Project Development and Execution in the Context of the Brewing Manufacturing Process

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ABSTRACT

This paper presents an operation model for the execution of projects, congruent with a world class manufacturing strategy supporting the core business of beer production. The objective is to demonstrate how the brewing process work cycle impacts, not only on the engineering functions of design, construction and commissioning, but also on commercial activities such as contract administration and procurement.

Specific topics discussed in the paper include: a systems approach versus area or discipline approach, structuring PLC and supervisory architecture, structuring contractual arrangements, in-house resources or a managed turn-key, structuring of documentation.

Practical examples will be provided from SA Breweries recently completed Alrode Project. A US $200 million expansion to increase brewery production from 75,000 hl/week to 137,000 hl/week. Plant and equipment installed include a 1500 hl brewing plant, 48 x 3000 hl FV, a 2 x 600 hl/h candle filter plant, yeast handling and CIP plants, 6 x 20 t/h boilers, engine room utilities and a 60,000 bottle/h pack-line. The brewery incorporates the highest level of process automation and control in the SAB group.

1. INTRODUCTION

In order to enhance competitiveness in today's local and international markets many industry leaders have embraced strategic plans which are founded upon the philosophies of World Class Manufacturing (WCM), in particular:

- participative management
- teamwork and structured problem solving
- continuous improvement

A work breakdown analysis of the beer manufacturing process will identify that value is added to raw materials through Brewing and Packaging. These disciplines may be considered as the core technology of the business, a source of competitive advantage; and all other activities and functions should be supportive thereof.

Typically, the business architecture of an organization that strives towards World Class Manufacturing status will be flatter in structure and decentralized. Many service functions will be devolved to line managers in the value added chain, and traditional design and project engineering activities will be "outsourced" and managed by the operating company.

A dilemma exists, however, in the question as to whether the Brewer in an operating region is willing and, indeed, able to assume these new roles and responsibilities.

To assist in this, a model for the development and execution of projects which is congruent with WCM strategy is presented with the objective of demonstrating how the brewing process work cycle impacts on the engineering functions of design, construction and commissioning, as well as the commercial activities of contract administration and procurement.

Practical examples are provided from a recently completed project which spanned some five years from 1990 - 1995 and during which time the company developed and implemented WCM into the business.

SINTÉSIS

Este trabajo presenta un modelo de operacion para la ejecucion de proyectos, congruente con una estrategia de operacion de clase mundial que soporta al negocio principal de produccion de cerveza. El objetivo es demostrar como el ciclo de proceso de hacer cerveza impacta, no solo en las funciones de ingenieria de diseño, construccion y arranque, sino tambien en las actividades comerciales tales como la administracion del contrato y proveeduria.

Topicos especificos tratados en este trabajo incluyen: un enfoque de sistema versus enfoque por area o disciplina, estructurando PLC y arquitectura de supervision, estructurando arreglos contractuales, recursos propios o administracion llave-en-mano, estructuracion de documentacion.

Se da ejemplos practicos del proyecto alrode de las cervecerias del Africa del Sur, recientemente terminado. Una expansion de USS200 millones para llevar la produccion de cerveza de 75,000 hl/semna a 137,000 hl/semna. La planta y equipos instalados incluyen una casa de coccimiento de 1500hl, 48 x 3000 hl tanques de fermentacion, una sala de filtracion con dos filtros de bujia de 600 hl/h, plantas de CIP y manejo de levadura, 6 calderos de 20 t/hr, sala de maquinas y servicios y una linea de embotellado de 60,000 botellas/hr. La cerveceria incorpora los mas altos niveles de automatizacion y control de proceso en el grupo de cervecerias de Africa del Sur (SAB).
2. BACKGROUND

At this stage then, it is appropriate to present a brief description of the Alrode Brewery Expansion Project as a basis for the development of the operational model for project execution.

The Brewery is located at the Alrode Industrial Site, near to Johannesburg in South Africa. The scope of the project was to increase site output capacity from 75,000 hl per week to 137,000 hl per week in a phased manner. This involved installation of the following major capital plant and equipment to expand existing facilities at the 20 hectare site.

- Phase 1: main sub-station, dilution plant and tanker bay
- Phase 2: front-end engineering design
- Phase 3: 40,000 bph packline, and warehouse
- Phase 4: 1,500 hl brewing plant
  - 48 x 3,000 hl fermenters
  - 2 x 600 hl per hour filtration lines and service plant
  - 8 x 2,000 hl bright beer cellar
  - 60,000 bph packline
  - 6 x 20 tph boiler plant
  - 18.5MW refrigeration plant

The brewery expansion was designed to be fully automated interfacing with existing plant which incorporated both manual and a medium level of automated control.

The project team was established in the Company’s Central Office approximately 45 km from site. Process design and project engineering resources were provided both in-house and through a partnering relationship with an Engineering Management Contractor with experience in the process and petrochemical industry. The project team interfaced with a small, full-time group from the operating region.

3. AN OPERATING MODEL

3.1 Competing Philosophies

The foundation of the model proposed is that all dimensions of the project life cycle should be designed and developed around systems which are derived from the value added manufacturing chain of the environment in which the project will be executed.

One alternative philosophy commonly adopted is the division of the work cycle to align with engineering/functional disciplines, throughout the various stages of conceptual design, detail design, procurement, implementation, commissioning, etc., for example:

- Process engineering design
- Process control hardware and software
- Civil engineering
- Electrical engineering
- Plant and equipment layout
- Procurement
- Construction, etc.

A further alternative would be to develop and execute the project along boundaries imposed by areas. These areas may be operational or physical in nature, for example:

- Brewing Department
- Filtration room or a multi-purpose building

All of the approaches described above have been tested in S.A. Breweries with varying degrees of success. However, there is a fundamental theme which makes the system approach the preferred option - and that is the question of ownership.

It is suggested that to significantly increase the likelihood of success of a project the role of System Sponsor or System Champion must be effectively fulfilled. This role demands that the incumbent understands all of the interfaces, both internal and external, which must be taken into account for any logical systems derived from the manufacturing value chain. Activities must be focused to realize the output of the system as opposed to the outputs of subsets of the system.

3.2 The Designer’s Dilemma

Company experience of the hereto commonly accepted alternatives to project execution, i.e. the discipline or area approaches, reveals a tendency to create “functional silos.” This results in resources being utilized to produce any number of “parts,” the sum of which, in many cases, do not add up to the desired “whole.”

To illustrate this by way of example, consider the strategy used on the Alrode Brewery Expansion regarding discipline, area and systems design. Figure 1 shows the significant systems identified in the project which are typical of the value added chain for brewing. Initially it was believed that the allocation of responsibilities based on physical area was appropriate, and Area Project Engineers were duly appointed to act in the role of overall coordinators. Figure 2 shows how these physical boundaries did not coincide with the value chain or primary production systems.

The area strategy was further weakened by the fact that budget responsibility for the entire project rested with Lead Discipline Engineers who interfaced horizontally across all areas in a typical project matrix structure. A tendency developed for procurement and contract structures to be driven by the disciplines without due regard for system accountability. This undue technical influence was, in fact, the greatest single criticism of the overall project implementation strategy in a subsequent audit exercise; and was perhaps most divisive in the process control discipline.

Process automation and control has been evaluated somewhat by adopting a manufacturing strategy which strives to attain reliability, consistency of product quality, and to provide on-line information from data. The implementation of a process automation and control philosophy congruent with systems engineering design provides a further useful illustration of the advantages of this model over both the area and discipline based approaches.

The design of control system hardware architecture requires only basic knowledge of the process being automated. To exaggerate for the purpose of example, an exercise to summate the total number of input and output signals will determine hardware capacity, and the installation of this capacity will be dictated by layout and cable routing considerations. This traditional discipline design approach can lead to a situation illustrated in Figure 3 which shows how the boundaries were initially established on the Alrode Expansion with respect to PLC hardware and software design. These boundaries then became the battery limit conditions for contractual agreements which would typically include the provision of any supervisory and management information system.
**FIGURE 1 - Alrode Brewing Process Systems**

![Diagram of Alrode Brewing Process Systems](image1)

**FIGURE 2 - Alrode Brewing Process Systems - Physical Layout**

![Diagram of Alrode Brewing Process Systems - Physical Layout](image2)
FIGURE 3 - Automation and Controls - Contractual Boundaries

FIGURE 4 - Documentation Structure

<table>
<thead>
<tr>
<th>Alrode Brewery</th>
<th>No</th>
<th>System Name</th>
<th>Contractor</th>
<th>PLC Name</th>
<th>Node Numbers</th>
<th>PLC Numbers</th>
<th>Design Database</th>
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<td>Bright Beer</td>
<td>Contractor 1</td>
<td>BBT CIP</td>
<td>13 15 14</td>
<td>01 02 03</td>
<td>BBT CIP BBT FILL &amp; FILTER</td>
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<td></td>
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MECHANICAL CATALOGUE SECTIONS

- Compiled in Global Brewery Catalogue
- Compiled By System
- Compiled By PLC
- eg. Standards & Specifications
- eg. Process flow Diagrams (PFD'S)
- eg. Software documentation (PLC)
In this particular example, the single process system of filtering and diluting high gravity green beer into bright beer tank involved no less than ten disciplines design interfaces.

The net consequence is an automation and control system that does not reflect the process, or operating system, does not meet the preferred operability requirements of production, and has numerous interfaces which create both design and management conflict during the course of project execution.

It is further suggested that a similar situation could arise in the implementation of industrial electrics design due to the manner in which MCC capacity is determined by a summation of electrical drives and capacity location is once again largely dictated by layout and cable-routing considerations.

### 3.3 Commercial Considerations

The philosophy outlined in the examples described above may also be applied to project activities which are not technical. Consider first the requirements for documentation that will be utilized for operator training, scheduled maintenance and as the basis of design for any future developments. Whether in hard copy or software format there should be no doubt that appropriate documentation is critical to the long-term sustainability of process system performance.

However, documentation will be provided to the end user, the Brewer, as a deliverable of a contract. If the contractual battery limits are either discipline or area-based then so is the scope of documentation. The interface problems created by imposing plant-wide control and electrical design architecture across a number of process systems will be duplicated in the documentation. Figure 4 shows how, for a process area on the Altrode Project, the detailed design and training documentation was made up of a number of PLC nodes, databases and mechanical equipment catalogs.

Consider next the development of contractual agreements. With a flatter, more decentralized structure, the organization is focusing on developing core competencies and key support skills internally, whilst outsourcing those functions which do not directly deliver or support improved business performance. Consequently, detailed engineering design and project management services will increasingly be provided through "partnering" relationships.

By entering into an alliance with a partner organization that has a culture, set of values and goals similar to our own, it is hoped that a common "spirit of agreement" can prevail in contractual arrangements. This implies that, over time, our partners will develop an intimate understanding of our business and technical requirements, which will negate the need to continually renegotiate these for every contract.

To date this philosophy has had limited success. One reason for this is that there is a reluctance on our part to truly commit to a few partners for the majority of our business. Likewise, our potential partner organizations do not readily perceive the benefits of such an agreement themselves, possibly brought about in part due to the fact that an engineering "partner" has limited scope in Southern Africa to offer his industry specific services to a wide enough customer base.

There has also been a tendency to overestimate the maturity of Regional Brewers and partner organizations to be able to appreciate the importance of the systems-based model described for project execution and, consequently, the System Sponsor or Champion has not emerged to take full ownership in the manner envisaged. In short, the Production Manager, Engineering Designer and Project Manager have yet to be successfully merged as the Generalist in a contract management organization serving our brewing industry and, until such time as this is achieved, SAB will have to be careful not to delegate unrealistic requirements to its partners by avoiding classical "turn-key" contractual arrangements in favor of retaining the management of our core and key support functions.

### 3.4 The Model Summarized (refer to Figure 5)

As an organization, SAB has adopted world class manufacturing as a core strategy which has a direct impact on overall business performance. This implies that the group recognizes that the total pool of technical skills is a single resource, and the operating division is the overall unit of measure. We understand the difference between functional specialization, the application of engineering and technology, and the different roles and responsibilities this requires in the successful execution of projects.

Overall performance requirements are established by the end user, in conjunction with a centralized group who are the custodians of core technology, divisional standards and specifications. These requirements must be expressed in terms of outputs of logical systems in the value added chain, and are not determined by either discipline or area requirements.

Having established the "WHAT" and the "WHEN," the project execution team sets about determining the "HOW." In the majority of cases this will require an integrated, multi-disciplinary team approach working within the overall system quality
requirements and functional standards and specifications. This team will be constituted by entering into appropriate “partnering” relationships with organizations which specialize in those areas which are not considered a core or key support activity.

Experiences like those described on the Alrode Project has led our organization to believe that an effective team leader must be able to achieve focus, and a direction of efforts in order to drive operational systems to completion. Inter- and intra-system integration is recognized as a key success factor, particularly in the activities of design and subsequent commissioning. The role of the functional discipline reverts to that of the traditional matrix structure: to ensure technical integrity, continuity and consistency of standards and specifications, and to achieve across-system horizontal integration.

Applying this model to latter stages of commissioning and handover on the Alrode Expansion avoided the protracted tailing-off of the project life cycle that had been typical of previous major projects. By way of a final illustration, Figure 6 below shows how the process control resources allocation was rationalized along systems boundaries as proposed in the model.

4. CONCLUSION

The Alrode Expansion was one of the last projects that SAB intends to develop and implement on either a discipline or area basis through in-house project management. Manufacturing strategy dictates that Regional Breweries become accountable for capital investment and process development, supported by a centralized group of core competencies and on a basis of being measured, year by year, against the concept of “Economic Value Added.” Routine engineering design and project management are not regarded as a source of competitive advantage and will be outsourced on a managed contract basis.

A key success factor for the model is to use the process system of the manufacturing value chain to define the outputs of projects. Organizational structures will mirror the process system and multi-discipline teams will be led by generalists with the ability to identify and manage both the internal and external interfaces.

Defining the Beer Division of SAB as the unit of measure and empowering the core technology groups as divisional custodians of our processes will consolidate all our learnings into a unique SAB way of operating which, in the future, will form a basis of successful competition.