban Form and the Environment of Cities"

Dr. Newton's Web page provides further details of his research activities, publications and presentations.

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