THE ROLE OF STRATEGIC PROCUREMENT IN THE
MANAGEMENT OF LONG TERM ENGINEERING PROJECTS

FINAL REPORT TO ESRC

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Background

The Innovative Manufacturing Initiative

This project was originally funded by the EPSRC under the Innovative Manufacturing Initiative (IMI) programme on Learning Across Business Sectors (LABS). It was passed to the ESRC in order to circumvent EPSRC rules concerning the holding of grants by contract research staff. The project has been overseen by the Construction sector of IMI and has involved the active collaboration of three industrial companies: ALSTOM Transport, Clarke Chapman and Northumbrian Water Ltd (NWL). This was a requirement of the programme, which stipulated that 50% of the expenditure on the research came from industrial sources. In this project most of this has been in-kind, but also included a modest cash sum provided by each partner. Clarke Chapman was forced to withdraw from the collaboration towards the end of the project owing to its impending sale by the parent company. However, the main empirical investigations in the Clarke Chapman case study had been completed by then.

It also needs to be stressed at the outset that, in line with IMI rules, a collaboration agreement between the University and the collaborators was entered into. This, amongst other things, provides for each collaborator to have the right to approve material for publication, whilst not prohibiting the researchers from so doing, which does mean that the rate at which material can enter the public domain is slower than in a conventionally funded ESRC project.

Long Term Engineering Projects

The project itself has its roots in the observation that in the capital goods and low volume industries there is an increasing tendency for companies to be asked to provide not just a capital product, but a complex bundle of services associated with that product (Gann and Salter, 1998). This process is being driven by a number of factors that are changing the nature of the competitive environment in which capital goods companies are operating. These include the effects of privatisation, both in the UK and abroad, new entrants into the industries affected, increased levels of outsourcing by clients and changing regulatory environments.

Whilst this tendency has been noted in research into complex product systems (e.g. Davies and Brady, 2000), one feature which has not been researched in any detail is the long term nature of many of these projects. Here the contractor is asked to design and supply capital equipment and to operate and/or maintain it over a long concessionary period. Similar tendencies are apparent in Private Finance Initiative projects, although the methods of project financing differ. We hypothesised that this would create a need for contractors to acquire new capabilities and knowledge to enable them to create and manage complex projects with this mix of product and service provision over a longer time period than conventional capital projects. This was seen as a strategic procurement issue.
We also hypothesised that in order to manage this increased complexity of project content, the role of project integrator would be key. We define project integration to include the development of the overall strategy for the project in order to bring together the range of capabilities necessary for its delivery, organisation and management, as opposed to just the integration of different technical systems (a systems integration task).

Each complex long term engineering project is likely to require new and substantially different intra- and inter organisational relationships (alliances, supply chains, project teams etc.), technologies and financing. There are therefore important issues for organisations in terms of how they can learn from the experiences of one project, or indeed from one phase of a project, to the next in order to avoid ‘re-inventing the wheel’. As Shapiro (1999) has noted, in such circumstances particular problems of knowledge management can be identified, because there is a paucity of formalised methods for doing this. This was therefore one of the key issues in the research and the bringing together of collaborators engaged in similar types of long term project, but in very different sectoral contexts, was designed to enhance the scope for this cross-project learning. This was an issue that was central to the IMI LABS research programme, which required collaborators to be in a mix of industrial sectors.

In order to develop an holistic understanding of long term engineering projects we have drawn on a wide range of different literatures and concepts. These include project management (e.g. Morris, 1994; Winch, forthcoming), supply chain management in the context of project-based organisations (e.g. Cox and Townsend, 1998; Hicks et al, 2000), networks and networking (e.g. Elg and Johannsson, 1997; Harris et al, 1999), knowledge management (e.g. Blackler et al, 1998; Coombs and Hull, 1998; Nonaka and Takeuchi, 1995) and complex product systems (CoPS) (e.g. Hobday, 1998).

The research issue therefore consisted of a multidisciplinary problem and a multidisciplinary approach to the research was needed. The research team was deliberately constituted of a mix of social scientists and engineers covering management, economics, sociology, geography, engineering and strategic industrial management expertise. The project was designed in conjunction with the three industrial partners, each of which was engaged either as a client or as a product/service provider in a long term project which became the focus of study in the research.

**Objectives**

The objectives for the research were as follows:

1. To develop an improved methodology for the strategic procurement of new capabilities within long term engineering projects.
2. To identify how companies currently organise procurement and approach the acquisition of new knowledge and capability for unfamiliar types of product/service delivery.
3. To establish future learning, knowledge management and organisational needs for long term engineering projects.
4. To identify the skills and competencies for procurement of the external technologies and knowledge required for long term engineering projects.

5. To provide a framework for learning between projects.

Whilst these objectives have largely been met, it should be borne in mind that the original proposal specified the project in two phases. The first phase involved conducting three case studies and carrying out a comparative analysis of these. The second phase envisaged the development and testing of an improved methodology and tool for companies to use in relation to strategic procurement. This second phase was not funded. Thus, whilst the research has enabled objectives 2-4 to be progressed in detail, objectives 1 and 5 have only been developed in terms of a broad framework and their detailed progression is dependent on further funding.

It also needs to be stressed that, because the IMI is an industry-driven programme, changes in the emphasis of the project are a reflection of the desire of the collaborators for the project to focus less on the initial strategic decisions regarding new capabilities and more on the issues associated with their embedding and operation within the organisation and the associated project supply networks.

**Methods**

The research used a case-study methodology, focusing on three long term projects. These were firstly, ALSTOM’s project to supply and maintain a fleet of high speed tilting trains for Virgin on the West Coast Main Line (WCML); secondly, Clarke Chapman’s contract for the refurbishment, upgrading, operation and maintenance of wharf-side materials handling facilities on behalf of a steelworks in Argentina; and, thirdly, the design, construction and operation of a regional sludge treatment centre (RSTC) in the North East of England by NWL.

In each case study the strategy was to map out the complete project network and identify all the key actors in the project. This approach commenced with initial interviews with the principal contact within each collaborating company and snowballed out to over the collaborator’s project team and subsequently the supply chain and other organisations associated with the project, including where possible the client. In the RSTC case Northumbrian Water itself is the client and this project permits an alternative perspective to that of the other two projects concerning the problems and issues arising in long term engineering projects.

The method of interviewing was to have at least two members of the research team present and to record the interview using a mini-disc player. This equipment was chosen after attempts to record the first workshop at the ALSTOM factory were dogged by background noise from passing forklift trucks and the like. Interviews were not transcribed verbatim except for specific quotations, but edited transcripts were compiled and returned to each interviewee for verification and assessment of sensitivity. This enabled errors of fact to be corrected and ensured that our interpretation at least reflected what the interviewee had intended.

Having a minimum of two interviewers present was one way of introducing multidisciplinarity into the research process. Whilst more expensive, it resulted in a
higher quality of information than could have been obtained by one interviewer alone. The second interviewer was able to pick up issues that might not have been explored in sufficient detail and to consider the discussion with the project framework in mind, leaving the first interviewer to concentrate on the interaction with the respondent.

Interviews were triangulated through a process of cross-checking of stories with other accounts and other sources, including secondary sources such as industry journals, as appropriate. Ultimately, the story of the project emerged from a consideration of multiple viewpoints. An important feature of the research method was the ability to mobilise information that increased the credibility of the research team and reassured the respondent that it was ‘okay to talk to us’, because we were in possession of details about the project that could only have been released at a more senior level.

Whilst the Clarke Chapman case study was largely retrospective, in that the project was already into its operations phase, the ALSTOM and Northumbrian Water studies were conducted ‘in real time’ as both projects were still in the design and procurement phases. These case studies do not extend fully into the operations phase (partially in the NWL case).

The second principal method of obtaining data was through a series of workshops held with the collaborating companies. These were hosted by one of the partners and were designed to promote a well structured exchange of views and experiences (genuine cross-sectoral learning) between the collaborators, supported by briefing papers prepared by the research team. Participants were drawn from the collaborating companies as appropriate to the topics under discussion, but included representatives at Director level. The workshops were focused on key themes that initial investigations suggested to be critical in long term engineering projects. These workshops were therefore very different from the conventional dissemination workshops that academics traditionally organise. They provided a forum for the collaborators to come together and learn from different sectoral contexts and they generated information and insights that would not normally emerge from one to one interviews.

The final workshop followed a different format, at the request of one of the collaborators, in that it broadened the scope of participation to include representatives of a number of other firms that formed part of the collaborators’ supply chains. This workshop was hosted by the University in part to provide a neutral environment for the participants to come together to discuss often difficult issues surrounding the organisation and management of project supply chains, particularly in the context of long term procurement requirements. This workshop led to the creation of action plans by the collaborators and the arrangement of follow-up activities.

Interpretation of findings adopted a multidisciplinary approach. Involving all the project team in the data collection process helped ensure that the whole team was engaged in the interpretation of the material. Project away days were held regularly to bring the research team of six together to brainstorm and discuss the findings. This led to the creation of a framework for analysis and interpretation and also facilitated the writing of research papers (see below).
Results

The three case studies and the associated workshops have furnished an extremely rich picture of the operation and management of long term engineering projects. Inevitably, given the long period of time needed to conduct all the fieldwork, analysis is still ongoing, but the industrial contributions to the project mean that the project itself is able to continue beyond the immediate period of Research Council funding. It is also not possible at this stage to provide details of the individual case studies for reasons of space and confidentiality as outlined above. However, the following provides a flavour of the empirical findings, some of which are discussed in more detail in the various research and conference papers listed in the outputs section.

The conduct and analysis of the empirical research was guided by a framework developed as part of a previous EPSRC funded IMI study. This framework, based around the notion of the value-added system (Maffin et al, 1998), focuses attention on the broader context within which major projects are being undertaken. As such it goes beyond conventional framings of complex products/projects. Given the importance of the customer in major projects, the framework guides the tracking of the sources of customer value in the project and hence the key procurement strategies and decisions relating to the delivery of what the customer values. It particularly draws attention to the importance of actors beyond the conventional idea of the supply chain, notably regulatory bodies, consultancies and other third parties and other external sources of knowledge essential for delivery of the complete project. More details are provided in McLoughlin et al (2000).

The collaborators were identified originally on the basis of their manifest technical capability and project management experience. An important finding was that they were to some extent still finding their way in these projects, partly because of the shift in scale and scope, and were therefore learning as they went along. The three projects were also being conducted in a turbulent environment, due to corporate reorganisation, regulatory changes, and other uncertainties and the companies were having to cope with a tremendous degree of change.

The analysis of the case studies has been carried out on a thematic basis and the most significant of these themes, which emerged during the course of the field investigations, are addressed below.

Understanding customer requirements

This was the topic of the first project workshop held at ALSTOM’s Washwood Heath assembly plant in Birmingham. It dealt with the front end issues in long term engineering projects, namely how to translate a customer requirement defined in terms of outcomes into a strategy for the design, procurement, assembly and delivery of the products and services demanded.

Engineering contractors entering into long term engineering projects are having to move away from the conventional approach to projects. This typically involved delivering the product and ‘walking away’ at the end of the warranty period. Now they have to take on responsibility for the operations and maintenance phase of the
project (even its decommissioning at the end of the project’s life in some cases), effectively running an outsourced business on behalf of the client.

One of the implications of this transformation is that the client’s requirements are often expressed in terms of an overall business plan. The details of how to achieve this are left to the contractor. Interpreting the customer’s vision for its business is therefore critical to the delivery of what the customer requires. The case studies demonstrated how this is not reflected in a simple process of interaction between client and contractor, but through the mediation of numerous third parties. These include regulatory bodies, design consultants, technical and business consultants, financing agents and suppliers.

One of the ways Virgin interacted with ALSTOM was through a document known as the ‘Red Book’. This represents in essence an aspirational design, comprising, amongst other things, a series of visual images that capture what it is the client wants the train to look like and (just as importantly) what it should not look like. This approach is reminiscent of the way many architects interact with clients. The Red Book is thus an important mechanism for managing the process of conveying customer requirements in this instance.

Complex projects such as these also display the presence of multiple customers in that the immediate customer for a particular provider may not be the client, but an intermediary or internal functional department. Under such circumstances a lack of correspondence between immediate (local) needs and overall project requirements may occur.

Supply chain management

This theme formed the subject of the second and third workshops. Strategic procurement in the context of long term engineering projects requires new types of relationships with suppliers. In particular, through life cost, maintainability and reliability of components and subsystems becomes the responsibility of the prime contractor and there is a desire to pass this on to the respective elements of the supply chain. This in turn calls for earlier involvement of suppliers in the project process, improved relationships between customers and suppliers and the development of more collaborative working relationships.

Our previous research into supply chain issues in the capital goods industry identified a number of difficulties in achieving this. These stem from the transient nature of projects and their associated supply chains, the fact that capital goods producers are often in relatively weak positions of power as a result of the small amount of their suppliers’ business they account for and the associated problems of apportioning risk equitably.

From our research it is clear that the management of the supply chain is enacted, not just by the prime contractor, but also by suppliers themselves. The form and timing of the specifications (formal and informal), contracts and rewards (payments, further contracts), which flow back up the supply chain, can be critically influenced by suppliers. Having recognised this, we believe that suppliers could take a greater role
in supply chain management – in managing their own customers. Suppliers can do so by actively promoting their technical and service strengths to their customers and identifying and solving project-level problems, by demonstrating full commitment to the project in hand and by being transparent in their decision making and processes. More research is needed here to articulate how best this may be achieved.

Main contractors, by the same token, can do much to facilitate this more proactive approach. They can think more about the amount of time they spend listening to their suppliers; they can also be more transparent in their decision making and planning; they can improve their response times to suppliers (on both project and longer term issues such as technology development); and they can seek to stabilise their own workflow in order to promote stability in their supply chains.

There remain considerable barriers to change. First, there are internal organisational barriers to transparency and quick response times in the form of differing professional and functional group objectives. Second, procurement and project management may have limited power to push for change in the broader corporate body. Third, there are external barriers to change in terms of existing regulatory and market pressures. Clearly, change in supply chain management is linked to change across the whole business and its contexts and this constrains what can be achieved in the short term.

Project integration

We commenced the research with the expectation that we would find the prime contractor in the project network playing the role of project integrator; that is performing the task of integrating, not just technical systems, but the inputs of a wide range of project actors in order to deliver the customer’s requirements. We found the project integrator role to be more complex than envisaged and to be underdeveloped in these case studies. Project integration in a long term engineering project is about instantiating the client’s vision. In practice we found that the nature of project integration appeared to change as the project developed and different actors were observed to play a greater or lesser role as the project progressed. This was found to have implications for the organisation and management of the project and our findings suggest that the process of project integration is something that needs to be considered and negotiated between the project partners.

Complex long term projects such as these tend, by default, to be broken down into sub-projects that can be managed using conventional project management tools and techniques with which project managers are more familiar. The danger with this is that the desired outcomes of the project as a whole (what we have termed the meta-project) may not be achieved as a result of a focus on short term or local pressures, such as the need of a particular business unit to show a profit on the capital equipment sale. In particular, there is a tendency for the design and supply phase to be separated from the operations phase.

In some cases, even the project we were studying was itself just part of a much larger capital investment programme. The Pendolino high speed trains, for example, form a part of the overall upgrade of the WCML (the West Coast Route Modernisation, see Geyer and Davies, 2000), where the problems of integrating the acquisition of new
trains, infrastructure upgrades, signalling improvements, on-board customer service, ticketing and timetabling etc. comprise the meta-project (see Alderman et al, 2001 for more detail).

The research has revealed a need for more attention to be paid to the processes of project management in the context of complex networks of projects delivering long term capital investment programmes. We would add project integration to Winch’s (forthcoming) core project management business processes. Current management tool kits are not up to this task.

Knowledge management

Knowledge management is another of the underpinning themes of the research. Our initial project formulation stated that the acquisition of new knowledge would be one of the key strategic procurement issues for firms entering into long term engineering projects. Our research findings indicate that knowledge should not be treated as though it were a material resource in the way that the IT-centred approach to knowledge management does (Whitley, 2000).

Our case studies revealed that knowledge needs to be conceptualised in terms of its production and consumption. Customer requirements (discussed above) were found to be redefined during the project as a result of interaction between client, contractor and intermediaries such as design consultants. Some requirements were contested as engineering designers were required to operate in new ways to accommodate a focus on client business needs rather than purely technical considerations. There were sometimes conflicting demands placed on designers concerning the need to incorporate maintainability over the long term into the design criteria as against the desire to maximise profit on the sale of the equipment (first cost versus life cycle cost). Again, this is something that the ‘walk away at the end of the warranty period’ mentality does not encourage.

Our conclusion is that for the successful management of long term engineering projects, companies have to develop the capability to manage unfamiliar domains of knowledge. One of the mechanisms we observed in two of our projects for doing this was the joint venture. Clarke Chapman had entered into a joint venture with Portia, the management consultancy arm of Mersey Docks and Harbour Company, in order to procure port operations knowledge and capability, while ALSTOM had entered into a joint venture with Fiat Ferroviaria in order to obtain access to a tilting technology, which was one of the few technical specifications stipulated by the client. NWL, on the other hand, dealt with unfamiliarity in the technical domain by financing a design competition amongst tenderers for the drying equipment to be installed in the RSTC, in order to identify the most appropriate technical solution prior to placing the contract.

The innovation process

The case studies also provided some insights into the nature of the innovation process in the context of long term engineering projects. Long term projects call for innovation
across a whole range of different fronts. For both Clarke Chapman and ALSTOM, innovative financing arrangements were needed to enable the contract to be won. Technical innovation has to pay more attention to the long term commitments and responsibilities of the manufacturer. Design for maintainability becomes a primary consideration. In all three case studies issues around maintenance and maintainability have been central to the innovation process.

Implementation of innovation in the long term project context demands the changing or circumventing of long-established cultures of design and development. There was evidence in some instances of resistance to change amongst those involved in the design process.

Long term projects imply that the technology available at the outset of the project may not be the optimal technology as the project progresses over time. Incremental innovation will be of vital importance if the returns over the operations phase are to be maximised. In part this is dependent upon the timely and appropriate feedback of operating experience into the design process. Capital equipment provided under the terms of such contracts may well undergo major refurbishment during the life of the project at which point the opportunity for upgrades will arise.

At NWL, because it is operating and maintaining the drying plant itself, there is a particularly strong need for learning from the project. A number of problems have already arisen during the early part of the operations phase. For instance, the input material, i.e. the raw sewage sludge, has been found to be more variable in its characteristics than was at first anticipated, for example in terms of the tar and grease content. This has created a number of problems that have required a joint problem solving approach and NWL have created specific groupings to deal with these e.g. the TAG (tar and grease) group. The process equipment supplier is an integral part of these groups, bringing its own experience to finding solutions and learning for itself more about the conditions that its equipment has to operate under and enabling it to improve its product offering.

Concluding remarks

In terms of the original objectives for this research, we have identified project integration as a key issue in relation to the strategic procurement of new capabilities in long term projects. At present this is being approached by companies in a piecemeal and largely unmanaged way. We conclude that, even in long term engineering projects where the operations phase forms a substantial part of the contract and where operating revenues and costs dominate, there is still a tendency to focus attention on the manufacture and delivery of the capital items rather than on their long term operation and maintenance. The developing role of project integration should help to prevent this.

Future learning needs include the incorporation of long term issues into product and service design (e.g. design for maintainability) as well as the ability to manage unfamiliar domains of knowledge. Contractors will need to develop the ability to interpret client business plans and to understand the wider context in which these sit in order to design the appropriate project for the client. There are also implications for
the skills and abilities of the individuals dealing with project integration in this wider context. Decomposing a complex problem into manageable sub-projects that are amenable to treatment with conventional project management tools is not sufficient to meet wider ‘meta-project’ needs.

Our case studies have investigated three very different long term engineering projects. The context and environment within which each is situated are very different. Consequently, the response of the individual organisations to particular problems or issues differs. Moreover, the degree of control each has over the environment in which it is operating also varies dramatically. What does emerge from this research is a framework for learning between complex projects and an attempt to move towards an improved methodology for strategic procurement. To this end we have developed an analytical framework, based more on conceptual distinctions, that provides an alternative to conventional linear notions of projects.

This framework is something that has emerged from the analysis, and in this sense is firmly grounded in the empirical reality of the case studies, rather than having been theoretically derived. A brief outline of this framework is as follows:

1. **PROJECT CONTENT AND CONTEXT**

   Understanding the sources of complexity in the project
   - Including regulatory and market contexts, new technology requirements, product/service bundling, inter and intra organisational networks and risk

2. **DYNAMICS OF THE PROJECT**

   Understanding the complexity of the project process
   - Including, changing customer requirements, the role and nature of contracts, internal organisation, suppliers and supply chain relationships, the role of intermediaries, sources and locations of innovation, and the role of knowledge management and learning.

3. **PROJECT INTEGRATION**

   Understanding the means by which complexity is simplified (or not)
   - Including winning resources and managing risk, changing processes and systems and the management of meaning (interpreting the customer’s vision, changing, incorporating and challenging cultures such as traditional design cultures)

At present industry is not paying sufficient attention to the breadth of issues that underpin the management of long term engineering projects. As research by Morris et al (2000) shows, not enough attention is given to the management of networks, knowledge and complex project systems in the project manager’s thinking. There is a need to bring together the technical literature that tends to adopt a ‘how to’ approach, with some of the more nuanced considerations to be found in the social science literatures we alluded to at the start of the report.
Activities

Interaction with the industrial collaborators has been an important aspect of the activities carried out during the project, in line with the requirements of the IMI.

A steering committee, comprising the research team, representatives of the collaborators and a representative of the IMI was established and met at six monthly intervals to discuss the objectives, progress and outcomes of the research. These meetings were held at Bran Sands (the RSTC site on Teesside), Washwood Heath and Clarke Chapman’s plant at Gateshead. Each meeting was accompanied by a tour of the collaborator’s facilities and in the initial meetings presentations by each collaborator of their case study project.

Workshops were held at Bran Sands, Washwood Heath and Newcastle University, the latter involving representatives from 10 supplier organisations in addition to NWL and ALSTOM. Guest speakers were also brought into these workshops: Dr. Rajesh Nellore of Electrolux and Prof. Michael Quayle of Glamorgan Business School, to talk about specific aspects of the workshop topic.

A project seminar was also organised in November 2000, with papers presented by Dr Tim Brady of CENTRIM, Prof. Graham Winch of UMIST and Dr. Neil Alderman of CURDS. This seminar was held to promote exchange of ideas and findings amongst the project management / complex product system communities and to develop networking opportunities. One of the latter is a proposal for an international workshop in Denmark next year dealing with some of these issues.

Members of the project team also participated in a workshop organised by Prof. Harry Scarbrough at Warwick University in June 2000, which brought together a number of project teams funded under the first round of the IMI LABS programme. This enabled an exchange of views and discussion of methodological issues in relation to the problems of cross-project learning and knowledge management.

The research team has also been active in the dissemination of early findings from the research project. Papers were presented at the following conferences, workshops and seminars (see also Appendix 1):

PREST seminar series, Manchester, December, 2000.

A further two papers will be presented at the Future of Innovation Studies Conference in Eindhoven, September, 2001.
Outputs

Although the project was only of 18 months duration a significant number of conference papers have already been presented, with more in the pipeline. These papers are now in the process of development for submission to appropriate journals. Consistent with the multidisciplinary nature of the research team, dissemination has been to a number of different audiences in management and other social sciences. A complete list of papers is provided in Appendix 1.

Some of these papers are posted on the project website [http://www.ncl.ac.uk/labs/](http://www.ncl.ac.uk/labs/). The web site also has links to the collaborators’ sites and related academic and public web sites. After the completion of the project the website will be used as a vehicle for rapid dissemination of analyses and additional project findings.

There are also a number of outputs specific to the collaborators in the project. These include a detailed analysis of each case study. One of these is complete and the other two are still in progress. A comparative analysis report will also be prepared for the collaborators. Feedback reports on the workshops have been produced for workshop participant with a restricted circulation. Public domain summaries will also be prepared with the collaborators’ permission. These will appear first on the project website.

Discussions are currently in progress with the publisher Routledge with regard to a proposal to produce two complementary books based on the research. The first is to be an academic monograph based around the analytical framework outlined above, together with details of each empirical case study. The second is envisaged as a guide for practising managers who have to deal with the complexities of long term engineering projects.

Some of the understanding gained from such an in-depth analysis of the case studies has been used by the principal investigator to address issues in the disciplines of regional science and geography, where theorising and empirical investigation is often carried out with only a superficial level of detail of the activities that firms are actually engaged in. The project has contributed to a workshop and book chapter and a further two conference papers in this way.

Impacts

The research has generated a number of impacts beyond the academic community. Firstly, the design of the research and the activities involving the collaborators have had a direct impact on those organisations. Specifically, there has been an opportunity for the collaborators to learn from each other and from different sectoral contexts. The development of the workshop activity extended beyond this, however, to bring together organisations that are working together in supply chains and led to the creation of sets of action points that these businesses intend acting upon (see Appendix 2). These activities debated issues that were not just pertinent to the research, but were central to the business processes of these organisations. The University research team was an essential independent facilitator of this process.
The findings of the research have also generated interest from other bodies. The chartered Institute of Purchasing and Supply has shown particular interest in the research and was featured in the 15 February 2000 issue of Supply Management, which has a wide circulation amongst purchasing and supply chain management professionals (see Appendix 3).

The study of the WCML high speed trains has led to a commitment of support from the Strategic Rail Authority for further research into the meta-project problem occasioned by major rail infrastructure upgrade programmes.

Future research priorities

Inevitably, in only 18 months of a two phase research programme of which only the first phase has been funded so far, there are numerous areas for future research. One issue is that in 18 months we have only been able to follow these long term projects through part of their life cycle. There is a need to continue the observation of this project process into the operations phase.

Other significant research issues to emerge include the project integration problem, the management of meaning (how companies can convey and instil the requirements of the client’s business vision within their own organisation and within their project networks), the design process in relation to long term projects of this type and a more systematic study of the knowledge and learning that flows from this sort of complex project.

We are actively pursuing some of these issues, in particular in conjunction with industrial sponsors such as ALSTOM and the SRA.

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We should like to stress that all views and interpretations presented in this report are those of the University research team and do not necessarily represent the views of the collaborating companies or their employees.
References


Appendix 1: Outputs from the project


Forthcoming:


Appendix 2: Workshop participant comments

The following is a selection of anonymised comments received in the form of a post-workshop questionnaire distributed to the participants of the final project workshop. In general there were no major criticisms of the workshop and most of the participants indicated issues that they would be taking further subsequently.
Appendix 3: Supply Management article