CONSTRUCTING NEW AUTOMOTIVE PRODUCTION FACILITIES IN A MATURE BROWNFIELD SITE

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ABSTRACT

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.

KEY WORDS

Alterations; industrial construction; project management; refurbishment; strategic management.

1. INTRODUCTION

The scope of industrial projects directed at producing consumer products covers a wide range of considerations and activities. Manufacturing operations which incorporate advanced or rapidly advancing technology and which produce products 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 in two ways, viz.,

- provision of new facilities, either on a new site or on the currently used site but separate from existing facilities, or
- adaptation, upgrading, reconstruction or refurbishment of existing facilities, frequently while simultaneously continuing with production of existing product ranges.
A comprehensive research project has been undertaken, among motor vehicle and component manufacturers but also relevant to other manufacturing industries, to 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 contractors during the construction phase.

This paper presents the latter issue.

2. THE RESEARCH PROBLEM

The problem statement for the overall project was formulated as “An investigation into the problems influencing the implementation of a new expansion project in a mature brownfield site”.

The research problem was approached via eight sub-problems and eight corresponding hypotheses. One of the sub-problems 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.

For the purpose of the study, 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.

3. THE RESEARCH METHODOLOGY

Qualitative and quantitative methods were utilized. A literature survey provided the domain knowledge and theoretical basis for the study. Empirical data was collected by means of utilizing a questionnaire to conduct surveys among motor vehicle manufacturers and their supplier networks. Data was also collected by means of conducting a number of interviews. The manufacturers and many of the supply chain firms are governed by decisions and practices originating from international principals and several of the firms who participated in the surveys manufacture for the export market.

Data collection was done 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.

The total population of 166 was obtained from the supplier list of one of the vehicle manufacturers. It was decided that a sample of 35 (approximately 20%) would be sufficient, including 5 vehicle manufacturers. To ensure this response required that 100 potential participants, identified by means of random number selection, had to be contacted prior to the survey. Interviews were conducted with executives from an additional 12 respondent firms.
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.

In respect of the topic of this paper, i.e., the effect on contractors, 5 of the 81 question categories of the questionnaire were relevant. The topic was also included in the interviews. The respondents of course were motor industry related and hence the responses reflected their perceptions of the effects of upgrading, reconstruction and refurbishment on contractors during the construction phase. Therefore, for the purposes of this paper, further data were collected by means of conducting structured interviews with executives from four construction contractors who, over the preceding 5-year period, had completed numerous large and small projects in the plants of 16 vehicle and component manufacturers.

4. LITERATURE SURVEY

For the overall research project, sufficient management literature on strategic issues, financial and technological feasibility, organisational dynamics and leadership, the business environment and project management was available, enabling a comprehensive survey to be compiled.

Selected aspects of the literature survey, as relevant to the current topic, are outlined as follows.

4.1 Drivers of change
External pressures cause companies to introduce strategic, technological and other changes. Kerzner (1998) identifies
- customer expectations relating to competition (lower cost), enhanced quality, financial factors (lower profit margins), legal concerns and technological factors (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).

4.2 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 the following product and industrial project factors which interrelate with physical production facility design and construction:
- there is a limit to the project budget (hence also to the facility budget)
- the project must meet prescribed specifications and standards
- the project must be energy efficient
- there are statutory health and safety requirements
- ease of maintenance and repair
- predetermined levels of systems redundancy, manpower levels and automation
- provision must be made for future expansion
- the project must be operational by a given date.
4.3 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 which are relevant to the success or failure of the facilities construction component of industrial projects are:

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

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, cost increases, delays and other negative effects
- some technical solutions are too expensive
- legal requirements in respect of health, safety and environmental issues can cause extra costs.

4.4 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, in particular 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, it has to be integrated into the rest of the operation and technology 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, one being the parallel changeover strategy, which entails that 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, where the new expansion project is fully implemented on a pilot basis in a selected area within the plant. During this phase the existing facilities are renovated and upgraded, on completion of which the pilot project is expanded.

4.5 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.
Langford and Retik (1996) identify 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.
- A light renovation project, such as a new expansion in a mature brownfield site, in which the space is in use during renovation and upgrading and this places exceptional requirements on production planning and control, calling for 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.

### 4.6 Problem areas during renovation and upgrading

Levy (1987) identifies a spectrum 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 of the spectrum lies partial renovation in which sound mechanical, electrical and other components and systems will be left in place. In between total and partial renovation, 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; will they be able to be refurbished or reconditioned; can existing utilities be used during construction or will temporary utilities have to 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?
- Is there asbestos or other hazardous or potentially hazardous 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 subsurface services known or are they likely to be found in unexpected positions?
- Periodically check dimensions and the condition of structural elements as demolition proceeds. Demolition of structural elements should be done with circumspection – beware of overloading, weakening of structural elements, cutting of reinforcement and pre-stressing cables.
- Check interfacing between existing and new services, systems, components, etc.
- Has proper planning and coordinating been done and has sufficient attention been given to technical detail?
- Aspects to avoid during construction are poor quality and the resulting re-works; not maintaining scheduled outputs; cost and budget overruns; contractors and production staff having to work overtime; occurrence of conflict between the parties.
5. 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 written survey were that the majority of motor industry respondents believed that:

- integrating new and existing technology does affect contractors and place constraints on both the manufacturing firm and on contractors
- new expansion project facilities having to be downgraded to accommodate existing facilities places considerable constraints on contractors and that 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 result from 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.

6. THE CONTRACTOR SURVEY AND FINDINGS

Subsequent to the main investigation, structured interviews were conducted with four building and civil engineering contractors to obtain data reflecting their views and experiences.

The four firms had collectively over the past 5 years completed numerous projects at the premises of 4 motor vehicle manufacturers and 12 component manufacturers.

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

Projects completed over past 5 years:

<table>
<thead>
<tr>
<th>Minor maintenance / Refurbishment</th>
<th>Contractor Number</th>
<th>Number of Projects</th>
<th>Individual Highest Value</th>
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<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>&lt;R 2.5 million</td>
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<tr>
<td>2</td>
<td>4</td>
<td>&lt;R 2.5 million</td>
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<tr>
<td>3</td>
<td>Numerous</td>
<td>&lt;R 2.5 million</td>
<td></td>
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<tr>
<td>4</td>
<td>Numerous</td>
<td>&lt;R 2.5 million</td>
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<thead>
<tr>
<th>Major maintenance / Refurbishment</th>
<th>Contractor Number</th>
<th>Number of Projects</th>
<th>Individual Highest Value</th>
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<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>&lt;R 15.0 million</td>
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<tr>
<td>2</td>
<td>3</td>
<td>&gt;R 15.0 million</td>
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<tr>
<td>3</td>
<td>10</td>
<td>&lt;R 10.0 million</td>
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<tr>
<td>4</td>
<td>3</td>
<td>&lt;R 5.0 million</td>
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</table>

<table>
<thead>
<tr>
<th>New facilities (not in ongoing production areas)</th>
<th>Contractor Number</th>
<th>Number of Projects</th>
<th>Individual Highest Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>&gt;R 20.0 million</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>&lt;R 10.0 million</td>
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<tr>
<td>3</td>
<td>5</td>
<td>&lt;R 10.0 million</td>
<td></td>
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<tr>
<td>4</td>
<td>8</td>
<td>&lt;R 15.0 million</td>
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</table>

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

<table>
<thead>
<tr>
<th>Timeous provision of information you require</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td>Smooth flow of your work</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention to technical detail</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior identification of unknown factors</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding of construction problems</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
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</tbody>
</table>

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, although one respondent qualified by saying that they did not do much of this kind of work but did carry out significant number of 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 which they undertook for other clients.

1 = strongly agree ; 5 = strongly disagree

<table>
<thead>
<tr>
<th>MIPs are no more difficult to execute than other contracts</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIPs have increased security and health and safety problems</td>
<td>2</td>
<td>2</td>
<td></td>
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</tr>
<tr>
<td>We price MIPs on the same basis as other projects</td>
<td>1</td>
<td>2</td>
<td>1</td>
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<tr>
<td>MIPs do not pose scheduling problems</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>We are able to complete MIPs on schedule</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>We are able to complete MIPs to budget</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We are able to achieve required quality standards easily on MIPs</td>
<td>1</td>
<td>2</td>
<td>1</td>
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</tr>
</tbody>
</table>
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 significant proportion of this type of work is executed during the annual industry shutdown.
- With reference to completing on schedule, 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 significant 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. Extra work, not envisaged when agreeing on a project amount, is often required by the client, for which the client has to pay extra. The client’s representatives often have to apply for additional funding within the client organisation.
- In general, executing industrial work is not easy.

**Summary of Contractor Survey**
The client’s representative, in general,
- provides information in good time
- promotes the smooth flow of construction work
- pays reasonable attention to technical detail
- does identify unknown factors prior to construction activities
- has some understanding of 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
- are able to 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
- to some extent experience access and material delivery problems on motor industry projects.
CONCLUSIONS

The characteristics of refurbishment, upgrading, reconstruction and adaptation projects in an industrial environment, as revealed in the literature, have been confirmed by the experiences of contractors regularly operating in the motor industry. In particular, 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 been illustrated.

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 of 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

It is recommended that industrial clients should:
• place greater emphasis on the effectiveness of project management of industrial projects. This entails education and training in all aspects of project management.
• plan thoroughly and realistically. This will avoid late design and scope changes, construction and production interruptions, cost escalation and budget variances.
• improve integration of outside construction consultants’ services and responsibilities with the role of in-house project managers and engineers.
• keep 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.
• focus on good communication and information management.
• develop an understanding of construction processes and problems.
• consider 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.

It is recommended that construction contractors should:
• improve their project management skills.
• acquire diversified skills to offer industrial clients, including design skills, not necessarily in-house but in partnering arrangements with consultants and other specialists.
• consider specialising in industrial reconstruction and upgrading, including keeping up to date with technological advances.
• consider introducing specialised construction and project management professional development programmes dedicated to industrial reconstruction and upgrading.
REFERENCES


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Main interests:Various aspects of construction management and project management. Qualifications: BSc (Building Management) (U Pret) and MBA (U Pret). Served as Deputy Dean (9 years) and Dean (4 years) of the abovementioned Faculty and as Head of the Department of Construction Management (23 years). Prior to lecturing spent 18 years in the construction industry in various technical and managerial positions, up to the level of Director, Managing Director and Consultant.