Institution: Imperial College London
Unit of Assessment: 19 Business and management studies
Title of case study: Transforming the project-based firm: creating effective commercial and innovation capability

1. Summary of the impact (indicative maximum 100 words)

Development of the UK construction industry was hampered by a focus on individual projects, with two drawbacks: limited transfer of lessons learned from one project to the next, and limited focus on systemic innovation and wider commercial opportunities.

Drawing on their research, our Innovation and Entrepreneurship Group helped construction companies - including Laing O'Rourke (LOR), Arup, and Mace - overcome these obstacles by adopting a 'systems integration' model to capture and utilise lessons learned, and by developing Executive Education programmes to make project engineers aware of wider commercial and innovation issues. These improvements enhanced delivery of major projects such as the Olympic Park and Crossrail.

The Group changed firm behaviour, re-orientated project management practices, and translated lessons learned into organisational capabilities at LOR, Arup, and Mace.

Beneficiaries were the UK construction and consulting engineering sector, who as a result were better equipped to innovate and compete globally, and their clients, such as the UK Olympic Delivery Authority and Crossrail.

2. Underpinning research (indicative maximum 500 words)

Several research projects examined the design, integration, and delivery of complex systems in infrastructure industries, enhancing significantly their long-term operational performance. Project-based firms are focused on the next project and can often struggle to learn lessons from their own previous projects, and from others in the industry.

Knowledge Transfer

We compared the R&D strategies of four Engineering design firms. We showed that building organisational capabilities from fractured project data is possible by using 'meta-routines' to ensure project-to-project, project-to-business and business-to-project knowledge exchange. A second research project examined geographically dispersed project teams and the mechanisms for knowledge transfer. We compared behaviours of geographically separated and co-located teams, across five project-based firms. Contrary to the new conventional wisdom, we showed that face-to-face knowledge exchanges are more effective than software-enabled mechanisms. Older methods of interaction remain prevalent for both types of team. Project-based work is, by nature, decentralised and episodic; we developed new models to capture disparate knowledge and skill development, channelling lessons learned into future firm capabilities. Research outputs were published in *MIT Sloan Management Review* [3], *Industry and Innovation* [5] and *European Planning Studies* [6].

Providing Solutions

Our work on integrated solutions showed that firms wishing to develop products or services tailored to individual customers must develop new capabilities. We identified how a customer's perception of value is created, and articulated a number of skills critical for success:

- Key account management (understanding customers' business);
- Risk analysis and management (controlling and identifying);
- Financial acumen;
- Legal skills;
- Information management (between technologies and over time);

- Innovation management (current and future products and processes);
- Portfolio management (building teams and managing partner relations).

Our research showed that firms looking to provide integrated solutions needed to re-evaluate their entire business practices, using the skills we identified, to become 'entrepreneurial, experimental and open-minded.' [4].

Managing Mega-Projects

Given privileged access to BAA and Laing O'Rourke, we examined the management of their mega-projects, in particular the construction of Heathrow Terminal 5. We developed a systems integration model of six key processes to demonstrate how organisations can improve performance through better management:

- Systems integration to develop an operational system;
- Project and programme management to manage the supply chain;
- Digital technologies to support design, construction and maintenance;
- Off-site simulation and pre-production for improved on-site progress;
- Logistical coordination of material supply;
- Operational integration for effective preparation and tests.

We showed LOR that projects are not isolated endeavours: by using our integrated model, it could simultaneously improve delivery of mega-projects whilst developing organisational capabilities for innovation in the central firm. This work was published in the *California Management Review* [1] and *International Journal of Project Management* [2].

Staff: Professor David Gann, Head, Innovation & Entrepreneurship Group (2003-12);
Professor Ammon Salter, Co-Director, Innovation Studies Centre (2003-12);
Dr Andrew Davies, Reader, Innovation Studies Centre (2007-12);
Dr Lars Frederiksen, Research Fellow (2005-07), Lecturer &Assistant Professor (2008-09);
Dr Ian MacKenzie, Research Affiliate (2005-11);
Dr Samuel MacAulay, Research Associate (2011-present).

3. References to the research (indicative maximum of six references)

Key Outputs

[1] Davies A, Gann D, Douglas T, (2009) 'Innovation in Megaprojects: Systems Integration at London Heathrow Terminal 5', *California Management Review*, Vol. 51, No. 2 (Winter 2009), pp. 101-125

[2] Brady, T, Davies A, (2009) 'From Hero to Hubris – Reconsidering the Project Management of Heathrow's Terminal 5', *International Journal of Project Management*, Volume 28, Issue 2, February 2010, Pages 151–157

[3] Davies A, Brady, T, Hobday, M, (2006) 'Charting a Path Towards Integrated Solutions,' *MIT Sloane Management Review*, Volume 47(3)

[4] Brady, T, Davies, A, Gann, D, (2005) 'Creating Value by Delivering Integrated Solutions', *International Journal of Project Management*, Volume 23, Issue 5, July 2005, pp. 360–365

[5] Acha, V, Gann, D, Salter, A, (2005) 'Episodic Innovation: R&D strategies for Project-Based Environments', *Industry and Innovation*, Volume 12, pp. 255-281

[6] Sapsed J, Gann D, Marshall N, et al,(2005) 'From here to eternity?: The Practice of Knowledge Transfer in Dispersed and Co-located Project Organizations', *European Planning Studies*, Volume13, pp. 831-851

Grants and Related Funding

[7] Gann,D. Built Environment Innovation Centre EPSRC Innovative Manufacturing Grant, 2003-07, £3.1m;

[8] Gann, D, Salter, A, Davies, A, Autio, E, Innovation Studies Centre, EPSRC, 01/04/2008 – 31/03/2013, £5.4m;
[9] Gann, D and Davies, A, Crossrail Innovation Programme, Crossrail, 01/04/2012 – 31/02/2015, £300k.

Evidence of research excellence

- A condition of the EPSRC grant (won via competitive tender) is a detailed annual reporting process in March each year which considers the progress made by the Innovation Studies Centre (both within the preceding 12 months and since the award began) and detailed outputs from all projects funded by the core grant including impact on business, academia and policy. The Innovation Studies Centre submitted its benchmarking seventh year review in 2010 where we obtained an overall rating of 4.8 out of 5 from the EPSRC (comprising: quality of our research - 4.8, academic impact and dissemination - 4.8, and relevance to the needs of industry and other research users - 4.9). Corroboration of this is available from the EPSRC Innovative Manufacturing Research Centre programme manager;
- Output [1] won the Institution of Mechanical Engineers Best Management Paper Award in 2009.
- Papers from this work were published in both elite and leading management journals, which use an anonymous peer review system (three independent reviewers per paper), including *California Management Review*, *International Journal of Project Management*, *Organization Science*, *MIT Sloan Management Review, Industry & Innovation*, *European Planning Studies*.

4. Details of the impact (indicative maximum 750 words)

Impact at Laing O'Rourke (LOR)

We developed a 'systems-integration model' for firms managing mega-projects to enhance organisational capabilities, innovation and learning [1, 2, 4]. After we interviewed 50 senior managers, at LOR - the UK construction industry's largest solutions-provider - and analysed their technological resources, practices and earlier project performance, the company adopted our proposal and reorganised how projects were managed and organisational capability developed.

We also showed that the episodic nature of their work means that project-based firms are inefficient at capturing learning and risk losing opportunities to build organisational knowledge [3, 5, 6]. Using our notion of systems integration and meta-routines, we developed an annual Executive Education course for groups of 20 LOR senior managers to transfer and develop skills necessary for innovation and for superseding project management with business development capabilities [6]. The course has run annually since 2009, so almost 100 senior LOR managers have now absorbed our approach and translated it into operational practice:

> "Applied research undertaken by Imperial's Innovation and Entrepreneurship Group has allowed us to take the construction industry to a level comparable with the world's best manufacturing companies"
>
> *Head of People Development, Laing O'Rourke, 2012* [C]

During the period of Imperial's collaboration with LOR – during which LOR turnover rose from £0.6bn to £5bn p.a. - Professor Gann was partially seconded to the company as its Group Innovation Executive, for the purpose of embedding our research in LOR operational practice:

> "In this capacity, he translated ideas developed at Imperial into strategies for innovation, implemented within our business. This stimulated the transformation of LOR from one based on discrete project-by-project activities to a systematic approach, capturing and transferring lessons from one project to the next. The Imperial team produced valuable case-based evidence of benefits to using manufactured construction components, digital engineering tools, and systematic innovation processes.

These guided our strategy to introduce a systematic set of processes for Design for Manufacture and Assembly and our £100m+ investment in the Explore Industrial Park at Streetley with a state-of-art automated factory."

Chairman, Laing O'Rourke, 29 October 2013 [D]

Impact beyond LOR

Our model has now been used in several major British infrastructure projects including the St Pancras Eurostar Terminal in London (2007) Heathrow Terminal 5 (2008) and the construction of venues and stadia at the London 2012 Olympic Park, completed ahead of time and on budget (2011). Corroboration of the contribution of the Group's research to the success of construction of the Olympic Park is available on request from senior executives at the Olympic Delivery Authority [E, F]. The model was also used by LOR in the construction of the $20bn Al Raha City in Abu Dhabi and has been implemented at Crossrail.

The success of our research projects has led to ongoing collaborative efforts with LOR, including Olympic venue construction. By analysing senior management decisions and project innovations including key processes such as our systems integration model, we established clear evidence of knowledge codified and reinvested across LOR, and among its project partners, the Olympic Delivery Authority (ODA) and CLM (a consortium of CH2M Hill International, Laing O'Rourke and Mace). This ensured the delivery of an effective and successful Olympic Games in 2012, as well as the diverse utilisation of sustainably developed structures in post-Games East London. A report from this work was published as part of the ODA's Learning Legacy initiative [B].

Mace (the UK's largest project management firm (£1bn+ pa) has now engaged Imperial College Business School in an Executive Education leadership programme to instil these lessons more widely in the project management community.

Crossrail

We are now applying our mega-project experience to Crossrail, examining how innovative knowledge can be integrated and shared across the project. The Crossrail Innovation Strategy, published in December 2012, credits our 'core input' into the strategy and contains a foreword by Professor Gann [A]. Crossrail chose us as a research partner based on our tested research in construction management and reputation in major infrastructure projects (outlined above).

"As CEO of Crossrail, we have partnered with Imperial College in developing an innovation strategy to support the implementation of this complex £14.8bn rail industrial project. For the first time in this sector we see the developments of an open innovation model that will bring together the intellectual property of supply chains that span the construction, rail and manufacturing sectors. It is difficult to put a value on the opportunities this will open up for us and, I believe, the wider industries. As a conservative estimate, it will be in the region of tens of millions of pounds."

CEO Crossrail, 24 October 2013 [G]

5. Sources to corroborate the impact (indicative maximum of 10 references)

[A] 'Crossrail Innovation Strategy: Moving London Forward', Crossrail December 2012 – credits the Innovation & Entrepreneurship Group (p18) and foreword by Professor Gann (p3);
[B] Davies, A., MacKenzie, I. (2012), *Lessons Learned from the London 2012 Games Construction*, ODA Learning Legacy Programme;
[C] Letter of support from the Head of People Development, Laing O'Rourke, available on request;
[D] Letter of support from the Chairman and Chief Executive, Laing O'Rourke, available on request;
[E] Former Head of Venues and Infrastructure, Olympic Delivery Authority (now Head of Programmes and Projects, Nuclear Decommissioning Authority);
[F] Information Manager, Olympic Delivery Authority;
[G] Letter of support from the CEO, Crossrail, available on request.