Knowledge-intensive mining.

By Nick Griffith, Graham Lumley & Trevor Trott
10 November 2008

Introduction

The aim of this paper is to describe a process and a culture. The process is data-information-knowledge-innovation. The culture is based on an outwardly-looking attitude. One where the people don't think they know it all: one where people are prepared to seek knowledge and apply it, (innovate). The process under study couldn't have taken place without the culture.

It is a process which simply could not occur at the majority of Australian coal mines. Most Australian coal mines fail to take the steps from information to innovation. Getting a benchmark or a consultant's report or a mine plan demonstrates that the manager is doing something. But really, all he/she has done is waste the company's money in an attempt to make themselves look good and tick their career boxes. Without taking the step to innovation / change nothing of value has been achieved for the mine. A culture has developed whereby not taking risks is rewarded. "If you want to get ahead don't stuff up". Add to this the personal issues many Australians (and North Americans, and English people, and…….) have to being wrong and you can see why innovation is so difficult for some mines. This paper will demonstrate what is possible if people will take the steps to innovation.

What is Knowledge-Intensive Mining

If you knew that there was an M8050 dragline that achieved 21 MBCM annually (17% higher than the next best), would you want to know how? Most people do. The following definition is proposed for Knowledge-Intensive Mining.

> *Knowledge-intensive mining is the acquisition (from internal or external sources); absorption (through active understanding) and application (via systemic processes or one-off projects) of knowledge which improves the mining process.*

The knowledge-intensive mine is one where focused knowledge is delivered via the most convenient media to the people who have an interest in it. Every day that a mine operates knowledge is being gained. Around the world a vast amount of knowledge is being accumulated at thousands of sites on a continual basis. This mostly resides in the people at the mine/s and has a habit of walking out the door when people retire or leave or projects completed. The continuity of knowledge acquired and applied to run the mine efficiently is broken as people come and go. The boom in the mining industry has seen a diffusion of the knowledge across a wider base of mines and contractors.

For more information;

Graham Lumley 0412 787 920 Graham.Lumley@gbimining.com
Trevor Trott 0408 022 240 Trevor.Trott@gbimining.com

Further to this, potential knowledge is being lost through insufficient resources to create knowledge from the vast amount of data which is generated. Data is archived or worse still, disposed and the latent or potential knowledge lost. Mines are data and information-rich. Data and information overload is a common problem. Information overload occurs when the information is not understood, the amount of information is overwhelming, finding the desired information or not having access to it. Many managers are finding that their ability to make important decisions is being hindered by too much information and too little knowledge, (ie. what they actually need to make decisions).

A simple knowledge - innovation process is shown in Figure 1.

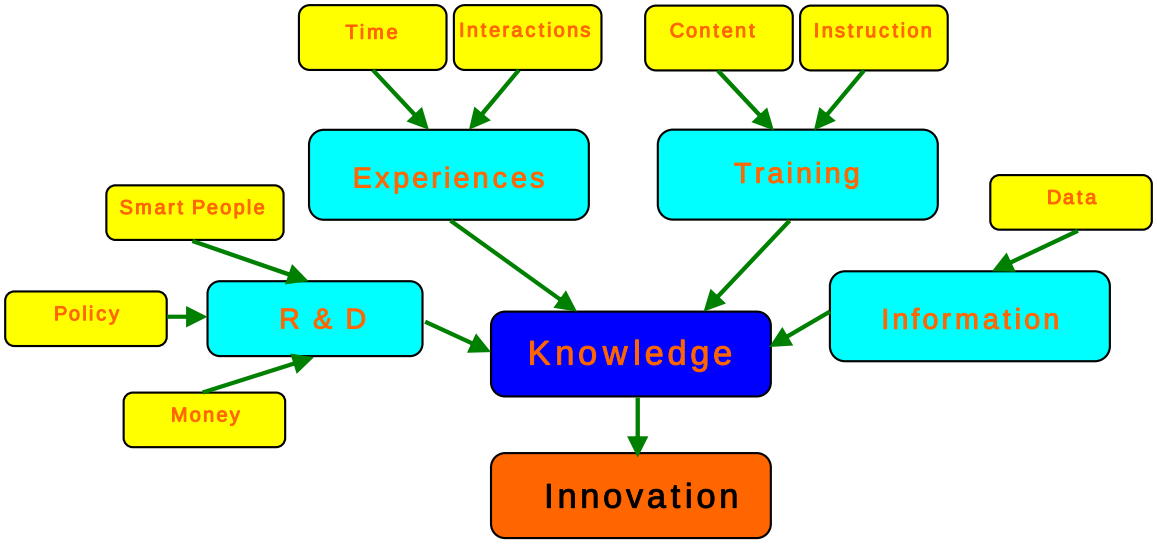

Figure 1: The Innovation Process

Experience happens, data is collected, training is provided and research is done by various organisations, however the transition from this level to knowledge is not always done well. Many have said, "If you don't measure it you can't improve it", but it is more than this. If you don't actively acquire it, absorb it and apply it, you can't improve it. On the right hand side of this figure is the data–information process.

Many mines are aware of the value of knowledge and its role in improving what is being done (innovation). Internal knowledge resides in the people and the captured data. External sources may include trainers, researchers, consultants, market intelligence, etc. As a topical example, the community attitude towards climate change is creating global demand for expert services.

The development of knowledge-intensive mining services has been accelerated by a number of factors, including; lack of labour, cost-effectiveness of outsourcing particularly with global and flexible labour markets, development of broadband technologies, research and development networks, (eg. CRC program and many other

For more information;

Graham Lumley 0412 787 920 Graham.Lumley@gbimining.com
Trevor Trott 0408 022 240 Trevor.Trott@gbimining.com

industry – University – CSIRO alliances), etc. The expansion of knowledge-intensive mining services has attracted the attention of many key mine people, however, the further one looks up through the corporate ranks the less appreciation for the value of knowledge is apparent. Many people in decision-making positions, struggle with grasping something which is not tangible.

To understand how knowledge has been applied on a broad level consider that prior to 1999, only five per cent of BE1370W draglines achieved over 100 tonnes average payload. Since then mining companies have been provided access to equipment productivity data making them more aware of what is achievable. Now, the figure is more like 51 per cent of these draglines achieving 100 tonne average payloads.

Returning to the example of the M8050 dragline that achieved 21 MBCM annually (17% higher than the next best); every class of equipment is the same. There are 15 different dragline models, 11 excavator models, 8 front end loaders, 6 electric rope shovels, 20 truck models and 19 drill models in data warehouses and they are all the same - "the bell curve of performance is flat". Best practice (defined as the average of the top decile) is up to 50% higher than average in one make and model of mining truck; there is one model of excavator where best practice is 41% higher than average and one electric rope shovel shovel model where the difference is 37%. It doesn't matter where you look, the picture of under-utilisation of capacity is prevalent. So now this knowledge is available, what will the reader do about it?

To understand the interaction between mining and knowledge-intensive mining services consider Figure 2 which has been modified from a figure presented by Dr Jari Kuusisto to the Smart Innovation Festival in Brisbane in May in 2008. Dr Kuusisto presented the curve of ROR vs Product Life Cycle. The authors have added the risk and cost benefit to this.

The rate of return is highest during the development / selection stage of the product and during the after-sales service / equipment enhancement phase. The risk on the investment is highest early in the process and reduces further after the product has been delivered. The cost-benefit (return / risk) is moderate at the start of the process (during R&D / selection) and highest after delivery/commissioning (during the process of "asset optimisation" or "capacity utilisation"). It is no coincidence that knowledge-intensive mining services apply during these two sections and are largely responsible for the higher cost-benefit achieved during these two stages. It is also interesting to note that the highest cost benefit occurs when the knowledge is applied in the after-delivery phase which is largely process related.

From Knowledge-Intensive Mining to Innovation

The big step forward which is needed for the mining industry is a better understanding of the link between knowledge-intensive mining services and innovation. Figure 3 is

For more information;

Graham Lumley 0412 787 920 Graham.Lumley@gbimining.com
Trevor Trott 0408 022 240 Trevor.Trott@gbimining.com

modified from the presentation given by Dr Jari Kuusisto to the Smart Innovation Festival in Brisbane in May in 2008.

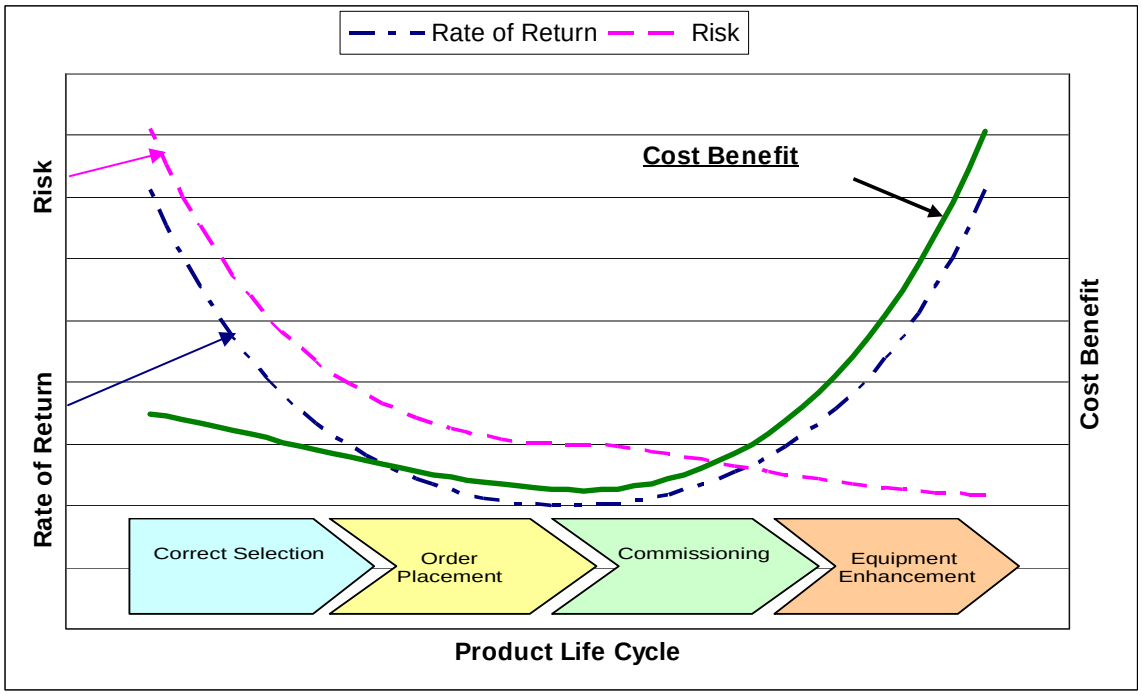

Figure 2: Risk / Reward vs Value Chain

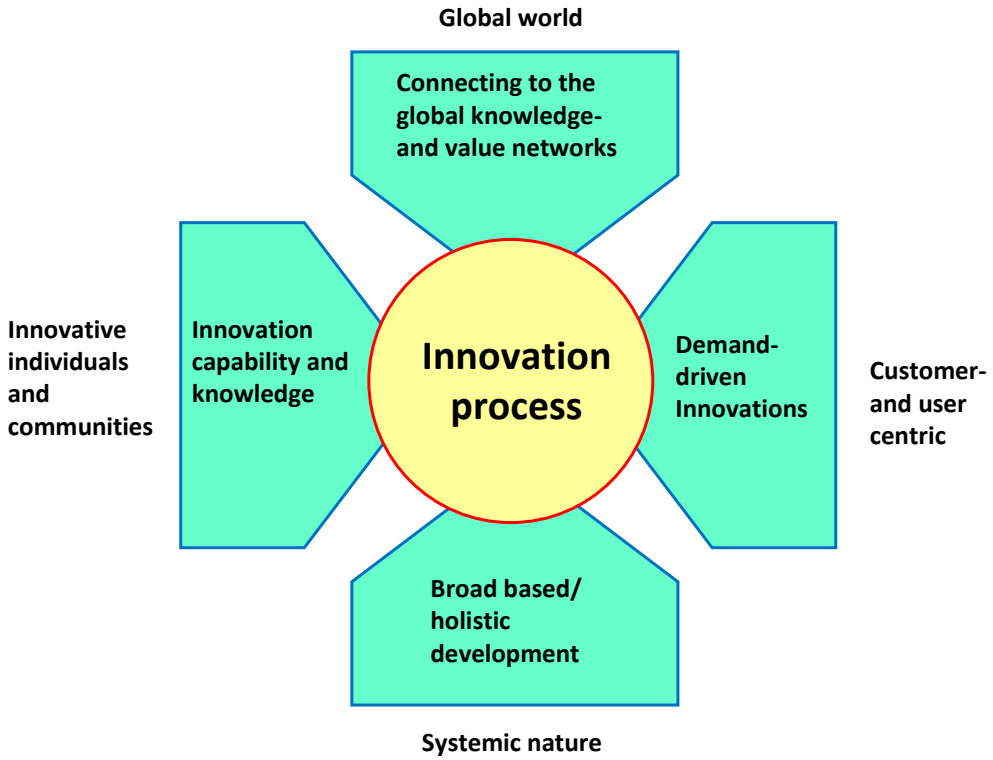

Figure 3: Knowledge Use / Innovation Process

For more information;

Graham Lumley 0412 787 920 Graham.Lumley@gbimining.com
Trevor Trott 0408 022 240 Trevor.Trott@gbimining.com

Figure 3 shows the innovation process having four characteristics

1. **Being part of the global world**. Knowledge is everywhere and there is good work being done around the globe. For example, Europe is not renowned for mining knowledge (although maybe Russia and several of the former Russian States may be exceptions). Many of the European countries fall in the top quartile for innovativeness and as such frequently have developments of interest here in Australia. In addition to a number of large equipment companies from Germany which are doing some good work, there are real technology advancements coming out of Europe. The Vienna Test System which comes from Austria has tremendous application in the Australian mines for operator selection; significant electrical advancements are being made in Germany and tested on draglines in Estonia; etc, etc. Mines should be grasping knowledge and/or developments from anywhere they might come. As a primary consideration they should be benchmarking wherever possible.
2. **Innovative individuals and communities**. This industry needs innovative people. The perfect example here is the Australian Coal Association Research Program which distributes over $10M annually of the industry's money for coal mine research. This program draws some of the smartest and most innovative thinkers into the coal industry research and development arena. To their credit, they do get the whole concept of knowledge development and the link to innovation. AMIRA also plays a vital role for the broader mining industry. Mines need to build an innovation culture where change is not done for the sake of change but rather to make the operation better.
3. **Systemic Nature**. Being innovative is not something which can be turned on and off. It is the culture; the way the people think and act. Some people believe it is difficult being innovative within a large mining company. This is because they are thinking on too large a scale. Too often we think that multi-million dollar projects such as Universal Dig and Dump, automation, etc. are required to be innovative. However, knowledge intensive mining and being innovative can be done on a micro-scale. Each person can take responsibility for themselves and can follow the path of acquiring, absorbing and applying. On a micro-scale the operator who, having difficulty loading one bucket ends up with half a load, actively changes their digging for the next cycle and the one after that has applied knowledge. As a summary, each individual being innovative relies on how they are acquiring, absorbing and applying the knowledge which is available.
4. **Customer and user-centric**. This is what the authors call "bottom line" services. From the provider's perspective, knowledge and service provision must be focused on what the user / mine needs. All too often the mining industry funds work by research groups and unfortunately sometimes consultants, which focuses on the process and how smart the process and people are. For knowledge to be valuable and to facilitate the innovation process it must be value-based, ie. it must provide bottom-line / profitability improvements for the mines. Central to this is effective measurement systems.

A Case Study – New Vaal Colliery Dragline Operation, South Africa

New Vaal Colliery (Anglo Coal, South Africa) is an open cut coal operation with three BE1570W draglines. The mine is situated on the banks of the Vaal River in the Maccauvlei area south of Johannesburg. New Vaal provides Eskom's Lethabo power station in excess of 17 million tonnes per year of low-grade coal.

Like all South African operations New Vaal's workforce is majority indigenous, South Africans. The workers have little education with the majority being illiterate due to previous Governmental policies. There are 3 to 4 spoken languages and a culture of respect based on age regardless of position. The mine faces daily cultural struggles with regards to training and management. Every mine's workforce is subject to poaching due to the skills shortage, retirement, HIV impact and natural attrition.

New Vaal suffers from the same lack of skills which many South African mines encounter. A huge amount of training is required as the turnover rate with dragline operators can be up to 25%. Without a structured training program trainees were largely learning on-the-job. The dragline culture stands with the oldest operator being seen as the most experienced. This operator is then chosen as a 'mentor' for a trainee to pass on both good and bad practice. Consequently, they are exposed to 'bad habits' instead of best practice.

New Vaal also confronted the problem which many mines face, they literally had data overflowing. This is a major problem for the mine which is innovation-focussed as a bridge must be built from the data to innovation. As previously explained this must pass through the data-information-knowledge-innovation and must facilitate the mine culture. Another key problem has been the poaching of technical people and management personnel. This creates a drain of people-knowledge and particularly causes problems through the lack of continuity in key positions such as dragline engineer.

Over the last ten years New Vaal colliery has taken a pro-active approach to innovation in their dragline operations. Each of the four characteristics of the knowledge – innovation process can be clearly seen.

- **Being part of the global world**. Partly due to a brain-drain and partly due to the isolation of Apartheid, South Africans have a global perspective on their mines and New Vaal has been like a sponge for dragline knowledge from around the world. They commenced benchmarking in 1999 and sent teams of mine personnel to Australian and/or North American dragline operations on a yearly basis. New Vaal also utilises University students from around the world to assist them in various projects. This commitment continues. The most important characteristic which

For more information;

Graham Lumley 0412 787 920 Graham.Lumley@gbimining.com
Trevor Trott 0408 022 240 Trevor.Trott@gbimining.com

New Vaal people demonstrate is that they listen to outside people. They have no notion that they "know it all". In fact, quite the opposite, they acknowledge their knowledge shortfall.

- **Innovative individuals and communities**. Innovative people are simply those people who are prepared to try something new. New Vaal was in the first group of mines from South Africa to do dragline benchmarking; they were in the first group to do truck and loader benchmarking; they were the first mine to introduce monthly dragline reporting / mentoring and more recently have been the first to do monthly truck and loader reporting / mentoring. They are always the first to run specific courses and are continually looking for new courses. Not everything they have tried has contributed to improved dragline productivity but they are working on the principle that if they aren't prepared to be wrong then they won't achieve anything.
- **Systemic Nature.** New Vaal has systems set up to ensure they capture the latest best practice knowledge from around the world. Every report has best practice on it. Every report is personally delivered to the operators to facilitate the understanding. Every operator is audited on a regular basis. One of the key characteristics of the New Vaal operation is that management is rewarded for innovative effort regardless of the outcome. This ensures that innovation is just part of the way the mine works.
- **Customer and user-centric**. New Vaal's research has been based completely focussed on what they need to do to be more productive. New Vaal supports students from the South African universities but this is kept separate to the real innovation which is taking place. While being knowledge and innovation driven they are also very demanding on their knowledge sources. If there is something they want to know they are not afraid to ask. Requests for specific (and sometimes quite elaborate analysis) are frequent.

The performance of the New Vaal draglines since 1998 is demonstrated in Figure 4. New Vaal has shown a consistent increase in dragline performance. They have come from 22% below average in 1998 to exceed average in 2006 and will pass the previously best performing fleet worldwide in 2008 with the latest advancements.

The culmination of 8 years of knowledge-based, innovative work at New Vaal has been the recent strategy developed by ANGLO Coal South Africa to establish a uniformed approach to training for all dragline operators including trainees. If Figure 1 is considered, a key driver for knowledge and innovation is training and as has already been explained New Vaal has substantial training requirements. The p^3 strategy is broken down into five stages from selection through refresher training, with beginner, inter-mediate and advanced training being represented as T1-T3.

For more information;

Graham Lumley 0412 787 920 Graham.Lumley@gbimining.com
Trevor Trott 0408 022 240 Trevor.Trott@gbimining.com

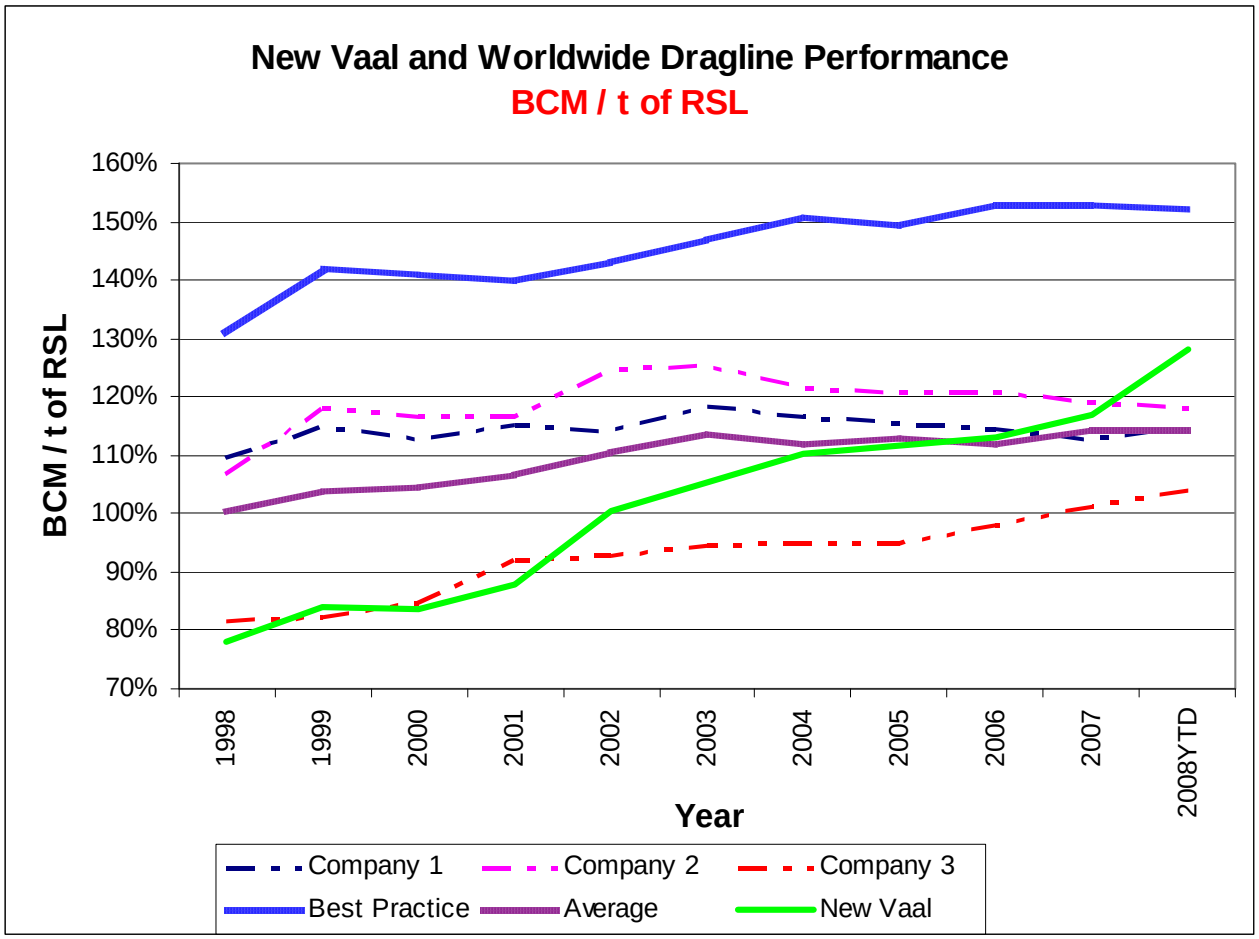

Figure 4: New Vaal Dragline Performance

Stage	Description
Stage 1	Operator Simulator Assessment (deciding entry level of T1 – T3)
Stage 2	Snapshot taken of individual operator performance (VTS)
Stage 3	Operator Training Course (T1/T2/T3)
Stage 4	Operator benchmark to measure individual improvement
Stage 5	Refresher training every 18months

This is not a program for upper management's benefit or for Business Improvement people to demonstrate they are valuable to the mine. This is a program with real commitment, real investment and real on-the-ground benefits. New Vaal Colliery has been a major contributor and supporter of p^3 ensuring they harness the gains offered. At present all 26 dragline operators at New Vaal have been trained to intermediate level (Stage 3). New Vaal has seen an improvement across fleet of 10.7%, with operator variances significantly reduced (42% - 26% between best and worst). In addition, the mine now has a standard approach towards *'best practice'* as trainers liaise with operators each week. This is demonstrated in Figure 5.

For more information;

Graham Lumley 0412 787 920 Graham.Lumley@gbimining.com
Trevor Trott 0408 022 240 Trevor.Trott@gbimining.com

The changes at New Vaal have been worth over A$30M per annum.

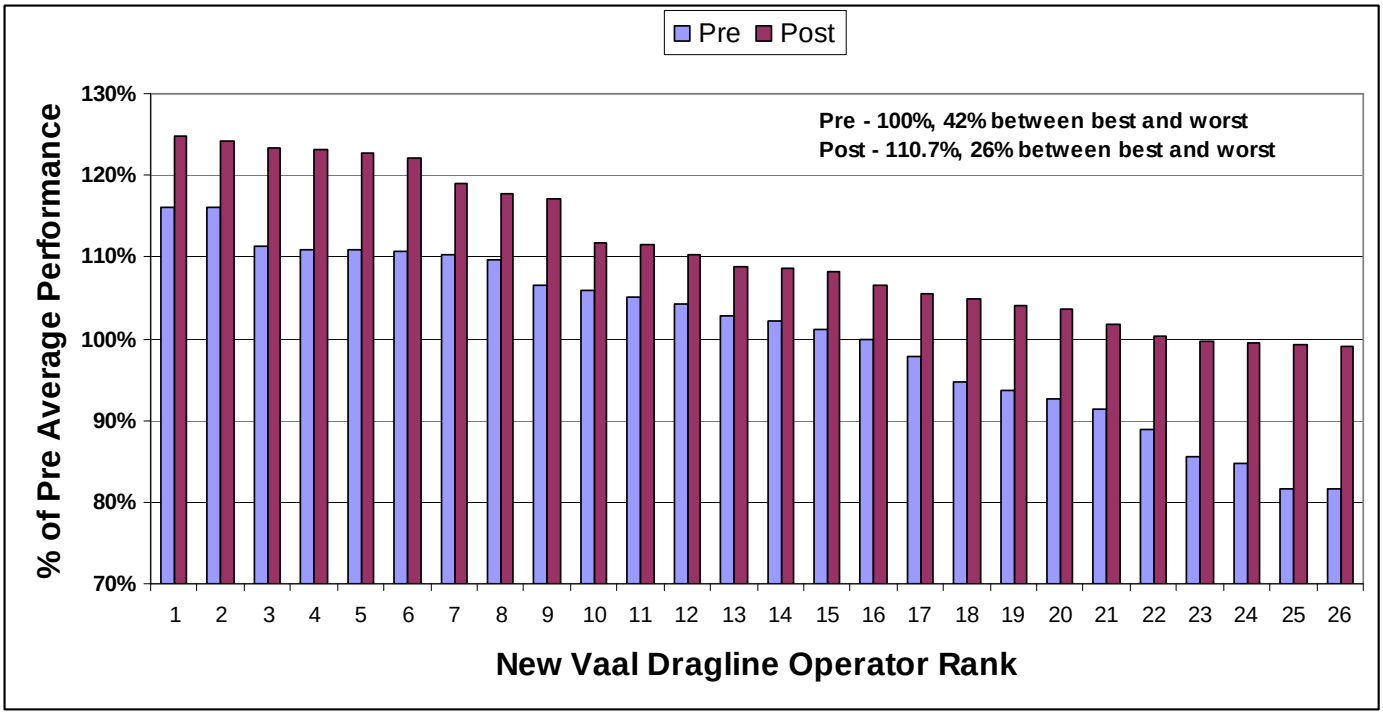

Figure 5: New Vaal Dragline Operator Performance

Conclusion

So where to from here? This paper has addressed a dragline example. Whether work is in mining, infrastructure, clean coal, or wherever, the messages are the same:

1. **The idea that only tangible things add value must be changed**. Change / innovation from knowledge is good. Not change for the sake of change. It is more about the attitude / culture of the operation. It is the valuing of knowledge and the processes of using that knowledge.
2. The attitude of rewarding people who don't "stuff up" and not rewarding people who "get it wrong" must be changed. **If you aren't allowed to be wrong then you won't ever achieve anything**.
3. You have a right to be wrong. **If you aren't prepared to be wrong then you won't ever achieve anything.**

It is these attitudes (or lack of them) which is strangling the advancement of this industry.

There are very few mines in Australia which could achieve what New Vaal has achieved both in terms of acquiring, analysing, absorbing and applying the multitude of data and the innovative attitude which the mine and the people have.

The steps to gaining the tangible improvements, whether they be due to a change in the machine or mining process, must be preceded by a number of steps of gaining the intangible knowledge which involve processes and attitudes. Each individual needs to

For more information;

Graham Lumley 0412 787 920 Graham.Lumley@gbimining.com
Trevor Trott 0408 222 240 Trevor.Trott@gbimining.com

be accountable for their own attitudes and actions, regardless of their position. Not everyone; keeps detailed records of everything he/she does, recognise some form of sub-optimal result, do something different, etc. What is needed is people doing business improvement on a "micro scale". What that means is when a person sees something happening which is sub-optimal they immediately do something to change it. For an operator an example might be a half full bucket or poor positioning on a block. Improving this doesn't take a BI program but if you look at it, a very similar (undocumented) quality / six sigma / lean process is taking place. To achieve these gains you don't need a BI program, you need a focussed and motivated workforce / team. Each person up the management line, Operator, Foreman, Supt, Manager, General Manager, etc. needs to take this micro approach to business improvement and it appears clear that many are not. All too often the upper level manager is too concerned with "ticking the boxes" and / or not making a mistake to worry about really using knowledge to achieve innovation. After all, their performance is normally judged on how many mistakes they have made, not how innovatively they have acted.

Everyone needs to understand the value of knowledge and put processes in place to acquire the knowledge, absorb it into the organisation and apply it to improvement activities.

For more information;

Graham Lumley 0412 787 920 Graham.Lumley@gbimining.com
Trevor Trott 0408 022 240 Trevor.Trott@gbimining.com