ACADEMIC ARROGANCE OR INDUSTRY INTRANSIGENCE: INNOVATION INERTIA IN THE CONSTRUCTION INDUSTRY

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There is growing recognition that academic research outputs should be robustly evaluated. Current evaluation models in Australia and the United Kingdom are beginning to emphasise the impact of research. There remains a lack of clarity about how this impact can be practically gauged. One measure is the number of citations of a published work in other published documents. While this is a useful measure of the impact of research on the work of other researchers, this is likely to be a poor indicator of the impact of research on industry practice and outcomes. Academics are public servants, whose income (and much research funding) is provided by governments. As such, academics have a professional responsibility to undertake research that is relevant, useful and provides some societal benefit. This is particularly true in the case of construction academics whose activities are industry-specific and whose research must be driven by the desire to help the construction industry to solve its problems and improve its practices, processes and performance. This paper examines the relationship between industry and academia in the field of construction. In particular, it explores the barriers to the transfer of research outcomes into industry practice. A cyclical model of translational research is argued and presented as a useful mechanism for understanding the translational position of ones research. A selection of current and recently completed research projects at RMIT University are positioned within this model and used to support a discussion of the limitations of these projects and inherent challenges for the translation of research outcomes into industry practice. To further demonstrate the translational value of the model, an example of an industry engagement and feedback model produced by Virginia Tech is briefly examined.

Keywords: industry, innovation, practice, translational research.

INTRODUCTION

Sydney Brenner, Nobel Laureate, challenged the conventional translational research model in medicine that flows from 'bench' to 'bedside' – arguing that this ought to be reversed from 'bedside' to 'bench' (Ledford, 2008). He criticises the linear approach of medical research, contending that a cyclic approach is more informative and mutually beneficial. Many would argue that research in an applied discipline such as construction management naturally flows from 'bedside' (practice) to 'bench' (research) back to 'bedside', and therefore does not suffer the maladies of medical research. This paper however argues that CM research is not cyclic but linear and given the fragmented nature of the industry has very limited impact on the

construction industry. It is rare for researchers to be able to point to instances where research outcomes have been successfully implemented and which have made significant, measured impacts on practice. Instead researchers often tend to move from one idea to the next without seeing their work bear fruit.
Reflecting on the imperative to undertake research that is relevant, useful and provides some societal benefit, researchers at RMIT and Virginia Tech developed a 'translational research model' that articulates an ideal symbiotic relationship between industry and academia. It is argued that a systems understanding of this cyclic relationship is essential, for both industry and academia, if any meaningful impact is to be made to the construction industry. The model provides a simple method for placing particular projects within the translational research cycle to assess how much of the cycle they cover and thereby understand what would be required to ensure 'translation' into the industry. The paper discusses the development of the model, and demonstrates its application by assessing a selection of CM research projects undertaken at RMIT University within the past three years, highlighting the major obstructions to their full translation into industry. It is posited that innovation inertia in construction management research generally emanates from two broad sources; academic arrogance and industry intransigence. Some strategies for overcoming obstructions in the translational research cycle are also explored.

The industry-academia interface

The interface between industry and academia has been the subject of considerable research and comment in recognition of the potential for commercially useful knowledge to be generated through interaction and learning between researchers, industry and government (Polt et al. 2001). Relationships between academia, industry and government are very valuable for innovation (Butcher & Jeffrey, 2005). Universities often seek partnerships with industry to find alternative sources of funding, and industries seek partnership with universities to access scientific knowledge (Crespo & Dridi, 2007). Universities are seen to provide a reservoir of talent and creativity that can be engaged in cost-effective R&D to service the needs of industry (McAdam & McAdam, 2008). As such, effective industry-academia partnerships have the potential to provide significant competitive advantage to the industries that are able to tap into this resource.

Yet there remain considerable obstacles – on both the sides of industry and academia – to the effectiveness of partnerships. Studies of process and product development report that manufacturers and users contain basic differences in tendencies of types of innovation valued for development (von Hippel, 2005). Butcher and Jeffrey (2005) identify differences in purpose, cultures, procedures, consents, value systems and incentives as being challenges to collaboration. Henderson et al. (2006) suggest that collaboration with industry sometimes leads to disillusionment on the part of academics who find they engage in training and consultancy with few systematic research outcomes. On the other hand, industry is often frustrated by the apparent esoteric and high level intervention of academics, preferring to engage with consultants. Mudambi and Swift (2009) refer to R&D managers and research scientists as belonging to two professional guilds, who are driven by different goals and subscribe to different belief systems. The same may be said of academics and business managers, making collaborative relationships fraught with tension.

Destler (2008) summarised other obstacles to effective collaboration between industry and academia in research and development (R&D) projects. Destler (2008) describes the 'Gatorade factor' – or the unrealistic intellectual property and royalties demands that university lawyers often seek to impose in collaborative projects with industry as an impediment to collaboration in R&D projects. Destler also argues that academics pursuit of funding to support their own ideas, together with an unwillingness to engage in research that they did not initiate, can also discourage industry collaboration. A desire by industry for the quick results required in competitive markets is also incompatible with the timeline of academic research projects. In many Australian and US universities, typical Research Council grants have a duration of three years, with additional time lags of one year between submission of the grant application and the signing of a funding agreement. This is simply too slow for industry who seek solutions to specific problems within a time scale of one year or less (Destler, 2008).

There are also systemic factors that impede the translation of research into industry practice. For example, the ways in which research findings are communicated. Academic outputs are, for the most part, communicated by publication in peer reviewed journals and presented as the meetings of learned societies, making them inaccessible to the majority of industry participants. Bielak et al. (2008) suggest that researchers effectively 'entomb' information in obscure journals, which are not read beyond a narrow group of academics in a particular field. Criteria against which academics are assessed perpetuate this situation, with government and university incentives heavily weighted towards peer reviewed publications and success in winning competitive research grants. In many Australian and US universities, for example, industry-based publication and direct industry research funding often carry very little kudos, though they have considerable potential for the industry.

On the industry side, the focus on commercial outcomes and the need to respond to shareholders' expectations for short term profit growth create the situation in which managers are reluctant to commit to medium or long term R&D projects. In construction, the project-based nature of work and high level of 'churn' in the workforce exacerbate this problem. Destler (2008) also comments on an attitude among businesses that, rather than invest heavily in R&D, they will just 'buy' new technology through acquisitions and mergers. Henderson et al. (2006) report that, even when formal partnerships between industry and academia are established, high level goals are often downgraded due to business pressures, a lack of available time, and changing organisational expectations. In this context training and consultancy take precedence over in-depth analysis, therefore research and learning objectives are not met.

Given these tensions, a better understanding of the interdependent, symbiotic relationship needed to enable effective translation of research, is required. A model of the full translational research cycle, that systematically incorporates the 'research-to-practice' (r2p) and 'practice-to-research' (p2r) concepts, is likely to be an effective method for communicating the interdependence of industry and academia for achieving change in the construction industry. The model aims to successfully integrate industry best-practice and research knowledge through demonstration and dissemination, respectively.

TRANSLATIONAL RESEARCH

Traditional models explaining how scientific research is translated into practice assume a linear process. Bielak et al. (2008) argue that it is untenable to rely on the notion that there will be a linear progression from scientific research to a dissemination phase in which research is communicated to a wider audience to an adoption phase and put into practice by end users, i.e. industry and/or government. This is the most pervasive understanding of research translation encountered in CM research across the UK, US and Australia. The most common methods cited for 'translation of research findings' into industry include; publication of peer reviewed papers, industry booklets or pamphlets, workshop presentations, and continuing education programs of training sessions or classroom modules.

Instead, Butcher and Jeffrey (2005, p.1273) argue that the generation and transfer of knowledge are 'non-linear processes of problem identification and analysis, communication, interaction and learning by and among the various partners in the innovation process.' Figure 1 (based on Ledford, 2008) depicts a cyclical model of translational research that may better facilitate the translation of research into practice, than traditional linear models.

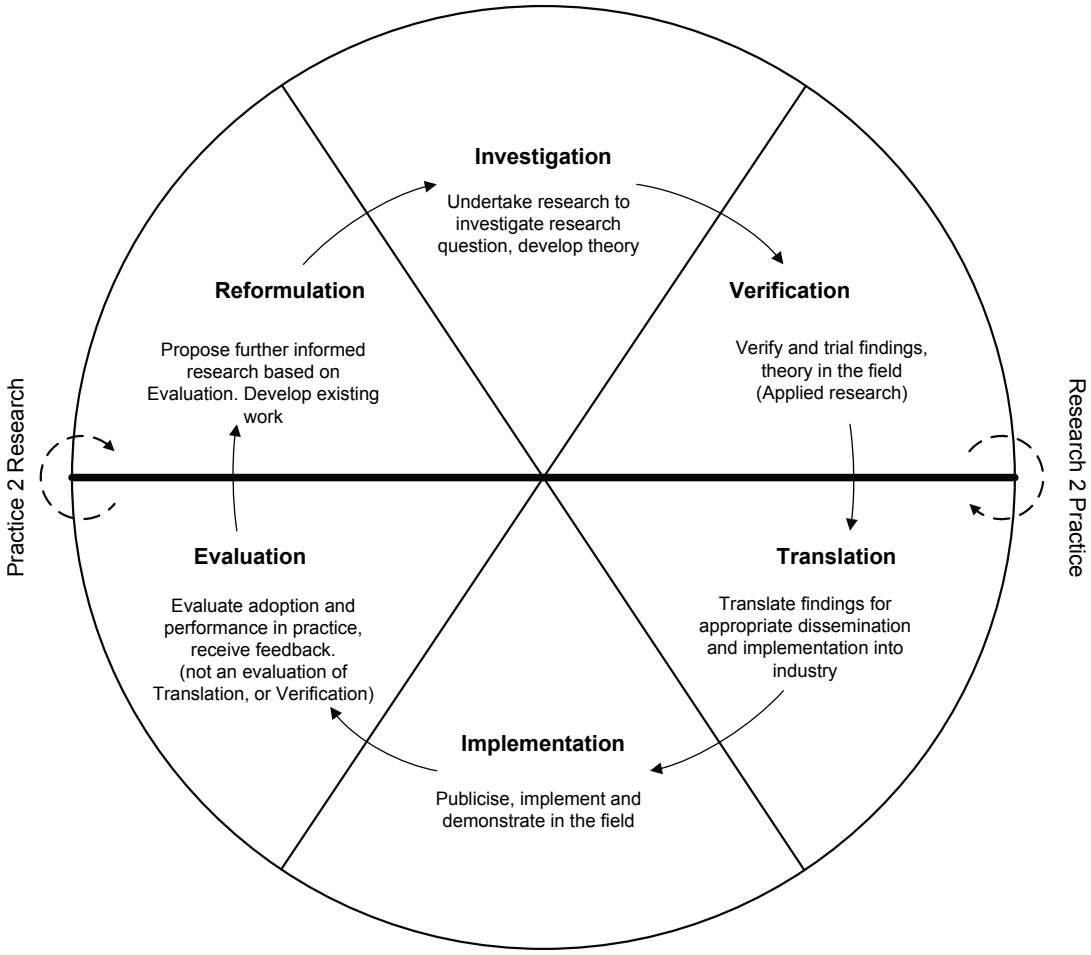

Figure 1: The 'full cycle' of translational research (based on Ledford, 2008)

The model does not have an obvious starting point, as perhaps a linear model would, however it is best explained commencing at the top of the chart with basic research

(Investigation), which is often undertaken by publicly funded researchers, including academics. However, this basic research often responds to questions derived from practice. That is, the basic research attempts to develop robust theory about complex real world problems. This basic research leads to applied field research or theory testing in real world settings (Verification), followed by a period of Translation and Implementation, followed by feedback and Evaluation. From this testing, observation and evaluation, new ideas emerge about which further theoretical propositions may be generated and so the cycle continues (Reformulation). Central to the model is a threshold (thick line) of decision planning as to the nature of subsequent propositions: incremental research that follows existing paths or disruptive research that introduces new value to existing markets. Flexibility of the research process might also require such thresholds, allowing for academia and industry to re-define needed values: overcome barriers and continue or re-direct the relationship (with mutually-agreed termination as one option). For this model to be effective, researchers need to be consciously aware of where their research is positioned within this cycle and there must be effective interaction between academics and industry.

It is contended that, in many instances, the cycle is not complete. Researchers engage in activity that is positioned within a narrow 'wedge' of the cycle, limiting the extent to which research is translated. For example, Roland (2005) suggests that academic researchers tend to have difficulty articulating the rationale for and implications of their basic research, i.e. why was a piece of research undertaken, and what should be done differently as a consequence? Academics have become highly skilled in following research protocols and writing formulaic reports and papers describing how research was done and what was found. However, unless the rationale and implications of research are considered and articulated, publications of this kind might widen the gap between researchers and the potential end users of research. It is essential that academics understand (and can articulate) the reasons for undertaking a piece of research in the first place, i.e. why was the question asked, that the research was intended to answer.

A further example of poor completion of the cycle is demonstrated by the virtual lack of any effective feedback mechanism for research. The commonly employed mechanisms are surveys undertaken to gauge industry response to the presentation of research outcomes. This however is not a true impact measurement mechanism, and only gauges perceptions of the usefulness based on presentation and not application. Evaluation on actual adoption and effectiveness are needed to complete the cycle.
Unfortunately academic processes, whether funding processes or academic performance metrics, have driven academic behaviour and to a large extent obstructed against completion of this translational research cycle. Without this cyclic perspective, research will continue to be viewed as linear, and risks perpetuating the notion in industry that 'academia is arrogant'.

Conversely, industry's misunderstanding of the translational research cycle, and insistence on quick, 'consultancy-type' outputs, coupled with its highly fragmented nature mitigate against effective innovation adoption. Barrow et al (2003) found that uncertainty of expected benefits for industry stakeholders limits marketplace success for the Architecture, Engineering, and Construction (AEC) industry. Perhaps industry stakeholder resistance lies not in the characteristics of new products or technologies but in a manufacturer's understanding of the innovation development process for

unique markets within construction (Isabelle, 2004, Sexton and Barrett, 2004, Shaw et. al, 2005). The ability of manufacturers to incorporate knowledge, not replace it, from users in the construction industry could therefore reduce product uncertainty and increase adoption.

Along the construction supply chain, various stakeholders contribute to the difficulty of introducing innovative (new) products, processes or technologies. Among stakeholders, end-users such as professionals in the workforce best understand the complexities of industry adoption (McCoy et. al, 2009). Further, the construction industry supply chain requires each innovation to be compatible with numerous parties (Koebel, 2004; Hassell et al., 2003; Toole, 1998, Slaughter, 2000). Various stakeholder uncertainties along this chain hinder adoption (Koebel et al, 2003, Hassell et al., 2003 and Toole, 1998).The industry's inability to effect change across the complex supply-chain can likewise perpetuate the notion in academia that 'industry is intransigent'.
The cyclical model depicted in Figure 1 could therefore help to ensure that ‘the right science gets done, that the scientific information gets out, and that it gets used’ (Bielak et al., 2008, p.203).

APPLICATION OF THE MODEL

Application of the model to a selection of current and recently completed research projects at RMIT University has been useful for positioning research within the translational cycle. The relative position in the model immediately identifies the further steps required to close the cycle and thereby enhance the applicability and adoption of the research into the industry. Table 1 briefly describes the selection of case projects positioned in the model. Figure 2 superimposes the projects on the model, showing that even those projects viewed as highly translational in their design, are deficient in at least 50% of the cycle.

For instance, two construction safety best practice guides, one commissioned by the Australian government (project 1) and the other by a high-level industry consortium (project 2), were by all anecdotal accounts highly successful. However, lack of funding to continue the work beyond the Implementation phase of the cycle has meant that the success or impact of the work remains largely unknown. Further development is therefore dependent on anecdotal evidence, rather than active engagement and evaluation. As a consequence of this model, RMIT University has now encouraged a PhD candidate to complete the Evaluation and Reformulation phases of the 'Safety Best Practice Guide for clients' so that the cycle is completed and the engagement with the 'industry' is enhanced for mutual benefit.

Other examples from this list demonstrate that applied, industry-engaged research often fails to go beyond the 'research-to-practice' phases. For RMIT much of the challenge lies in convincing industry to engage fully with the cycle and thereby ensure that success is maximised. Research proposals and strategies are now fully informed by the model, to the degree that projects are subjected to the model test and proposals adjusted accordingly. An example of the types of steps that can be taken within research proposals to move research beyond the current linear translational paradigm are provided by researchers at Virginia Tech, who likewise apply a 'research-to-practice-to-research' (r2p2r) model to their proposals. The following

section elaborates on an example of the application of this model to a recent large-scale proposal.

Table 1: A selection of current and recently completed research projects in the School of Property, Construction and Project Management at RMIT University

Research Project	Description	Position in the TR Model
1. Safety Best Practice Guide for clients	An Australian federal government sponsored guide for government construction clients to drive safer practice through the industry.	Translation – Implementation
2. Safety Best Practice Guide for the Industry	An industry-academia consortium guide produced with industry peak-bodies for diffusion throughout the whole industry in Australia.	Translation – Implementation
3. Group-level safety climate in Construction	Applied/Basic research project funded by the Australian Research Council.	Investigation – Verification
4. Design-decision complexity for safety	Basic research project funded by the Australian Research Council.	Investigation
5. Off-site manufacture in Australia	An industry-academia consortium document produced to show-case OSP and present 'state-of-the-art' in Australia.	Verification – Translation – Implementation
6. Development of a Technology Roadmap for concrete housing	An industry-academia consortium investigation into the development of a Technology Roadmap to produce a concrete housing system into the Australian housing market.	Verification – Translation
7. Development of a design-safety knowledge tool	A small government funded project to develop a prototype design-aid for safe design, with the aim of developing a commercially viable product.	Verification – Translation – Implementation
8. Design relatedness – theoretical development through construction fatalities	Small grant from an industry-body to undertake a one year study and develop a new design-relatedness model using construction fatalities as cases.	Investigation – Verification

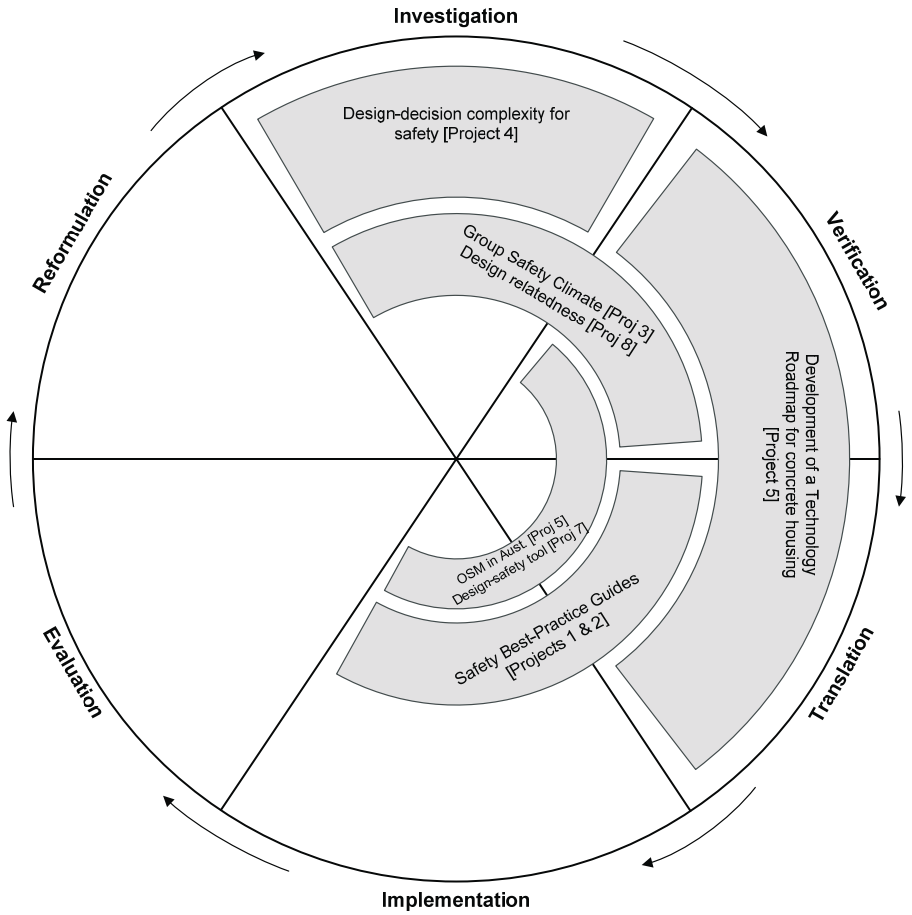

Figure 2: Positioning of a selection of RMIT research projects on the translational research model

MECHANISMS FOR FACILITATING TRANSLATIONAL RESEARCH

Universities provide scientific pools of highly skilled labour and industry provides universities with funding, equipment, knowledge and an array of current research needs and problems (Lin & Bozeman, 2006). The establishment of research centres are mechanisms to attract researchers who are genuinely interested in solving industry problems. Lin & Bozeman (2006) report that researchers with industrial experience are highly represented among researchers in university-industry research centres in the USA, and that, although researchers with industry experience produce fewer papers per year than those without industry experience, they support more graduate research students, submit six times more grant proposals and are awarded four times more grants and contracts than those without industry experience. Thus, in the production of scientific and technical human capital, the contribution researchers with industry experience are considerable.

Studies also promote the importance of user involvement through a 'leading edge' status, where industry-based knowledge is captured and incorporated early into the development process, greatly improving commercial viability in construction (McCoy et. al, 2009) and increasing use of innovations (Von Hippel et. al, 2005). The lack of

an iterative loop (feedback) is troubling and the focus of this model and current translation efforts for 'r2p2r' at Virginia Tech and RMIT.

Case example

Recent work at Virginia Tech has attempted to position its research as the basis for a National Construction Center (NCC) of Occupational Safety and Health. As a result, and per National Occupational Research Agenda (NORA) goals, Virginia Tech needed to demonstrate effective processes of research translation. Among various processes for effective translation, NCC created a mobile platform of research translation termed Project DEMO. DEMO aimed not to replace current use of technology, but to develop dissemination and feedback mechanisms for lead user preferences as a method of improving innovation viability and reinforcing use. Project DEMO primarily proposed to investigate the physical realization of an alternative to traditional platforms of education and training through an appropriate mobile environment for the transfer of technologies to all stakeholders, especially users and subscribers in the field. Plans for DEMO included: collecting user preferences, distributing them to all safety stakeholders, incorporating these preferences into architectural drawings for physical applications, constructing mobile platforms that incorporate user-based preferences to effectively reinforce and improve technology use and collecting data as to the efficacy, for the construction industry, of physical knowledge transfer environments versus those that are virtual or community-based.

Physical applications, termed Mobile Demonstration Units (MDUs), of similar type were combined for efficiency of equipment and interior construction. MDU deployment also required the fabrication of one mobile, flat platform, approximately 40 feet long that would carry individual units. In concept, the platforms' use responds to the type of exhibit or market. For example, projects containing research-based dissemination exhibits for a safety conference might be housed simultaneously on the platform while a completely different arrangement targeting a professional conference would transport a variety of safety research disseminations and training demonstrations. Another configuration may include a mobile laboratory for field data collection regarding a specifically researched construction safety and health issue. All MDUs would conceivably be transferred onto and off-of the platforms with the use of a forklift. DEMO's mobile spaces aimed to successfully demonstrate and disseminate knowledge through two main functions, respectively: industry best practice (i.e., scaffold, fall arrest, or hoisting and rigging training) and academic research (i.e., virtual reality displays on electrocution, machine operation, silica exposure, or musculoskeletal research). In effect, DEMO physically translated innovative research and best practice to the public, aiming to explore "non-traditional social media" and attempting to close the loop, of research to practice (r2p), to research to practice to research (r2p2r).

CONCLUSION

Academics must ask fundamental questions about what research is done, how it is communicated and what impact it will have on the industry. At the same time, industry needs to consider their role in the creation and application of new knowledge. The translational model presented, demonstrates the symbiosis necessary to ensure

relevant, impacting research in construction. The model therefore provides the basis for both academics and industry to engage in research with a common understanding of the long-term process required to effect lasting change in the industry.

Academics ought to consciously position their research within some form of translational research cycle, such as that suggested here, to appreciate their part within a broader context. Once understood and applied, the model constrains the academic community to operate throughout the full cycle ensuring that it poses industry-relevant and important questions for fundamental research, it engages in robust applied research to test propositions and defines new and worthy research problems through observation and evaluation of real world phenomena. Academics can no longer afford to simply publish results and hope that they will have an impact. It needs to engage in mutual learning between industry, government and academia if it is to make a significant impact.

The relationship between academia and industry is the key to the successful translation of research knowledge into industry practice. Impact requires a coordinated 'unity of effort' between industry, government and academics to implement and rigorously evaluate innovations through applied field-based research and to inform the development of evidence-based policy and practice in the construction industry.

REFERENCES

Baba, Y., Schichijo, N. & Sedita, S. R., (2009), How do collaborations with universities affect firms' innovative performance? The role of "Pasteur scientists" in the advanced materials field, Research Policy, 38, 756-764.

Barrow, L., Savvides, A., Hou, J.H., and Cacace, K. (update, 2003). Margulies & Associates, Inc. Harvard Design School, Center for Design Informatics Case Studies. Boston, MA.

Belkhodja, O. & Landry, R., (2007), The Triple-Helix collaboration: Why do researchers collaborate with industry and the government? What are the factors that influence perceived barriers? Scientometrics, 70, 301-332.

Bielak, A. T., Campbell, A., Pope, S., Schaefer, K. & Shaxson, L., (2008), From science communication to knowledge brokering: the shift from 'science push' to 'policy pull', in D. Cheng et al. (eds), Communicating Science in Social Contexts, Springer Science and Business Media. pp. 201-226.

Butcher, J. & Jeffrey, P., (2005), The use of bibliometric indicators to explore industry-academia collaboration trends over time in the field of membrane use for water treatment, Technovation, 25, 1273-1280.

Destler, B. (2008), A new relationship, Nature, 453, 853-854.

Henderson, J. McAdam, R. & Leonard, D., (2006), Reflecting on a TQM based university/industry partnership: Contributions to research methodology and organisational learning, Management Decision, 44, 1422-1440.

Hassell, S., Houser, A., Knopman, D., Bernstein, M. (2003). "Building Better Homes, Government Strategies for Promoting Innovation in Housing." RAND Science and Technology Policy Institute.

Hughes, T., O'Regan, N. & Wornham, D., (2008), The credibility issue: closing the academic/practitioner gap, Strategic Change, 17, 215-233.

Isabelle, D. A. (December 3, 2004). S&T Commercialization of Federal Research Laboratories and University Research: Comprehensive Exam Submission. PhD Dissertation: Eric Sprott School of Business: Carleton University.

Koebel, C. T., Hudson, E., Cavell, M. (April 2003). "The Diffusion of Innovation in the Residential Building Industry." Blacksburg, VA, Virginia Polytechnic Institute and State University.

Koebel, C. T. (2004). "Housing Technology, Community and the Economy" Proceedings of the NSF Housing Research Agenda Workshop, Feb. 12-14, 2004, Orlando, FL. Eds. Syal, M., Hastak, M., & Mullens, M., Vol. 1, Focus Group-4.

Ledford, H. (2008), The full cycle, Nature, 453, 843-845.

Lin, M. W. & Bozeman, B., (2006), Researchers' industry experience and productivity in university-industry research centers: A 'scientific and technical human capital' explanation, Journal of Technology Transfer, 31, 269-290.

McAdam, M. & McAdam, R. (2008), High tech start-ups in University Science Park incubators: The relationship between the start up's lifecycle progression and use of the incubator's resources, Technovation, 28, 277-290.

McCoy, A. P., Badinelli, R.D. and Thabet, W. (2009) "Understanding the Role of Developer/Builders in the Concurrent Commercialization of Product Innovation" European Journal of Innovation Management, (2009): Vol. 12, Issue 1.

Mudambi, R. & Swift, T., (2009), Professional guilds, tension and knowledge management, Research Policy, 38, 736-745.

Roland, M. C., (2005), The changing paradigm of science communication: Challenges for researchers, Communicating European Research, European Communities, pp.63-67.

Sexton, M. and Barrett, P. (2004). "The role of technology transfer in innovation within small construction firms." Engineering, Construction and Architectural Management, Vol. 11 No. 5, pp. 342-348

Shaw, E., O'Loughlin, A. and McFadzean, E. (2005). Corporate entrepreneurship and innovation part 2: a role-and process-based approach. European Journal of Innovation Management. 2005. Vol. 8, No. 4, pp. 393-408.

Slaughter, E. S. (2000). Implementation of Construction Innovations. Building Research and Information, 28(2), pp. 2-17.

Toole, T.M. (1998). Uncertainty and Home Builders' Adoption of Technological Innovations. Journal of Construction Engineering and Management, 124(4), pp. 323-332.

Von Hippel, Eric (2005). Democratizing Innovation. The MIT Press: Cambridge Massachusetts.