

Defining Quantitative Problems using the System Dynamics Framework: Quantifying the Mining Industry Workforce Problem While Waiting for Data.

Abstract

The recent growth in both the Indian and Chinese economy has fuelled an unprecedented expansion of the global need for extractive resources. No more is this the case than in Australia. This growth in the mining industry has coincided with a global stagnation of the mining talent pool, putting significant pressure on mining companies to identify and manage their human resource risk. This paper provides a case study of the approach adopted by one organisation in quantifying their problem with a view to developing strategies to address their risk areas. The organisation utilised SD techniques and software packages to quantify the problem using a common language framework.

The Growth of the Global Extractive Resource Industry and the search for talent

Over the previous decade the growth in the worlds extractive resource use has experienced substantial increased growth. This increase has been fuelled largely through the expansion of the Chinese and Indian economies, their growing presence in the export market and their burgeoning middle class.

This growing need for resources has proved beneficial to Australia, with exports of Iron ore and concentrates expanding by 27% p.a. over the previous five years (Australian Department of Foreign Affairs and Trade, 2007)

Independent of this growing market for extractive resources is a relative decrease in the number of qualified professionals in the mining workforce. This decrease in the mining sector resource pool is due to a number of reasons.

1 – The number of mining graduates entering the workforce has stagnated, and in Australia has actually decreased over recent years.

2 – An ageing population in traditionally large extractive resource economies. According to the Australian Productivity Commission (Australian Government Productivity Commission, 2005) Australia faces a pronounced ageing of its population over the next forty years. One-quarter of Australians will be aged 65 years or more by 2044-45, roughly double the present proportion. The changing proportions of the different age groups (15 to 24, 25 to 49, and 50+) will impact on the size and structure of the future labour force. Essentially, the labour force will continue to shrink relative to the total population and will consist overwhelmingly of the older segment of the working-aged population (Minerals Council of Australia, 2006).

One of the results of these two factors is illustrated in Figure 1. The decrease in worker experience is impacting on productivity, with lower productivity comes a series of other impacts, with the end result being higher turnover and further loss of experience.

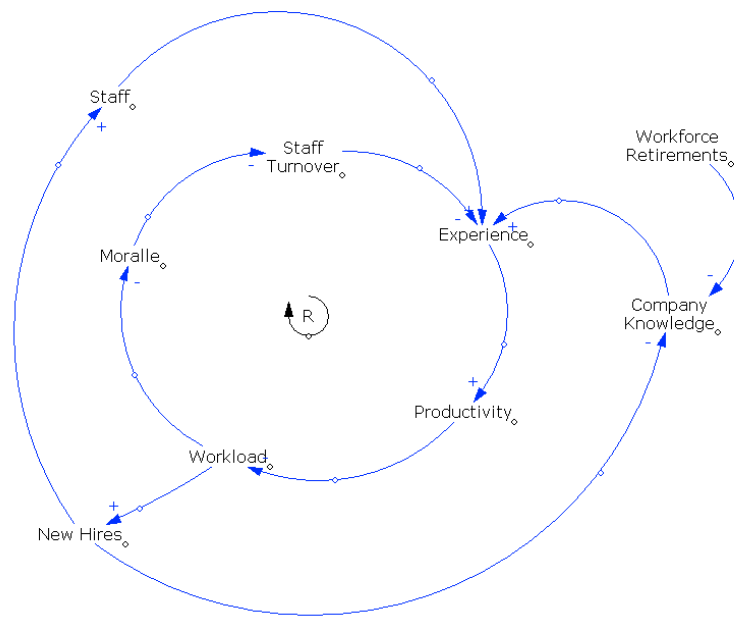


Figure 1 – Productivity Decreases

An Australian Example

One of the larger mining houses in Australia recognised this trend and engaged Evans & Peck to assist in developing a strategy to meet this upcoming demand. Our client specifically wanted the following question answered; “How many Graduates do we need to recruit over the next five years and where are the key areas?” Secondary to this question was the belief that they were heading to a situation where a number of senior managers would leave in a short period of time and they wanted to understand the likelihood and impacts of this scenario.

The belief of the mining house was that a long term focus on bringing on graduates straight out of university, running them through a graduate training program and then offering them a challenging and rewarding career path would go along way to ensuring that the long term experience requirements of the organisation could be met. The initial hurdle that the organisation needed to clear was that of information.

Specifically they did not have a good understanding of the quantum of the problem. The organisation has thousands of employees, spread across five continents and having to cope with different regulatory frameworks, languages, education levels and demographic trends, all of which impact on the ability to develop a clear picture of resource requirements in the medium and long term. Without an understanding of the quantum of the issue it was not possible for management to test their theory or test other strategic alternatives.

The Chosen Approach

In choosing an approach to this problem the work of James Thompson and (Thompson, 1991) was reviewed. In his paper he posed a number of questions to guide the problem solving decision. These were:

- Are the client’s issues dynamically complex?
- Has the client used other problem solving techniques that led to no solution?
- Do the members of the client group share a desire to solve the problem?
- Is there an imminent crisis and demand for a quick solution?

The response to all these questions was yes, and this assisted in putting a case forward to the client to look at this problem in a less than conventional manner.

In adopting an approach to this issue two main variables were examined. The first of these variables was related to the level of complexity to build into the model. It was apparent that in the first instance this model would not contain any significant feedback loops and as such it could be built utilising a standard spreadsheet package such as excel. We were, however cognisant of the fact that the results from this model would be utilised to inform further policy decisions. It was felt that a dynamic package that could include feedback would allow senior managers to understand how their policy decisions played out over time. In addition a dynamic modelling package would also provide the ability for management to visually examine the logic that they believed was in place.

The next issue was then whether to utilise a System Dynamic Package, such as iThink or an Agent Based package, such as Anylogic. Utilising an agent based package would allow a great deal of flexibility with the model, allow us to tailor specific agents for mine sites and business units and could be structurally complete in roughly the same time as for an SD model. However, the ability of an agent based model to provide a useful output would be severely hampered by the large data gaps that we believed to exist across the organisation. As discussed by (Deborah & Grabau, 2004) a lack of data can severely impact on the estimated project duration It was decided that adopting an SD approach would allow us to accurately reflect the generic structure and behaviour of the organisation and provide enough robustness to cope with any data gaps. Most importantly it would allow senior management to quickly gain an understanding of the magnitude of the problem and identify the business units and mines that had the greatest exposure to HR risk.

The second variable to be determined was that relating to the level of interaction that the modelling team had within the client organisation. At one end of the spectrum was the option to rely on the knowledge and expertise of senior management in developing the model and populating it with data, at the other end of the spectrum was travelling to each mine site and undertaking an audit of employee numbers. The adopted approach was guided by, available time, available budget and the law diminishing returns. It was determined that the most suitable approach was to work with the senior management in developing the model structure, this would then be presented to each of the mine site/business unit managers for comment. The final model would then be rolled out to each mine site to be populated by the mine sites themselves.

In summary the approach that was adopted:

- Utilised a System Dynamics modelling package,
- Aggregated staff positions to as high a level as possible
- Involved the Senior Management in the development of the model structure
- Involved the individual business units to review the model and provide feedback
- Required the mine sites to enter their own data
- Enabled the introduction of a common language of stock and flows to the organisation that could be used when developing strategies to address the HR issues
- Enabled us to physically draw the flow of employees through the organisation.

The Approach in Practise

The chosen approach and the approach adopted are often two very different creatures. For this investigation the approach that was agreed with senior management was however followed reasonably closely. As was suspected the largest issue was in obtaining the data. Provided below are the steps that were followed in developing the model, and the issues that presented themselves along the way.

Step 1 – Agreeing the Approach

Following our initial discussions with senior management an approach was developed, as discussed above, that we felt would provide the client with the level of information required in a suitable timeframe and would allow them to build on this information to develop and test a series of strategic interventions.

It was essential at this stage that senior management agreed with this approach and adopted it as their own. Key to the success of this strategy would be the business unit managers adoption of the model, and it would be members of the senior management team that rolled out the model to the business units. If senior management understood the process, believed in the model framework and were willing and able to explain the logic inherent in the package then they would prove to be key resources in the success of the strategy.

Step 2 – Initial Workshop and Model Development

The initial workshop involved members from the senior management of the global HR group within the client organisation. This workshop focussed on developing a generic structure for the flow of personnel throughout the organisation, from graduate recruitment to senior management retirements. Key at this stage was to develop a generic flow pattern that could be communicated across all levels and all business units. The structure developed did not reflect any business unit specifically but rather was representative of how a graduate may flow through organisation, especially if they moved between business units and mine sites. The structure also needed to capture the leakage from the system as this was seen as a key issue in coming years as the “talent war” heated up.

The initial structure that was developed is shown below.

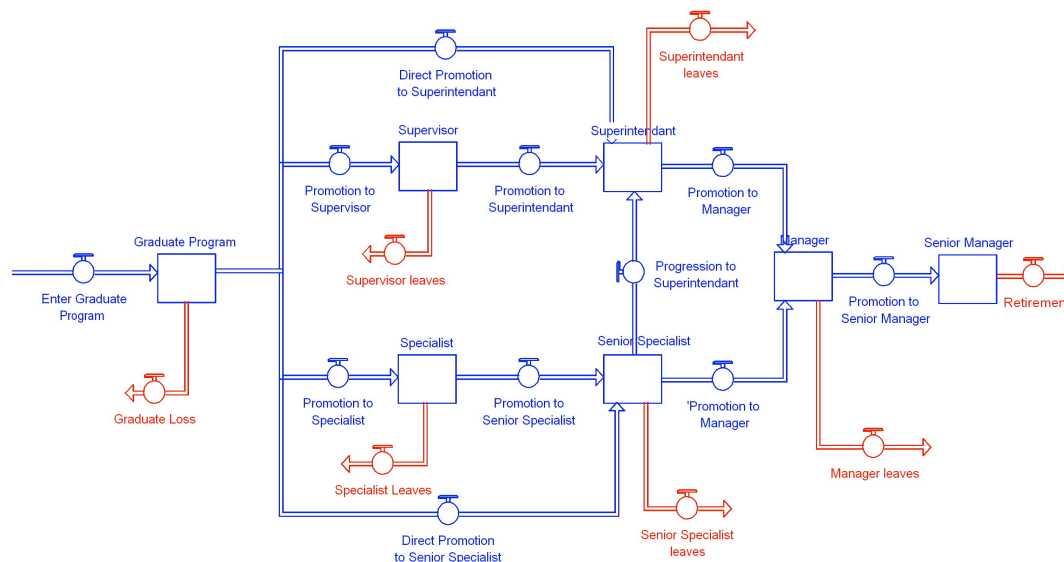


Figure 2 – Generic Flow of Personnel

Step 3 – Follow up workshop, adding detail

Following the development of the initial model a second workshop was held with the client organisation, this workshop involved the same representatives that were involved in the initial workshop. This was due largely to good luck rather than good management, it is however a key component of a modelling project that the team remains consistent throughout the project in order to ensure that everyone is working from a common understanding and has some “skin in the game”.

The second workshop was focussed on moving towards lower levels of aggregation and adding details regarding length of time steps and likely leakage rates and input rates. This data would allow us to undertake sample runs and check with the working group as to the models output and whether they were consistent with the groups understanding.

The key during this workshop was ensuring that we were reaching the correct level of aggregation and that enough detail was included to be useful but not so much that it was too specific for all sites or would require too much data input from the sites.

Step 4 – Model 1.0, Roadshow to Business Units

Once the model had been completed to a level that the working group was happy with it was rolled out to each of the business units for review and comment. This roll out was co-ordinated through the HR Manager and involved a series of road shows throughout Australia, the USA, Europe and Asia. The HR Manager also worked individually with what were seen as key business units to ensure that they understood the model and to capture their feedback and improvements.

Step 5 – Model Finalisation

Following the road show a number of changes were incorporated into the final model. One of the major issues that we faced during this stage was having to push back on the client to a number of their requested changes. A number of the improvements that were suggested reflected the organisations eagerness to start solving the problem. As a result a number of the changes being suggested did not reflect what was happening in practise but rather potential solutions. An example was the request to decrease the time taken for promotion to superintendant, a worthy solution perhaps, but one that was not currently occurring and one that would have other additional consequences to just increasing the number of superintendants (see Figure 1). It was explained that a number of these strategic suggestions would be examined during phase 2 and would be incorporated into a model involving a greater level of feedback.

In order to make the model as simple to use as possible a number of instructional video's were included in the model package itself. These videos provided step be step instructions on how to enter the information and operate the model. A video featuring the HR Manager was included as part on an introduction package.

Step 6 – Model Version 2.0, Roll Out and Data Collection

The Final model was developed and rolled out. It was provided to all mine sites in a format that they could enter the data, run the model see their shortfalls over time. They were then able to export their input and output data and email the file to head office for collation into the master model. This process did prove problematic for a number two reasons. The first was due to different operating systems etc being utilised throughout the world. A web based input platform would have been a more effective solution. The second was due to the level of data available at each mine site and the format of the data. This was an issue that was identified and raised early on and is not particular to this project. Nevertheless, data was collected and provided a clear picture to the organisation of the quantum of the problem and their key problem areas. Provided in Figure 3 is an example of the output graphs provided to the client for each of the business units.

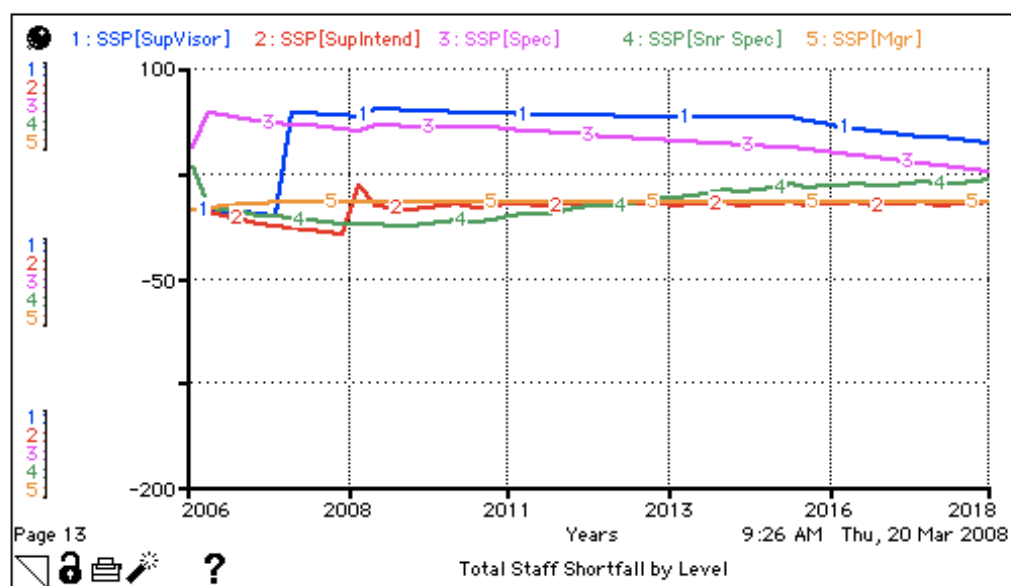


Figure 3 – Example Output Graph

Outcomes and Conclusions

This project is a work in progress and as such it is not possible to draw any firm conclusions on the end result. At the current stage it is possible to say that the adopted approach has proven successful in obtaining information from the business units. The approach has allowed all of management to develop a common understanding of the flow of employees through their organisation and identify areas where they are currently experiencing issues and where they are likely to experience issues over the next 5 years. Finally the approach has introduced the organisation to a set of tools that will allow them to take a System Dynamics approach to investigate the effectiveness of strategic interventions.

Future Directions

The organisation now has an understanding of the quantum of the problem that they are facing. The next steps are to expand the existing model to take into account the feedback loops that are inherent in this type of system. Given the work undertaken to date it would appear that the members of the working group understand the concepts of system dynamics and identify with them. Another session of workshops will be required in which the process of drawing and discussing reference behaviour patterns and identifying feedback loops will begin. This will lead to the modification of the existing stock and flow model into a true SD model.

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