CONSTRUCTING NEW AUTOMOTIVE PRODUCTION FACILITIES IN A MATURE BROWNFIELD SITE

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Manufacturing industries periodically adapt, refurbish or upgrade their production facilities to produce new products or new models, introduce new technology or accommodate new business strategies. Intensive and lengthy market, environmental and internal analysis, reengineering and adaptation precede the need for new facilities. This process is dynamic and thus project management, design and construction of new facilities, while under way, may be subject to frequent and considerable change, which must be accommodated within the project parameters of budget, time and quality. Research was conducted on project management issues affecting the provision of new production facilities in a mature brownfield site in the motor industry. This industry was selected for the study, inter alia, because it frequently introduces major and minor changes to its production lines and operates in a complex, competitive and high-technology environment. The research included a literature survey and empirical data obtained from motor vehicle and component manufacturers and service providers. This paper presents those literature and empirical surveys and findings dealing with the effects on the contractors who construct the new facilities, includes a survey among contractors who undertake such work, concludes that particular demands are made on contractors and suggests guidelines for clients and project managers.

Keywords: alterations, industrial construction, project management, refurbishment, strategic management.

INTRODUCTION

Industrial projects for producing consumer goods require a wide range of considerations and activities. Manufacturing processes which incorporate advanced or rapidly advancing technology and produce goods that may be subject to frequent style or other changes dictated by market factors and competitive forces are particularly complex. Product ranges and characteristics as well as technological innovation are issues of business strategy, positioning and marketing. Manufacturing processes may incorporate product and technological innovation either by providing new facilities on a new site or on the currently used site but separate from existing facilities, or by adapting, upgrading, reconstruction or refurbishment of existing facilities, often while simultaneously continuing with production of existing product ranges.

A comprehensive research project was undertaken among motor vehicle and component manufacturers (but also relevant to other manufacturing industries) to

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investigate project management issues relevant to providing new production facilities in an ongoing industrial environment. The study embraced:

- strategic and project management issues, including project compatibility with the strategic position of the company
- technical and financial feasibility
- company performance characteristics
- non-project issues such as change management, organizational culture, leadership, the environment, workplace democracy and related contemporary issues, and
- the effects of upgrading, reconstruction and refurbishment projects on contracts during the construction phase.

This paper deals with this latter aspect only.

THE RESEARCH PROBLEM

The problem for the overall project was stated as "An investigation into the problems influencing the implementation of a new expansion project in a mature brownfield site". Eight sub-problems and corresponding hypotheses were formulated for the overall study. One of these examined the impact of and the constraints imposed by a new expansion project in a mature brownfield site on contractors during the construction phase. The corresponding hypothesis stated that a new expansion project does not affect contractors and does not place various constraints on them during the construction phase.

The term "brownfield site" was defined as a site having previous building development on it, and a "mature brownfield site" as one having an existing developed facility that is functional on the site.

THE RESEARCH METHODOLOGY

For the overall study, qualitative and quantitative methods were utilized. A literature survey provided the domain knowledge and theoretical basis for the study. Empirical data was collected from motor vehicle manufacturers and their supplier networks by means of a questionnaire and by conducting a number of interviews. Data collection was in three stages : a pilot survey as a trial run for the questionnaire, followed by the actual survey, followed by the interviews. The questionnaire consisted of 81 question categories covering all the areas mentioned in the introduction above.

For the original study, a total population of 166 was compiled from the supplier list of one of the vehicle manufacturers. A sample of 35, (approximately 20 %), comprising 5 vehicle and 30 component manufacturers, was considered to be sufficient. 100 potential participants, randomly selected, had to be contacted prior to the survey to ensure that a response of 35 would be obtained. In addition, 12 executives from respondent firms were interviewed.

The collected data were analysed, interpreted and presented by means of appropriate statistical methods to enable the hypotheses to be tested and conclusions to be drawn.

5 of the 81 question categories in the original questionnaire were relevant to the topic addressed in this paper, i.e., the effects of reconstruction, upgrading and similar projects on contractors. The topic was also included in the interviews. Since the respondents were from the motor industry, the responses reflected their perceptions of

the effects of upgrading, reconstruction and refurbishment on contractors during the construction phase. For the purposes of this paper, further data were thus collected by interviewing executives from four construction contractors who, over the previous 5 years, had completed numerous large and small projects in the plants of 16 vehicle and component manufacturers. A questionnaire containing 28 question categories and allowing for voluntary comments was used for the contractor survey interviews. The questionnaire covered brief demographic details, project type and value details and the majority of items covered issues that were identified from the literature as having the potential of affecting the contractors' performance, production, pricing and other management aspects. The interview results are presented and discussed in a later section of the paper.

LITERATURE SURVEY

The literature consulted for the overall project consisted of more than 100 texts, journal articles and some industry-specific sources on relevant aspects of management, strategic issues, financial and technological feasibility, organisational dynamics and leadership, the business environment and project management. The following is a selection from the literature, as relevant to the impact of and the constraints imposed by a new expansion project in a mature brownfield site on contractors during the construction phase.

Drivers of change

According to Kerzner (1998), external pressures such as the following cause companies to introduce strategic, technological and other changes:

- customer expectations relating to competition (lower cost), better quality, financial factors (lower margins), legal concerns and technology (state-of-the-art products)
- social concerns among customers and employees, including environmental concerns
- political factors, nationally and internationally
- economic pressures, including inflation and the effects of international exchange rates
- stakeholder concerns (internal growth and external expansion).

Industrial projects

Industrial projects typically undergo four phases, i.e., conception, study, design and implementation (Angus and Gunderson, 1997). Product design and production are related to manufacturing process and facility design and construction. Construction projects are thus part of the overall industrial project.

Burke (1996) identifies several product and industrial project factors that interrelate with physical production facility design and construction. These are that the project must meet prescribed specifications and standards, must be energy efficient and must be operational by a given date. In addition, there are statutory health and safety requirements, there is a limit to the project budget (hence also to the facility budget), provision must be made for ease of maintenance, repair and future expansion and there are predetermined levels of systems redundancy, manpower levels and automation.

Project success
Design and construction of production facilities contribute to the success of company strategy and of projects. Harrison (1992) identifies a number of factors that contribute to project success or failure. Those relevant to the success or failure of facilities construction in industrial projects are :

- Commitment of project team; on-site, effective project manager; good team spirit
- Good relationships; enthusiasm; suitable organisation structure; good public relations
- Adequate project team capability; participative problem-solving and decision-making
- Good coordination and communication
- Accurate initial cost estimates; monitoring and control of budget; adequate funding for project completion
- Adequate and realistic planning; use of network techniques; adequate control techniques; adequate use of status and progress reports; good risk management
- Avoidance of design changes at an advanced stage; good information management; good change control procedures.

Cleland and Gareis (1994) have investigated unsuccessful projects and disasters and have found that project budgets are frequently exceeded, sometimes hugely; poor management is common; lack of cost consciousness and poor cost control are common; consultants are often given major freedom, with too little in-house involvement; incomplete planning causes errors, change, higher costs, delays and other effects; some technical solutions are too expensive and health, safety and environmental legislation and regulations can cause extra costs.

Technology upgrading
Technology management is central to the upgrading of facilities. According to Slack *et al.* (1998), operations and project managers are routinely engaged in planning and management of process technology, particularly in assessing how technological improvement could improve operational processes. Technology has to be selected and installed so that it does not interfere with ongoing activities, has to be integrated into the rest of the operation and has to be upgraded or replaced when necessary. Included in these considerations are the possible downgrading of new technology to suit existing facilities and the upgrading of existing technology to suit new facilities.

According to Badiru (1996), there are two strategies for executing expansion projects. In the first, the parallel changeover strategy, the existing manufacturing process coexists with the renovation and facilities upgrading project. In the initial phase, flexibility, adaptability and cooperation between project and line management are required. The final phase, normally carried out during the year-end shutdown, entails closing the facility to enable final replacements and adjustments to be made.

The second strategy is the pilot changeover – the new expansion project is fully implemented on a pilot basis in a selected area in the plant. During this phase the existing facilities are renovated and upgraded. On completion, the pilot project is expanded.

JIT applied to renovation and upgrading projects
Stevenson (1996) defines just-in-time (JIT) as a repetitive production system in which processing and movement of materials and goods occur just as they are needed, usually in small batches to eliminate waste.

Toikkanen (1996) identifies three strategies for effecting facilities upgrading and renovation projects :

- In a repetitive renovation project, people continue to work during renovation and upgrading or move to another work area for a short time.
- A heavy renovation project is technically very similar to the internal works phase of a new construction project in respect of scheduling and production planning.
- Light renovations, such as a new expansion in a mature brownfield site, where the space is in use during renovation and upgrading, place exceptional requirements on production planning and control, necessitating an approach such as JIT.

JIT can be tailored to any process. It is therefore also applicable to construction, which differs from factory production in that materials, equipment and workers move while the item being produced remains stationary, whereas in factory production the item being produced moves from one work station to the next. JIT in renovations enables overlapping production, slowing down when problems occur to resolve them and producing only what has been planned.

Problem areas during renovation and upgrading

Levy (1987) identifies a range of renovation and upgrade work. On the one end is total renovation in which internal finishes and utilities (services) will be demolished. At the other end lies partial renovation in which sound mechanical, electrical and other components and systems will be left in place. Between these extremes, any components or systems could be left in place, removed and replaced, reconditioned or refurbished, depending on age, condition, compatibility with new technology and re-use potential.

Levy (1987) further identifies a number of renovation difficulties :

- What is involved in removing existing facilities; can they be refurbished or reconditioned; can existing utilities be used during construction or must temporary utilities be provided?
- What is the condition of surfaces, sub-surfaces, the structure or area to be refurbished or retained?
- Do any of the items to be removed have any scrap value?
- How long will demolitions take before new work can be commenced?
- Are asbestos or other hazardous or potentially hazardous materials present and how will they have to be dealt with?
- Who will deal with the removal or partial removal of electrical, mechanical, communication or other sensitive or potentially hazardous or unhygienic systems?
- Are the positions of all services known or could they be found unexpectedly?
- Check the dimensions and condition of structural elements as demolition proceeds. Demolition of structural elements should be carefully done – beware of overloading, weakening of structural members, cutting reinforcement and pre-stress cables.
- Check interfacing between existing and new services, systems, components, etc.
- Have planning and coordinating been thorough and included enough technical detail?

Aspects to avoid during construction are poor quality and the resulting re-work; not maintaining scheduled outputs; cost and budget overruns; contractors and production staff having to work overtime; occurrence of conflict between the parties.

THE ORIGINAL SURVEY AND FINDINGS

The original questionnaire approached the question of the effects on contractors in a generalised manner and from the perspective of the motor industry. The findings of the survey were that the majority of respondents believed that :

- integrating new and existing technology does affect contractors and place constraints on both the manufacturing firm and on contractors
- downgrading new expansion project facilities to accommodate existing facilities places considerable constraints on contractors and this could affect the quality and dependability of the new project.

It also emerged from the interviews that problems exist when integrating existing and new technology but that, if downgrading of technology is necessary, it should happen as result of compatibility and not to accommodate suppliers. Other aspects emerging from the interviews were :

- Unsuccessful projects are a consequence of a lack of commitment from management.
- Manufacturing company planning processes were not effective. Often the planning phase was short, followed by a phase in which many, often costly, corrective actions were required to implement the project.
- Poor communication inhibited effective project management.

THE CONTRACTOR SURVEY AND FINDINGS

The purpose of this survey and the basis of the data sought were described under a previous section of the paper. The results of the interviews with the four contractors and their experiences, gained during the previous 5 years, while completing numerous projects of differing size, value and complexity at the premises of 4 motor vehicle and 12 component manufacturers, are as follows:

The *executives interviewed* were :	Managing Director :	2
	Construction Director :	1
	Contracts Manager :	1

Projects completed over the past 5 years :

	Contractor number	Number of projects	Individual highest value
Minor maintenance / Refurbishment	1	5	<R 2.5 million
	2	4	<R 2.5 million
	3	Numerous	<R 2.5 million
	4	Numerous	<R 2.5 million
Major maintenance / Refurbishment	1	2	<R 15.0 million
	2	3	>R 15.0 million
	3	10	<R 10.0 million
	4	3	<R 5.0 million
New facilities (not in ongoing production areas)	1	2	>R 20.0 million
	2	1	<R 10.0 million
	3	5	<R 10.0 million
	4	8	<R 15.0 million

In general, who is in charge of the project on behalf of the client?
Consultants (architects / engineers) were involved on projects exceeding R500 000.00 in value and where specific services were required. Independent project managers were involved to some extent in new construction. In-house project managers / engineers were involved, particularly in projects executed in the ongoing production environment, but did not seem to fulfil a predominant role from the contractors' viewpoint.

In general, how would you rate the management by the client's representative of the work you undertake, regarding?

1 = excellent ; 5 = extremely poor	1	2	3	4	5
Timeous provision of information you require		3	1		
Smooth flow of your work		3	1		
Attention to technical detail	1	1	2		
Prior identification of unknown factors		2	2		
Understanding of construction problems		2	1	1	

No. of responses out of 4

Type of work undertaken in the motor industry environment.
All four respondents undertook :

- Integrating new and existing processes / technology
- Upgrading existing facilities to suit new processes / technology
- Removal and replacement of existing facilities to suit new processes / technology
- Constructing completely new facilities for new processes / technology. However, one of the firms mainly undertook upgrade projects in respect of office accommodation, canteen and ablution facilities.

Respondents were asked to compare Motor Industry Projects (MIPs) involving technology integration, upgrading, removal and replacement with other projects not involving work in an ongoing production environment, undertaken for other clients.

1 = strongly agree ; 5 = strongly disagree	1	2	3	4	5
MIPs are no more difficult to execute than other contracts				4	
MIPs have increased security and health and safety problems	2	2			
We price MIPs on the same basis as other projects	1		2	1	
MIPs do not pose scheduling problems			1	3	
We are able to complete MIPs on schedule	2	2			
We are able to complete MIPs to budget	2	1	1		
We are able to achieve required quality standards easily on MIPs	1	2	1		
We are able to integrate construction with ongoing production in the factory	3	1			
We do not experience access or material delivery problems on MIPs		1	2	1	
MIPs do not create human resources problems	1	3			

No. of responses out of 4

RESPONDENTS' COMMENTS

- Delays in providing information were often caused by overseas principals.
- Smooth flow of work was often influenced by having to make allowances for inconvenience to the client's employees.
- A large proportion of this type of work is done during the annual industry shutdown.

- All respondents stated that they had no choice but to complete on schedule, even though scheduling was complex, schedules were often interrupted and delays caused by the client were a given factor.
- With reference to pricing, a large proportion of the work undertaken by the respondents' firms was negotiated and hence not subject to competitive tendering. Pricing generally was higher than for other types of work, to allow for the physical and other conditions under which projects were carried out. Pricing of motor industry projects in cases of competitive tendering was influenced by construction market conditions and the degree of competition.
- Integrating construction with ongoing factory production was not easy.
- Completing projects to budget is not straightforward. The client often requires, and pays for, extra work, not envisaged when finalising the project amount. The client's representatives often have to request additional funding within the client organisation.

In general, executing industrial work is not easy.

Summary of Contractor Survey
The client's representative, generally, provides information timeously; promotes the smooth flow of construction work; pays reasonable attention to technical detail; identifies unknown factors prior to construction activities, and understands construction problems.

Motor industry projects, compared with other types of projects, are more difficult to execute; present increased security, health and safety challenges; are priced on a different (higher) basis; pose scheduling problems; are nevertheless able to be completed on schedule; can be completed to budget; do not create serious human resources problems.

Contractors are able to achieve the required quality standards fairly easily on motor industry projects; are able to integrate construction with ongoing production in the factory; experience some access and material delivery problems on motor industry projects.

CONCLUSIONS

The characteristics of industrial refurbishment, upgrading, reconstruction and adaptation projects, as identified in the literature, have broadly been confirmed by the experiences of contractors regularly operating in the motor industry. Many of the features of industrial projects, project success factors, technology upgrading, problem areas during renovation and upgrading, and the effects of and on the management of such projects have also been illustrated. These aspects of the survey correspond with the views expressed by the motor industry participants during the original survey. Nevertheless, the contractors surveyed considered that they coped adequately with the challenges of this type of work.

It can also be concluded that, in respect of motor industry projects in which construction, reconstruction or upgrading of production facilities may form an essential part, project management processes do not as yet adequately integrate the construction component into the overall project. This leads to inefficiencies in respect of cost and budget overruns, production interruptions, the management of construction operations and other effects, which may compromise the overall project to a greater or lesser extent.

By extension, other industries may also benefit from greater integration of construction, reconstruction and upgrading activities into the overall scope, planning and implementation of their projects.

As technology becomes increasingly central to business strategy, and as the time to obsolescence decreases at an accelerating rate, the construction aspects of industrial projects will increase in importance, as will the management thereof.

RECOMMENDATIONS

Improvements are possible in respect managing the construction component of industrial facilities upgrading projects. Possibilities exist for both industrial clients and contractors. Industrial clients should consider:

- More thorough and realistic planning. This will avoid late design and scope changes, construction and production interruptions, cost escalation and budget variances.
- Improving integration of outside construction consultants' services and responsibilities with the role of in-house project managers and engineers.
- Keeping an accurate and up-to-date data base of all production facilities, including machine, system and building maintenance data, location of services and utilities, etc. This will avoid disruptions to construction and last-minute decisions by the client.
- Implementing the best possible communication and information management.

Gaining an understanding of construction processes and problems and closing or narrowing the divide between design and execution in construction by incorporating construction specialists, including contractors, in their project teams, or by utilising construction procurement systems such as design and construct or other alternatives appropriate to specific applications.

Both industrial clients and construction contractors should consider:

- Improving their project management skills, especially in respect of industrial projects.
- Construction contractors should consider:
- Acquiring diversified skills to offer industrial clients, including design, not necessarily in-house but in partnering arrangements with consultants and other specialists.
- Specialising in industrial reconstruction and upgrading, including keeping up to date with technological advances.
- Introducing specialised construction and project management professional development programmes dedicated to industrial reconstruction and upgrading.

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