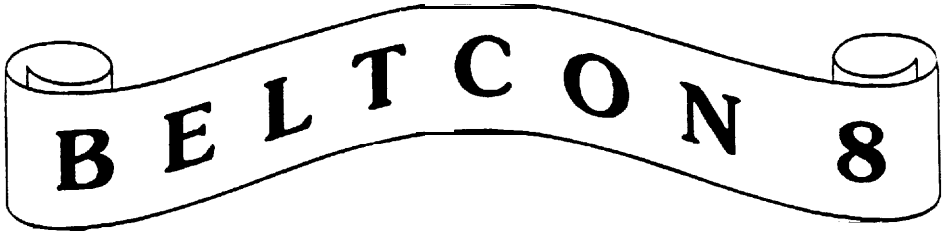

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INTERNATIONAL MATERIALS HANDLING CONFERENCE AND EXHIBITION

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CONVEYING OF MATERIALS AND THE PROBLEMS ENCOUNTERED

SIMULATION MODELLING FOR MATERIALS HANDLING

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October 1995

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Introduction

Simulation modelling is invading the engineering market aggressively, attracting increasing attention from engineering and industrial clients. It has evolved over the last 3 decades into a powerful tool for the design, analysis and control of complex systems with almost unlimited application. There are a number of software packages already available in South Africa with more to come - it seems to be quite the fashion to simulate! Why does this happen? The reasons are simple and understandable.

Firstly, any system can be simulated accurately providing that you are in possession of the correct set of parameters - a good simulation model can replace reality and allow for experiments with the models one would not even think about of doing in actual industrial environment as some of these can be very costly and unsafe.

Secondly, a simulation model incorporating an appropriate animation can create a very clear understanding of a process specifically in complicated systems like the mines employ. It may sound as a paradox but quite often a modeller will understand the process better by completion of the model than a site manager!

And, thirdly, a correct simulation model can produce results on which significant improvement of the process can be achieved.

What Is a Simulation Modelling?

There are quite a few definitions of simulation modelling, however most of them interpret simulation modellling as an experimental and applied methodology to:

* Describe the behaviour of systems;
* Construct theories or hypotheses that account the observed behaviour;
* Use the model to predict future behaviour, i.e. the effects produced by changes in the system or in its method of operation.

Reasons to Apply Simulation Modelling

The application of simulation allows to:

- Reduce the uncertainty and risk associated with proposed decisions and better understand their consequences before implementation of the decisions in the real system;

- Quantify the impact of any changes to a system without incurring the cost of mistakes;
- Assess the answers to "what-if" questions
- Identify bottlenecks and problem areas

C/assification of Models

Depending on a specific task, models of various types can be built. A few classifications of models are described in literature, based on different classification parameters:

a) Due to presence of random variation in the modelled system:

- Deterministic models ignoring the randomness of the real world, assuming it to be unimportant for the decision to be made;
- Stochastic models explicitly capturing the important random components of the system.

b) Temporal relation:

- Dynamic models describing the behaviour of the system through time;
- Static models portraying the behaviour of the system at a single point in time.

c) According to the manner in which the model represents changes of the state within the modelled system:

* Discrete models describing the changes in the status of the system as occurring only at the isolated points in time;
* Continuous models treating changes like a continuous occurring phenomenon;
* Combined models representing some parts of the system as discrete and other parts as continuous.

Expected Results of Simulation Modelling

Simulation modelling provides significant benefits for analysts and system operators:

- Improved throughput;
- Improved delivery performance;
- Reduced cost;
- Reduced lead times;
- Improved utilisation of resources;
- Other benefits (optimised scheduling etc).

Case Study 1: Simulation of a Mobile Stacking Conveyor System

This simulation refers to a design of a unique conveyor system mounted on crawlers to deposit tailings mixed with Taster™ material at Venetia diamond mine (refer to the paper by Mr P Staples titled "Mobile Stacking Conveyors" presented at Beltcon). This

mixture is similar to a fluid with a long consolidation time, and the dump it forms is totally different compared to conventional tails. The simulation modelling was used to study the dynamics of the dump growth and to define and quantify some key design parameters of the conveyor system.

Case Study 2: Audit of a Design

The importance of simulation modelling specifically at the early stage of a new mine's design was proven by an audit study completed by Xcel for a proposed colliery. This represents a multi-million Rand investment based on static planning approach. The objective of the study was to balance the mining plan, the primary mining equipment, material handling operations, the plant and stockpiles with the proposed sales.

The dynamic simulation model encounting the actual temporal statistics showed that the original design was imbalanced. Apart of deficiency in resource utilisation it showed that the mining plan and the capacity of the coal washing plant were not completely compatible, which could cause blockages coal conveyors in the plant and overaccumulation of coal in the buffers.

Case Study 3: Optimisation of Ore, Waste, Material and Personnel Handling

The most complicated simulation model we have done covers the overall ore, waste, material and personnel handling in a representative level in one of the gold mine's shafts. The client's requirements were:

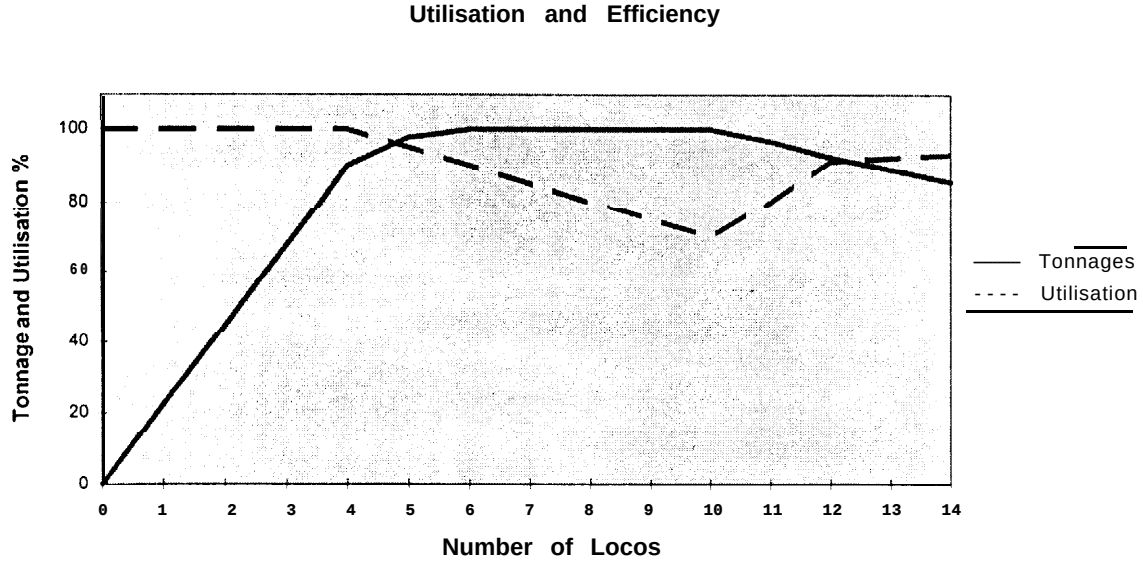
* Increase face time by reducing the travel time of miners from the surface to the underground development areas;
* Improve utilisation of locomotive fleet and identify possible ways for it's potential reduction;
* Upgrade delivery performance;
* Improve control over labour.

The following constraints were indicated:

- Underground infrastructure;
- Shaft schedule;
- Mining plan;
- Fixed resource capacities.

Obviously the trials at the mine could impact productivity and cause other losses. A very extensive modelling exercise was undertaken to simulate the overall underground operation in the selected representative area of the mine. Some of the results of simulation are shown in the diagram on page 5.

It was surprising to see that after a certain number of locomotives a further increase of the fleet did not add any extra amount of ore and waste removed. And with more than 10 locomotives the amount of transported ore and waste started to drop due to natural congestions in traffic.



Our simulation model allowed to work out the following recommendations:

1. Introduce locomotive central management system;
2. Adjust shift schedule;
3. Adjust locomotives maintenance schedule;
4. Improve drivers' daily task definition.

As a result of implementing the above mentioned recommendations certain potential improvements could be achieved which were proven by our simulation model:

a) Face time increased by 30 minutes per 8 hour shift;

b) Reduction of locomotives fleet by more than 50% with adequate delivery performance;

c) Complete labour monitoring.

The above mentioned examples show the advantages of simulation modelling for the material handling and other systems. The best effect can still be achieved at the design stage when a design can be thoroughly audited and reviewed, if necessary. However simulation of an already operating system or a plant can give a clue of how to optimise the process: improve resource utilisation, empower process control, reduce stoppages and losses, re-engineer problem areas and upgrade productivity, which still remains a crucial issue in South African industry.