CONSIDERATIONS FOR THE DESIGN OF MODERN-DAY LABORATORIES

By

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Abstract

LABORATORY BUILDINGS ARE an essential part of every sugar mill. In Maryborough Sugar Factory's case the building was in poor condition, dated, and well below required minimum laboratory design standards. The poor state of the building and unacceptable working conditions led to the development of a plan to build a modern purpose-built laboratory. The basis of the paper will outline the methodology, developed design and difficulties associated with the design and construction of modern day sugar mill laboratory. The paper gives particular emphasis to design briefs, building approvals, juice sampling, Sugar Industry Act and cane payment, modes of construction, and project management, all aimed at developing and implementing a successful plan to construct a modern-day laboratory.

Introduction

Maryborough Sugar Factory's existing laboratory (Figure 1) was relocated and shifted to a riverbank site in the 1940s and was in very poor condition. The building was believed to have been up to 100 years old. The riverbank location was not ideal and it was costly and not feasible to renovate the building to meet current building codes and standards.

This led Maryborough Sugar Factory (MSF) to develop a plan to design and construct a purpose-built sugar mill laboratory. This plan had a number of hurdles to overcome not only from the design and planning perspective but also due to other business priorities relating to mergers and acquisition of sugar businesses at the time.

This created a situation where the project was postponed a number of times over a 7-year period. Eventually in 2013 a new sugar mill laboratory (Figure 2) was constructed and this paper provides information on considerations for the design of modern day sugar laboratories based on Maryborough Sugar Factory's experience.

Fig. 1—The old laboratory building at Maryborough Sugar Factory.

Fig. 2—New laboratory building at Maryborough Sugar Factory.

Methodology

The aim of the project was to deliver a functional, compliant, and cost effective solution for the purposes of sugar mill analysis and engineering office space at Maryborough Sugar Factory. The CONOPS (concept of operations; Figure 3) model was developed and outlines the processes taken to deliver the project. The model was divided into four parts: management, development, compliance, and operational.

The CONOPS shows how the project transitioned from one phase to the next and the interaction of MSF's management with contractors.

Early in the project, MSF made a conscious decision to undertake the role of self-managing the project. This was an unconventional decision given that MSF had no experience in the construction industry. However MSF staff believed this to be necessary for two reasons: firstly the unique aspects of sugar mill laboratories; and secondly to ensure the project was delivered on time and on budget.

To initiate the project, MSF formed a committee and allocated a project manager to develop, approve, and oversee construction of the project. After management roles were defined, architects were engaged to develop a design brief (this is further discussed later in the paper).

All the design and planning work was under the direction of the MSF project manager. After developing a design brief the architects created concept plans for review by the building committee. After the concept plans were approved by the building committee, architects worked on further developing and drafting preliminary drawings for construction.

At this point a development application was submitted and tender documentation developed based on the architects work.

Once development approval was granted the project was put out for tender and the preferred contractor engaged. With the contractor engaged, the focus of the project transitioned from the development phase to finalise compliance requirements and hence to the operational phase.

MSF submitted building approval documentation and completed construction drawings and commenced earthworks the day after finalising building approval.

Project management

For the project to be delivered on time and on budget, an effective management strategy was essential. There are many different models or options available to effectively manage a project such as this. The biggest decision to be made is whether to engage a project manager or utilise existing staff. The model chosen by MSF was to form a building steering committee. This committee comprised of the general manager, project manager (also acting building superintendent),

engineering superintendent, safety advisor, and an accountant who were all existing MSF staff. Additional members of the committee during the construction phase included the building supervisor and company manager of the contractor appointed to construct the building.

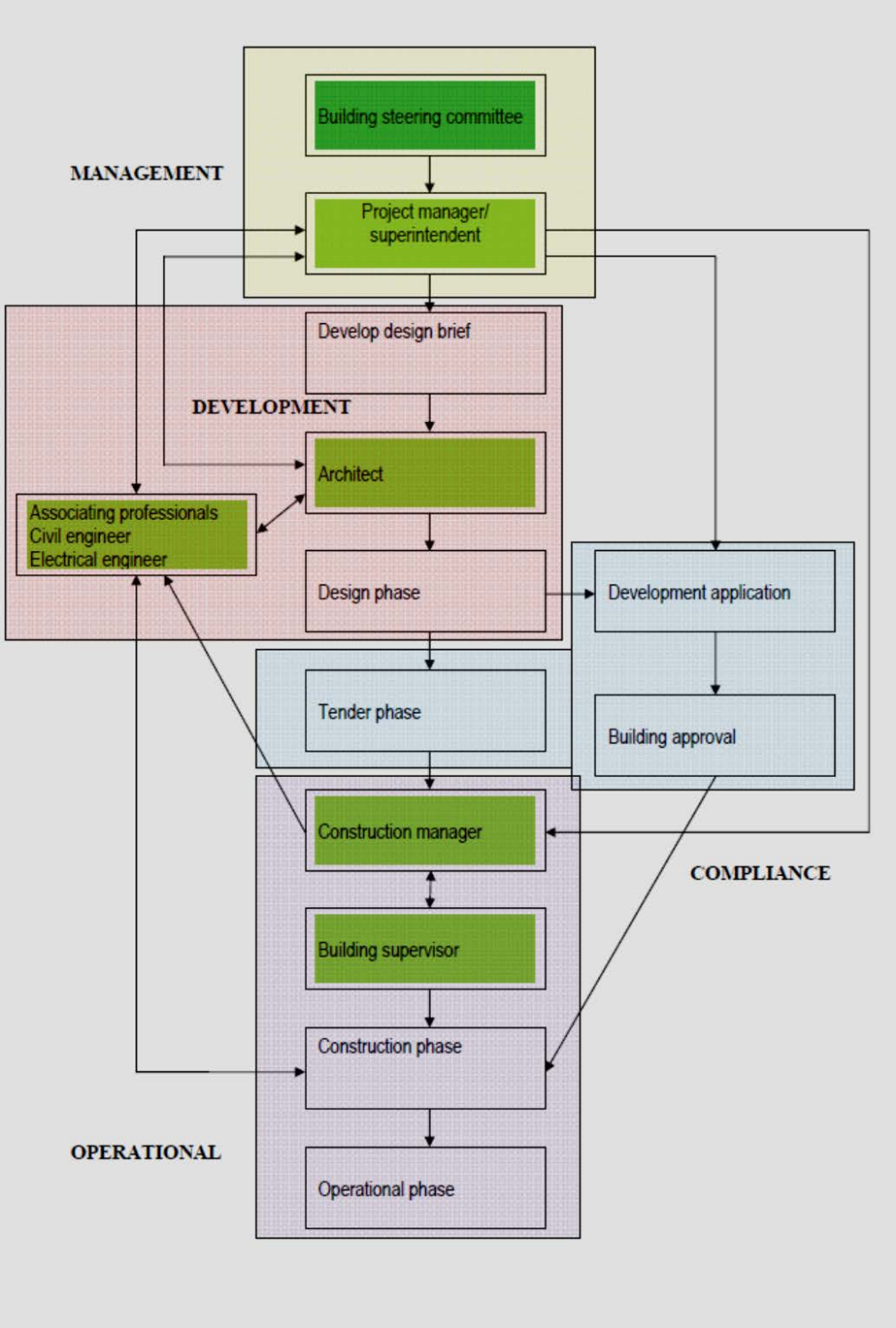

Fig. 3—Concept of operations.

The building committee was responsible for developing and endorsing all aspects of the project. All variations, design issues, budgeting and reporting were directed through the building committee.

The building committee also appointed a building superintendent, and in the case of MSF, this came from MSF's own resources. The building superintendent was responsible for all design and construction aspects of the project during the build and reported to the building steering committee.

Traditionally the superintendent normally acts as an agent of the principal and in addition as an independent certifier, ensuring all workmanship is to appropriate standards and built as per the plans. MSF in order to contain costs combined this role with that of the project manager.

Design brief

The design brief is the single most effective tool for delivery of a successful project. A good design brief will be of substantial length and provide significant detail. The design brief consists of a scope of work outlining the desired outcomes. It also contains core project data outlining specific detail including:

- number of employees and their respective positions and work areas
- special areas or tasks required i.e. juice sampling, analysis areas, oven rooms, communications, office space, etc.
- any specific service requirements for rooms or employees i.e. fibre optic, hot water, steam, air, and cane juice sampling lines.
- any new or existing fixed or portable plant equipment which is intended to be used i.e. disintegrators, fume cupboards, polarimeters, etc.

Before any concepts were devised, MSF engaged a specialist company to develop a design brief in collaboration with mill management (Insight Projects, 2008). It was important to collect as much information as possible as all this information needed to be processed and manipulated to develop a conceptual design for the laboratory.

This conceptual design could then be used by the architect and associating engineers to develop a general design of the laboratory which included all essential services and accommodated specific tasks, plant and/or equipment.

Building codes and standards

Like any other type of construction, whether it be a house or high rise building, there are minimum building codes and standards that must be followed.

In the case of laboratory buildings there are additional requirements (Standards Australia, 2005) that add significant cost to the building such as safety, ventilation, and fire systems design.

The laboratory at MSF was a multi-class building 5, 7a, 7b, and 8 low grade laboratory (Australian Building Codes Board, 2014). This basically means that for the different areas of building there were specific building requirements i.e. class 5 was office space and class 8 was laboratories. These areas were built to differing standards.

During the project, consideration was given to how the building was to be used and class designations. It was identified that there were potential savings in the construction requirements by utilising less regulated building classes, for example a medical grade laboratory class 9 has higher regulation than a class 8 laboratory or a storeroom 7b.

The amount of bulk chemicals intended to be stored (Standards Australia, 2004), segregation of chemicals, ventilation, fire design requirements, were all considered. To help reduce regulatory requirements, MSF limited the types and amounts of chemicals kept on the premises.

Recent legislative changes around disability access in the workplace meant that new constructions or any building work requiring a development application must provide disability access (Anon., 2010).

In the case of this project, the building was two storeys which meant a lift or ramp needed to be included as well as suitable PWD (people with disabilities) facilities on each level.

Through careful consideration of building codes, standards, and legislation, MSF made significant saving to reduce costs without compromising design or build quality. These saving were, however, offset by additional costs to meet safety and access requirements such as the inclusion of a lift and PWD facilities.

Juice sampling

Juice sampling is essential for sugarcane analysis to determine CCS and formulate for cane payment. Typically the juice laboratory is located close to number 1 mill and pumping the juice is a relatively simple process over a short distance.

The previous Sugar Industry Act 1999 and Cane Analysis Program 2013 (Maryborough Sugar Factory, 2013) set out specific requirements for juice sampling, mainly sample size, juice line velocities, sample contamination, and sterilisation of juice lines. Meeting these requirements becomes more difficult the further the laboratory is from number one mill. This was the case with MSF as the laboratory building was located over 140 m from number one mill. Therefore sizing the juice line is a critical process and should be considered carefully to maintain line velocities and eliminate line contamination and sediment.

The new juice laboratory (Figure 4) at MSF is fully equipped with necessary analysis equipment, CCTV, communication, and sample tracking controls and is separate to the main analytical laboratory.

Fig. 4—New juice sampling laboratory at Maryborough Sugar Factory.

Other considerations

Undertaking design and construction of a new laboratory is a problematic task. There are numerous issues that continually arise. A good design brief should identify the obvious problems and resolve any issues at the design stage. Changing designs or modifying plans after this is a costly exercise and can have dramatic effects on the flow and functionality of a good laboratory.

Important considerations from MSF's experience on the design of a laboratory are as follows:

1. Location: Consider the location of the proposed laboratory: Is it in close proximity to number one mill? Can the juice be pumped to the proposed site readily? Is it accessible to the public? Is there acceptable vehicle traffic egress? Is the location prone to flooding? Are all essential services available i.e. water, sewage, power, gas etc.?

2. Environmental: What environmental impacts are there e.g. water ways, trade waste, air pollutants etc.?
3. Local government: Consider local government development policies and zoning. MSF for example requested exemption with regard to local planning policies to build close to the river.
4. Design life: What is the intended design life of the building 10, 25, 50 years?
5. Juice sampling: The guidelines outlined for juice sampling in the Cane Supply Agreements.
6. Timeline: Can the laboratory be constructed in time for the crushing season? What contingencies are required to negate the risk of not completing the laboratory on time?
7. Cost: Consider all costs. The physical building is only a small portion of the cost of the laboratory. There is a significant cost in fitting out even the most basic laboratory building.
8. Mode of construction: This is reflective of your budget, location, and footprint. Types of construction include: pre-fabricated, block construction, cladded construction, tilt slab, single story or multiple storeys.
9. Building codes: Access, fall arrest systems, fire systems, energy efficiency, etc.

Modes of construction

There are many modes of construction to consider when designing and constructing a new laboratory. Ultimately the type of construction will be determined by various factors including: cost, design life, environmental issues, and location.

The two main factors which influenced the type of construction of the laboratory at MSF were location and cost. MSF had very few options when choosing a location, and was constrained to an area that was prone to flooding.

To overcome this issue the building was designed with two storeys (Figure 5). The lower floor was core-filled block construction and the upper floor a traditional timber frame and cladded with fibre cement sheeting. This option was cost effective and durable at the same time if the building was flooded. The ground floor provided car parking, wet laboratory, and storerooms.

All materials on the ground floor were chosen to withstand flooding and all electrical services were raised above the design flood level including the main switchboard which was relocated on the first floor. This minimised any risk posed by flooding and made it easy to get the laboratory operational quickly after a flood.

Primarily the building was constructed and fitted out for an industrial environment with the standard and quality expected of a commercial building.

Fig. 5—Construction of the laboratory building at Maryborough Sugar Factory.

Building design

The MSF laboratory was designed for functionality and the various processes specific to sugar mill analysis. The main analytical laboratory was located on the first floor (Figure 6). This area was made up of multiple rooms for juice sampling, ovens and hot work, general analysis, all serviced by a central chemical store.

The wet laboratory was located on the ground floor (Figure 7) and was dedicated to analysis of fibre, hot room, and storeroom.

Additional to the laboratory, the building provides office space for both production and engineering department staff in an additional wing of the building. The office spaces were a combination of open plan for staff and a separate personal office for each department manager.

The laboratory also had a central lobby on both floors and a spine providing easy access from one side of the building to the other. The lobby provided access to both floors via stairs and/or a lift that bordered each section of the building allowing uninterrupted access to the mill from either department.

Demolition

Through the duration of the project, MSF had two existing buildings to demolish, one of which was an old mill house and the other the existing laboratory building. The old mill house was demolished first to make way for the new laboratory.

The house was relatively easy to demolish as most of the material was salvageable and there was only a small amount of bonded asbestos. The existing laboratory however contained a considerable amount of asbestos. Of key concern was the friable asbestos in the linoleum flooring.

The asbestos in the floor coverings required full encapsulation and hygienists to monitor the site while licenced asbestos contractors removed the floor coverings.

This was an expensive exercise as the cost to remove just the floor coverings was significantly more than the cost of demolishing both the laboratory and mill house.

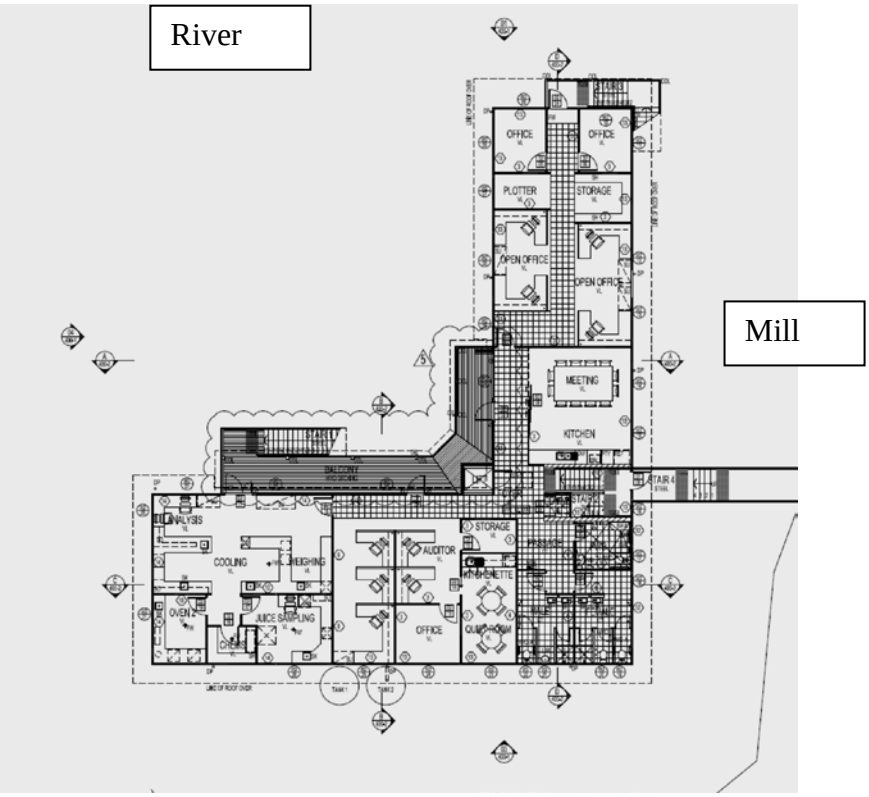

Fig. 6—Plan view of first floor of laboratory building (Parups Waring Architecture, 2012).

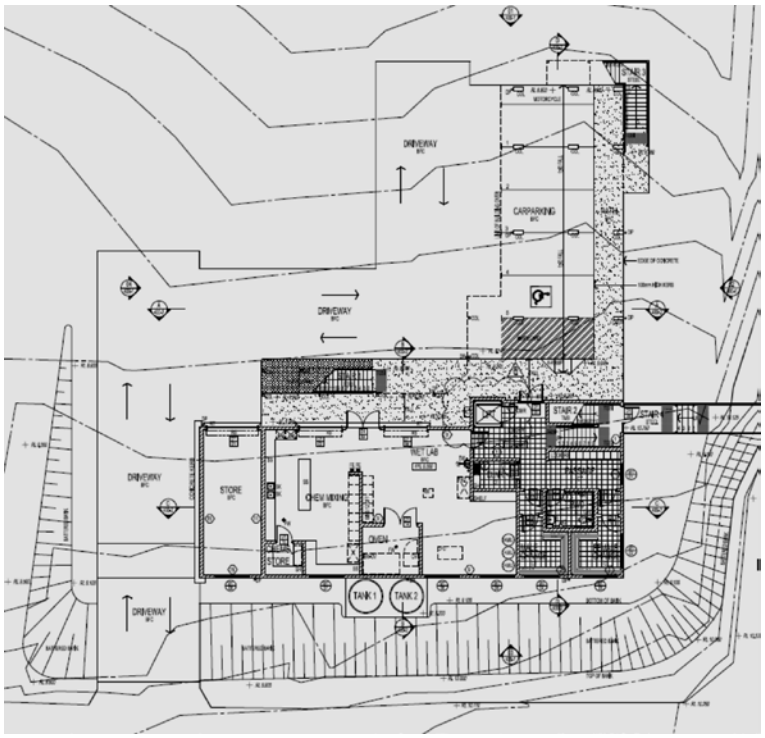

Fig. 7—Plan view of ground floor of laboratory building (Parups Waring Architecture, 2012).

Conclusion

In the 2013 maintenance season Maryborough Sugar Factory constructed and moved into the new laboratory two weeks before the start of the crushing season. The project was delivered on time and on budget with minimal issues even after successive flood events caused lengthy delays.

Given MSF's experiences from constructing a new sugar mill laboratory the key to a successful project is not in the physical aspects of the building but getting the detail right in the preliminary design stage.

If an effective management strategy is implemented together with a comprehensive investigation and planning in the design stage including understanding of standards and compliance aspects, the transition from an old laboratory to a new will be a smooth one.

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REFERENCES

Anon. (2010) Disability (Access to Premises – Buildings) Standard 2010. Available at http://www.comlaw.gov.au/Details/F2010L00668 (accessed 5 January, 2015).

Australian Building Codes Boards (2014) National Construction Code Series, Volume 1–3. Australian Building Codes Board.

Insight Projects (2008) Design facility brief. Prepared by Peter Carlisle, Insight Projects, Sydney.

Maryborough Sugar Factory (2013*)* Cane analysis program. Maryborough Sugar Factory, Maryborough.

Parups Waring Architecture (2012) Maryborough Sugar Factory Laboratory and Office. Prepared by Denis Waring, Parups Waring Architecture, Brisbane.

Standards Australia (2004) Safety in laboratories Part 10: Storage of chemicals. AS 2243.10-2004. (Standards Australia: Sydney).

Standards Australia (2005) Safety in laboratories Part 1: Planning and operational aspects. AS 2243.1-2005. (Standards Australia: Sydney).