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Industrial and Business Process Optimisation

What to Improve First

Common sense

plus a simple technique to quantify

what's important to your business

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Summary

Improving and changing industrial and business processes is a difficult process that needs a clear incentive to be successful. Key factors commonly present in improvement situations are discussed for both operational and business processes.

The paper shows how simple but effective methods can be used to develop a high-level benefit estimates at an early stage in the project. Studies of a Tool-making Shop and a Quarry are used to illustrate how the technique was utilised.

The paper illustrates some ways that the technique can build consensus, and keep the team focused on the agreed objectives. These techniques show how individual businesses, large and small, can use the data and knowledge of their businesses to effect profitability improvements.

Introduction

Improving and changing any status quo situation is a difficult process as many managers have known only to well. Changing operational processes, operating procedures or, implementing new management information system software, provide many examples of these difficulties. But even before these difficulties, decisions would have to be taken as to what improvement to implement. In manufacturing, as in many other endeavours, there are always competing options for the improvement resources available. How do you decide on which one? Even further, how do you know that you have all the worthwhile possibilities on the table?

Analysis abounds in the literature as to how to improve the chances of success of change processes. Three of the main findings are that there must be (in some useful form);

1. measurable definition of the objective(s) for the improvement,
2. demonstrated and on-going buy-in from the senior management,
3. well communicated objectives and scope (to the change team initially and eventually to all those affected).
4. a project team of no more than 4 to 6 people.

When you have many possible projects competing for limited resources, choices must be made. When you make choices you are starting the optimising process for your enterprise.

- How do you gauge the relative merits of each project?
- How do you know that you have project suggestions from all the worthwhile areas?

This gets hard with many possibilities, especially when some of the suggestions appear to worsen performance in another area. In a lot of the situations choices are made on instinct and / or personal bias. If the decision-maker has a good handle on the business, all will be well, if not …!

In other situations, detailed and complex analysis is carried out, providing a barrier to suggestions in the first place and absorbing a lot of time and effort too. So again, you find short-circuits developing to maintain momentum, and we are back to the instinct / personal bias again!

In these situations a lot of time and effort is then spent "convincing" other players that the decisions are the right ones. If you are the "boss / owner" you have to make calls and dictate courses of action and then check up that they are being followed. It all gets very hard!

So what is needed is a way of helping to make good choices, and define objectives. If we do this in terms that are "meaningful" to the senior management, and we can also crystallize some clear objectives we start to have the makings of a selection process, and a process to arrive at a common agreement of the major players.

Further, given that what we are trying to do is

- to define where to look for new ideas for improvements and
- to sift and sort these and the existing ideas,

We are looking for a technique that is simple, yet discriminating, were we can model or measure the short-listed projects as required, only to the required level of detail so it that gives clear decisions

1 Objective Setting

Central to the process of setting up a method or process to improve and optimise processes is the overall business goal. For our purposes, given we are not talking about Benevolent Societies, but manufacturing enterprises, Goldratt [(1)] has probably cut to the chase the most succinctly. He contends that for a profit based organisation, no matter how you express it, in the end the central objective is;

> "To make money now and to make more in the future"

Given this objective, even survival projects (i.e. environmental / statutory requirements) can be expressed in terms of making money (or at least minimising the effect on how much money is able to be made). Further, as this is most likely to be the focus of the senior management, it provides criteria to rank and measure competing projects.

The common and most transparent measures used of making money that balances the results achieved and resources required are;

- Net Profit and
- Return on the Capital Employed (Return on Investment, RoI)

So, if we can express the effect of projects on the business' Net Profit and RoI, we can start to gain the attention of the senior management and have criteria for ranking the projects.

2 Background to the Technique

Provided we can not worry about the time effects of money (i.e. either the projects can be implemented relatively quickly, or we only need a coarse mechanism to highlight the good projects), then we can look at "steady-state" effects only. This means that we can simplify the initial processing immensely. This does not preclude a more detailed ranking later, taking into account time effects utilising such techniques as Payback Periods, Discounted Cash Flows etc.

Keeping the process simple also has the benefit of transparency, i.e. everybody is able to understand how the result has been derived. This makes obtaining the "buy-in" more straightforward as people will now be discussing the assumptions and so gaining understanding, rather than having an unfocussed debate based on opinion and rank, that is difficult to resolve.

The other complication that generally arises with project ranking is the apportionment of various costs to the effects caused. This becomes very arbitrary, and also clouds the central issues of effect on the objectives. If we can avoid doing this, without distorting the result, it will aid "keeping things simple (stupid)". One of the fundamental principles of optimisation [(2)] holds that

> the overall optimum of a situation is NOT the sum of the individual process working at their own optimum.

This is saying that you can only get to an optimum overall by considering everything together. This suggests that you need to consider each project's effect on the whole company, not just the sector or area that is the most affected.

3 The Modelling Basis

So, if we can build simple relationships between the physical drivers of the business and the financial results we could start to develop our technique. Hamilton and English [3] show a diagram technique to represent a businesses Profit and Loss report with the Balance Sheet. This gives an ability to simplify and to present the results graphically too.

Analysis of typical Manufacturing Financial statements, together with understanding the physical processes underlying them and Goldratt's concepts of Throughput, Expenses and Inventory gives a generalized form to a possible simple model.

This generalized form is shown in figure 1. This form is characterized by;

- The Throughput being the difference of Revenue minus Direct Costs (typically materials);
- Profit being the difference of Throughput and Expenses (usually Labour and Overhead type costs, split out as suitable for understanding);
- Capital is typically expressed in terms of Stock, Creditors, Debtors, Cash plus Fixed Assets;
- The Return on Capital is then the Net Profit divided by the total capital.

All these relationships are kept simple, and can be set up to be dynamic using a spreadsheet.

The physical parameters necessary to give the model its predictive ability need to be kept as high-level and as easily obtainable as possible consistent with giving the model the accuracy necessary to be useful (but no more than that).

Again, in a manufacturing environment we have found that the minimum drivers seem to be;

- Units sold and average price for Revenue
- Unit consumption, yield and unit costs for materials
- Labour rates and consumption, plus a variable factor to allow for volume effects
- Days of Inventory, Debtors and Creditors to model the Working Capital effects.

Where special, or different drivers would be appropriate, these can easily be accommodated. However the aim is to produce as high-level model as possible, consistent with the accuracy needed to help sift and sort the proposals.

4 Use of the Model

The example shown is set up so that by inputting the current or basis financial position that best describes the situation, the drivers can be calculated where they are not input. Then, to gauge the financial effect, the drivers are adjusted to reflect the effect likely from a project implementation and the changed Overhead and Fixed Asset costs needed for the project are added to the relevant area. The resulting position can then be displayed directly onto the same output as the current position showing directly, the financial results and the changes. Simple relationships can be modelled too. For example increasing revenue will increase Debtors, unless you reduce the Debtor Days. The model can easily be programmed for this to happen

An alternative use of the model is to show the sensitivities of Net Profit and RoI to changes in the drivers of the businesses. So given you present situation, what has the most powerful effect on the financial results.
Such questions as;

- What is the effect of increasing market volume?
- What is the effect of getting a price increase?
- What is the consequence of a price war?
- Should we be cutting costs or increasing sales?
- What is the effect of obtaining a cost reduction on the Direct Materials?
- What effect does reducing our inventory have?
  Increasing Creditors?

Then, add to the model the requirements to achieve these ends, increased Fixed Assets, any increases in Overhead (e.g. Marketing) costs, Labour costs etc

Once you have decided what financial targets you want to set, you can now set about deciding what the most effective ways of achieving the increases or decreases in the drivers. The risks of pushing the drivers can be debated, agreed and documented as a means of generating the buy-in of the senior managers. Examples of how to affect these critical drivers might include;

- Increasing market volumes by increasing Customer Service.
  - Increasing Customer service can be achieved by
    - improving the Planning and Scheduling systems
    - improving the equipment availability and reliability

- Increasing the yield by reducing scrap production
  - due to identifying and correcting and their causes.

- Decreasing Work in Progress by
  - improving the Scheduling procedures
  - improving the Sales Forecasting accuracy

- Decreasing the cost of Direct materials
  - by negotiating more open contracts with the suppliers and sharing your future requirements to enable your supplier to plan more efficiently.

Analysing the results from several different situations in manufacturing environments under good cost control and where the Direct materials typically accounting for 45 to 60% of the revenue, you typically can achieve improved results most effectively by;

- Increasing market revenue (price and / or volume)
- Improving the manufacturing yield and
- Reducing the Direct material costs.

Reducing expenses and Inventory levels quickly gives diminishing returns for the efforts needed and the further they are reduced, the risk of damaging your ability to satisfy the customer increases. This puts your ability to increase revenue in doubt, the exact opposite of what was targeted.

5 Case Studies

5.1 A Tool-making Shop

The Situation: A Tool Shop for the manufacture of Extrusion Dies employing 5 or so Toolmakers working a 6 shift week operation was not returning good enough financial results to enable itself to re-equip and maintain its market. Its major costs were pretty well controlled. The price of the Tool steel blanks for the dies was negotiated on a long-term contract and so was fixed. The Toolmakers had an Award contract that was standard for the period, but had 18 months to run. Given that the Tool Shop was a "make-to-order" manufacturer, the Finished Goods inventory was essentially zero. The Work in Process was high and the Raw Materials reflected the long lead-time supply. The financial situation was modelled and a result similar to that show in Figure 2 was derived. After a series of discussions and use of the model, it was agreed that increasing the market volume was the most effective means to improve the results. Other small affects were also suggested. This is shown as the improvement case in figure 2.

The means of increasing market share was to improve the Customer Service. A very crude form of determining the Delivery date of new orders, together with little control of the jobs on the shop floor meant that their on-time delivery performance was about 55 to 60%. This resulted in rush jobs, more out-of-control jobs and many dissatisfied customers. The stresses on the owner and staff were high and mistakes were made, affecting both the yield and the delivery times. Discussions with the Tool Shop owner highlighted that there were only about 8 generic tooling job types and routings and that they all knew pretty well how long each generic routing took. This was all undocumented, but verified by observation. All Die design was CAD based and the Milling and Wire-Cutting machines were CNC enabled. Some of the routings had up to 10 steps although many had less than 8. One of the processes was Heat-treatment. Although it took a long time and was a significant portion of the lead-time, it wasn't a bottleneck. Again by discussion and verified by observation there appeared to be one major bottleneck process and another process that could become a secondary bottleneck when the tool-type mix was awkward. To get control of the shop floor, three new procedures were instituted,

- Manual capacity planning diaries were run for the 2 bottleneck processes,
- No job was released to the shop floor before it was required by the routing to meet its due date, and
- The Tool makers moved from machine to machine, bench to bench as was required by the job mix at the time. No job / task was to be started before it was required.

After the initial backlog of work was brought under control (which only took about 6 weeks due to the cooperation of the workforce) any new delivery promises were checked against the bottleneck capacity diaries to see if they had space available on or before the day necessary as determined by the relevant routings.

Within 3 months the on-time delivery had jumped to 75% and capacity had also increased 15%. After 5 months on-time deliveries achieved 90+% and another 5% had been added to the capacity (which, even more importantly was sold!). An unplanned result was the reduction in the Work in Process, lowering the working capital required, so improving the financial results and giving a 1-off injection to the cash flow. The owners and the staffs stress levels decreased markedly too.

After the system settled down a PC-based Project Planning software package was implemented to enhance the promising and planning process and assist the shop floor control further. The Tool Shop survived and got new equipment to maintain its competitive advantage.

5.2 A Rock Quarry

The Situation:
A Rock Quarry is operating producing aggregates and importing a small amount of added value materials is producing nearly 300,000 t/yr of material, with an average price of $12.50/t. The profitability of the operation was 10% of sales or 380k but the RoI was 5.1%, below the current bank rate.
A model of the Quarry's performance for 12 months was developed, and the actuals input into the top line of each section (see figure 3 below). What the model showed was that there were large amounts of relatively fixed costs in their makeup. This isn't surprising for a capital intensive operation; the large costs being depreciation, labour and equipment maintenance. Unlike most manufacturing or processing industries, there isn't any significant input material cost, as the rock is essentially "free". Labour and maintenance are usually only partly variable, as modelled here. Sensitivity analysis shows that price and volume (especially the volume) are the most powerful influences on profitability. A 10% increase in volume bringing nearly double the profit, and hence nearly doubling the Return on Capital.
After discussing the various factors it was decided that a mixture of efforts should be tackled to improve the performance. These are shown in Figure 3 also (the second line in each section).
The goals and resources allocated were for;

- A $1.0/t price increase driven by an doubling of high-value material sales and a doubling of the amount of customer delivery
- An increase in volume of 10%, increasing the Sales & Admin budget by $30k to help the marketing effort.
- An increase in labour productivity (over the volume effect) of 5%
- An 5% improvement in the maintenance efficiency – both of these being driven by better planning and scheduling efforts
- Reducing the inventory levels by 10% to help release working capital, through better sales forecasting and planning and scheduling.
- Reducing the Debtors level by 22 days to bring it to an average debt age of 45 days. This would be done by improved accent on payment terms and the hiring of debt collection agencies (part of the increased Sales & Admin budget).

Further it was expected that $200k of capital would be needed to purchase systems, equipment and advice to help achieve some of the efficiencies required.

The net effect of all these efforts if achieved would be an increased profit of $280k (75%) in the first year, and an increase in the RoI of 3.8% (a 75% increase).

6 Review

Typically manufacturing enterprises utilise 4 resources to achieve the financial results that are intended to make their investors wealthy, these being;

- People
- Materials
- Machines and
- Money.

Today, to achieve enduring strategies, a 5th resource needs to be utilised effectively, that of information. Each enterprise generates data to enable its owners, managers and staff to combine it into information that is useful, that enables its managers to make better decisions.

In projects and studies done previously, this sort of model building takes 1 to 5 days, and has a life beyond it's original reason. This paper has shown possible ways and means of utilising data simply and in an uncomplicated way so as to improve decision making in manufacturing in an ongoing manner.

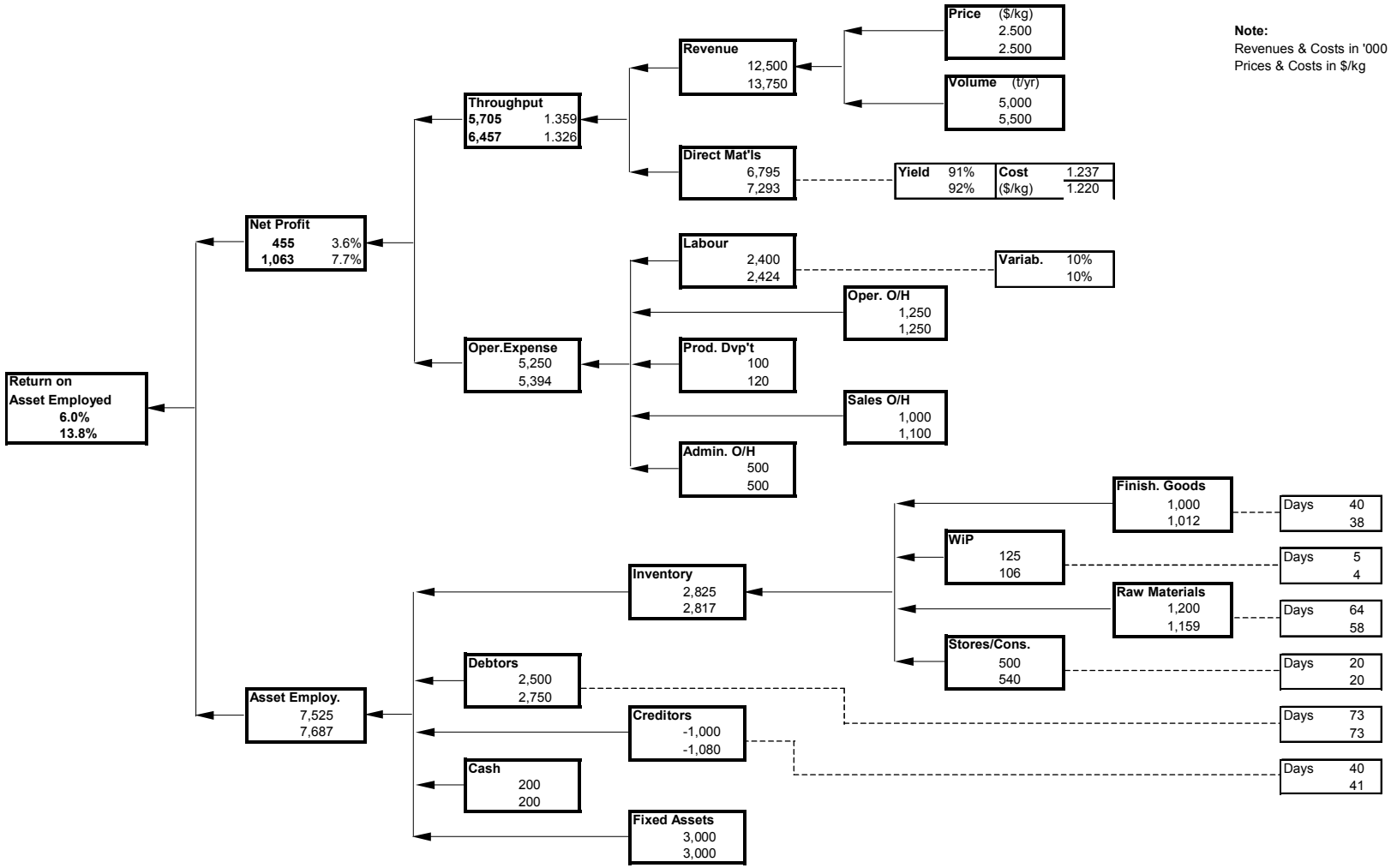
7 Acknowledgements

1. Goldratt, Eliyahu M.; Theory of Constraints (1990), The Goal (1985), It's Not Luck (1994): North River Press.

2. Wilde, Douglass J, and Beightler, Charles S.; Foundations of Optimization (1967), Prentice Hall.

3. Hamilton, Robert, and English, John; The Small Business Book, a New Zealand Guide (3rd Ed, 1997); Allen & Unwin.

Figure 1 - Example Model



Financial Returns - Cause and Effect

Relationships between Operations and Finacial Wellbeing

Figure 2 - The Tool Shop

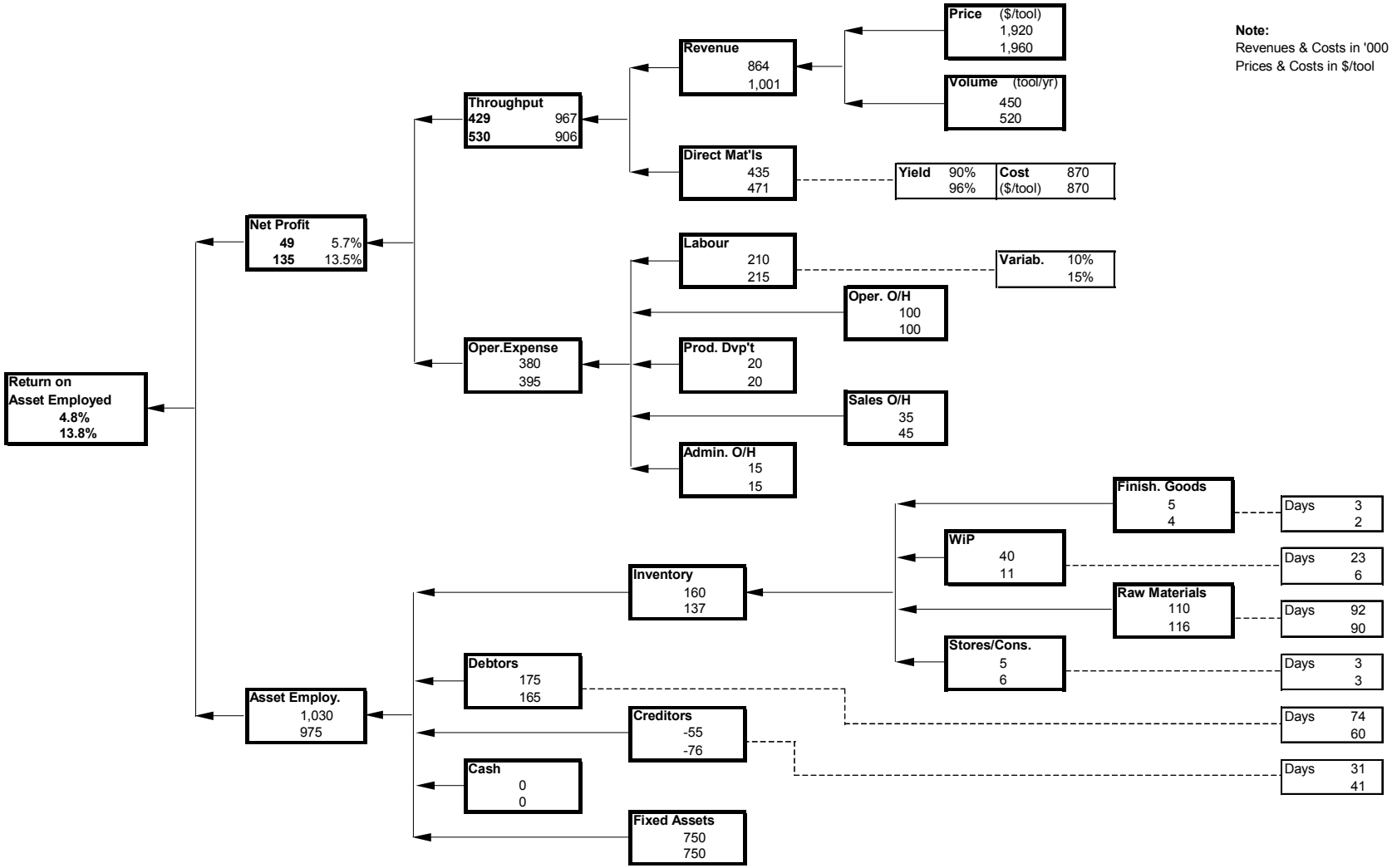


Figure 3 - The Rock Quarry

Financial Performance - Cause and Effect

Relationships between Operations and Financial Wellbeing