

**LEADERSHIP IN MEGAPROJECTS AND
PRODUCTION MANAGEMENT: LESSONS FROM
THE T5 PROJECT**

CENTRE FOR INFRASTRUCTURE DEVELOPMENT

**MANCHESTER BUSINESS SCHOOL
THE UNIVERSITY OF MANCHESTER**

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EXECUTIVE SUMMARY

This report summarises findings from a workshop organized jointly by Nuno Gil and Don Ward, Centre for Infrastructure Development, Manchester Business School, UK, and Iris Tommelein and Glenn Ballard, Project Production Systems Laboratory, University of California at Berkeley, USA on 14 April 2011 at BAA Heathrow Point.¹ The underpinning motivation for the workshop was the idea to bring together practitioners and academics for one day in order to explore and discuss collectively the extent to which the management of ‘production’ in construction (including logistics) was a key dimension of the ways in which BAA and the integrated supply chain exercised leadership in the development and delivery of the £4.2bn (2008 prices) Heathrow’s Terminal 5 – largely viewed by many people and in many accounts to be a successful mega project.

The anecdotal evidence shared in the presentations and follow-up discussions with academics and practitioners with intimate knowledge of the T5 project, whether from a client or supplier perspective, suggested that innovation in the management of production in term of methods, tools, and processes was indeed a key dimension of the T5 project leadership. Importantly, in T5, the capital investment in developing innovative practices appeared to be by and large funded by BAA, the project client. Put differently, in T5, the project client brought in-house the project management capability and made innovation in production management an integral part of the ways in which it exercised project leadership. BAA representatives asserted that the firm generally believed this strategic approach had been appropriate to respond to the particular challenges in delivering T5 including the particular institutional and economic conditions of the time.

In the current institutional and economic climate, however, BAA representatives asserted that the company expected suppliers to take ownership of the production management agenda and make the necessary capital investments. The workshop revealed that whilst some suppliers have responded to the call, and accordingly developed sophisticated practices and methods to manage production and support high-performance work, other suppliers may be reluctant to make the necessary capital investments. Some ways in which clients and suppliers can create an environment conducive for

¹ Appendix I includes the invitation letter, agenda, full list of attendees, and biographies of speakers

suppliers to gain enough confidence to make investments and modernize production management practices were discussed, notably risk pooling based on the supplier's project portfolio and the client's willingness to underwrite risks in case assumed project opportunities fail unexpectedly to materialize.

Nuno Gil (CID academic director)

Don Ward (CID executive director)

1. BACKGROUND: MODERNIZING THE UK'S CONSTRUCTION INDUSTRY

- In 1993, in response to legal disputes in the eighties, an independent commission publishes the New Engineering and Construction contract (NEC) to improve contracts along three dimensions — flexibility, clarity and simplicity — and stimulate good project management. NEC embraces the concept of partnership, introducing notions such as 'trust', 'working together', and 'cooperation in planning.'
- In 1995, BP receives an "Innovation in Industry" award for its relational contracting strategy at the Andrew facilities alliance project, a North Sea oil field development;² and a British industry-government initiative produced the Latham report *Constructing the Team*. The latter rang alarm bells in a construction industry characterized as 'adversarial' and 'incapable of delivering for its customers'.
- In 1998, the *Rethinking Construction* report, presented by Sir John Egan³, spells out a number of proposals for driving modernization of the industry. These were influenced by suggestions by such Western firms as Chrysler that the achievements of the Toyota Production System were transferable and not culture-bound. In particular, *Rethinking Construction* exhorted project clients to replace competitive tendering of the suppliers with long-term partnerships, sustained through performance measurement and incentives for continuous improvement.
- A subsequent report *Accelerating Change* further encouraged clients to move towards integrated teams made up of existing supply chains; Once successfully formed, the report exhorted teams to move from one project to the next, taking their experience and a culture of continuous improvement with them.

2. THE T5 PROJECT CONTEXT: KEY FACTS

- The scope of the £4.3bn (in 2007 prices) project to add a fifth terminal to London's Heathrow Airport, the Terminal 5 (T5) project, encompassed a number of facilities to be delivered between 2002 and 2008, including terminal buildings, an air traffic

² Knott, T. (1996). *No Business as Usual. An Extraordinary North Sea Result*. The British Petroleum Company, plc.

³ Sir John Egan was the CEO of BAA from 1990 to 1999 after a career in the automotive industry.

control tower, over 60 aircraft stands and new taxiways, a baggage handling system, a new energy centre, and an inter-terminal train.

- The airport owner, operator, and project client, British Airports Authority (BAA) decided to bring in-house the tasks of systems integrator and project manager, and used a relational contracting strategy - the T5 Agreement (T5A) – to frame the inter-firm relationships with all the first-tier project suppliers. From a BAA’s perspective, this strategy aimed to encourage the suppliers to move away from “business as usual” to a project environment where “we all continually challenge how we can be successful.” Commercially, this strategy involved a reimbursable contract with built-in target costs and ring fenced profit (see Appendix II for details).
- As part of its strategy to commission design and construction work to the first-tier suppliers, and mindful of uncertainty in design requirements, BAA asked the suppliers to reduce production costs while remaining flexible to accommodate changes:

“The idea of building £4bn worth of infrastructure over 4 or 5 years and not having to rework and go around the loop a couple of times is nonsensical. Therefore, we’ve to manage change and minimize it in the best way. We won’t be able to get it right the first time. We need to be realistic — change is a fact of life.” (Fiona Hammond, T5 Project Lawyer)

- BAA deemed the T5 Agreement fundamental for encouraging the T5 suppliers to achieve “exceptional performance (...), new standards, both in the building of the facilities and in the built facilities.” Hence, the T5 agreement — the “absolute bedrock of getting the relationships right” in BAA terms — aimed at creating incentives for “positive problem-solving behaviors that would not allow things to go wrong in the first place”. It discarded confrontational clauses seeking to pass the blame and recover money from suppliers if things went wrong:

“We cannot load suppliers with risk, drive prices down, and complain this is costing us more than we thought. It’s fundamentally dishonest and economically illiterate. Our approach is: we can drive prices down by removing inherent waste and allowing suppliers to have a decent return just like us. We’re trying to align interests (...) There’s no point trying to think that the traditional contract — lots of indemnities, liquidated damages, penalties — protects the client. I’m an ex-contractor. Many times clients asked me...to work together, and then you get the contract, and it says ‘stick one hair above the parapet and I’ll fire at you.’ What we’ve then is a behavioral response that says every time something goes wrong, the contractor will fire a thousand letters explaining why it’s not its fault.” (Fiona Hammond, T5 Project lawyer)

3. BAA’S LEADERSHIP PRACTICES FEATURED DURING THE WORKSHOP

In the course of the workshop, the various speakers shared anecdotal evidence pointing to how BAA exercised project leadership, and decided to make the capital investment upfront necessary for putting in place a number of innovative practices, methods, and tools in addition to its innovative commercial approach to commission the works to the supply chain. We summarize these practices under three categories: (1) organizational; (2) production management (process and product), and (3) communication and branding. Importantly, this list does not aim to be exhaustive, but rather aims to merely capture the innovations featured in the workshop.

From an organizational perspective

- BAA implemented a ‘devolved governance’ model by which it sought to empower suppliers to accelerate decision-making and problem-solving
- BAA created an organizational effectiveness team to facilitate inter-firm relationships
- BAA insisted on co-locating on site the teams of project suppliers, client, and customers
- BAA invested in good working and living conditions as part of a broader strategy aiming to improve work productivity on site as well as drive out the threat of industrial relations issues; some of these investments were
 - a decent network of canteens on site providing breakfasts and hot meals
 - accommodation compounds for workers
 - network of buses and shuttles
- BAA invested in a centralized insurance policy for all construction risks
- An email address for all T5 workers -- @t5.co.uk – was institutionalized irrespectively of whether the worker’s direct employer was BAA or a supplier

From a production management perspective

- BAA funded the construction of two logistics centres at the periphery of the Heathrow airport, of which BAA still owns one and uses it to support the current capital programme. The speakers suggested a number of reasons contributed to this initiative notably:
 - BAA was mindful that it had very limited lay down space on the T5 site
 - BAA wanted to avoid clogging the nearby highway (M25)
 - BAA wanted to shield planned deliveries to the site and T5 construction works from the unpredictable traffic conditions around the Heathrow airport
 - BAA wanted to enable the delivery of materials by heavy-rail (this option turned out commercially unviable, but interesting is now viable due to today’s fuel costs)
 - BAA aimed to consolidate deliveries and support a just-in-time, pull-based distribution system with Kanban stores (see details in Appendix I).

- BAA invested in setting up a set of processes and tools for supporting design and construction work influenced by the Toyota Production System, namely the Last Responsible Moment policy (a design postponement policy), digital prototyping, milk runs between the site and the logistic centers, first run studies and the ‘right first time’ campaign, early involvement of specialist suppliers in design, value stream mapping, and Last Planner (a planning system to improve reliability of work planning)
- BAA established integrated teams around products/elements of work
- BAA drove the development of design standards for operational experience
- BAA strongly encouraged suppliers to develop modular, standardized solutions as well as pre-assembled solutions, e.g., pre-cast elements, pre-assembled pile cages, and supported the required capital investment. Speakers expressing the point of view of AMEC, the key M&E supplier in T5, argued that this investment had been instrumental to shave off 4 months in the programme and to significantly reduce labour costs and requirements of space on site during construction. This investment also helped to improve product quality and to enable more trades to work concurrently.
- BAA drove the development of a snagging system

From a branding and communications perspective

- BAA invested in a number of initiatives related to branding and communications, notably quarterly town hall meetings, descriptive project videos, production of posters and joined up stories, and a Sun-branded T5 newspaper intended to the workforce. The motivations underpinning these efforts were various and included:
 - generate feelings of passion and pride for working on the project
 - raise public awareness for the magnitude of the capital investment
 - make people feel ‘involved’ in the project and they were part of something huge
 - encourage people to develop a sense of belonging
 - encourage people to change behaviors
 - get people to identify themselves with the project and develop a sense of allegiance
 - create shared understanding between project client and suppliers
 - keep people informed
 - motivate workers to behave safely with the aim to drive accidents to zero (one speaker recalled messages in the posters such as ‘come home safely, daddy’ and ‘take care, son’)
- BAA invested in various gifts and rewards schemes, e.g., £150 card, breakfast tokens, high 5 awards, events to celebrate achievement of key project milestones
- BAA invested in a high quality job induction workshop

- BAA was willing to take on difficult issues, acknowledging there are risks a project client cannot offload and push back to the supply chain; hence, in T5, BAA communicated extensively that it believed that the airport operator client owned the risk mindful that the supply chain was better at managing those risks
- BAA put in place an industrial relations policy with a performance-based bonus scheme

4. KEY EMERGENT INSIGHTS/LESSONS LEARNED

- BAA, the project client, believed and had a crucial role in ensuring high-performance production management practices were integral to the delivery of the T5 project. Thus, the client believed leadership in megaprojects ought to encompass innovation in production management, and decided to exercise that dimension of leadership and incur itself the corresponding capital cost assuming it would reap significant benefits throughout the project delivery that would be enough to pay off the investment.
- The exercise of leadership in terms of driving investment towards modular and standardized solutions, and use of pre-assembled solutions was shared in the sense that these practices were encouraged by BAA, but the suppliers themselves were keen to adopt these practices encouraged by results observed in other projects, namely capital projects in the offshore oil & gas industry.
- In T5, BAA brought in-house some the procurement of some materials in bulk e.g., cement, PFA, rebar, aggregate, because the firm was worried about inflation in construction costs. On hindsight, BAA acknowledges this decision helped the firm to make some good deals, but also some deals were less good compared with deals suppliers could have reached if they had procured the materials on their own. Today, BAA would only buy materials in bulk if they were specific to works in the Heathrow airport.
- Some particularities of the T5 context itself, notably the scarcity of lay down areas on site and the availability of only one entrance to the project site, appeared to have strongly influenced BAA to exercise leadership and invest in innovative production management practices.
- In today's environment, BAA expects that by and large suppliers appropriate the production management dimension of the leadership agenda in BAA capital projects and accordingly make the capital investment in innovative practices, in part due to a perception that BAA got perhaps too much involved in the management of the T5 project and as result paid a premium for delivering T5 that cannot afford in the current economic climate. As one BAA speaker

noted, for example, BAA's current involvement in logistics 'stops at the site boundary'.

- The workshop clearly indicated that, presently, some suppliers are ready to exercise leadership in production management, but certainly not all. A supplier also indicated that the exercise of leadership in production management best practice can happen even under projects with fixed price commercial arrangements. Put differently, if the supplier believes leadership in production management can help the firm become more efficient and competitive, the reward for the firm that chooses to make the capital investment is that it will reap 100% of the savings that the upfront investment can produce.
- From a BAA perspective, there was the belief that the capital investment in the development of T5's relational contracting strategy paid off as it helped to accelerate delivery, reduce design and construction costs, avoid legal disputes, and deliver product quality (the endured legacy)

5. SALIENT FEATURES OF BAA'S CURRENT APPROACH TO LEADERSHIP IN CAPITAL PROJECTS

- BAA is mindful that the economic climate has changed and wants to take advantage of shift in market power to buyers by appointing contractors through open competition
- Similar to the T5 project (and with the exception of the T5C project), BAA continues to practice reimbursable contracts with target costs built-in to incentivize performance
- BAA's approach departs from the recognition that a few highly capable and 'production management-smart' suppliers are operating in today's UK market, and accordingly the airport operator is significantly less actively involved in the practice of managing projects.
- BAA still brings in-house the management of project risks that are specific/unique to Heathrow airport, namely issues of security and of shielding Heathrow operations from possible disruptions from construction works.
- BAA no longer gets involved in buying bulk materials unless they are strictly specific to the works at Heathrow airport.
- The fact BAA currently has very good project data about expected productivity for construction works at Heathrow airport (which it did not have when T5 was being built) gives

the airport operator confidence to step back into a role of overseeing rather than managing design/construction works and productivity, and the capability to do so.

- The Colnbrook logistics centre at the periphery of Heathrow airport is still instrumental for BAA as it plays a crucial role in enabling suppliers to consolidate deliveries. It is also critical to provide a place where all deliveries can be screened for security purposes.
- BAA is significantly committed to invest more effort upfront to resolve major project design issues at front-end strategizing, thereby reducing uncertainty in design criteria throughout the project delivery.
- BAA acknowledges that the supply chain tends to modernize itself step by step; fundamental change in production management and operational practices is difficult if the project client is not leading the change. Related to this, BAA as a client now expects suppliers to make the capital investments necessary to modernize and innovate their practices. Yet, whilst suppliers recognize the value of some production management practices, they may find themselves reluctant to make this investment, e.g., in a logistics centre, production management software, worried that the client may abandon the project unless the risk can be somehow mitigated.
- Some suppliers showed the ability to exercise leadership in production management best practice, taking it to business level. Suppliers which are willing to do so seem to have found ways to mitigate the risk of the investment upfront, for example, by making the investments in ways that they can contribute to improve performance of a number of projects unfolding at the same time or in sequence. One supplier illustrated how a strategic choice for centrally locating a logistics centre is benefiting all the projects it undertakes in Greater London.
- One supplier suggested clients could further encourage them to make the capital investment in innovative production management practices and methods if they underwrite the investments when suppliers are concerned the investment does not pay off unless the project indeed goes ahead.

ACKNOWLEDGEMENTS

We acknowledge the contribution of all participants, including presenters and attendants, which were all crucial to ensure the success of the workshop. We are particular grateful to BAA for welcoming the initiative and offering to host the event at its premises. This technical

report does not intend to serve as endorsement or source of primary data. The authors assume sole responsibility for this account of the presentations and outcomes of the discussion.

Appendix I – Letter of invitation to the workshop, agenda and attendees

Increasing numbers of multi-billion (mega) projects to deliver large-scale infrastructure assets such as airports, offshore platforms, railways, highways, utility grids, and power plants are being delivered around the world and those numbers appear to be rising. In the last decades, scholarly- and practitioner-oriented literature on managing megaprojects has uncovered management and leadership principles, frameworks, and practices that—provided project teams get their implementation right—contribute to making megaproject planning and delivery more successful in the eyes of a range stakeholders collectively, notwithstanding their different perspectives.

Yet, for a variety of reasons, many megaproject deliveries are perceived by experts and/or the layman to have failed and have received plenty of criticism. Within this context, the £4.2bn (2008 prices) project to add a fifth terminal to Heathrow airport (T5) stands out in that, by many accounts, many people view this to be a successful project. T5 project strategy and various practices have been accordingly dissected in the literature:

- T5 contracting and procurement strategy (embodied in the T5 agreement)
- T5 flexible approach to design development (enabled through the Last Responsible Moment policy)
- T5 flexible design architectures (built-in design safeguards and modular architectures)
- T5 strategy to manage the relationship with the local communities.
- T5 use of organizational behaviour specialists in cross-firm team building

Critically, however, much less—if anything—has been researched and documented on T5 project's leadership in lean thinking and implementation, as well as in the management of "production" in construction (including logistics), and how corresponding principles, practices, and tools can contribute to make megaprojects successful. This workshop aims to address this gap.

To this purpose, we want to bring T5 executives' leadership in developing and implementing production processes used on T5 to the foreground. Departing from the premise that 'lean is all about process', the aim of this workshop is: *Discuss if and to what extent 'new' processes have enabled the T5 project team to be as successful as they have been generally perceived to be.*

This workshop is a part of an ongoing research Initiative on Megaproject Leadership, supported by the international oil company Statoil, conducted by staff from the Project Production Systems Laboratory (P2SL) at the University of California at Berkeley and colleagues from the Norwegian Technical University (NTNU).

To all of you who have accepted to join the discussion at the first workshop dedicated to T5's production management strategy and practices, we extend our warmest welcome. And on April 14 at Heathrow airport, we look forward to learning your views which we are sure will help to develop our conceptual and practical understanding of production management's role in megaproject leadership.

WORKSHOP AGENDA

9 AM Welcome and brief introduction

9:15- 9.30 AM: Iris Tommelein, U.C. Berkeley. Overview of P2SL; the P2SL's Research Initiative on Megaproject Leadership

9:30-9. 45 AM: Nuno Gil, MBS. Overview of CID; putting T5 project management/leadership in context

9.45-9.55 AM: Chris Elliott, BAA Infrastructure Programme Manager. BAA's welcome

9. 50-9.55 AM: Presentation of a short video about the T5 project filmed in 2004-05

10-11.20 AM: The client's views (3 ~20 min presentations)

- Russell Batchelor, Jacobs Engineering (former BAA T5 project manager)
- Matt Palmer, BAA Capital Re-engineering Director (former Airfield BAA project leader)
- Andy Weber, BAA Programme Delivery Leader for T2 Concourse A (former BAA project leader for T5A and T5B)

11:20-11.50 AM: Morning break

11:50-13PM Roundtable Discussion on the Client's views (Don Ward, chair)

13-14PM Lunch

14-15.20PM- The specialist suppliers' views (4 ~20 min presentations)

- Collin Potts, Byrne Brothers Formwork (former T5 project manager for Laing O'Rourke)
- Prahbat Garga, independent consultant (former T5 Project director for AMEC (M&E largest supplier))
- George Adams, Spie-Matthew Hall (former T5 Chief engineer for AMEC)

15.20-15.50 PM Afternoon break

15.50-17.00 PM Roundtable Discussion on the Suppliers' views (Glenn Ballard, chair)

17.00-17:30 PM Plus/Delta and Next Steps (Iris and Nuno)

WORKSHOP PARTICIPANTS

Speakers

- Russell Batchelor, Jacobs Engineering (former BAA T5 project manager)
- Matt Palmer, BAA Capital Re-engineering Director (former Airfield BAA project leader)
- Andy Weber, BAA Programme Delivery Leader for T2 Concourse A (former BAA T5 project leader)
- Chris Elliot, BAA Infrastructure Programme Director
- Prabhat Garga, former T5 Project Director (AMEC)
- George Adams, Spie-Matthew Hall, former T5 Chief engineer for AMEC
- Liz Collins, Heathrow East for Balfour Beatty
- Colin Potts, former Laing O'Rourke, now Byrne Group
- Aran Verling, Byrne Group

Organisers

- Glenn Ballard, Research Director, P2SL, University of California at Berkeley
- Nuno Gil, Academic Director, Centre for Infrastructure Development, Manchester Business School
- Iris Tommelein, Director, Project Production Systems Laboratory (P2SL), University of California at Berkeley
- Don Ward, Executive Director, Centre for Infrastructure Development, Manchester Business School

Research Collaborators

- Stephane Denerolle (student UCB, P2SL). Stéphane is involved in P2SL's research initiatives on Megaproject Leadership and on Target Value Design.
- Marit Schei Olsen (student NTNU) Master's degree in political science from NTNU, Norway. Work as a research assistant at NTNU Social Research AS.
- Prof. Asbjorn Rolstadas is Vice Dean at the Faculty of Engineering Science and Technology and Professor in Production and Quality Management at Norwegian University of Science and Technology (NTNU)
- Prof. Per Morten Schiefloe is Head of Department of Sociology and Political Sciences at the NTNU and project manager for the research contract *Understanding Success and Developing Management Leadership on International Mega-projects* with Statoil and University of California, Berkeley

Attendants (actual)

- Adrian Blumenthal, Amec/EDF
- Ian Russell, Astins
- Alastair Kennedy, Balfour Beatty Vinci
- Olivier Colle, Balfour Beatty Vinci
- David Lloyd, Balfour Beatty Vinci
- Henry Loo, Constructing Excellence
- Simon Adams, Crossrail
- Richard Peart, Defence Infrastructure Organisation
- Jonathan Mann, Deloitte
- Mark Austin, Kier
- Matt Loder, London Underground

- Stephen Prendergast, Network Rail
- Mike Gallop, Network Rail
- Ian Ballentine, Network Rail
- Graham Robinson, Pinsent Masons
- Neil Turvey, Turner & Townsend

BIOGRAPHIES (alphabetical order)

Organisers:

Glenn Ballard is the Research Director of the Project Production Systems Laboratory at the University of California, Berkeley. He was involved in the Civils Phase of the T5 project as Technical Director for StrategicProject Solutions, a management consulting firm supporting Laing O'Rourke and BAA.

Nuno Gil, Academic Director, Centre for Infrastructure Development (CID), Manchester Business School. Nuno earned a PhD in Engineering, UC Berkeley and interdisciplinary certificates in the Management of Technology and Logistics. Nuno's research focuses on new infrastructure development, investigating processes, design architectures, procurement and contracting strategies, risk management practices, and governance structures for high-performance capital project/programme delivery. Nuno has worked or done research with IDC/CH2M HILL, Intel, Rolls Royce, BAA, BP, Manchester City Council, Network Rail, and Beetham. Nuno directs CID in partnership with Don Ward, Constructing Excellence's Chief Executive.

Iris Tommelein, Professor of Engineering and Project Management, in the Civil and Environmental Engineering Department at U.C. Berkeley. For more than 15 years, Iris has been teaching and conducting research developing the theory and principles of project-based production management for the architecture-engineering-construction industry, what is termed 'lean construction.' Together with Dr. Glenn Ballard, she directs the Project Production Systems Laboratory (P2SL), a research institute dedicated to developing and deploying knowledge and tools for project management as well as a learning lab for the Northern California construction industry. She is an active participant in the International Group for Lean Construction.

Don Ward, Executive Director of the Centre for Infrastructure Development at Manchester Business School. He is also the chief executive of Constructing Excellence, the independent industry improvement body. He specialises in industry change, supply chain integration and collaborative working, and has twenty-five years' experience of best practice and change programmes in the construction industry. Previous roles include chief executive of Be, the Design Build Foundation, and the Construction Industry Board, set up to implement the 1994 'Latham Report'. Previously he worked at the Building Research Establishment for 10 years to identify and promote best practice in energy efficient housing.

Presenters:

George Adams, Engineering Director, Spie UK business including Energy design capabilities. Involved with industry wide organisations such as BSRIA, Defence Estates Construction Excellence Programme and CIBSE, HVCA and Build Off Site. Continuous Service from University to current includes the following key positions: Designer - systems, value engineering and Energy; Business Development Manager - development of business streams and securing new customers including Europe; Chief Operations manager - major London operation with full responsibilities Design and Build; Engineering Manager T5 - strategic design, system and product development, modularisation, commissioning management and compliance

Russell Batchelor, Jacobs Engineering, Director of Operations in Programme Management.

Russell joined Jacobs in 2008 after over 20 years of leading projects of all sizes for BAA where his roles included: Head of Projects at Stansted Airport; Head of Buildings on Heathrow Terminal 5; Head of Terminal 5 Phase 2: and Head of Design and Construction on Heathrow East Terminal. Russell led the T5 Buildings Team from shortly before the Public Inquiry Decision until the lifting of the T5A roof, T5 Phase 2 through Scheme and Detailed Design to start on site, and created and led the Heathrow East Terminal project through from Inception to Scheme Design. His major interest is the application of Lean Techniques to construction, and he is currently providing Lean Specialist Support to the UK Highways Agency.

Liz Collins, Balfour Beatty. Liz leads and facilitates performance improvement, process definition and behavioural change programmes across major projects in the Process and Construction industries. She was responsible for implementing collaboration tools at Heathrow Terminal 5 and developing them for application across the Infrastructure business at Laing O'Rourke. As an independent change specialist, Liz is currently implementing production control processes and techniques at T2B for Balfour Beatty.

Chris Elliott, Heathrow Airport's Infrastructure Programme Director (since May 2010). Chris is responsible for the delivery of Heathrow's £750m airport infrastructure programme within BAA's overall development of the airport. In a career spanning more than 13 years in the airport industry, covering airport operations, airport strategy and airport development, Chris has previously been involved in the development of Heathrow's Terminal 5 and Dublin's new Terminal 2.

Prabhat Garga, Project Management Consultant Recently retired as head of project management function at AMEC. Broad experience of infrastructure, industrial, defence and energy industries of which over 30 years experience of offshore oil and gas projects in various project management roles for both client and contractors. Relevant for this workshop are his roles as Head of the Topsides Alliance on the North Sea Britannia project and AMEC's Terminal 5 Project Director for Building Services.

Matt Palmer, BAA's Capital Re-Engineering Director. Matt has been a Director at Heathrow Airport since May 2008 and is currently Capital Re-Engineering Director transforming Heathrow's Capital Programme team into an Intelligent Client, to ensure Heathrow delivers the maximum benefit for its passengers & airlines through its strategic investment programmes. In a career spent on a variety of large transport infrastructure developments worldwide, the predominantly focused on transforming Airports, with the last 10 years at BAA on a number of projects including Stansted & Gatwick terminal extensions and Terminal 5 at Heathrow.

Potts, Colin, Senior Project Manager at Byrne Brothers Formwork. In his role as project manager for the civils element of main terminal building at Heathrow (T5A), Colin was instrumental in developing and implementing Production Control tools. Since then, he has worked with several project teams to create the right environment and mindset to implement the tools within a variety of contract styles. This includes at a JV design and build road project (N7) in Ireland, a traditional contract relationship at Dublin Airport, and at Birmingham International Airport. Colin is now heading up the FRC element of the T2B project for Terminal 2 at Heathrow where he is again developing his team to use the tools.

Andy Weber, BAA's Delivery Leader. Andy has been working on the construction of the new Terminal 2 at Heathrow for 3 years as BAA's Delivery Leader for the T2A Building Shell, Core and Fitout. The project forms the centre piece of an extensive £4.6bn programme of works at Heathrow to provide improved passenger facilities. Andy has worked almost all of his 18 years in the construction industry at different airports on a variety of projects including retail fitout at Manchester Airport, cargo warehouse fitout at Stansted and the Heathrow Express Rail link and Terminal 5 at Heathrow.

Appendix II - Relevant excerpts of Gil, N. (2009). Developing Project Client-Supplier Cooperative Relationships: How much to Expect from Relational Contracts? *California Management Review*, Winter, 144-169.

The T5 Agreement

The ethos informing the design of the T5 agreement was about creating an environment where “attitudes and roles bedeviled with concern about exposure to risk, unbalanced focus on capital cost, lowest costs, and layers of practices that inhibit change are unacceptable,” as stated in the contract. The contract also recognized that the targets for the T5 project were aggressive, and urged suppliers to change work practices:

Thinking of others as well as oneself, so that we [BAA and suppliers] all win together, is a must. Being able to see the wider benefits will entail a change of mindset, possibly changing out people; there will be little room for those who are not committed, who want to spend all their time saying ‘why it can’t be done’. (T5 Agreement)

The BAA ideal was that the suppliers would achieve “exceptional performance,” i.e., they would be better than anything anyone else had achieved before. The contract further added:

Best practice is the minimum level of performance that we require people to commit to. While this is a step up from the normal levels of performance required, “business as usual”, this should not be a problem. We have procured companies and people on the basis that you are experts in your field; you are leaders in your industry; you are making available people and skills committed to this expected level of performance.

The principle for remunerating the suppliers, as spelled out in the commercial policy, was reimbursable cost of time and materials plus an agreed profit margin. The T5 contract manager explained the rationale:

The fact that we’re paying people by the hour allows us to be pretty flexible in using resources, and changing and moving things quickly around (...). We’ll give suppliers a level of profit for the tasks we can see ahead of us, but suppliers won’t be taking any of the risks of inefficiency or overspend. This is a very positive environment. Suppliers may not make their best returns here, but they aren’t making any loses.

The T5 suppliers were expected to demonstrate to BAA that the costs had been properly incurred. BAA reserved unfettered rights to carry out reviews to audit supplier accounts, staff and labor payrolls, purchase ledger systems, volume discounts, retrospective rebates, early payment discounts, and cash flow statements. (This is known as the “open book regime”). Occasionally, BAA and the suppliers could agree to fixed rates or lump sums for specific elements of work, based upon clarity of scope and utilization of standard products. Still, three details designed into the contract could have major impacts on the profit mark up to be made by the suppliers: (1) ring-fenced profit, (2) incentive plan, and (3) compensation for changes.

Ring-fenced Profit

The contract spelled out that the suppliers' profit was "ring-fenced", as an agreed lump sum amount against an agreed estimate of resources for a defined scope of work. Suppliers could increase their profit margin percentage by delivering their work at a cost less than the estimate. Conversely, the profit margin could shrink if the estimate of resources was too optimistic relative to the actual amount of work needed to deliver the defined scope of work.

Incentive Plan

Influenced by the use of target costing in Toyota, the commercial terms aimed to provide incentives for suppliers to 'realize the client ambitions' and exceed the 'client's expectations'. Thus, BAA contractually agreed to share benefits of exceptional performance 50:50 with the first-tier suppliers. The benefits were calculated as the difference between the baseline target cost and the actual cost of work. Target costs were agreed to with the suppliers involved in the design and implementation. The targets were meant to reflect benchmarks, yardsticks and norms free of allowances and contingencies for inherent construction risks.

Compensating for Change

The way BAA categorized a change request impacted the profit margin of the supplier. Changes that BAA described as 'design evolution' meant that, in the view of the T5 agreement, they did not alter the design scope:

Evolution isn't change.... managing the ambiguities between the objectives, potential solutions and delivery practices is a basic requirement of your and our delivery practices. This requires delivery plans and actions to evolve and adapt through the project. This evolving and adapting activity does not constitute change, but may involve transferring responsibilities, budgets, time, etc, between teams and team members. (T5 Agreement)

Thus, BAA did not amend the ring-fenced profit in response to design evolution – while suppliers were reimbursed for the actual costs incurred with additional work stemming from design evolution, their profit margin was reduced. Conversely, BAA considered as 'exceptional' all the events and issues changing the project scope. In these circumstances, BAA would sanction the change and amend the ring-fenced profit so as to keep unaffected the agreed supplier's profit margin. Conversations between BAA and the suppliers preceded the categorization of an event as design evolution or change in scope.

Sociological features of Japanese-style partnerships in organizing the T5 project

BAA sought to incorporate many of the sociological features of Japanese-style partnerships in the T5 organization. Physical proximity is a key enabler of relational rents as it facilitates the establishment of knowledge-sharing routines and inter-firm cooperation.⁴ Hence, BAA and the T5 suppliers (a designation which BAA used equally to refer to architects, engineering consultants, contractors, and manufacturers) were co-located at the T5 site. Other efforts to create a shared purpose and build a sense of collective identity with the suppliers' staff ('there weren't lots of people on site, there were T5 people on site', emphasized the T5 commercial director) included giving everyone a T5-email address (@t5.co.uk), funding a monthly site newspaper (The Site), seconding suppliers' staff to work for the BAA T5 team (a *de facto* transfer of employees), and establishing inter-firm committees for quality, health, and safety. BAA also coined the term 'T5 preferred supplier' to help the suppliers draw reputational benefits, and signed framework agreements with the suppliers to give them prospects of a long-term collaboration.

The Production Strategy for the T5 Project

Inter-firm cooperation and sharing of technical knowledge and confidential information were prerequisites for institutionalizing a production strategy on the T5 project. Influenced by the Toyota practice of setting up an operations management consulting division to acquire, store, and diffuse knowledge,⁵ BAA hired a team of consultants specialized in lean production. The consultants were tasked to visit the suppliers' facilities and assist them in improving productivity and quality. BAA did not charge the T5 suppliers for the consultants' time, but expected suppliers to share confidential data on their production processes and costs. The consultants would then apply value stream mapping to examine the processes and find ways to help the T5 suppliers achieve the following objectives: reduce variability in production and installation rates; identify critical information flows and feedback loops; eliminate non-value-added activities; reduce lead times and batch sizes of manufacturing releases; coordinate work flow between feeder and primary workstations; and maximize the number of deliveries of materials and components just in time for assembly on the construction site. Further, BAA sought to emulate the way in which networks of Toyota suppliers facilitate the distribution of know-how and reduce information asymmetries.⁶ Hence, it institutionalized a T5 supplier "buy club"

⁴ See Dyer, J. (1996). "Does Governance Matter? Keiretsu Alliances and Asset Specificity as Sources of Japanese Competitive Advantage," *Organization Science*, 7/6, 649-666; Saxenian, A.(1994). *Regional Advantage*. Cambridge, MA. Harvard University Press.

⁵ Dyer, J.H. and Nobeoka, K. (2000). "Creating and Managing a High-Performance Knowledge-Sharing Network: The Toyota Case", *Strategic Management Journal*, 21, 345-367.

⁶ Dyer and Nobeoka op. cit.

that operated on the assumption that the suppliers would share confidential cost data for products that they were regularly buying.

In an effort to emulate the asset-specific investments by suppliers in Japanese-style partnerships, BAA and selected T5 suppliers built two logistics centers adjacent to the construction site. These centers included bays of trailer parking to handle road transport or transfers from rail and a covered manufacturing and assembly facility with overhead cranes and drive through access for consolidating materials and pre-assembling building components. By providing storage and lay down areas for raw materials, the centers allowed site construction to be buffered from variations resulting from road transportation.

Further, BAA, the consultants, and a few suppliers (the first to get involved in the project) together developed a production planning tool, termed Project Flow.⁷ This tool encouraged the suppliers to pull materials from the logistics centers, and to produce materials on demand. Project Flow aimed to help “deliver today what will be installed tomorrow” akin to the lean just-in-time maxim. Further, it aimed to improve the reliability of the suppliers’ production plans by ensuring that, first, the inputs for a new task were ready when needed for the task; and second, the reasons planned tasks were not completed would become visible.

BAA and some T5 suppliers also cooperated in setting up a Kanban-like system, influenced by a similar practice in the Toyota factories. This allowed people on the T5 site to place an order which would trigger a request to deliver a product from one of the logistics centers (or from a marketplace/shared store for small tool replacements and consumables like water-proof suits) with the help of lorries performing ‘milk runs’, or compound deliveries. Reorder points and maximum levels of inventories for commodities were reset periodically in accordance with replenishment lead time and forecast consumption rates.

BAA also required cooperation and flexibility from the T5 suppliers to accommodate design change requests over time, cognizant that the project requirements would need to flex to evolve with the needs of the T5 customers. Foreseeable uncertainties included the speed of the evolution towards ticket-less air travel, developments in the technology for handling baggage and airport security, new aircraft designs, and changes in the business models of the airlines. BAA institutionalized the demand for flexibility through a postponement policy, termed the ‘last responsible moment’ (LRM). This allowed BAA to delay design decisions until a date after which, if a decision was not made, BAA would have to accept a negative impact on the estimated costs or baseline schedule. This procedure

⁷ For research at the basis of ProjectFlow, see Ballard, G. (2000). *The Last Planner System of Production Control*. Doctoral dissertation, School of Civil Engineering, The University of Birmingham, UK; Choo, H.J., Tommelein, I.D., Ballard, G., and Zabelle, T.R. (1999). "WorkPlan: Constraint-based Database for Work Package Scheduling." *J. of Constr. Engrg. and Mgmt.*, 125 (3) 151-160.

was integrated with a stage-gate approach.⁸ Formal approvals were the gateways through which the sub-projects had to pass to move from one stage to the next. BAA reserved the right to change the design before D-day, a period it termed 'design evolution'. To pass the D-day review, the sub-project teams needed to develop a production plan exhibiting 90 to 95% design completion and price certainty. Its approval released the funding needed to do the work.

⁸ Cooper, R.G. (1990). "Stage-Gate Systems: A New Tool for Managing New Products," *Business Horizons*, May-June, 44-54.