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Project management: Dynamics and performance*

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Construction projects follow a life-cycle that is dynamic and goal oriented. They are managed by a project team, each phase of the project life-cycle is different in nature demanding different skills, roles and responsibilities from the team. This paper explores the dynamic and changing focus of the management of construction projects and the ingredients of performance drawing on case studies of major projects in Australia.

Keywords: Project management, project teams, project performance, Australian case studies

Introduction

This paper reports a study of three major Australian construction projects in three states. The objective of the research was to explore the nature of project management in complex dynamic environments. Each case study has a number of complexities in technology, economics, organization, and project environment. The paper discusses the nature of project management particularly in relation to the project life-cycle, project organization, and project environment.

The case studies are then examined to see how effectively the project management team coped with the vagaries of the project. Although project managers may be individuals with sole responsibility, in these case studies the term more correctly applies to a team effort.

Project life-cycle

Construction projects are characterized by the project life-cycle, the ephemeral organization of the project team, and the susceptibility to influence from the project environment. The project manager is not merely concerned with project construction but with the total process from inception and design right through to implementation or start up. Fig. 1 is intended to

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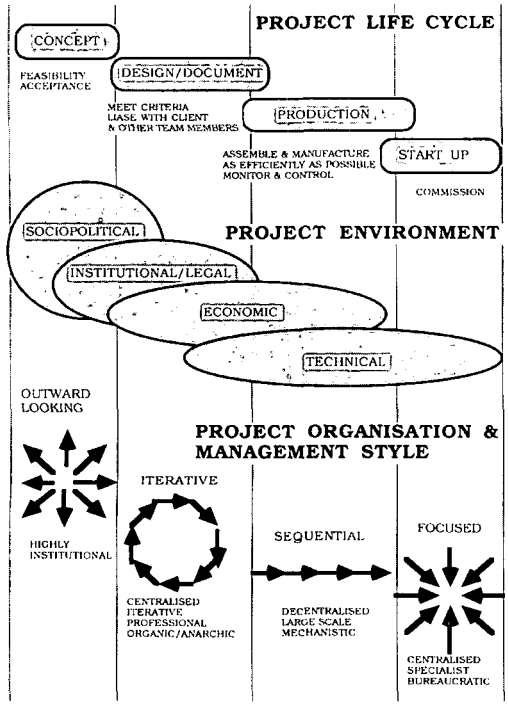

Fig. 1. The major environmental influences and changes in management organization and style throughout the project life-cycle

illustrate the four stages of the project life-cycle, the major environmental influences and the leadership or management style required of the project manager throughout these phases.

At concept stage the project team is concerned with feasibility and acceptance by the client and other interest groups. Critical environmental influences are often encountered during this phase in what is referred to as the sociopolitical arena, is the project acceptable to government or people pressure groups? At this stage the project manager needs to be outward looking, a project champion, publicist, persuader, harnessing the approval and commitment of investors, regulatory bodies, government, pressure groups and even the general public. This phase demands flexibility, awareness, entrepreneurial skill and political perspicacity. During the design phase he needs to stimulate the design professionals, liaise, co-ordinate, and deal with planning regulatory and other institutional bodies. This requires empathy with the design objectives plus patience to cope with the bureaucracies. At the production stage the project manager must cope with a large, diverse production oriented team working under extreme time and cost pressures. He will be involved in monitoring and controlling the project and may have to become the project driver. Finally during the commissioning stage the project manager must organize his team of consultants to assist the client in operating the new facility.

A fundamental aspect of major projects is the progression from concept to production and the concomitant increasing definition of the project details. As the design is developed, there is less and less room for manoeuvre in redefinition of the cost and time parameters. Throughout this cycle the project team must work within the constraints of the project

environment and must be suitably organized to cope with these stresses successfully. This is project management dynamics and performance.

The project environment

No project exists in a vacuum, it is subject to an array of influences from regulatory control to political and industrial intervention. Child (1972) and Mintzberg (1979) focus on the nature or properties of these influences, their magnitude and intensity. Child refers to three properties of environment variability, environment complexity and environment illiberality. Mintzberg uses the terms stability, complexity, market diversity and hostility.

An organization's environment can range from stable to dynamic, the higher the variability and uncertainty the more the organization needs to be organic and adaptive. Unstable government, unpredictable shifts in the economy, unexpected changes in consumer demand, a rapidly developing technology are all examples of a dynamic and uncertain environment. Governments and project managers must balance financial, employment, and technical gains against heritage, environment and social needs. The project manager can cope with known problems, but it is the rate of change and the degree of difference in change in the project environment which creates particular stress. Long range, major projects are even more susceptible to influences such as changes in the interest rate, inflation, and international currency exchange rates. The cost management system may be unable to cope with such variability in the economic environment.

Complexity refers to the diversification and complexity of the operating environment. In order to cope effectively the organization must have sophisticated knowledge of sociopolitical, institutional-legal, economic and technical influences. Such organizations must be highly skilled, intuitive and have excellent boundary communications at what Morris (1982) describes as the institutional level of management and Mintzberg (1979) refers to as the strategic apex.

Market diversity and hostility or illiberality is the competitive nature of the environment. It can range from benign to hostile. A hostile environment is characterized by high risk, severe competition, difficult laws and regulations, perhaps an unaccommodating community and certainly the danger of developing a vulnerable industrial and operational environment. Such an environment requires the organization to develop both aggressive and defensive behaviour. Because of the very nature of the construction industry these components are rarely benign in the project environment. The construction project is usually dynamic, complex, diverse and hostile. This may occur across all components of the environment and may do so simultaneously.

Owners are increasingly having to answer for their project in the political arena. Traditional mechanistic production management tools and techniques are of limited value in handling such problems. Different people with varying political or social mores may have divergent value systems and may come to capricious, but to their minds, rational decisions on the merits of uranium mining, heritage conservation, airports or highways. Project managers must learn to cope in this sociopolitical arena utilizing quite different skills such as political lobbying, negotiation, trade-offs and publicity.

Various studies of the time taken from initial brief to obtaining planning permission have found that the process may take from 12 weeks to 10 years (Sidwell, 1984). Depending on controversiality and public sector or government involvement, the project may be subject to

public hearings, environmental impact studies and supreme court appeals, all eating up valuable time and cost. Under these circumstances the project manager must become a project champion, alive to these crucial relational problems rather than the technical details.

Project organization

The success of construction projects hinges on the efficacy of the project team in managing the process. The nature of the task is somewhat different to the management of traditional vertical organizations since there is particular emphasis on the horizontal nature of the team. The effectiveness of the project organization depends on a range of diverse factors such as the technology of the project, its size, the project environment, role and relationship of team members, and the degree of management and control. The contingency theory of organization asserts that there is no single ideal structure but that the organization should be tailored to meet the needs of the project. The project manager's task therefore is to understand the pressures and variables in the project and create an appropriate project organization.

Organizational change is often inevitable and necessary and therefore a project's sub-system boundaries and interdependence are crucial. A major part of the project manager's job is integrating the work of others and guiding the project, particularily at the pinch points and interfaces between the various phases. Projects are goal oriented, dynamic and ephemeral. Conflict is high – groups are new to each other and may have conflicting objectives.

Mintzberg (1979) hypothesises that the more dynamic the environment the more organic the structure encouraging an organization to be more responsive and flexible. Khandwalla (1977) suggests the more turbulent and complex the environment the more important are uncertainty absorption and avoidance mechanisms such as market research, advertising, vertical integration, optimizing and planning. From Mitzberg's hypothesis, one would expect that the structure would be decentralized and organic with mutual adjustment as the prime co-ordinating mechanism. Khandwalla's hypotheses would suggest that management tries to emphasize uncertainty absorption mechanisms, seek sophisticated control systems, stress planning and optimization oriented style and try to standardize procedures and cut costs in case of extreme hostility in the environment.

It seems that successful construction firms generally adopt an organic and decentralized structure which makes them flexible and less bureaucratic. Lansley and Quince (1982) conclude that the construction firms which remained profitable during the turbulent environment of the 1970s were those that exhibited flexibility. In a later paper Lansley (1987) discusses the construction environment over the last thirty years and suggests appropriate management styles for each decade. Constraints to good performance appeared to arise from fragmentation of activities and a lack of suitable devices for handling, sensing and appraising the environment, together with the failure of senior managers to pursue objectives likely to facilitate flexibility.

Cleland and King (1975) characterize project management as:

1. a manager operating in a horizontal mode independent of, and cutting across, the traditional vertical hierarchy;
2. single point responsibility, authority, planning and control;

3. negotiation for resources with functional managers with a consequent web of relationships and possibility of conflict;
4. finite life of the project.

The construction project team is a living organism, at each phase in the project life-cycle it transforms in structure and style. Team members are drawn from other organizations with different priorities, capabilities and resources. Individual firms have to balance the goals of the project with their organizational goals and must cope with the vertical and project manager matrix structures and styles of management. Inevitably they will consider the impact of project failure on their own company and balance effort against gains. Mintzberg (1979) argues that project managers do not manage in the traditional sense – they liase, co-ordinate, and negotiate. Most importantly they must be sensitive to the changing needs of the project during its life-cycle as well as changes in the environment.

Matrix management structures have developed as one effective way to manage projects. Originating in hierarchal functional organizations the matrix concept requires careful balancing of interests and proper project management authority to be successful. It may best be described as a superimposition of the horizontal project structure (which is a problem solving entity), over a vertical functional structure (which is a technical/administrative hierarchy). The relationship between functional, matrix and project organizations can be represented as a continuum with functional and project organizations at opposite ends with matrix lying approximately midway between the two ends (Bennett, 1985).

The matrix structure is an attempt to create synergism through shared responsibility between both project and functional managers. This shared responsibility has been labelled the balance of power. Cleland and King (1982) describe the characteristics of matrix structures as:

1. *High flexibility and adaptability* – the matrix organization is dynamic and ready to adapt to the turbulent environment that it exists in. Furthermore functional groups and task forces are created under the matrix structure to solve problems which arise unexpectedly.
2. *Intensive boundary positions* – matrix structures allow the transaction of information between functional boundaries far more extensively than any other type of organization.
3. *Resource sharing, multiple team membership and interpersonal skill development* – the matrix organization provides a framework for personnel to participate in a variety of project groups. This framework allows a more efficient use of their expertise and allows personnel exposure to a variety of situations so they may have the chance to develop their personal skills in communication and group interaction.
4. *Proactive behaviour* – in a matrix structure the project manager has the option to seek the service he needs from either inside or outside sources. Therefore, the functional manager will strive to provide quality service and thus change his behaviour from reactive to proactive.

Thomas and Bluedorn (1986) describe the construction of a new nuclear power generation facility in Pennsylvania, the Susquehanna Steam Electric Station (SSES). This was the first such power station constructed by the Pennsylvanian Power and Light Co. and their initial organization structure was essentially functional with not enough authority and project organization, there were conflicting needs and priorities. The organization structure was modified to give greater project orientation swinging from a functional to matrix organization. Eventually the cost and time scale had increased so much that the project was

clearly top priority and the executive management of PP&L felt the matrix approach too cumbersome. Finally they moved to pure project authority structure establishing primacy in the company under the control of a special presidential assistant. In Australia the State Electricity Commission of Victoria experienced similar problems with their organization for the new power generation facilities in the La Trobe valley. Originally run on functional basis the Commission was forced to review their approach and adopt a project management structure.

Clearly matrix and project structures are more suitable for the management of construction projects than the functional type of organizational structure. Resource and information sharing can be optimised without the loss of focus on the overall project objectives but conflict can be prevalent in such an intricate organizational structure. Pretorius and Taylor (1986) suggest that the matrix structure with its dual reporting system provides an environment which is more conducive to conflict than others. It is this conflict which causes stress and job dissatisfaction and can impede proper progress if not handled correctly.

Conflict management for project managers is discussed in a monograph by Kirchof and Adams (1982). They discuss four conditions – high stress environment, ambiguous roles, multiple boss situation, and advanced technology which are inherent in project organizations. They outline strategies for managing conflict and creating positivism as opposed to negative attitudes and resultant conflict. Thamhain and Wilemon (1975) ranked sources of conflict for each phase of the project life-cycle. Project priorities and administrative procedures were significant in the early stages of the project and technical matters and schedules of significance in later stages of the project (see Fig. 2).

RANK	CONCEPTUAL	PLANN ING	IMPLEMENTATION	CLOSE OUT
1	project priorities	project priorities	schedules	schedules
2	administrative procedures	schedules	technical opinions	manpower
3	schedules	administrative procedures	manpower	personality

Fig. 2. Sources of conflict during phases of the project life-cycle (Thamhain and Wilemon, 1975)

Many construction projects of modest size are operated by small project teams. Relations between members of the team and with the workers are close and delegation of responsibility and decision making resides at lower levels. There are reduced communications and co-ordination problems, job satisfaction and motivation are generally higher. Work is less

departmentalized as workers often accomplish a variety of tasks at one time. These may include supervision, procurement, control and construction. Since the majority of construction projects fall into this catagory most organizations are similarily structured with little difference in organizational structure between projects other than an increased number of employees.

However, large complex projects with long durations force adaptation in organizational structure. The project organization becomes multi-levelled, departmentalized and more bureaucratic. Formal operating procedures and controls are developed and implemented and communications and co-ordination become more tortuous. There is a tendency for the organization to drift back to a bureaucratic functional type. Site management staff used to smaller projects are unaccustomed to these deep hierarchical structures where they have limited responsibility and decision making and seem remote from the central decision process. Their ability to solve problems and to communicate effectively within the larger organization decreases substantially. Unlike manufacturing industry there is little time to gradually develop an effective organizational response.

Instead of a small project team drawn from parent organizations a different form of long term and permanent organization is created with a life of its own. What we see in large project teams is a nesting of organizational approaches. The large structure develops bureaucracy in order to cope with the volume of business and yet it must retain its organic, responsive nature at the workface. Because projects have a distinct life-cycle there is also a horizontal time related dimension to their organizational form, they change over time from organic to mechanistic to bureaucratic. Fig. 3 illustrates the nature of the changes in organizational form which may occur. At concept stage the consultant team tends to have an anarchic structure. Design and documentation is a more mechanistic process leading to bureaucracy in monitoring the construction phase. On the other hand the contractor is likely to operate organically whereas subcontractors may be more mechanistic. With large bureaucratic project structures there is a danger that at the very time in the project cycle when flexibility is required the organization is too bureaucratic and turgid to respond adequately.

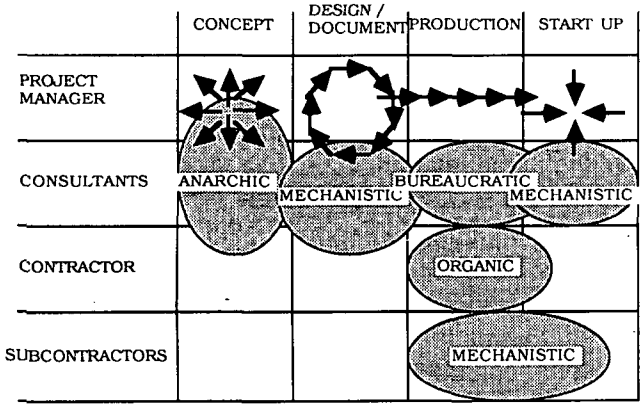

Fig. 3. Style changes during the project life-cycle

Case studies

ASER

The Adelaide Station and Environs Redevelopment project exhibits many of these organizational and environmental variables. Sited in the parkland greenbelt around the city's CBD it first had to gain extraordinary planning approval. This process was expedited by enacting special legislation thereby avoiding protracted public hearings and pressure group lobbying. The ASER act of parliament invested planning powers in the minister of environment and planning, taking away the power from the local government. The minister established a special building regulations advisory committee to co-ordinate all the various public utilities. Clearly the project manager was successful in handling these institutional-legal aspects of the environment thereby circumventing many of the potential difficulties which can arise in the sociopolitical arena by way of public hearings etc. The project was a joint venture between the State Superannuation Fund (SASFIT) and a Japanese firm Kumagai Gumi, each with 50% stake in the Development Company, the ASER Property Trust. In the initial stages the state government gave financial guarantees to SASFIT in case the project did not go ahead.

The project, one of the first examples of the use of air rights in Australia, is built on a podium slab over the top of the existing railway station. It is believed to be unique being a rail terminus which means there is not a flow through of air to assist with the exhaust of engine fumes. The State Transport Authority required a guarantee that the air quality within the new station would be unchanged. Subsequent testing during design phase revealed the need for an exhaust system twice as large as that originally envisaged.

Comprising a casino, convention centre, hotel, office tower, car parks and station redevelopment, the project has presented a challenging task to the project management team. A fast track project, the design commenced in 1983 with major work starting on site in 1985 and final completion in 1988. The original budget was in the region of A$160m but the total cost is likely to exceed A$200 million. During the period 1983–88 the project management team underwent five major revisions of the project organization with changes in personnel and structure demonstrating the flexibility and responsiveness of the project team. Figs 4–8 illustrate the changes in the organization of the project team.

Fig. 4. Initially the team was organized on a functional basis with the project divided into three areas or phases with a project manager for each. One of the first tasks for project management in Australia, before start on site, is to hammer out a site agreement with the unions covering all allowances, working hours, safety and welfare arrangements. The project manager devoted a lot of effort to achieve a site agreement which included a three-day cooling off period for disputes, however, this aspiration proved to be in vain and was never honoured by the unions. This is one illustration of the nature of industrial relations in the Australian construction industry, and is an example of Child's environment illiberality.

Fig. 5. The functional organization was changed following pressure from the client to place greater emphasis on documentation and construction. Delays were occurring in production of documentation and so a project manager was appointed in charge of documentation and a project manager in charge of construction. The previous principal project manager, Mr Keppoch, was seen to be a man with a sound construction management background but

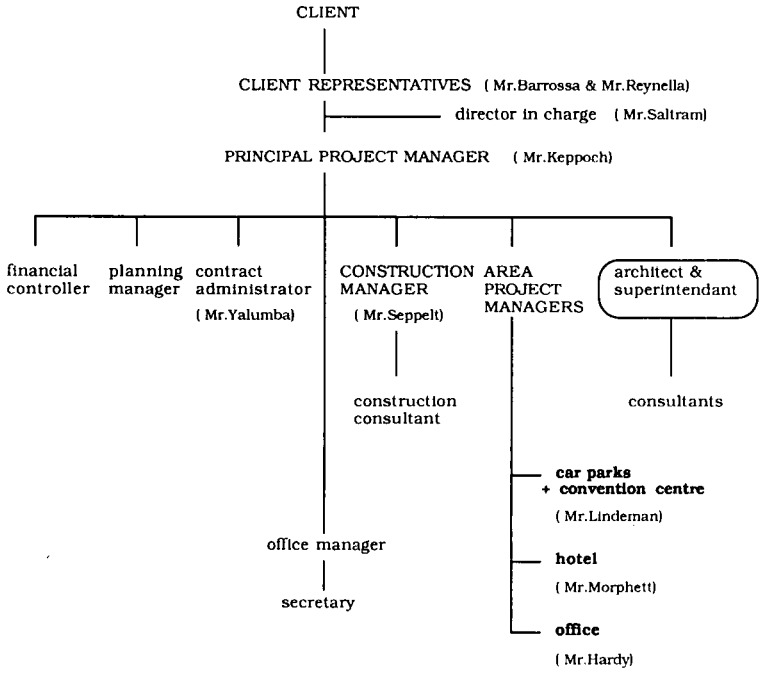

Fig. 4. ASER organization: early 1983 to late 1984

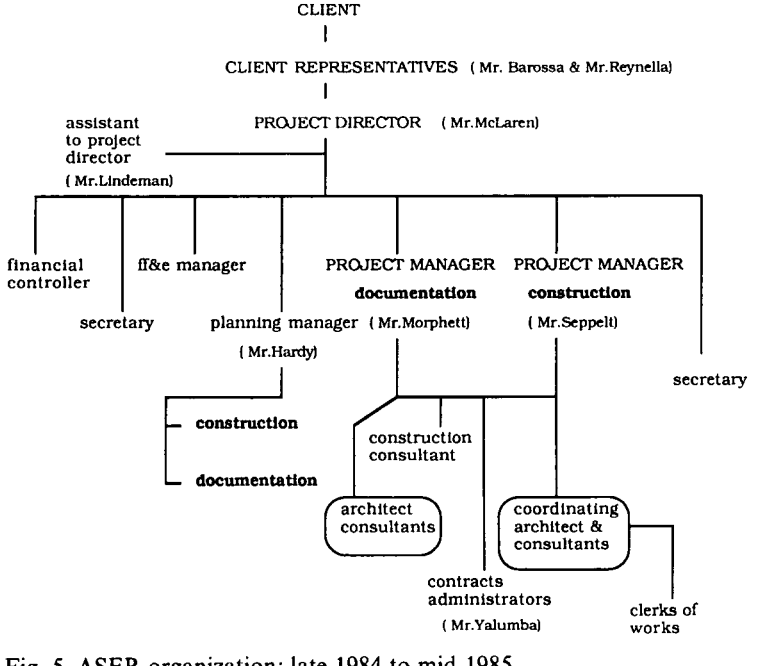

Fig. 5. ASER organization: late 1984 to mid-1985

lacking adequate design/documentation orientation necessary to drive and empathise with the design team. The new project director, Mr McLaren, was an architect with design background who was in sympathy with the client/design team interface.

Fig. 6. During the early stages of construction the organization was restructured to provide greater emphasis and support for the construction superintendents faced with complex construction problems. The project director Mr McLaren was replaced by the project manager Mr Morphett who had been in charge of documentation and had gained the client's confidence becoming project manager for the entire job. The project manager for construction Mr Seppelt moved closer to the action and also performed a co-ordinating role between the architects and the site contracts co-ordinator Mr Stonyfell. One of the clients representatives Mr Reynella moved down to the work face and took overall charge of the site work.

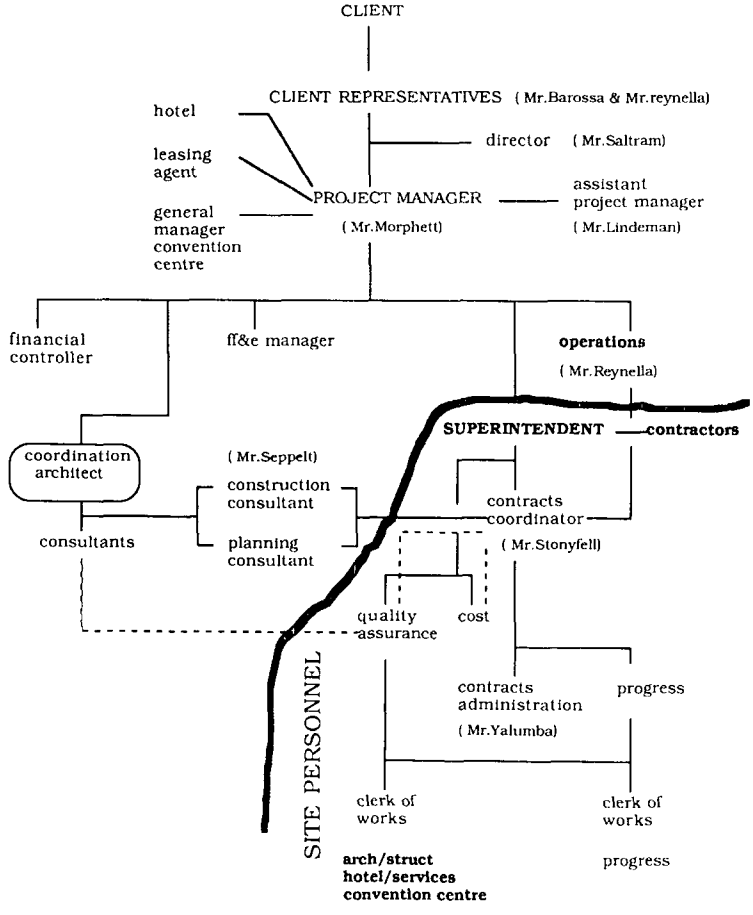

Fig. 6. ASER organization: mid-1985 to late 1986

The construction consultant assumed a stronger role in linking consultants and the site team. Major technical problems included co-ordinating the phased removal/replacement of rail tracks to allow construction while maintaining rail flow. This need for continued station operation dictated the construction sequence. For example the restricted site caused the convention centre to be built from the inside outwards. The fast track nature of the job had necessitated provisional documentation which created a number of problems. For example there were discrepancies between sizing and fixings for steelwork and precast concrete panels which caused delays and dispute.

Fig. 7. With the project well underway the organization reverted to a more bureaucratic and functional format. The client representatives were replaced by a new project diretor, Mr Henscke, with a development background at the instigation of the client to interface between the client and the project managers during the completion and commissioning phases.

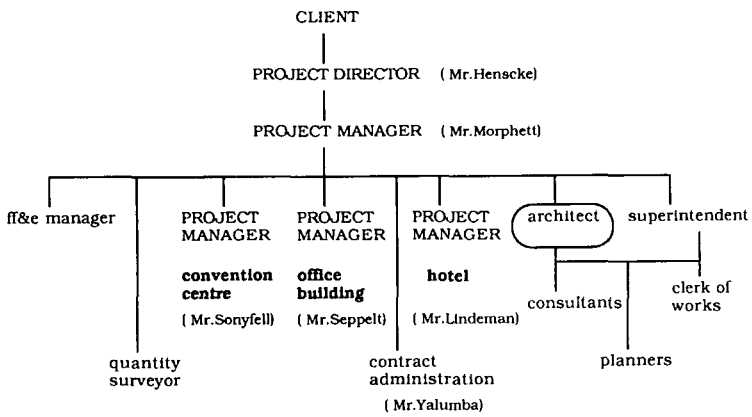

Fig. 7. ASER organization: late 1986 to 1987

Fig. 8. Difficulties arose in the final stages of the hotel and office building due in part to schedule slippages and industrial problems. Yet another change was made to the organization of the team with emphasis on co-ordination. One of the contract administrators, Mr Yalumba, who had been involved since the beginning taking a lead co-ordinating role.

The team chose to break the project up into modules or phases to afford greater control, flexibility, and freedom of action:

1. Site clearance, excavation piling, plaza structure, and new railtracks and platforms, (under an overall construction management contract)
2. Car parks
3. Convention centre
4. Casino
5. Hotel
6. Office tower

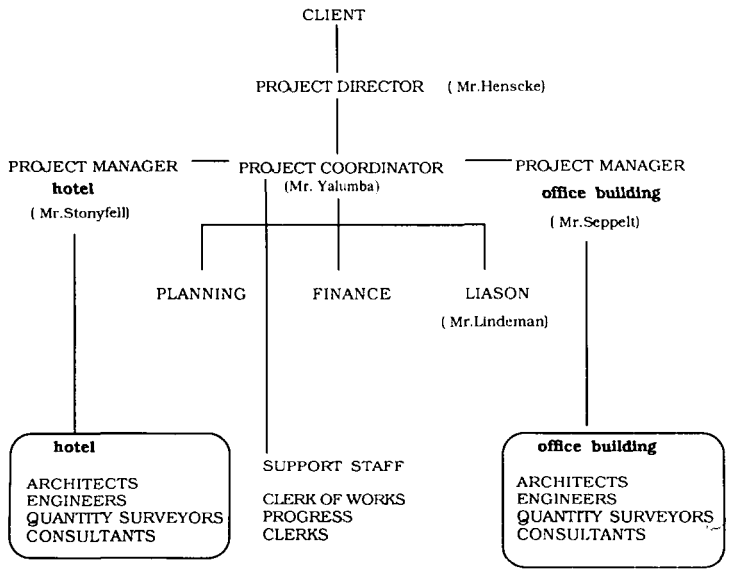

Fig. 8. ASER organization: late 1987 to 1988

The site plan and design solution facilitated treating the various buildings separately and contracts were let competitively and progressively for each module. Whilst reaping the benefits of flexibility and control nevertheless the greater interfacing problems created more work for the consultants and necessitated greater attention to communications and management. One of the last buildings, the office tower, was redesigned before going out to tender to optimize costs. Most were let under traditional competition but the initial site and station work were undertaken on a construction management basis. Dividing the project up into modules which were successively let out to tender kept the contractors keen. Naturally with such an approach the project manager has to pay particular attention to the project boundaries both physical and informational. All phases progressed reasonably successfully except for the hotel which was delayed by 12 months. An out-of-state contractor was the lowest bidder (by only a few thousand dollars) but unfortunately suffered disruptive industrial problems with local subcontractors. As a result of industrial action and demands workers were awarded an *ex gratia* payment rumoured to be A$6500 each to get the project back on track.

A vital ingredient in the hotel project was the tax credits available if the project was completed by end of June 1988. The industrial troubles and other illiberalities in the project environment required drastic action by the project manager. An entirely new commercial agreement was reached with the contractor absolutely responsible for achieving completion on time. The new agreement in essence transformed the competitive bid into a negotiated design and construct arrangement, with a new form of contract. The new contract was fixed time, fixed price, with liquidated damages. The architect and consultants came under the control of the builder, the project manager acted as mediator and expeditor, and the project director was the sole arbitrator.

Too often members of the team retreat to defensive adversarial positions. However, this case illustrates the flexibility and lateral thinking of the client and project manager which

transformed an adversarial no-win situation into a win-win situation, (accepting the penalty of higher costs).

The last component of the ASER project, the office block, had great difficulty in stemming the flow on of industrial trouble. They were reasonably successful, due mainly to the fortitude and reputation of the local contractor and his site management team.

Rialto

The Rialto project in Melbourne is an outstanding success in cost and time performance. It is a complex project comprising two office towers of 86 000 sq m accommodation, 650 capacity car park, restoration of heritage buildings to provide a 243 room five star hotel, a 260 seat theatrette and ancillary shops. One of the towers is claimed to be the second highest reinforced concrete office building in the world at 242 metres with 56 levels. The fast tracked A$220 million project was completed in a total of five years from first contact between the joint venture partners. Delays were experienced initially in satisfying the planning authorities on the size and scale of the development and heritage conservation in the hotel. The reinforced concrete structure is technically complex, built on 76 caissons because of poor ground. Wind loading, creep and shrinkage on a reinfored concrete building of this size require major design engineering. Most such tall buildings in the world are steel framed but in this case reinforced concrete was chosen to capitalize on the large direct labour force of concrete, formwork and steelfix tradesmen employed by the builder (one of the joint venture partners) as well as his ownership of one of the major pre-mix concrete plants in Melbourne.

The project organization structure is shown in Fig. 9. The client/developer was a joint

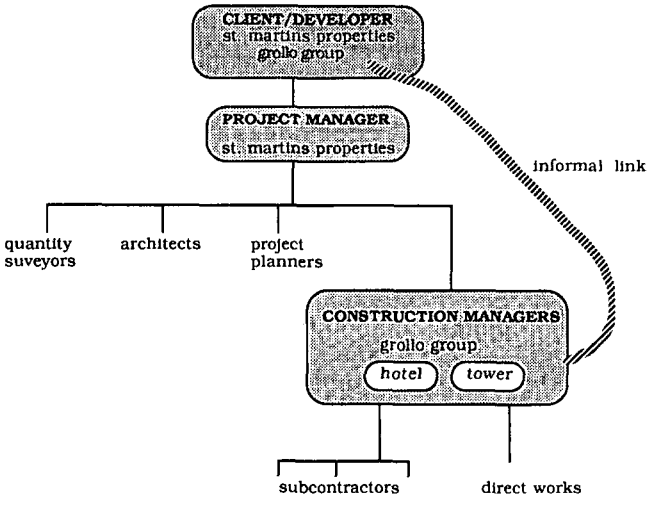

Fig. 9. Rialto organization chart

venture between St Martins Properties and the Grollo Group. St Martins Properties undertook the role of project managers and Grollo was the construction manager and builder. Management theory and study of construction management would suggest that such an organization structure would allow the development of an informal direct link

between the client and the construction manager. This would inevitably bypass the project manager and would create conflict and jeopardize the success of such a large and complex project. Although this direct link did indeed cause difficulties the project was nevertheless completed successfully. Two factors probably had a strong influence on performance, one was the drive and dedication of the construction manager on site and the other was Grollo's excellent relations with their labour force. It is perhaps also relevant that the project was undertaken during a period when there was very little other construction work in progress.

Most construction work today is virtually all subcontracted which means that the general contractor's major role is one of co-ordination and control of the trade contractors. This is particularily true of the Australian industry. On large complex projects with a multifaceted team this presents a heavy construction management burden. By contrast Grollo have their own direct labour force in the important trades of reinforcement steel, formwork and concretework. On an *in situ* concrete building such as the Rialto this brought considerable advantages in simplified co-ordination and control. The good employee relations and industrial harmony is a significant bonus in Australia where something like 13% of contract time is lost due to industrial action. Such action very often stems from the unions involved in these key leading trades. Therefore in this case environment illiberality and team interfacing problems were reduced allowing the construction manager more time to concentrate on the technical and financial problems.

Although the Rialto is similar in cost magnitude to the ASER project it is less complex organizationally and contractually. There was only one head contractor and he had a financial incentive to perform since he was a joint partner in the development.

New Parliament House

New Parliament House is the largest single building project ever undertaken in Australia. The site area is 33 hectares, the usable floor area 80 000 sq m and the expected final cost will exceed A$1 billion. It replaces the temporary Parliament House and fulfills the 1912 Burley Griffin master plan for the city.

In the Australian Capital Territory (ACT) public projects are normally overseen by the National Capital Development Commission (NCDC) but the Government made the decision to set up a separate Parliament House Construction Authority (PHCA) to manage the project. The overall project organization is shown in Fig. 10. The PHCA was answerable through the Minister for Territories to the Government and the Parliament. It reported quarterly on cost, programme, and industrial matters. Essentially the Government held the purse strings with executive power whereas the Parliament was the user group represented by the Joint Standing Comittee. The terms of the Act of Parliament which established the PHCA gave the Minister the power to direct the Authority whereas the Authority shall (only) have regard to any advice furnished to it by the Joint Standing Committee, (the PHCA Act 1979).

Heading the team as project managers the PHCA was established by the Government in 1979 to be responsible for all aspects of the design, construction and handover of the completed building to the client. When deciding on the procurement method in 1979 the PHCA personnel had limited experience of construction management but the complexity of the work and relatively tight time scale encouraged the adoption of the system. The selected construction manager was a joint venture of two of Australia's largest contractors, Concrete Constructions and the John Holland Group. The construction manager, project planner and

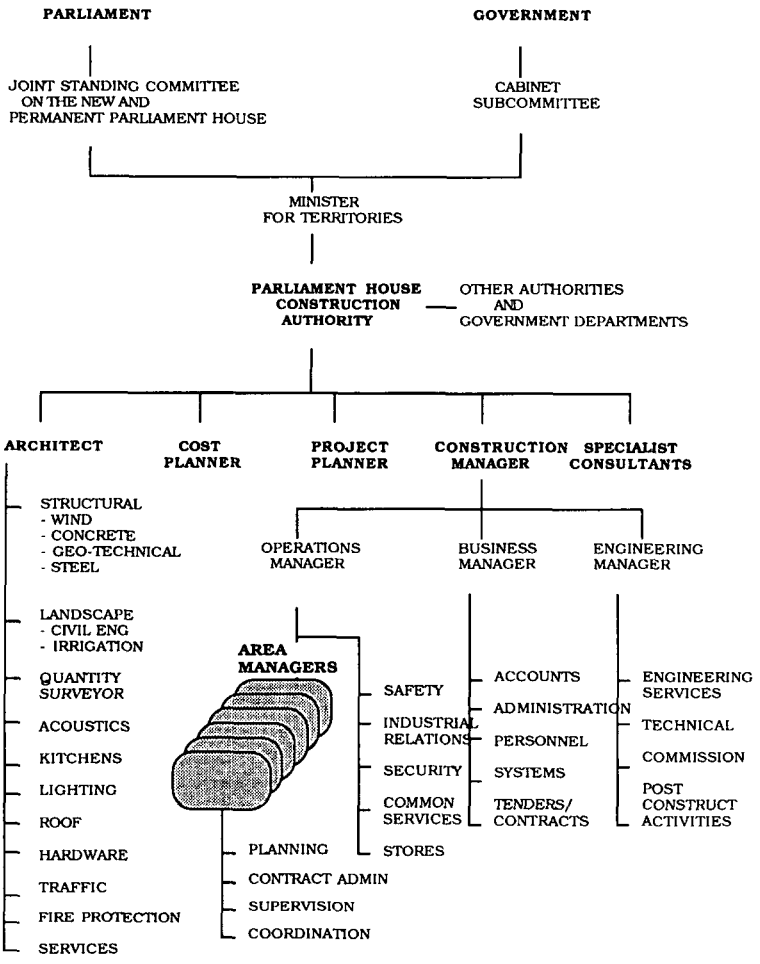

Fig. 10. New Parliament House, Canberra

cost planner were given interim appointments prior to the selection of the architect and were to provide advice to the assessors of the design competition. The PHCA insisted that the cost planner was directly responsible to it and saw the quantity surveyor as a sub-consultant to the architect responsible for documentation (Roberts, 1986). The New York firm of architects Michell Giorgola and Thorpe were appointed following a world wide competition and the rest of the management structure, workers and suppliers came from all parts of the world.

The construction manager interacted with the consultant team overviewing design constructability, planning and tender packaging. The construction manager was the superintendent for the principal, the PHCA. The construction manager did not directly perform any significant construction work on site other than the provision of common services such as craneage and other preliminaries.

This large complex project did not lend itself to subdivision into relatively discrete modules as did the ASER project. Consequently management of the works was split into

sections on a geographical basis, four zones of building works (north, south, east and west) with a fifth zone of works external to the main buildings (peripheral) and a sixth functional zone of building services running through a number of zones (global services). Each zone management team included the functions of supervision, co-ordination and administration. (Nixon, 1987).

Good communications were essential. The organization was structured in communication levels with an effective system of meetings and liaison including public and industrial relations. In the early days of the project the PHCA promulgated a set of written procedure guidelines. Something like 540 separate contracts were let, 20 000 drawings prepared and 750 000 prints issued. A comprehensive computer system was installed and updated covering all matters such as contracts, variations, payments, contra charges, extensions of time, statutory requirements, programming, maintenance, defects, safety and quality control. A separate, independent quality assurance group was established with some 30 site/offsite inspectors to monitor and force quality achievement. The QA team reported directly to a QA committee comprising representatives of the PHCA, architect, and construction manager. Time scheduling was the responsibility of the project planner, an independent consultant, based on monitoring and reporting against a four-level hierarchy of programs covering all design, construction, commissioning and fit out. Costs were monitored by an independent quantity surveyor and reported monthly to the PHCA. These costs were compared against the total project budget and reported quarterly to the Minister.

The project was subject to inflation, fall in the overseas buying power of the Australian dollar, scope changes and has been the target of some industrial disputation. The original budget was A$220 million at May 1978 prices with no allowance for contingencies or inflation. Allowing for inflation and the drop in the dollar the cost increase in real terms is assessed at 24% of which half is attributed to scope changes and half to industrial disputes. This figure is typical of major projects in Australia.

About two years before completion a subtle shift occurred in the balance of power in the management of the project as it changed from a design led to a construction led orientation. The team was forced to accept that change was necessary if the project was to be completed by the target date. Changes in detail design were no longer accepted unless the construction manager thought such changes could be accommodated without detriment to the time or cost criteria – and there were few of these. This meant the construction manager could be more positive in his approach to achieving successful completion of the works. There is a feeling that the project had been fast tracked to such an extent that scope changes and other problems contributed significantly to the cost increase. Another view is that the original budget was inadequate but politicaly expedient. However, it is debatable whether a major, unique project of this nature could have been built to the original budget over a ten year time span. If construction start had been delayed until completion of design, the project would have moved forward into a more expensive time frame and probably not have been completed on target.

Specific criticism of the project and the PHCA is contained in an efficiency audit by the Auditor General (Parliamentary papers, 1987a). The Audit concluded that the PHCA had not carried out its operations in an efficient or economic manner. The PHCA did not appear to be pursuing adequately its corporate objectives to function as an efficient management organization to achieve all reasonable economies in the project. At the start of the project the PHCA itself was new and this caused difficulties but even after it had become established the PHCA was slow to institute management information systems, slow to take notice of

construction problems when they arose and slow to formulate solutions to them. In relation to the management of costs the Audit concluded that the cost planner did not have the authority nor the structure to impose any control on any of the departments from which actual costs emanate or are logged. The Audit found that the cost planner had continued to bring to the attention of the PHCA instances that called for action but the PHCA had shown little disposition to act. The PHCA should have taken an active rather than a passive role.

The PHCA published their response (Parliamentary papers, 1987b), in which they refute all of the criticism of the Auditor General. They maintain the Auditor took scant notice of the information provided to the enquiry believing the exercise a waste of both time and resources. In their view the Auditor arrived at misleading conclusions presenting an often biased perspective and suggest a review of the Auditor's own office procedures. The PHCA remains convinced that construction management was the only practical option given the circumstances. They have published a budget which identifies the impact of dollar fluctuations and other factors and expresses the proportion of cost attributable to the original building brief. Remarkably, this is the same as the May 1978 cost plan of $220 million (see Table 1).

Table 1. New Parliament House Budget

Component	Cost ($m June 1987 prices)	Percentage of total
Inflation	463	45
Industrial disputes and insolvencies	66	6
Building works (May 1978 prices)	220	21
Non-building items	82	8
Additions	109	11
Contingency	87	8

Source: Parliamentary papers, 1987b.

As an interesting perspective of the need for good public relations the PHCA established a visitor centre to allow the tax paying public to learn about the new House. The centre includes a theatrette, models, displays and guides. The cost of the New Parliament House has been estimated at 17 cents per week during the 8 year construction phase for every man, woman and child in Australia.

Conclusions

The three case studies present interesting examples of the range of variables encountered on construction projects. Each had different client characteristics. ASER was a development joint venture between a Japanese construction consortium and a state superannuation fund working through a project manager. The Rialto was a joint development between an overseas property group and a local contractor with a direct stake in the building. New Parliament House had a public, government agency as client and construction management consortium. The projects, though different in construction were all large and technologically

complex. They all adopted a project management and construction management approach but differing nature of the clients, the buildings and project environment induced quite different organizational responses.

ASER was characterized by flexibility in the project team and differentiation in the project components. Exemplifying Mintzberg's (1979) concept of mutual adjustment the project team was responsive to the changing needs of the project and sensitive to conflict within the team. The organization evolved from an initially traditional functional form to a process orientation emphasizing documentation and construction. Later during peak activity on site the organization concentrated on site operational aspects with elements of matrix management to ensure co-ordination. In the final stages, and during a period of industrial illiberallity, the team again became more traditional in nature. As the project wound up the reduced team became more centralized with a single co-ordinator. ASER illustrates some of the elements of conflict management suggested by Thamhain and Wilemon (1975) as they occur during the project life-cycle, but with a greater incidence throughout of adjustment to overcome personality conflict and the complexity of the project in both technical and environmental terms. The early decision to divide the project up into separate contracts was fundamental in enabling boundary control. This was highlighted by the effective containment of industrial difficulties to one part of the site.

New Parliament House was overburdened by the size and complexity of the project and was necessarily bureaucratic. There is some evidence of flexibility and dynamics in the organization of the project team but in contrast to the ASER team it followed Khandwalla's (1977) approach of seeking sophisticated planning and control systems as a means of combating the complexities of the project. The project did not lend itself to division into discrete contracts, being one very large integrated building, and this was bound to prove challenging for project management. The diametrically opposed views of the Auditor General and the PHCA demonstrates the political nature of the project. When coupled with sensitivity to the economy and the risk of being used as a national focus for industrial disputes this case study encapsulates most of the environmental complexities discussed by Child (1972), Mintzberg (1979) and others.

The Rialto, though costly and technologically complex benefited from a tight informal organization. Compared to the other projects the environment was less turbulent. The industrial climate was eased by the good relations between the main contractor and his directly employed labour force, such a large number of direct employees is unusual today. The general level of building activity was low at the time, thus taking some of the heat out of the local construction economy. Potential boundary conflict within the project team was offset by the strength of the relationship between the builder/developer client and his construction manager on site. Given a more difficult environment and adversarial contractual relationships it is doubtful that the project would have achieved the same success.

Judgement of success for such projects is difficult. In some respects it cannot be said that any of them achieved original time and cost objectives, but then neither did the Sydney Opera House which is now considered to be an outstanding success. Perhaps such measures are too simplistic for major projects. ASER exceeded the original budget by a factor of 2 or more (the detailed figures are not released), and some elements were up to twelve months late. The Rialto was built quickly to time and budget but is considered to be around 25% more expensive than other office space in the city. New Parliament House cost five times the original budget and although it was opened on time some elements were omitted and some

delayed in order to make savings. A more important consideration for such projects might be that they were completed at all within reasonable time and cost parameters. On world basis many major projects fail dismally, or are abandoned. Perhaps for major projects we should accept that time and cost parameters are a moving target and the crucial role of the project team is to exhibit flexibility, responsiveness and determination towards a successful outcome.

In searching for variables which lead to project success a number of researchers have analysed the performance and characteristics of various organization forms or procurement methods and modelled the building process. These variables usually embrace the client characteristics, the project, the organization of the team and the project environment. Such analysis and the concepts of contingency theory suggest that there is no single right structure, and have lead to the design of models for matching procurement method to client needs, (see Sidwell, 1982, Nahapiet and Nahapiet, 1985). Study of the dynamics of project management, the changing form of the project team through different stages in the project life-cycle suggests that a successful project outcome is dependent not only upon the procurement method and the environment but also the project organization's ability to metamorphose.

These case studies of projects in Australia demonstrate that project and construction management organizational forms have the ability to evolve and embrace the multifaceted management structures, organization and style necessary to cope with the dynamics of major projects.

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