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Planning and control processes and techniques for refurbishment management

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Using a case study approach involving four refurbishment projects from both the construction and shipping industries (hospital, warship, hotel and passenger ship), 36 semi-structured interviews with key functionaries from both sectors and 49 completed postal questionnaires, this paper attempts to shed light on the function of planning and control by examining the various systems, methods and techniques associated with refurbishment management in both industries. The conclusion is that there is a substantially longer planning lead time in the ship refurbishment sector than in construction. The state of completion of design before refurbishment work commences is higher in the shipping industry. Site managers from the ship refurbishment sector are brought into the planning and control processes earlier than their counterparts from the construction industry. In both industries, however, schedules and bar charts are the most frequently used formal planning techniques, in comparison with computer based techniques such as PERT, GERT and expert systems; the main reasons being familiarity, the relatively low levels of skill and knowledge needed to understand them as much as their perceived flexibility and relative cheapness for their production and updating. Planning and control involving the management of risks and uncertainty by improving the quality and timing of relevant information for the works, and the timely integration of key functionaries in the refurbishment process, help to improve planning accuracy and effectiveness.

Keywords: Control, planning, refurbishment

Introduction

The growth in refurbishment work and its increasing importance, acknowledged for example by the 1995 Technology Foresight (OST, 1995) exercise regarding the UK economy, is not matched by the meagre amount of empirical research on the subject.

Construction refurbishment is one of the least understood and most under-researched sectors, especially in the management of such works (Quah, 1988; Egbu, 1994). The work is less well planned and more difficult to control than new build (Egbu, 1995, 1996) and, consequently, effective planning and control methods need to be developed.

Although there have been several empirical studies on planning and control in the general construction management field, these are geared mainly towards new construction works, covering such areas as factors affecting planning efforts, outcomes and effectiveness (Laufer and Cohenca, 1990; Faniran *et al.*, 1994); involvement of various parties in the preparation of construction plans (Laufer *et al.*, 1993, 1994; Cohenca-Zall *et al.*, 1994); and improving tools and methods (Birrel, 1980). In refurbishment, however, only a meagre amount of studies has focused on the planning and control processes (Fiedler, 1987; Weaver, 1993), yet refurbishment now is generally accepted to be of higher risk than new build (Quah, 1988; Teo,

1990; Weaver, 1993), more complex (Egbu, 1994; Boyd and Weaver, 1994), and needs greater coordination (CIRIA, 1994; Egbu, 1994) than new build. There would also appear not to be any industrial comparative studies on planning and control processes geared towards refurbishment.

The construction industry is not unique in this respect. The shipping industry compartmentalizes into shipbuilding and ship refurbishment, and the same conclusions can be drawn with ship refurbishment, which requires a different set of management skills and approach to working to those of shipbuilding (Petersen and Thorell, 1979).

While there are obvious distinctions between refurbishing ships and refurbishing buildings (for example, ships sail to dock and building contractors go to site), there are also many similarities between the two industries. Table 1 presents some of the main similarities and differences between both industries at a more general level.

This paper, however, attempts to shed light on the similarities and differences between ship refurbishment and building refurbishment by focusing on the planning and control functions especially methods and techniques used in the refurbishment management process. The intention is that by extending the boundaries of knowledge and understanding of the refurbishment processes, both the shipping and construction industries may benefit from the possibility of cross-transferability of systems, methods and control techniques.

Rationale for the study and methodology

Extensive enquiry took place prior to preparing a research methodology. Clients and contractors associated with the relevant projects were approached and data were collected which indicated that there was much to be learned from the shipping sector regarding management practice. For example, it was evident that a contracting organization considered a leader in the refurbishment of prestigious buildings had a history of once being a ship repair specialist and was considering entering the ship refurbishment market once again. This was not uncommon, and such incidents indicated to the research team that the underlying rationale for conducting a comparative study had great potential.

The 18 month study commenced in October 1994 with the purpose of determining best practice in each industrial sector and cross-transferring, where appropriate, methods and techniques associated with the management of refurbishment. The study was concerned mainly with the management of the refurbishment processes at the operational and production levels. The design aspects were not the remit of the study. Similarly, the focus was on contractors as opposed to clients.

Using a case study approach, four refurbishment projects were selected (two from the construction industry and two from shipping). The hospital and hotel were compared with the warship and passenger ship. Hospital refurbishment projects are arguably the most difficult and complex to manage in construction (Egbu, 1994). Similarly, warships are the most complex in ship refurbishment. Likewise, refurbishing a luxury hotel can be equated with refurbishing a luxury ocean liner.

During the investigation, a combination of research methods was adopted, including collecting archive documentation from each of the four projects, interviews with key participants attached to the projects, and postal questionnaires distributed to personnel associated with the four case studies. In all, 36 semi-structured interviews were conducted with key participants (including contracts managers, project managers, site managers, ship controllers, planners, quantity surveyors/cost controllers, variation order controllers, and estimators) from both industrial sectors. The interviews were augmented by 49 completed and usable questionnaires which represented a response rate of 86%. Table 2 shows the breakdown of the interviews and completed postal questionnaires. A workshop finalized the research programme with attendance from more than 20 interested parties from the shipping and construction industries willing to discuss the research results and provide feedback prior to preparing the report (Young *et al.*, 1996) of the study.

Project characteristics: the four case studies

Before discussion of the results can take place, it is useful to define the term refurbishment and to place in context the four case studies chosen for the study, the criteria and project characteristics.

First, refurbishment refers to such works as improvement, adaptation, upgrading, rehabilitation, restoration, modernization, conversion, retrofit, and repair which are carried out on existing buildings or ships for a variety of reasons. This definition, however, excludes such works as cleaning, decorating and emergency maintenance work.

At the project level, the four case studies had to comply with the following four criteria: (i) each refurbishment project was to have been completed within the previous five years (i.e. before the 1994 start date); (ii) most of the key personnel involved with the refurbishment projects were to be contactable readily for gaining access to information; (iii) the projects were to have been occupied by tenants or occupants during

Table 1 Similarities and differences between shipping and construction refurbishment sectors (at a more generic level)

Similarities	Differences
1. The main resources for managing refurbishment projects in both sectors are labour, materials, plant/equipment, finance and information.	1. Ships sail to dockyards and building contractors go to site.
2. There are identifiable stages in the refurbishment of buildings (pre-construction, construction and post-construction) and ships (pre-docking, docking and post-docking).	2. The structures and material components in ships are more standardized than in buildings.
3. There is a relatively higher level of risk and uncertainty in carrying out ship refurbishment and building refurbishment than in shipbuilding and new build work.	3. The life expectancy of ships (average of 30 years) is shorter than that of buildings (average of 60 years).
4. There is a relatively high level of variation in both ship and construction refurbishment projects in comparison with similar size shipbuilding and new construction projects. They are also relatively more complex than shipbuilding and new construction projects.	4. Ships are more frequently refurbished than buildings. This is due mainly to higher utilization and harsher environment. In accordance with the International Maritime Organization (IMO) regulations, a survey of a ship is required at least once every five years. More structural surveys also are carried out before commencement of refurbishment work (compulsory in warships) than in construction.
5. The management of refurbishment works in both sectors involves different key personnel, with different degrees of involvement throughout the phases of refurbishment work. The education and trades backgrounds of these personnel vary.	5. The frequency of refurbishment of ships is more co-ordinated, regulated and monitored by regulatory bodies. This, to some extent, allows clients to plan ahead for future refurbishment works.
6. In both sectors, time, quality, cost aesthetics and safety are the main project objectives of the clients. The degree of importance of one project objective over another varies from project to project.	6. Higher capitalization and higher investment in equipment in shipping.
7. In both sectors, refurbishment works are planned and controlled.	7. The construction refurbishment sector is more competitive than ship refurbishment. There are proportionately more building contractors bidding for fewer jobs than in ship refurbishment. There are only about a dozen shipyards in the UK able to carry out large commercial refurbishment works. Similarly, there are only four shipyards in the UK that carry out warship refurbishment for the MoD. There is, however, a large number of building contractors, locally and nationally, able to carry out large refurbishment works.
8. In both sectors, the decision making process is complex, involving the identification of problem(s), information gathering, development of alternatives, and choice making.	8. There is a variety of standard forms of contract for the procurement of construction works (e.g. JCT traditional forms, Design & Build, Management Contracting, Construction Management, Project Management). Apart from the MoD, which has a standard form of contract for warship refurbishment, bespoke arrangements between clients and contractors are more common in ship refurbishment.
	9. Unlike in construction, clients' consultants in the ship refurbishment sector are mainly in-house. Similarly, in ship refurbishment, the project team is based on site (dockyard). In construction, the team is mainly split between site and off-site offices.

Table 2 Breakdown of date collected

	Semi-structured interviews	Postal questionnaires
Ship refurbishment contractors	20 (55.6%)	25 (53.1%)
Ship refurbishment clients/client's representative	10 (27.8%)	12 (24.5%)
Construction refurbishment clients/client's representative	4 (11.1%)	8 (16.3%)
Construction refurbishment contractors	2 (5.6%)	3 (6.1%)

refurbishment (this would heighten the complexity of the works and could bring out best management practice under such conditions); and (iv) the necessary documentation in archives, relevant to the project, were to be obtainable.

Hospital refurbishment

The hospital refurbishment for a Hospital Trust involved the fitting out of a six-bed cardiology intensive care unit, and a four-room catheter/pacemaker

theatre suite. The works also involved the gutting of ward accommodation to allow the re-fitting of a twelve-bed adult/six-bed paediatric intensive care unit. Partial gutting and minor alteration works were also carried out to allow for a physiological measurement/ pacemaker test outpatient department.

The refurbishment work also included the provision of a four-theatre cardiac-thoracic operating suite. This involved the early refurbishment of the recovery department, gutting of the existing four-theatre suite and refitting in conjunction with the extension, together with minor alterations to the theatre entrance area, while retaining the department in use. Alterations with the X-ray department were carried out while retaining the department in use, to make provisions for two chest X-ray rooms and office and record facilities. Also, the remodelling of ward areas was necessary to accommodate three No. 20 bed adult cardiology wards, and the provision of one No. 8 bed paediatric cardiology ward. The project was made up of nearly 40 different phases, with different hand-over dates (contract period: 96 weeks; contract sum £5 600 00).

Hotel refurbishment

This involved the internal refurbishment of eight floors of a 25 year old nine-storey, five star hotel in London. In all, 327 rooms were refurbished. Refurbishment works involved the upgrading of all existing bedrooms and bathrooms, and the re-modelling of the executive and king size suites. Existing items, baths, basins, W.C., doors, etc. were restored and included within the new works.

Conference facilities were upgraded and incorporated within one of the floors. Also, the re-building works to the main entrance foyer were being undertaken simultaneously to compliment the internal works. The whole project was undertaken with the hotel still open to guests and fully functional (contract period: 50 weeks; contract sum: £5 052 000).

Warship refurbishment

This was the refurbishment (docking and emergency defects – DED) of a Class 22 stretched frigate. Refurbishment works were carried out on the rudders, hubs, and shaft/CPP systems. Work was carried out on protective bulkhead to the sonar compartment, the underneath hull, valves and sea tubes. The refurbishment work also included repair to ship side damage, weather work structures, tanks, doors and hangars; and to the hangar deck, Lynx deck, and landing deck. The warship had people on board while refurbishment works were carried out. There were 100% system support, and 100% Royal Navy (RN) personnel support during the refurbishment of the warship (contract period: 50 weeks; contract sum: £6 000 000).

Passenger ship refurbishment

This was the refurbishment of a cruise liner which can accommodate up to 800 passengers. Refurbishment works involved works as a result of side shell damage (structural damage to the side of ships), steel works to swimming pool, and repair to leaking pipes, and works on the tail shafts, propellers and stabilizers. Refurbishment works were carried out also on main and auxiliary machinery, tanks, lower and upper accommodation, superstructure and hull and weather decks. Refurbishment work was carried out with the crew on board (contract period: 20 weeks; contract sum: £2 848 285).

Planning and control processes in shipping and construction refurbishment

Planning is the determination of what has to be done and how it has to be done before action is taken. Control refers to the action taken so that the planning for refurbishment can be implemented effectively and targets can be achieved. It includes the monitoring of actual performance and corrective action should this be necessary.

Although the planning and control of construction projects (Laufer and Tucker, 1987; Cohenca *et al.*, 1989; Laufer *et al.*, 1994) and shipbuilding (Sample *et al.*, 1990) have been documented elsewhere, these studies were directed mainly at new construction and shipbuilding and, at best, on general planning and control of construction and shipbuilding works. In refurbishment, only a meagre amount of studies has described the planning process itself or captured insights of the key functionaries' roles. Yet, refurbishment works generally are accepted to be more difficult to manage than new construction works (Koehn and Tower, 1982; Quah, 1988; Egbu, 1994, 1995). Similarly, refurbishment works are considered to be less predictable than new construction works, with a higher element of risk and uncertainty (Teo, 1990). The essence of refurbishment planning processes and the tasks of the functionaries remain to be learned and refined, and implementation improved if efficiencies are to be made.

The key functionaries (i.e. contracts managers/ project managers, ship controllers, site managers, planners, quantity surveyors, cost controllers, variation

order controllers, estimators, site supervisors/foremen) in the refurbishment works were asked to indicate their degree of involvement in planning and control (from 'not involved' at one end of the scale to 'highly involved' at the other end, with intermediate scaling) at the pre-bid, post-bid, construction and post-construction stages, and in the management sub-systems of labour, materials, finance, plant/equipment, and quality.

The ultimate goal of project planning should be the effective implementation of project operations. Project planning therefore is the bridge between ideas and execution. Project objectives should be determined, communicated clearly, and managed and monitored continually. The process of planning also should be adjusted to fit project characteristics.

The timing of planning is very important for refurbishment operations. A long lead time, in terms of pre-bid/pre-tender and post-bid (pre-construction) periods, is vital for refurbishment. Ample time, finance, and effort are needed in organizing and collating contract documentation (including drawings and specifications) before tender interviews. Similarly, ample time is needed for post-bid (pre-construction) planning, especially during the mobilization phase of the project. This should allow the vital resources of labour, materials, plant/equipment, and finance to be mobilized effectively. There is substantially more lead time for planning in the ship refurbishment sector than in construction. This allows more time for project information to be collated. A long lead time should allow for better estimation of the costs of a project, and better mobilization of project resources. The risk strategy for a project also could be articulated better with a long lead time. In this study, for ship refurbishment, the percentage of pre-bid period to total contract period is in the range of 12–50%, compared with 3.5–6.25% for construction. Similarly, the percentage of total pre-construction period to total contract period for ship refurbishment is in the range of 36–90%, compared with 8.0–9.9% for construction.

The site managers (ship controllers), and to a lesser extent the supervisors/foremen/first line managers, from the ship refurbishment sector, appear to be brought into the planning and control processes (pre-bid and post-bid stages) earlier than their counterparts from the construction industry. This allows better liaison between planners and site management during the pre-construction stage of refurbishment.

However, it also was evident from this study that, for both sectors, there is the tendency for the site management team to view the planning programmes produced by the planners as not reflecting the works on site. Similarly, the planners' view is that members of the site management team are not able to interpret, and utilize the plans for site operations. The extreme of this situation is where plans produced by the planners are abandoned, and not utilized during refurbishment work on site. This less than satisfactory situation has the effect of jeopardizing the effectiveness of the refurbishment planning processes for the work. In attempting to address this situation, the site managers would need to be brought into the planning processes earlier. Also, the involvement of the planner should not cease just after the mobilization stage, but should continue until the final completion of the project. Reinforced education and training of site managers about planning techniques and their outputs, and the training of planners about site management practices would go a long way in addressing this issue.

Refurbishment works demand an ability to deal with non-continuous and complex processes. Advanced man-management skills especially are needed in occupied buildings. Those who operate in the refurbishment sector build on generalist new construction skills and depth of experience. They generally have a sound commercial awareness, man-management skills, and are able to respond to and deal with risks. With higher levels of skills, it is arguable that there should be greater reimbursement for staff, and therefore returns for refurbishment should be higher than for new build. Similarly, refurbishment should, arguably, commercially bear a higher mark up than new build.

There is a greater degree of supervision in ship refurbishment work than in construction refurbishment. For example, during the refurbishment of the passenger ship and the warship used as case projects for this study, there were 26 and 17 management and supervisory site staff, respectively, who were involved during refurbishment. These were exclusive of the subcontractors, and the subcontractors' supervisors. For the refurbishment of the hospital and the hotel, there were 7 management and supervisory site staff for each of the projects. For the passenger ship refurbishment, however, refurbishment work was carried out on a three-shift basis (eight hours per shift). The nature and the pace of the work, where work on site was carried out within 15 days, in addition to the relatively high value of liquidated and ascertained damages (LAD), meant that there was a need for adequate management and supervisory site staff to carry out the works within the specified contract period. The LAD if the refurbishment of the passenger ship was delayed for 48 hours was £1.4 million.

Ship refurbishment clients are more knowledgeable and better informed about refurbishment processes and products than their counterparts from construction. It is also worthy of note that in the ship refurbishment sector the clients' consultants are mainly in-house. The reverse is normally the case in the construction refur-

bishment sector. Ship refurbishment clients also are more involved in the planning, control and decision making processes. In this study, 92.3% of ship refurbishment personnel from the contractors' organizations responded that they were either satisfied or very satisfied with the involvement of the client during refurbishment, as compared with 66.4% of personnel from the construction contractors' organizations. This higher degree of involvement of ship refurbishment clients is, in part, due to the fact that for most ship refurbishment clients the ship is an integral part of their assets, whereas for most construction clients the building as a shell, represents only a small proportion of their business operations. Appropriate education and training of construction clients/employers is needed to improve their awareness of the refurbishment process.

Planning and control techniques in the shipping and construction refurbishment sectors

The study has shown that schedules and bar charts are the two most frequently used formal planning and control techniques in both the ship refurbishment and the construction sectors (see Table 3). The reasons for the high frequency of use of these two techniques are partly the flexibility associated with schedules and bar charts in accommodating and visually representing the changes to the works, and familiarity with the techniques, but also these techniques do not require a high level of knowledge and skills to understand, and they require less time and cost to produce their outputs.

The study also revealed that the usage and the frequency of update of the critical path method (CPM) as a formal planning technique appear to be higher in projects of higher complexity. In this study, it is higher in the refurbishment of the warship and hospital than in the passenger ship and hotel. Complexity in this study is operationalized in terms of the total number of subcontractors, total number of suppliers, total number of different trades in the project, and the rigidity/difficulty of the contractor meeting the construction operation objectives of cost, time and quality set by the client at the outset of the refurbishment project. Moreover, although the literature (Morad and Beliveau, 1991; Aoud and Price, 1994) may suggest that more accurate and sophisticated techniques are available (e.g. PERT, GERT, expert systems, and simulation techniques), interviews with the key functionaries revealed that these are of little use because, unlike schedules and bar charts, sophisticated tools do not lend themselves to the flexibility required for planning and controlling refurbishment works, where there can be very high degrees of variation, and a higher element of risk and uncertainty. In addition, respondents suggested that computer based techniques require 'expert' knowledge, and that the cost of training coupled with the investment in software are too prohibitive. There are also the added factors of familiarity and culture.

Informal planning and control techniques also are employed in carrying out refurbishment work in both industries. These are mainly in the form of meetings (see Table 4). The client and contractors meetings appear to be the most frequently used in both industries, followed by the meetings between main contractor and subcontractor(s).

Table 3 The frequency of use of formal planning and control techniques

Construction refurbishment (e.g. hospital)	Ship refurbishment (e.g. warship)
Schedules	Schedules
Critical path method (CPM)	Critical path method (CPM)
Project cost–value reconciliation	Labour (actual versus forecast) reconciliation
Bar chart	Project cost–value reconciliation
Milestone date programming technique	Bar chart
Labour (actual versus forecast) reconciliation	Man-hours (plan analysis and update)
Plant (actual versus forecast) reconciliation	Milestone date programming technique
Materials (actual versus forecast) reconciliation	Plant (actual versus forecast) reconciliation
Computer: expert system techniques	Materials (actual versus forecast) reconciliation
Programme evaluation and review techniques (PERT)	Elemental trend analysis/line of balance (LOB)
Elemental trend analysis/line of balance (LOB)	Computer: expert system techniques
Graphical evaluation and review techniques (GERT)	Computer: simulation techniques
Man-hours (plan analysis and update)	Graphical evaluation and review techniques (GERT)
Computer: simulation techniques	Programme evaluation and review techniques (PERT)

The frequency of meetings between the client and the contractor is higher in the ship refurbishment industry than in the construction industry. For example, with the passenger ship, meetings were held at 9 a.m. every morning. Similarly, the lines of communication between members of the contractor's team and between the client and contractor's teams is shorter in the ship refurbishment sector. This is due largely to the fact that all parties are based on site (dockyard). This allows for quicker response to problems, and decision making. Within the ship refurbishment industry, it is higher in passenger ship refurbishment than in warships. Interviews with the key personnel involved in refurbishment in both sectors suggest that the successful accomplishment of a refurbishment project is dependent on the appropriate mix of the application of both the formal and informal techniques. The informal techniques are important in accommodating the kind of flexibility which refurbishment works demand. The formal techniques ensure that the management team abides by the formal and structured objectives set for project completion. In their article on improving the management and operations of refurbishment projects, Boyd and Weaver (1994) noted that, in refurbishment, "... formal systems are not suitable for refurbishment projects and so can only act as a framework for the informal systems to complete the project".

When the respondents to the questionnaire were asked to comment on the techniques that they used for different planning horizons, it became clear that a variety of techniques was used (Table 5). In analysing these different techniques, the study revealed that the time period for long, medium, and short term planning are different for different refurbishment projects. In the main, long term planning tends to be

Table 4 The frequency of use of informal planning and control techniques

Construction refurbishment (e.g. hotel)	Ship refurbishment (e.g. passenger ship)
Client and main contractor meetings	Client and main contractor meetings
Main contractor and subcontractor meetings	Main contractor and subcontractor meetings
Client and main contractor and subcontractor meetings	Client and main contractor and subcontractor meetings
Main contractor and team members meetings	Main contractor team members meetings
Job meetings with workforce	Main contractor and end-user meetings
Main contractor and end-user meetings	Job meetings with workforce

Table 5 The main planning techniques used at different planning horizons

Planning horizon	Construction refurbishment (e.g. hospital)	Ship refurbishment (e.g. warship)
Long term	Method statement	Specification documents
	CPM/Master programme	CPM
		Work breakdown structures (WBS)
Medium term	Method statement	CPM
	CPM	Specification documents
	Bar chart	WBS
	Schedules	Work authorization documents (WAD)
		Schedules
		Bar charts
Short term	Bar chart	Task/time schedules
	Schedules	Bar charts
	Day work/labour allocation sheets	Progress reports
	Weekly materials return	Weekly earned value analysis (EVA)
	Weekly plant return	Weekly cost/value reconciliation
	Monthly progress report	Fortnightly appraisal of WAD
	Monthly interim valuations	Weekly labour returns
	Monthly cost/value report	Weekly materials returns
	Confirmation of verbal instructions (CVI's) from architect	Weekly plant returns
		Meetings
	Architect's instructions (AI's)	

associated with the planning that takes place at the pre-bid and post-bid (pre-construction stages). Medium term planning is associated with post-bid (pre-construction), i.e. at the mobilization stage. Short term planning or 'action' planning is associated with the construction 'proper' stage of the refurbishment process. A technique which is employed in one planning horizon may or may not be used, or be relevant, for another planning horizon.

A variety of factors dictates the choice of techniques used for a particular planning horizon. These include availability of information; time available to utilize the information and apply the technique; and the knowledgeability of personnel in the use of techniques.

Interestingly, the variance between the ship and the construction sector in the use of techniques at different planning horizons is noticeable during the long and medium term horizons. Apart from the fact that short term planning in the ship refurbishment sector mainly is carried out daily or weekly in comparison with weekly or monthly planning in construction, there is little difference between the two sectors where short term planning technique is concerned. Bar charts and schedules are favoured as short term planning techniques by key functionaries in both sectors.

Perceived planning and control efficiency and effectiveness in refurbishment

Managerial efficiency is concerned with doing the right things and relates to inputs and what the manager does. Managerial effectiveness, however, is concerned with doing things right, and can be seen to relate to outputs of the jobs and what actually is achieved.

From the information gleaned from the interviews from both sectors the most influential factors affecting planning and control effectiveness are risks and uncertainty (affecting planning accuracy); complexity of the works; past experiences of contractors' organizations; and the attitude of contractors' organizations towards planning.

Laufer and Tucker (1988) inform us that the greater the uncertainty on operational planning time, the lower the accuracy: that is to say, the extent to which plans materialize. Emery (1969) defines planning accuracy as the degree to which the planned value corresponds to the eventual actual value. There are certain criteria which could be used as indicators of planning accuracy, such as schedule variance, man-hour variance, and the extent of usage of planning programmes.

One of the difficulties in estimating the planning accuracy of different projects is the fact that most contractors do not document the relevant information for such an estimation. Where such information does exist, there is the problem of inherent differences in the ways different contractors collate such information, making a comparative analysis difficult.

In this study, respondents were asked to rate the extent to which prepared projects plans were used in the process of decision making at the construction stage of refurbishment. The responses of the personnel are presented in Table 6, which shows that a relatively higher percentage of respondents from the ship refurbishment sector (96.1%) noted that there was a high/very high extent of use of plans in decision making, compared with respondents from construction refurbishment (81.8%). This result may well indicate that the programmes and plans of work in ship refurbishment are marginally more accurate than in construction, and hence the greater reliance on their use for decision making.

The perceptions of the respondents to the questionnaire also were sought as to the extent to which project plans were reviewed and revised. Table 7 indicates that, in the main, the time duration for revision of project plans is shorter in the ship refurbishment industry than in construction. While 56% of the personnel from the ship refurbishment sector responded that project plans were reviewed and revised on either a half-daily or daily basis, no respondent from construction refurbishment reviewed or revised project plans this often (see Table 7). The majority of respondents from the construction industry noted that project plans were reviewed on a weekly basis. In the ship

Table 6 The extent of use of prepared project plans in decision making

Extent of use	Construction refurbishment ($N = 11$) %	Ship refurbishment ($N = 26$) %
Not used at all	0.0	0.0
Low level of use	18.2	3.8
A high level of use	63.6	76.9
A very high level of use	18.2	19.2

Table 7 The extent to which project plans were reviewed and revised, at the 'construction stage', during refurbishment

Duration	Construction refurbishment ($N = 11$) %	Ship refurbishment ($N = 25$) %
1/2 Daily	0.0	4.0
Daily	0.0	52.0
Weekly	63.6	24.0
Fortnightly	0.0	16.0
Monthly	27.3	4.0
Every 3 months	9.1	0.0
Every 6 months	0.0	0.0

refurbishment sector 24% of respondents reviewed and revised project plans on a weekly basis. Closer observation of Table 7 shows that whereas nearly 36% of respondents from construction refurbishment reviewed and revised project plans on a monthly basis or a three-monthly basis, only 4% of respondents from ship refurbishment indicated this.

Although the extent to which project plans are reviewed and revised is affected by a number of factors, such as the amount of detailed information available for planning, and the stipulated contract period, few will argue that a higher frequency of revision of project plans would help to keep a tighter control over the progress of the works. It could also help to improve the accuracy of planning. A higher frequency of revision of project plans also could be an indication of the degree of effort put into the planning and control of refurbishment work. In this context, therefore, it could be argued that more effort would appear to be put into planning and control by ship refurbishment personnel than by their construction counterparts.

From the postal questionnaires, the key personnel involved in refurbishment processes, from both industries, were asked the state of completion of design (including specifications and drawings) before commencement of refurbishment work. As Table 8 shows, the majority of respondents, from both industries, noted that between 51% and 75% of designs were complete. However, 80% of those from the ship refurbishment industry responded that over 50% of designs were complete, as compared with 66.6% from construction refurbishment. Bearing in mind the nature of refurbishment operations, where the full extent of works cannot be ascertained fully until site operations commence, 32% of respondents from the ship refurbishment sector, as compared with 8.3% from construction refurbishment, noted that 76% or more of the designs for the works were complete before refurbishment work commenced.

Interviews with key personnel from ship refurbishment revealed that design changes and other changes made during the course of refurbishment work are documented and then passed on to the client after refurbishment. Funds are specifically made available for this purpose, as part of the contract with the main contractor. This practice should allow as-built drawings to be available for future refurbishment works. In construction, it is hoped that the new construction design management (CDM) regulations will help to address this issue.

Table 8 The state of completion of design before refurbishment work commenced

Design completion	Construction refurbishment ($N = 12$)	Ship refurbishment ($N = 25$)
Less than 25%	8.3%	0.0%
25%–50%	25.0%	20.0%
51%–75%	58.3%	48.0%
76%–100%	8.3%	32.0%

Although there are no generally accepted planning and control effectiveness measures (Laufer and Tucker, 1988), the inference from this study has shown that a concerted effort made to manage the risks and uncertainty of the works (by improving the quality and timing of relevant information for the works during the 'construction proper' stage, and also by increasing the percentage level of design completion before commencement of the works) would help to improve planning accuracy and effectiveness.

It is interesting to note that Cohenca *et al.* (1989) have shown that the cost of planning in an 'average situation' for 90% and 20% design completion in construction is about 0.45% and 0.82%, respectively, of the total construction cost. Halpin (1985) has also shown that, in construction, planning and control costs would range between 15% and 27% of the contractor's profit.

Conclusions and recommendations

The management of refurbishment work in both the construction and ship refurbishment sectors is complex, highly specialized and contains elements of work which are unique to refurbishment and different from new build. It follows that effective planning and control are vital for contractors to complete refurbishment contracts on time and within budget.

There is substantially more lead time for planning in the ship refurbishment sector. This allows for better mobilization of project resources. It also allows for a better articulation of project risks and a better estimation of project costs.

In the ship refurbishment sector, site managers and, to a lesser extent, site supervisors are brought into the planning and control processes earlier than their counterparts from the construction industry. The site manager is, to a large extent, removed from the early planning stage, and only when construction proper commences is the site manager highly involved in the planning process. Equally, the planners' contribution largely ceases to have any significant impact on the planning process once construction starts. It would make both economic and operational sense for greater integration between team members from the contractors' point of view. Moreover, site managers should be more informed about early stage planning techniques and methods if they are to work with the planners. Likewise, planners should have a better understanding

of construction management practices for reciprocal working relationships to succeed.

Ship refurbishment clients are more knowledgeable about refurbishment processes and products than their construction counterparts. This is reflected in the long planning lead time for ship refurbishment and the money put aside for collating and documenting all changes to the design and construction during refurbishment. Refurbishment clients also are more involved in planning, control and decision making processes. This mainly is to do with the fact that the ship is an integral part of their assets, but may represent only a small proportion of the business operations of construction clients.

For both refurbishment sectors, a variety of planning techniques is utilized in managing refurbishment work. Schedules and bar charts are the most frequently used techniques, largely because of operator familiarity, perceived flexibility, the relatively low levels of skill and knowledge needed to understand them, and the relative cheapness associated with producing and updating them. The reluctance to use computer based programmes is partly to do with unfamiliarity and lack of confidence, which reflect the low level of investment attached to the education and training of refurbishment personnel.

Planning accuracy and effectiveness in managing refurbishment works largely are affected by risks and uncertainty, complexity of the works, past experience of the contractor's organization and the attitude of the contractor's organization towards planning. Any efforts made to improve the quality and timing of relevant information for the works, increase the percentage level of design completion before commencement of the works, and provide early and sustained integration of the key functionaries to the planning and control processes would help to improve planning accuracy and effectiveness. In construction refurbishment, more time, finance and effort than is currently the case are needed in organizing and collating contract documentation (including drawings and specifications) before tender interviews and subsequent site works.

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