

# **Production in Construction**

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## **1. Introductory Chapter : Production**

### **1.1 Background**

The main and initial aim of any firm is to generate a profit. This is done by adjoining a few important processes, under which the most important is delivering good production.

Production makes or breaks a firm. By delivering a good product, on time, within scope and budget keeps any firm in the market. It develops the potential for growth, which leads to greater profit and success.

A lot of aspects is involved in delivering good production. Work-flow is defined as the flow of work on-site, i.e. activities, carried out by the construction workers on the construction site. The work on site requires different kind of resources. These resources have also to flow to and within the construction site. This is defined as resource flow. Planning of construction projects does not only concern the planning of work on site, each material must be delivered in time, drawings must be available when an activity starts, subcontractors must show up when they are required, etc. These plans are not automatically coordinated during the course of a construction project, i.e. the site manager and its supporting team has a lot to keep track of during the project.

This research will look at the importance of production, and delivering alternative methods for improvement.

## **1.2 Main Problem**

Delivering a quality product, within time and budget is the most important aspect of any firm, but this goal is not always achieved. This problem persists due to a lack in production.

Production is influenced by the following sub problems: Planning, Management, Recourses, On-site financial control, Health and Safety

## **1.3 Sub Problems**

### 1.3.1 Planning

- Is the current method of planning sufficient and can it be improved?

### 1.3.2 Management

- Has top management, on and off site, got enough knowledge and experience and are they doing their job at their full potential?

### 1.3.3 Resources

- What resources are required and what resources are being used?

#### 1.3.4 On-site financial control

- What methods are used on-site, to keep record and control financially wise, and what alternative methods are there?

#### 1.3.5 Health and Safety

- How does health and safety affect a construction project?

### **1.4 Hypothesis**

#### 1.4.1 Planning

- Planning plays a very big role in a project and often determine the outcome
- Too little time is spent on the planning process and allot of small details is missed.
- By avoiding small mistakes in planning, big mistakes on site is avoided

#### 1.4.2 Management

- The correct personnel are often misplaced and care must be taken in choosing them. Site-Agents must see to it that the job gets done, and his supporting team must provide the adequate information and supplies for him to do it.
- A system can be developed to see to it that every employee does their job to full potential.

#### 1.4.3 Resources

- A lack of resources influences production

#### 1.4.4 On-site financial control

- A system must be developed to engage a day-to-day record keeping on the following :  
Daily production  
Daily cost  
Daily material used  
Daily materials received

#### 1.4.5 Health and Safety

- This is an issue that plays a crucial part in any project
- Accidents can be prevented if Health and Safety management is implemented correctly
- This could save money and lives

### **1.5 Delimitations**

- Not applicable

### **1.6 Definitions and Terms**

- BEE - Black Economic Empowerment
- H&S - Health and Safet

### **1.7 Assumptions**

- Not applicable

### **1.8 Importance of the study**

- The importance is the formulating of alternative methods, to increase production in construction, which could play a important role in the future of construction.

### **1.9 Research Methodology**

#### 1.9.1 Interviews :

- Jan van der Walt – CEO Lonerock Construction
- Fred Pogempoel – Director Lonerock Construction
- Louis van der Walt – Health and Safety(H&S)

#### 1.9.2 Literature

- Googleblogs (construction)
- South Africa.info
- NHBRC Reports

## **2. Chapter Two: Planning**

## 2.1 Survey of Planning

Construction planning plays a fundamental role in the management and execution of construction projects and has a big influence on production, and involves the following challenging tasks :

- Choice of technology
- Definition of work tasks
- Estimation of required resources
- Durations for individual tasks

Forming a productive and effective construction plan is a highly challenging task. As Sherlock Holmes noted:

“Most people, if you describe a train of events to them, will tell you what the result would be. They can put those events together in their minds, and argue from them that something will come to pass. There are few people, however, who, if you told them a result, would be able to evolve from their own inner consciousness what the steps were which led up to that result. This power is what I mean when I talk of reasoning backward.”

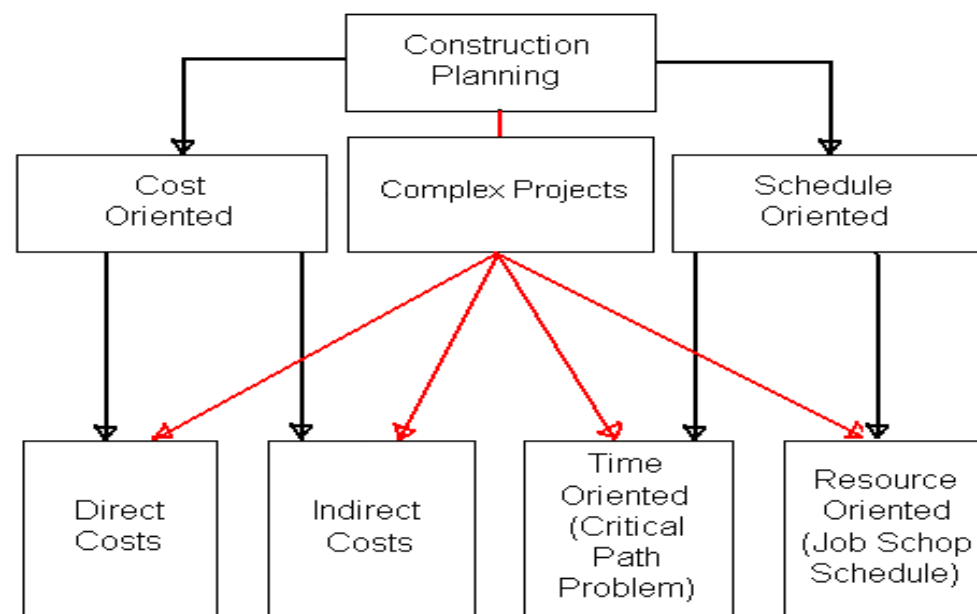
(A.C. Doyle, "A Study in Scarlet," *The Complete Sherlock Holmes*, Doubleday & Co., pg. 83, 1930)

Sherlock Homes further describes construction planning by using a detective's work.

A detective starts with a result and has to work back to determine how that result occurred. The only difference in construction is that the planner has to visualize the end result. The other problem is that there is different ways of obtaining that result and the best possible one must be discovered/formulated.

A good construction plan is the basis for developing the budget and the schedule for work. Developing the construction plan is a critical task in the management of construction. In addition to these technical aspects of construction planning, it may also be necessary to make organizational decisions about the relationships between project participants and even which organizations to include in a project. .

In developing a construction plan, it is common to adopt a primary emphasis on either cost control or on schedule control. A lot of projects are divided into expense categories with associated costs. This means the construction planning is cost or expense oriented.



**Fig 1 Construction Planning** (Baker, K.R., *Introduction to Sequencing and Scheduling*, John-Wiley and Sons, New York, 1974)



In other cases the scheduling of work activities over time is critical and is emphasized in the planning process. In this case the planning involves proper sequences among activities and that there are adequate resources available. This manner of planning emphasizes on the critical path.

Complex projects require the consideration of cost and scheduling over time. In this case both of above mentioned points are essential as indicated in flow diagram above.

## **2.2 Choice of technology**

To illustrate the importance of good planning and the effect of technology choice an example will be used.

In a roadway project in Pittsburgh the decks on overpass bridges as well as the pavement on the highway itself needed to be replaced. Initially the construction plan was to work from each end of the overpass bridges outwards, while below the bridges the highway surface could be replaced. The problem was access of equipment and concrete trucks to the overpass bridges. The highway work on the other hand could be arranged so that each overpass bridge was accessible from below at certain times. The plan was to pump concrete up to the bridge from the highway surface below. This planning and manner of pumping worked excellent, work was done faster and costs were actually reduced.

(Internet - Google blocs on Construction Planning, 2009/05/05)

There are always alternatives in technology to choose from in executing a particular job. Choosing the right technology is a critical ingredient in the success of a project.

As in the development of appropriate alternatives for facility design, choices of appropriate technology and methods for construction are often ill-structured yet critical ingredients in the success of the project. For example, a decision whether to pump or to transport concrete in buckets will directly affect the cost and duration of tasks involved in building construction. When a decision is to be made between these alternatives consideration of the following is important

- The relative costs
- Reliabilities
- Availability

### **2.2.1 Definition of work tasks**

At the same time of technology choice, the various work tasks that must be accomplished should be defined. These work tasks are needed to accurately determine the scheduling of activities, required resources per task and the sequence of these tasks.

Initially it takes up a lot of time to define all work tasks since projects normally consist of many. But once tasks have been defined it could be used on repetitive tasks with minor differences. An example would be a floor slab in a building. Each slab on different floors would have minor differences and the definition of the task could repetitively be used. As time progresses in a construction firm the definition of work tasks becomes easier.

### **2.2.2 Estimation of required resources**

In construction it is important to know exactly what resources are required for a certain project in whole. The problem arises when determining these resources by looking at the project in whole.

To determine this accurately the resources required for each individual task must be determined first. Compare these answers time wise against each other and see where one team can do more than one tasks on different time-scales. By adding up all these answers an accurate project resource requirement can be determined.

By planning accurately and having the exact amount of different recourses required to adequately complete all tasks within time and quality specified money can be saved and production increased.

### **2.2.3 Durations for individual tasks**

Accuracy in determining durations of each individual task plays an essential role in the planning process. This element influences the whole program.

In the construction industry *Time* and *Quality = Money*

It is plain and simple : If you can't determine the duration of the project, keeping external factors in mind the possibility of failure arises.

According to Jan Smit (Lonerock Construction,17/04/2009/,Heineken Brewery) the following formula can be used in determining any construction task duration:

$$D_{ij} = \frac{A_{ij}}{F_{ij} N_{ij}}$$

For Example :

$D_{ij}$  = Duration of concrete formwork assembly

$A_{ij}$  = Required formwork area to assemble ( m<sup>2</sup> )

$F_{ij}$  = Average productivity of a standard crew in this task ( m<sup>2</sup> per hour )

$N_{ij}$  = Number of crews assigned to the task

### 2.3 Test of Hypothesis

Planning plays a major role in the outcome of a project and is not sufficient enough to increase production. By dividing planning into these four simple steps, and breaking it down into tasks, avoids small mistakes which on its own in future will avoid big mistakes. This will increase a construction firm's productivity and profit.

### **3. Chapter Three : Management**

#### **3.1 Introduction**

Knowledge workers are essential for the success of construction projects. Unfortunately, experienced construction knowledge workers are retiring and taking their decision-making skills with them, generating gaps of knowledge in the construction industry. The replacement of highly experienced project managers and other construction professionals is a difficult process for the industry, because decision-making skills are acquired slowly over many years and sometimes through the execution of costly mistakes.

In addition, construction engineering and management curricula are not very helpful, as decision-making skills are difficult to teach in a traditional academic setting. The analysis of historical case studies is often used, but this approach is limited by what has already happened. Thus, a case study approach does not allow the exploration of “what if” scenarios or doing so in the context of active conditions.

The aviation and medical industries face a similar dilemma of how to expose their professionals to realistic situations for acquiring and developing decision-making skills without endangering the life of passengers or patients, respectively. Both industries are solving this problem by taking advantage of situational simulations in virtual environments. As an illustration, flight simulators allow pilots to virtually execute and study different alternatives, while computer-aided surgery allows doctors to perform virtual operations. A similar approach can be applied in the construction industry by developing situational simulations to provide construction managers and other decision makers the opportunity of experiencing and responding to risky events without endangering the success of real projects. (Eddy M. Rojas and Amlan Mukherjee)

### 3.2 Virtual Coach

Virtual Coach is a visualization-based decision-making technological environment for the execution of situational simulations. The Virtual Coach platform takes advantage of both client-server and peer-to-peer protocols to generate a Web-centric virtual environment where educators can focus on the development of simulation exercises rather than on the associated technological issues. The Virtual Coach technological platform supports the integration of modeling, simulation, visualization, and computational software into a virtual environment on the World Wide Web. This virtual environment responds to participants' manipulations, challenging them to use their knowledge and skills to experiment and solve problems in a dynamic setting where conditions constantly change in response to their actions.

The Virtual Coach platform supports the following objectives:

- Distribution of knowledge
- Building of partnerships
- Encouragement of education-oriented simulations
- Encouragement of post exercise activities
- Building of repository

The Virtual Coach environment is made up of three applications:

- the visualization engine
- the emulation engine
- development engine.

The visualization engine manages the user's interface, the emulation engine performs all computations necessary to implement the simulated environment, and the development engine provides a visual development environment to create simulation exercises. The following figure illustrates the interactions among these engines. This infrastructure facilitates collaboration, as developers are able to generate, modify, upgrade, and store their simulations on their own personal computers. There is no need to post the simulations to a Web server, as the system is built to take advantage of the peer-to-peer protocol (Eddy M. Rojas and Amlan Mukherjee)

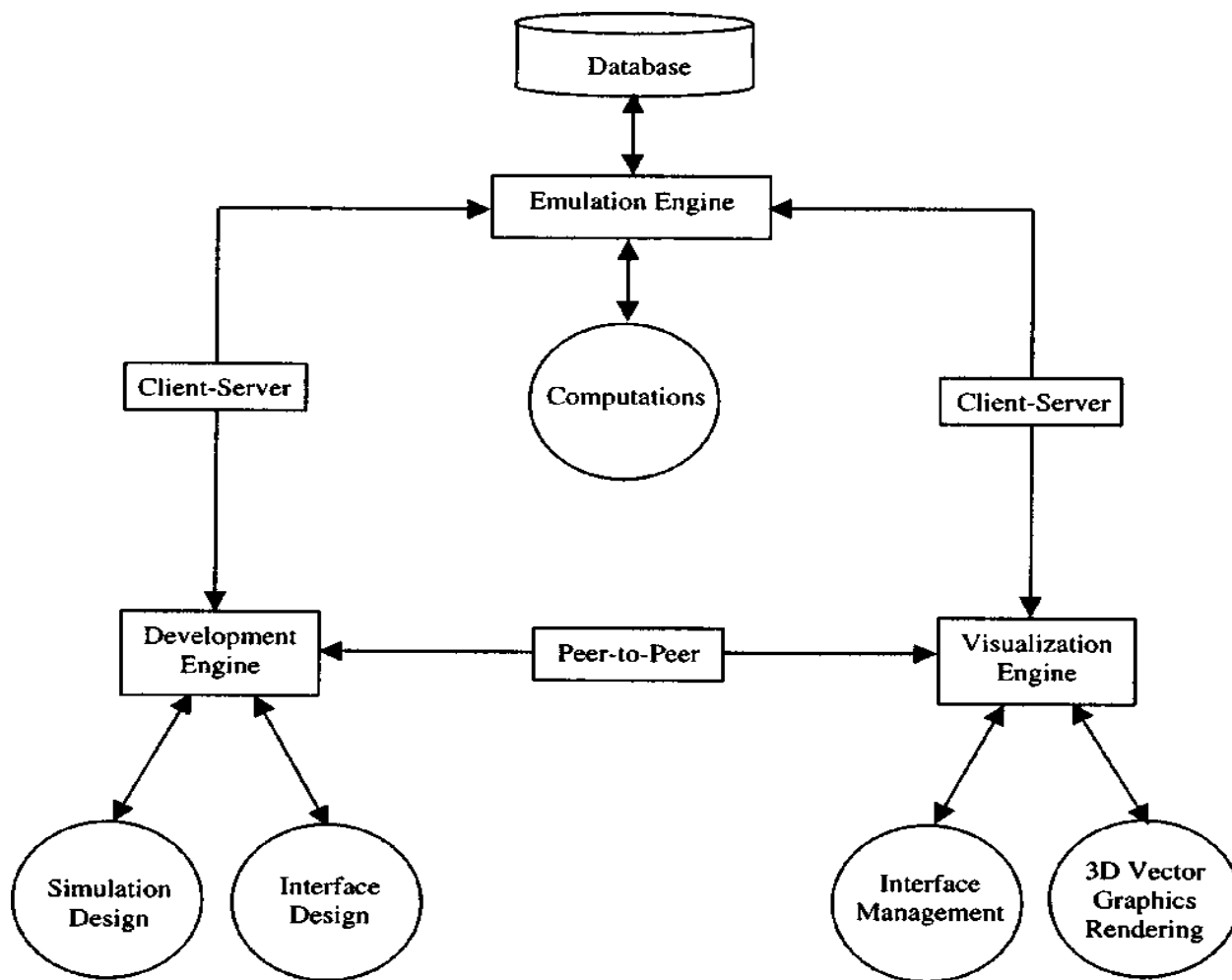


Fig 2 Virtual coach technological platform

(JOURNAL OF COMPUTING IN CIVIL ENGINEERING © ASCE / OCTOBER 2003)

### 3.3 Situational Simulations

The Virtual Coach implements temporally dynamic clinical exercises with the objective of exposing participants to rapidly unfolding events and the pressure of quick decision making. Such exercises usually require the evaluation and interpretation of relevant data to “solve the



crisis/problem.” Situational simulations are also known as strategic, role-playing, and crisis-management simulations. Learning environments that use situational simulations present concepts while clearly illustrating their relations to the environment.

Gaining in-depth knowledge and skill with respect to a particular practice or concept is directly related to the availability of resources and the contextual demands. In a field such as construction engineering and management, where context-specific knowledge and awareness is imperative, situational simulations would be able to challenge the students’ capabilities and thereby improve their understanding of the concepts and their interrelations.

An example of situational environments is the Virtual Gorilla Project at Georgia Tech, which has been developed to explore techniques for using virtual reality to present information experimentally to users that would otherwise be difficult for them to learn. Using real-life data regarding gorilla behavior from the Zoo Atlanta gorilla exhibit, an environment was modeled where the user could explore areas that are normally beyond limits to the casual visitor. The environment extends the educational experiences provided in the traditional zoo by encouraging users to personally experience what it is like to join a gorilla family group and test behaviors and elicit appropriate responses from other members of the gorilla family. This project is also being used to expose a graduate-level class from the School of Architecture at Georgia Tech to zoo design principles by allowing them to immersively experience the main gorilla habitat at Zoo Atlanta. They can also gather information regarding habitat design principles; create, delete, or modify design elements; and experiment with different visitor viewpoints.

(Allison 1997,Internet-Google Blocs)

Their studies have proved that learning occurs when people adapt to their environment. Hence, in order to understand adaptation, educationists will need to think of the learner as embedded in the learning environment and physically active in it. This indicates that an interactive situational simulation using virtual environments can be effectively used to create

a teaching environment where students can individually construct context specific concepts on their own rather than receive symbolic messages that they can only remember and recall.

### **3.4 Construction Simulations and the Virtual Coach**

Traditional construction process simulations are usually applied at the planning stage to optimize resource allocation. Virtual coach technological platform includes simulation-based scheduling. A common characteristic of these simulations is that they are event driven. By contrast, situational simulations are cycle based driven. In discrete event models, discrete items change state as events occur in the simulation. The state of the model changes only when those events occur and the passing of time has no direct consequences. Therefore, simulated time advances from one event to the next and it is uncommon for the time between events to be equal. In cycle-based models, the values of variables change based directly on changes in time, and time changes in equal increments. These values reflect the state of the modeled system at any particular time, and simulated time advances evenly from one time step to the next.

An example of a situational simulation developed for the construction management domain is “A Real Organizational Unit Simulated As Life”. This business simulation system designed to assist contractors and other construction industry firms in developing their managers and in evaluating the potential costs and benefits of different business and organizational strategies. AROUSAL simulates the management process in the construction industry. It generates information that would normally be available to management staff and enables teams of students to deal with this information and related issues as they would in real life. Business settings in AROUSAL are presented through audio-visual and written case study materials. The major difference between AROUSAL and the proposed system in the Virtual Coach is that, while the former focuses on the management process of a construction firm, the latter

simulates the management process of a construction project. AROUSAL does not simulate any technical situations related to construction engineering issues. Conversely, the Virtual Coach uses an event manager that randomly throws in events, as is expected during the course of a real-life project. The participant is not forced to take a specific set of decisions in a specific situation, but is challenged to decide on the relative urgency of various parameters and come up with the best decision. Unlike the approach used in AROUSAL, the participant using this system is provided not only with information specific to a crisis, but also with information that is specific to the simulated environment. Giving the participant an opportunity to construct the situation from the provided information and to identify a particular crisis is the goal of the Virtual Coach.

(Lutz, J., Halpin, D., and Wilson, J., 1994 "Simulation of learning development in repetitive construction.")

### **3.4 Conceptual Framework**

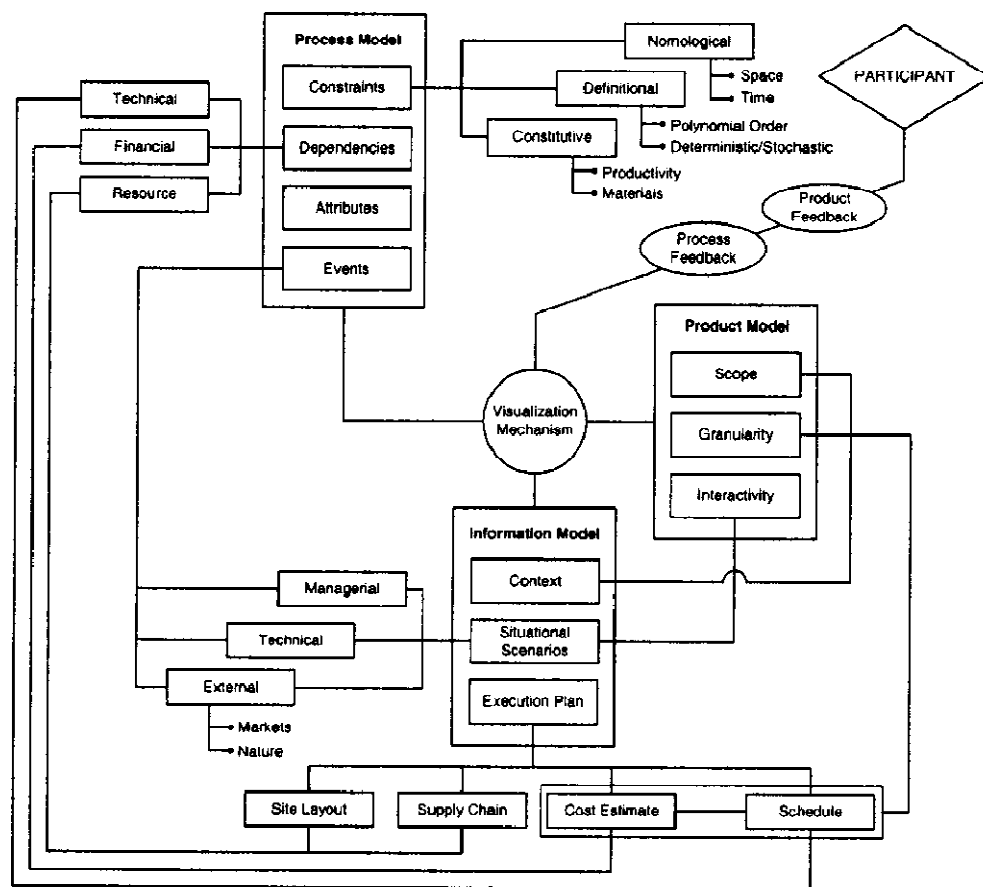
Construction management is an important process which encompasses a series of complexities that must be represented in any model. The conceptual framework introduced is a representation of the construction management process, which serves as the foundation for the development of situational simulations.

The components of this framework are shown in the following figure.

There are three major models:

- the process model
- The product model
- The information model

The process model is a representation of the building process, the product model is a representation of the physical facility, and the information model is a representation of the data environment. In addition, this conceptual framework also includes a visualization mechanism to provide process and product feedback to the participant.



**Fig 3 Virtual coach conceptual framework**

(JOURNAL OF COMPUTING IN CIVIL ENGINEERING © ASCE / OCTOBER 2003)

### 3.4.1 Process Model

As can be seen in previous figure the process model is defined by constraints, dependencies, attributes, and events. Constraints are limitations to the process given by nomo-logical, definitional, or constitutive principles. Nomo-logical constraints are nonnegotiable limitations that must be satisfied because they are dictated by natural law. Two instances are space and time.

For example, in the process model, two materials cannot occupy the same space at the same time, nor can the total amount of materials stored at the site exceed the available space. The Virtual Coach conceptual framework is imposed by mathematical relationships. Two instances are the polynomial order of the equations and the deterministic nature of the variables. All equations in the process model are first-order polynomials, which simplifies numerical calculations as linear relationships are used to extrapolate and interpolate data. In addition, all variables in the process model are deterministic, further reducing computation requirements. Finally, constitutive constraints are limitations imposed on the process model by choice. Two instances are productivity and materials. Productivity is represented in the process model as dollars per unit of time, rather than squared feet, cubic yards, or any other production metrics per unit of time. This limitation was imposed to provide a single unit to measure the variable and thus facilitate the application of events that impact the productivity of a variety of activities. Materials is another variable for which a limitation was specified. The number of different materials in a typical construction project could run into the thousands. In order to reduce the data storage requirements of the process models, materials were classified into two categories: driving and nondriving. An activity-based material tracking system for driving materials is implemented in the process model.

- Driving materials are defined as the biggest cost drivers in an activity. This self-imposed limitation on the process model significantly reduces that number of materials to be tracked, as it is often the case that only a handful of materials comprise most of the material costs of an activity, even if several dozens are required.
- Non-driving materials are bundled into one variable and are immune to changes in prices.

Dependencies are relationships among variables given by technical, financial, and resource enslavements. Technical dependencies are given by the construction schedule and represent the hard and soft logic sequencing of a project. Financial dependencies are dictated by the cost relationships among variables. For example, indirect costs are dependent on the duration of a project and the supply chain structure implemented. Resource dependencies are determined by the relationships among the different variables and resources such as materials, labor, and equipment.

As an illustration, the rate of consumption of resources by an activity is related to its scheduled duration. If the activity duration is to be compressed, the rate of resource consumption increases. Attributes are the specific characteristics that identify a variable. For example, a material may have attributes such as quantity, cost, procurement data, equipment required, and trade required, among others. Labor may have attributes such as crew size, wages, benefits, mark-ups, category, and efficiency. Events are particular occurrences of situational scenarios. For example, an event could consist of the receipt of a test report from a concrete pour of several columns, in which the experimental results from a three-day compression test are 25% below the expected strength. The participant as decision maker can disregard the results, order new tests, wait for the seven-day compression tests, demolish and reconstruct the columns, and so on. The specific action taken by the participant, as well as its cost calculated through dependencies and constraints, determine the impact the decision has on the original schedule and other relevant factors.

(Rojas, E, and Mukherjee, A.2002. “Data modeling for the Virtual Coach.”)

### **3.4.2 Product Model**

The product model is a representation of the physical facility and is defined by its

- Scope
- granularity
- interactivity

#### 3.4.2.1 Scope

The scope relates to the percentage of the actual facility that needs to be represented by the product model. This decision is dependent on the information and process model needs. For example, some situational simulations may focus only on a few activities rather than on an entire project. When this is the case, there is no need to model the entire physical facility, as a model of the physical structure associated with the previous activities and those required by the simulation exercise should suffice. In addition, the scope of the product model can also be limited by proper restriction of the interactivity of the model. There is no need to model those aspects of the physical structure that are not going to be experienced by the participant. In essence, the same principles that apply to the design of movie sets also apply to the definition of the product model: build/model only those items that the viewer/participant is going to be exposed.

#### 3.4.2.2 Granularity

Granularity is related to the level of detail on the model of the physical facility. The granularity of a product model is intrinsically associated to the project schedule in order to support 4D visualizations of the process. However, granularity is also linked to the situational scenarios, as different scenarios may require different levels of detail in the product model. Simulations should include fully developed details of the steel connections for the second and fourth floor walkways according to both the original design and the proposed modification. This level of detail would be of the essence for the success of such a simulation. However, if a similar facility is modeled for simulations without events related to the steel connections, then the product model does not have to provide such level of detail and details about the connections of steel members could be omitted altogether from the model.

#### 3.4.2.3 Interactivity

Interactivity relates to the ability of the model to be customized to better serve the participant. The interactivity of the product model is correlated to the scope and the level of granularity required. The technology selected to present the product model to the participant is also a limiting factor of the degree of interactivity of the model. For example, immerse virtual reality models are more interactive than non-immerse ones, and these in turn are more interactive than non-virtual reality models.

### **3.4.3 Information Model**

The information model is made up of the context, the situational scenarios, and the execution plan. The context provides the participant with information related to the construction project, including scope definition and business plan. It also provides data about the site in which the project will be erected, including information such as local availability of resources, labor,



materials, equipment and local regulations. This context information offers the participant a general understanding of the project goals and restraints.

Situational scenarios provide the participant with specific information about managerial, technical, and external events. An important factor that differentiates situational simulations from games is reality of function. Reality of function occurs when participants accept their roles and fulfill their responsibilities seriously and to the best of their ability. In order to accomplish this, a situational simulation must provide sufficient information so that participants can behave in a professional manner. The objective of the scenarios is to convey to participants the magnitude, severity, and timelessness of the problem or opportunity as well as all the relevant facts to encourage an analytical rather than a heuristic response. Finally, the execution plan introduces participants to the original resource-loaded schedule, cost estimate, site layout, and supply chain arrangements. Participants are free to deviate from the original plan while managing the simulated construction process if they believe that the process can be improved. However, the original plan serves as a benchmark to evaluate the appropriateness of their decisions. Deviations from the original plan can also occur when events happen and participants are expected to adjust the different parameters under their control to go back to the original plan.

#### **3.4.4 Visualization Mechanism**

The participant interacts with the process, product, and information models through a visualization mechanism that provides process and product feedback. Process feedback provides the participant with access to the “vital signs” of the construction process. Sample feedback data includes actual cost and scheduling information and comparisons with estimated values. Product feedback provides visual information about the status.

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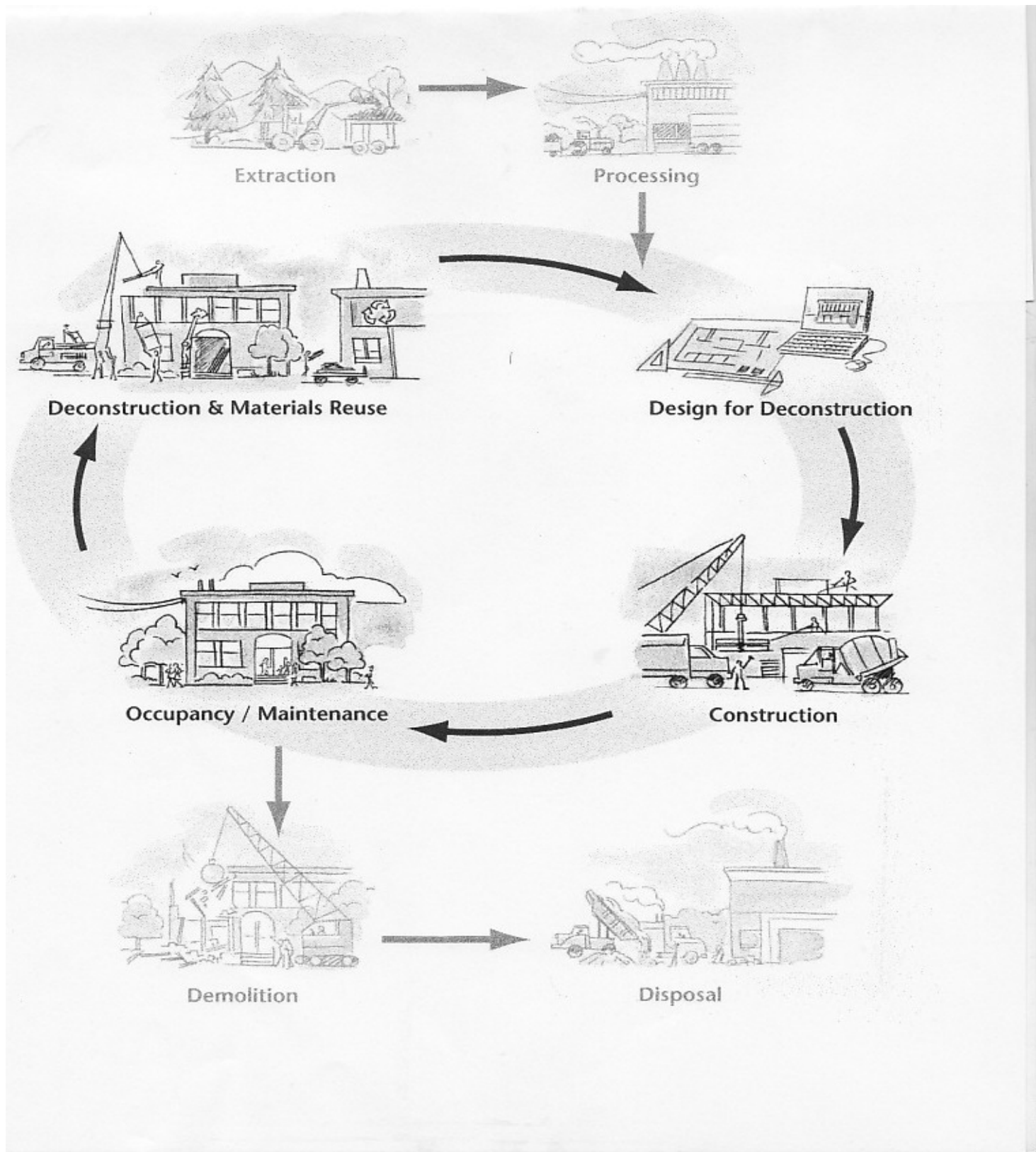
### **3.4.5 Test of Hypothesis**

By developing situational simulations in the virtual environment it could change the future construction management industry which will lead to enhanced production. Situational simulations covers the ‘‘what if’’ scenarios and leads to better decision-making. The whole idea of situational simulations is to develop a better learning environment for up and coming Construction Managers because at the moment there is a lack in knowledge and exceptional decision making.

## **4 Chapter Four : Resources**

### **4.1 Introduction**

Deconstruction is a technique practitioners are using to recover valuable building materials, reduce the amount of waste they send to dumping yards, and ease other environmental impacts over the world. Deconstruction needs to be introduced to the South African building industry. It is the disassembly of a building and the recovery of its materials, often thought of as construction in reverse. Worldwide today, the appreciation of the lifespan and value of materials has become diminished in the context of a more disposable society in which new is assumed to be better and it seems to be the same problem in higher class neighborhoods in South Africa . Technological innovation and increased availability of materials, coupled with a growing economy, population, and desire for more individualized space, has increased the demand for commercial and residential development, typically using new materials. By method of deconstruction a firm can be more productive by means of incorporating deconstructed material in their projects and saving money. Remember that being productive equals generating maximum profit on input within minimum time.



**Fig 4 Deconstruction Process**  
 (Lifecycle Construction Resource Guide—February 2008)

## 4.2 Types of Deconstruction

Two different types of deconstruction can take place on a project :

- Non-structural
- Structural

Non-structural deconstruction is a simpler method of deconstruction that demolition contractors have used for years and has more immediate financial benefits. Many projects already incorporate some non-structural deconstruction activities prior to demolition, though there is still room for the conventional demolition industry to incorporate this practice more broadly. Structural deconstruction consists of more involved recovery activities that require more time and resources to implement. To compensate the costs of these activities, projects aim to recover higher value materials. A complete deconstruction project would undertake both structural and non-structural deconstruction.

See Table 1 - attached on following page.

Deconstruction Type	Description	Characteristics	Types of Salvaged Materials
<b>Non-Structural</b> <i>(i.e. soft-stripping)</i>	The removal for reuse of any building contents that do not affect the structural integrity of the building.	<ul style="list-style-type: none"> <li>• Requires less planning and coordination than structural deconstruction.</li> <li>• Materials can be viewed and removed without much destructive access.</li> <li>• Uses few tools, and materials are salvaged relatively easily with minimum safety concerns.</li> <li>• Does not have a significant effect on project schedule</li> </ul>	<ul style="list-style-type: none"> <li>• Finish flooring</li> <li>• Appliances</li> <li>• Cabinetry</li> <li>• Windows/doors</li> <li>• Trim</li> <li>• HVAC equipment</li> <li>• Fixtures/hardware</li> <li>• Fireplace mantels</li> </ul>
<b>Structural</b>	The removal, for reuse, of building components that are an integral part of the building, or contribute to the structural integrity of the building.	<ul style="list-style-type: none"> <li>• Involves a range of tools and mechanization</li> <li>• Heightened safety consideration, and longer time-frame.</li> <li>• Materials removed are typically large, rough products that are reused as building materials or remanufactured into value added products such as chairs, tables, and surface coverings.</li> </ul>	<ul style="list-style-type: none"> <li>• Framing</li> <li>• Sheathing</li> <li>• Roof systems</li> <li>• Brick/masonry</li> <li>• Wood timbers/beams</li> <li>• Wood rafters</li> <li>• Floor joist system</li> </ul>

*Source: Adapted from U.S. Department of Housing and Urban Development (2000, 2001).*

**Table 1 Deconstruction Process**  
 (Lifecycle Construction Resource Guide—February 2009)

## 4.2 Deconstruction versus Demolition

While complete deconstruction is the preferred and most sustainable method for removing or renovating a structure, it is not always the most applicable depending on the type of building and its components. What types of buildings are ideal candidates for complete deconstruction? According to the Department of Housing and Urban Development (HUD) highly deconstructable buildings have one or more of the following characteristics:

- Wood-framed

Wood framed buildings are ideal for deconstruction because of their straightforward “stick by stick” construction, as well as the reuse versatility of the retrieved lumber. This will not be very useful in South Africa since wood is not often used for structures.

- Contain specialty materials

Certain materials such as hardwood flooring, multi-paned windows, architectural moldings, and unique doors or plumbing/electrical fixtures have a higher resale value than can help offset deconstruction costs.

- High-quality brick laid construction with low-quality mortar

Buildings constructed with these materials allow relatively easy break-up and cleaning and could be used efficiently.

- Structurally sound

Buildings that are weather-tight will have less rotted materials, maximizing the potential for deconstruction.

For those buildings that do not meet one or more of these criteria, partial deconstruction is an excellent option. In these cases, a combination of deconstruction and demolition can be used. For example, some projects are using heavy equipment to lightly knock over building sections, making it easier to recover materials. Also, demolition companies are increasingly incorporating deconstruction up-front to remove valuable parts of a structure prior to demolishing the building. Wood-framed buildings may be cost-effectively deconstructed, buildings constructed with masonry will likely require a combination of deconstruction and heavy mechanical demolition. The integration of manual deconstruction with traditional mechanical demolition methods has been shown to be time and cost competitive when compared with traditional demolition alone in America.

In cases where deconstruction is entirely infeasible, recycling of demolition waste is always a more sustainable option than sending waste to dumping sites.



### **4.3 Summary**

It is clear that simply demolishing of unwanted older buildings and disposing of the rubble is not a sustainable practice. A new and enduring lifecycle building approach is necessary, one that does not end at the dumping yard, but that is repeated and sensible. Existing structures should be deconstructed to reuse materials to the greatest extent feasible, whether it is through partial or whole deconstruction.

### **4.3 Test of Hypothesis**

Many construction and demolition professionals are eager to make deconstruction an everyday practice, as seen by the number of pilot and other projects occurring in America. Realistically, a selection of issues must be taken into consideration if a deconstruction project is to be successful, cost being highest on the list. Industry perceptions are also a challenge. Often construction and demolition professionals are used to constructing and/or removing buildings without thinking beyond the building's lifetime, the value of minimizing disposal costs, or the value of materials in the existing structures. Deconstruction is not yet a common practice, South Africa remains ignorant with the process and have not yet considered incorporating it into our projects and should be reconsidered.

## **5. Chapter Five : On-site Financial control**

### **5.1 Introduction**

A fundamental construction aspect that the Construction Financial Management tackles is construction cost control also known as cost management. For effective cost management, the Construction Financial Management team studies the existing market rates for construction materials and suggests crucial forecasting decisions to the directors. Other factors for cost management are also tackled by the Construction Financial Management, like hiring and looking for favorable deals. Cost overrun is most common in infrastructure projects but with thorough planning by financial experts, common misfortune such as these can always be averted.

Lonerock Construction is a civil's firm that mostly builds roads and services. At the moment they are running more than 23 projects in Gauteng and is a level C9 firm. The financial management in a firm this size is crucial.

(Jan van der Walt, 20/05/2009, CEO ; Lonerock Construction)

According to Jan van der Walt all 23 above mentioned sites have permanent on-site QS's. Except for measurements the on-site QS runs all the financial aspects on site on a day to day basis and will be discussed. Financial management on a daily basis leads to a positive outcome.

Lonerock uses a simple system which consists of two spreadsheets namely:

- Daily Cost Report
- Daily Production Report

### 5.1.1 The “Daily cost report”

Every morning on every site a daily cost report of the previous day is completed. This report shows every single cost of the previous day’s work and consists of the following items as can be shown in Fig 5 :

- Plant
- Labor
- Sub-Contractors
- Fuel and Oil
- Preliminary & General
- Material used

Example: Daily Cost Report.



Project : Kusile Power Station  
Date : 7 to 11 Sept '09  
**Weekly Cost Report**

Description	Days	Quantity	Rate	Total
<b>Plant on Site</b>				
<b>Lonerock</b>				
Grader x2	5	2	2992.5	29925
Bowser x3	5	3	1600	24000
Excavator x2	5	2	2280	22800
Roller x2	5	2	1330	13300
Dozer x1	5	1	3087.5	15437.5
Tipper x11	5	11	1567.5	86212.5
Crane x1	5	1	1285.6	6428
<b>Coms</b>				
Grader x1	5	1	2992.5	14962.5
Bowser x3	5	3	1600	24000
Excavator x1	5	1	2280	11400
Roller x1	5	1	1330	6650
Dozer x1	5	1	3087.5	15437.5
<b>Subcontractors</b>				
0				
<b>Labour</b>				
	5	62	No	12.09
35605.05				
<b>Fuel &amp; Oil</b>				
	5	16454	lit	6.83
112380.82				
<b>P&amp;G's</b>				
	5			68181.8
<b>Material Used</b>				
0				

Total JV Weekly Income : R 770698.8  
 Total Weekly Cost : R 486720.67  
 Total Weekly Profit : R 283978.13

Fig 5 Lonerock Daily Cost Report 2009

### *Plant :*

A lot of plant is hired/used every day. Every plant's description is on the report with amount of hours worked @ "x" rate p/hour and a total cost for the day. On average 38 plant is used on each site of Lonerock. Every cent here counts in discussing and settling on a rate per plant. Lets say for instance every rate for each plant on this particular example was priced R1 more. It sound like nothing looking at the sub total for plant for one day doesn't it ?! Well it makes a big difference. If each rate was R1 higher : 38 plant means R38.00 more cost per hour which is R361.00 per 9.5 hour day. This leads to an extra cost of R7942 per month. Lets multiply that with 23 sites = R182666 per month. Now this number definitely makes a difference for any size firm.

### *Labour :*

Resources are always the key point in every construction projects. Ultimately it decides on how the design should be made, the schedule, the scope of the work, and even the construction quality. Resources are synonymous to funding. When funding cannot fully wrap the costs for labor and materials, the construction project fail. This is one major priority of Construction Financial Management; taking care of the necessary cash flow needed by the project by means of bonds and sureties.

This item tells you exactly how much of every type worker was present the previous day. Financially it is easier for planning etc if you have a consistent subtotal each day. And as experienced the total can really differ each day if there is not control. If a worker is absent at Lonerock he must have an adequate reason otherwise he loses that days pay obviously but also gets a fine on the following days salary. This really seems to work and they have a consistent figure for labour each day.

*Sub-Contractor :*

This section includes all the work “financially wise” that was done by sub contractors for the specific day. A day to day figure lets you know immediately if the subbie is not working at full potential which can really bring the monthly production down. Now he gets caught out for every day that he works poorly.

*Fuel & Oil :*

Shows the exact amount of fuel etc that was used the specific day. This figure is normally consistent per day which means it would be easy to determine the date etc if fuel/oil goes missing.

*Preliminary and General :*

Fixed amount.

*Materials Used :*

Every time material leaves the yard it is written down and at the end of the day the totals are written down here with the cost of each material. At the end of the day you could see exactly which materials were used and you could look if it matches the amount in the Production report which will be discussed later on. If this is out of balance you immediately know that material went missing.

The big sub-total of this page shows you exactly how much your costs on-site were the previous day and could be weighed up to your production report to see how much profit were made the specific day.

### **5.1.2 The “Daily production report”**

Every foreman keeps a daily record with all specifics of the work that he has done that specific day. This paper is then given to the QS the following morning and a “daily production report” is completed. The foreman’s paper also gets filed so that if there is a problem you could come back to a date and see exactly what has been done.

Each piece of work is classified under an item number which can be found in the Bill Of Quantities for further specification on the work if needed. Each item is then accompanied by a rate (per m<sup>2</sup>/per m etc) straight out of the bill, with an exact quantity that has been done that specific day. This sub-total of this page gives you the exact amount of work (financially wise) that has been done the specific day.

As the daily production report is filled in, the work that has been done the previous day is also ticked of or highlighted on a drawing of the specific item. Fig 6 shows an example of a Daily Cost Report.





15.02b	Fill	3900 m <sup>3</sup>	34.53	41	159900	34.53	36	140400
	CH 4160 - 4550	390 m						
	Goal Post	6 No	14000	14000	84000	14000	14000	84000
55.02	Erected Diesel Storage tank				0			
	Fencing	3640 m	3.67	3.67	13358.8	3.336	3.67	13358.8
	CH 10 - CH 1820 LHS &RI	3640 m						
<b>Total Production :</b>							<b>770698.8</b>	<b>759953.28</b>

**Fig 6 Lonerock Daily Production Report / Page 2**

*The “Daily Production Report” fulfills 2 main functions namely :*

First of all the “Daily Production Report” is weighed up against the “Daily Cost Report”. This gives you the exact margin between cost and production. The Site agent looks at these figures every day and can immediately see if things went well and according to plan the previous day or not. Obviously the day to day goal is to broaden the margin positively daily. If the margin is small or even negative for the day the site agent can quickly look at all the item, see what was done the previous day and immediately determine where the problem lied. A daily meeting is held with the foreman and these figures are checked. It’s so much easier to tell a foreman he’s working unproductive if you can show him his figures for each day on paper if this happens to be the case.

When the certificate of claim needs to be completed at the end of the month or when ever specified the production report’s are quickly added together under each item or taken of a highlighted plan and gives you an exact figure of work that has been done to fill in to the certificate. If every item needs to be measured at the end of the month for the certificate it would take for ages to fill in the certificate if you didn’t keep production records.

### **5.1.3 Test of Hypothesis**

Both of the above reports gets signed on a daily basis by an RE (resident engineer) appointed by the client to confirm the work. These reports serve as wonderful communication to the contract manager’s, CEO etc. It is so easy to quickly email the reports through to your boss or contracts manager and they can see within minutes exactly what’s going on ,on the site without being there physically , and since it is signed by an RE nobody can cheat nobody and it is trustworthy! This is an alternative method that serves as the best feedback to any concerning party that can’t be on site on a daily basis.

## **6. Chapter Six : Health and Safety**

### **6.1 Introduction**

As a proactive measure to improve health and safety performance in South Africa's construction industry, the South African Federation of Civil Engineering Contractors (Safcec) and the National Union of Mineworkers (NUM) became the first employer and employee organizations in the nation's construction trade to enter into an occupational health and safety agreement

The agreement, signed 11 April 2009, would require Safcec and NUM to make a number of commitments, which include, among other things:

- Encouraging their members to make occupational health and safety a way of life;
- Providing their members with the required training opportunities, working together to achieve their joint ideals and objectives for occupational health and safety; and
- Promoting the integration of occupational health and safety into business processes and strategies.

During the signing ceremony, Safcec President Bryan Wescott said the agreement would underscore "the joint commitment of management and labor to improve health and safety in the industry." NUM President Senzeni Zokwana said the signing of the agreement was an important milestone in reducing injuries and fatalities in the construction industry.

Safcec represent about 25 percent of companies within the civil engineering and contracting industry and its members generate about 75 percent of the industry's turnover.

Although NUM is better known as a mineworkers' union, it also represents construction workers. NUM said that it represents more than 50,000 construction workers, which makes it the largest union of its kind in the South African construction sector.

The construction industry has injury and fatality rates second only to the mining industry in South Africa. The yearly fatality and injury statistics translate into about one construction worker killed and about four permanently disabled every day in South Africa, according to the South African Department of Labor.

This means that in South Africa on a daily basis at least 5 construction projects are brought to a hold due to casualties, and hundreds due to non compliance with the Health and Safety act. When this occurs production is heavily affected and contractors fall behind on there programs. (<http://ehstoday.com/construction/news/>)

Health and Safety issues must be well looked after in a construction firm to avoid a negative influence on production. This could be done by incorporating the following in a firm :

- Health and Safety Policy Statement
- Health and Safety Plan
- Labor Management Task Force

## 6.2 Health and Safety Policy Statement

A health and safety policy is a written statement of principles and goals embodying the company's commitment to workplace health and safety. Senior management must be committed to carrying out that policy consistently and completely. Health and safety must enjoy the same high priority as the organization's other major goals.

The policy statement should

- contain a written statement of principles and goals
- be signed by the chief executive officer
- be dated
- recognize the need to comply with the occupational health and safety act and construction regulations
- acknowledge the right of every employee to work in a safe and healthy environment
- spell out management's commitment to providing a safe and healthy work environment by eliminating or minimizing the hazards that can cause accidents and injuries
- recognize the priority of safety in relation to other organizational goals and policies
- encourage cooperation with unions and workers to involve all employees in putting the health and safety policy into practice.

As well the policy should be :

- clearly stated in terms that are easily understood
- posted in a conspicuous place and distributed and explained to all employees
- followed by every employee, including senior management, in all work activities
- kept up-to-date and in tune with current activities of the organization and with the latest legislation.

### **6.3 Health and Safety Plan**

Because the words "plan" and "program" are similar in meaning, they are often used interchangeably in everyday conversation. By assigning a specific meaning to each word, this data sheet aims to prevent confusion and make distinctions that help clarify the process of addressing health and safety.

The word plan has been chosen to name the overall activity of addressing workplace health and safety through an organized, step-by-step strategy. The plan begins with the company's written health and safety policy. A typical plan then calls for the research and decisions necessary to begin designing the program that will put that policy into practice. This is followed by the design of program content, as well as the procedures to implement and adjust the program.

Thus the plan is the organized, all-encompassing process that prepares for, creates, implements, and monitors the program. The program itself comprises the detailed assignment of responsibilities, with the specific requirements and activities necessary to promote and maintain health and safety on a day-to-day basis.

Right from the start, labour and management should work together as equal partners of a joint task force to create the safety plan (see next section).

A plan that has been developed jointly with input from workers, supervisors, and senior management is likely to receive more support than is a plan developed in isolation by any one party alone.

The overall plan should be matched to the firm's special requirements. Merely copying another company's safety plan or turning the program into another set of work rules will not do the job.

Simple plans and programs may meet the needs of small, centralized companies with closely supervised workforces. A more detailed approach, however, may be necessary for larger firms operating a variety of projects in widely scattered locations.

Some plans may be very detailed. They may, for example, establish a program that includes precise standards for such items as ladders, guardrails, and fire extinguishers, as well as detailed procedures for accident investigation and medical emergencies.

#### **6.4 Health and Safety Labor Management Task Force**

As an initial step, a task force should be formed representing labour and management. The task force should then begin with the corporate safety policy and clarify its own terms of reference.

Key first steps in the plan include the following.

- Start with a copy of the company's health and safety policy -- a written statement of company commitment to health and safety as a priority.
- Produce a statement of health and safety objectives related to the goals of achieving a safe and healthy workplace. Objectives may be of two types: performance objectives such as a specified reduction in lost-time injuries; or content-related objectives, such as ensuring that site hazards are pointed out to all new workers.
- Agree on the specific ways to measure success in meeting those objectives. For performance objectives, these will be statistics reflecting such things as injury frequency and equipment costs. For content-based objectives, measurement may involve record keeping; for example, checklists and sign-off sheets for new worker orientation.
- A monitoring and evaluation system to document how well objectives are being met and to identify needed improvements.
- A procedure for adjusting means and methods where necessary.

## 6.6 Developing the Health and Safety Plan

To be successful, the safety plan must address the specific problems identified during the review of the company's accident history. If, for example, ladder accidents are frequent, then final program documentation must include detailed rules for the proper choice and use of ladders.

Don't try to develop the final program before completing all preliminary work required by the safety plan. This includes assembling and reviewing statistics, reports on work experience, and current procedures, as well as other relevant information.

Trying to launch a program before defining clear needs and objectives will only undermine acceptance, implementation, and effectiveness.

### 6.6.1 Review of Records and Work Practices

Review injury records, WCB Form 7's, Ministry of Labour Orders, maintenance and inspection reports, and other records to identify potential or recurring safety problems.

This review includes a number of activities.

- Review WCB Form 7's, insurance claims, and other documents to identify the kinds of injuries and damages occurring.
- Compare the company injury frequency with that of the provincial average for similar firms in the same industry/rate classification.
- Identify who (e.g., which crews or trades) are having the accidents/ injuries.
- Identify where, when, and how the injuries are occurring.



- Identify where, when, and how the injury-producing activities are occurring, including tasks, equipment, and materials involved.

#### 6.6.2 Written Work Procedures (*Job or Task Safe Working Practices*)

Written procedures outlining the safest way to perform a task are important for job

instruction, monitoring of performance, and accident investigation. These procedures are vital elements of the safety program. They should address activities with a high potential for injury as well as any other activities that must be reviewed to reduce accident frequency.

Developing correct procedures may involve a job safety analysis where each step of a specific job is examined to identify potential hazards and to determine the safest procedure.

This involves :

- identifying the job
- breaking the job down into a sequence of steps
- identifying the potential hazards
- defining preventative measures.

Members of the task force formed to draft the plan and program should be involved in analyzing specific tasks by observing workers performing the job. Several separate job analyses may be necessary for jobs consisting of more than one task.

The final version of the correct work procedure should consist of a step-by-step outline of the safest way to do the job. Steps should be stated in positive terms, with reasons given, including references to applicable regulations. Workers who normally perform the job should be invited to comment on the procedure before the final version is adopted.

At this point a list with general descriptions of procedures for hazardous activities should be developed. Most of these activities will reveal a history of accidents and injuries.

To summarize, the development of proper work procedures involves

- selecting activities involving frequent accidents or the potential for severe injuries
- identifying the potential hazards
- determining how the specific job is currently carried out and what equipment is used
- establishing how to do the job the safest way and writing a step-by-step outline in clear, positive terms
- ensuring that procedures are practical, realistic, and workable in order to ensure compliance.

### 6.6.3 Compliance

Determine whether current company and project operations comply with the Occupational Health and Safety Act and construction regulations.

This involves tasks such as the following.

- Identify what activities, equipment, and materials are involved in non-compliance with the OH&S Act and construction regulations.
- Check that projects meet standards, including those of the Canadian Standards Association and the Ontario Hydro-Electric Code or others that may apply.
- Conduct a hazard assessment of the project.

#### 6.6.4 Enforcement

It is important to anticipate problems in implementation or enforcement before the program takes its final form.

Plan for compliance by specifying

- who will enforce the program within the company
- what penalties the company will apply
- what procedures will be established to ensure compliance and to administer penalties.

Compliance with safety rules should be a condition of employment. Site supervision, site management, subcontractors, and workers should be held accountable for following the rules.

Subcontractors should be obliged by contract to comply with the OH&S Act and the constructor's safety program. The client's safety program will also have to be considered.

It is important to anticipate and deal with some of the attitudes behind non-compliance. People don't do what they are supposed to for a number of reasons.

- They don't know
  - what they are supposed to do
  - how to do it
  - why they should do it
- They don't think it will work.
- They think their way is better.
- They lack motivation or have negative attitudes.
- They don't have enough time.

- They have different priorities.
- They think they are doing it already.

Solving these problems requires instruction, training, persuasion, and enforcement.

(DS030 Health and Safety Program Planning for the Construction Industry)

## **6.7 Test of Hypothesis**

Health and Safety plays a big roll in the Construction industry. Implementation takes up allot of time and faulty plans decreases production. By following above mentioned procedures time can be saved, accidents can be decreased, lives could be saved, money could be saved and very important ; production wont be affected

(Internet- Google Blocs, worksafe, 2009/08/12)

## **7. Chapter Seven : Summary**

As we all know and as stated many times, delivering a quality product within time and budget is what brings success to any firm's doorstep. But achieving this is not always easy. Production affects this goal in a huge matter. Delivering effective production enhances any firm's chances for success. In South Africa construction is one of the most competitive fields, and all the firm's wants to be the best but does not always want to walk the extra mile to achieve it.

Production is influenced by the following sub problems which can be enhanced with a couple of alternative methods: Planning, Management, Recourses, On-site financial control, Health and Safety

### **7.1 Planning**

Hypothesis :

- Planning plays a very big role in a project and often determine the outcome
- Too little time is spent on the planning process and allot of small details is missed.
- By avoiding small mistakes in planning, big mistakes on site is avoided

Conclusion :

Planning plays a major role in the outcome of a project and is not sufficient enough to increase production. By dividing planning into these four simple steps, and breaking it down into tasks, avoids small mistakes which on its own in future will avoid big mistakes. This will increase a construction firm's productivity and profit.

- Choice of technology
- Definition of work tasks
- Estimation of required resources
- Durations for individual tasks

## **7.2 Management**

Hypothesis :

- The correct personnel are often misplaced and care must be taken in choosing them. Site-Agents must see to it that the job gets done, and his supporting team must provide the adequate information and supplies for him to do it.
- A system can be developed to see to it that every employee does their job to full potential.

Conclusion :

By developing situational simulations in the virtual environment it could change the future construction management industry which will lead to enhanced production. Situational simulations covers the “what if” scenarios and leads to better decision-making. The whole idea of situational simulations is to develop a better learning environment for up and coming Construction Managers because at the moment there is a lack in knowledge and exceptional decision making.

## **7.3 Resources**

Hypothesis :

- A lack of resources influences production

Summary :

Deconstruction is a technique practitioners are using to recover valuable building materials, reduce the amount of waste they send to dumping yards, and ease other environmental impacts over the world. Deconstruction needs to be introduced to the South African building industry. It is the disassembly of a building and the recovery of its materials, often thought

of as construction in reverse. Worldwide today, the appreciation of the lifespan and value of materials has become diminished in the context of a more disposable society in which new is assumed to be better and it seems to be the same problem in higher class neighborhoods in South Africa . Technological innovation and increased availability of materials, coupled with a growing economy, population, and desire for more individualized space, has increased the demand for commercial and residential development, typically using new materials. By method of deconstruction a firm can be more productive by means of incorporating deconstructed material in their projects and saving money. Remember that being productive equals generating maximum profit on input within minimum time.

#### **7.4 On Site Financial control**

Hypothesis :

A system must be developed to engage a day-to-day record keeping on the following :

- Daily production
- Daily cost

Conclusion :

In South Africa no precise daily record is kept on construction sites. The system as explained in chapter 5 works, it simple to use and consists of only two spreadsheets namely:

- Daily Cost Report
- Daily Production Report

These sheets serve as a communication medium and are an alternative that serves as the best feedback to any concerning party that can't be on site on a daily basis.

## **7.4 Health and Safety**

Hypothesis :

- This is an issue that plays a crucial part in any project
- Accidents can be prevented if Health and Safety management is implemented correctly
- This could save money and lives

Conclusion :

Health and Safety plays a big roll in the Construction industry. Implementation takes up allot of time and faulty plans decreases production. By following the right procedures as explained in chapter 6 time can be saved, accidents can be decreased, lives could be saved, money could be saved, and very important ; production wont be affected



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