# Why mining innovation programs fail

## Increasing the return on innovation and reversing declining productivity

Substantial effort has been focussed on big data, digitalisation and automation as ways to improve mining profitability. Many mining companies have found this journey to be difficult and achieved disappointing results. Despite its promise innovation strategies have not managed to deliver substantial productivity improvement.

A McKinsey study[1)] found that productivity in mining has declined on average 28% over the last decade, across all mining jurisdictions. This even though the study compensated for declining grades and rising costs. Given this backdrop, one could argue that in some cases "innovation" (The way ERP systems were introduced and the use of information originating from this source) have decreased overall productivity and have become an impediment to further improvements.

Fifteen years of experience in mining has led us to believe that the slide in productivity and difficulty in embracing effective innovation in mining are two sides of the same coin. They are the logical outflow of using new technologies to become more efficient at implementing outdated operating models. More modern methods of seeing and acting in the world of business, as demonstrated by many successful Product Development (often software) companies have not gotten much traction yet. Specifically, we refer to Hyper Productive Knowledge Work Systems[2)] (HPKWS), with Scrum and Kanban the best-known attempts of realising these extreme levels of productivity performance. The ERP and budgeting processes in most mines are set up as if the operating environment is predictable, when we know that it is variable and highly interdependent. This faulty assumption constrains the options available and limit the ability to innovate. More data will not solve this problem, in fact, if the old view remains prevalent the ERP, budgeting and information systems will be implemented in ways that constrain improvement and prevent miners from becoming agile. We will argue that successfully incorporating new technology into mining companies are best done through creating a Hyper Productive Knowledge Work System. We have 15 years of experience in doing exactly this:

## Obstacles to effective automation, digitization and innovation

Mine managers and Information Technology departments mention the following obstacles to innovation;

- Siloed data that cause communication and interoperability issues. Without the overall context, this data is not information.

- Not knowing which information is crucial for effective running of the overall system.
- Not knowing how to implement effective systems to deliver the correct information to the right departments and decision makers.
- Not able to identify the crucial information each department requires and how changes in other parts of the system affect this.
- Not knowing in advance how decisions could affect other stakeholders and therefore not knowing where to start and how to adapt?
- Lack of ownership and resistance from those who must use the data to start working in new ways. (Not invented here, especially noticeable where technology has been centralised away from future users)
- Not having the right skills and/or not knowing what the right skills are (which makes it difficult to effectively upskill employees)
- Culture, measurement and reward systems not in line with the new ways of managing and operation required.
- Presence of silos and difficulty in coordinating in agile fashion across functions, close to where the real work is being done.
- Not understanding the capabilities of our current system, or its potential to be adapted for what is needed.

These issues can be considered as component parts of an overall "wicked problem" first explained by Horst Rittel[3)]. With wicked problems "the overall problem cannot be clearly stated; understanding the problem is the same as solving it; we are not sure if we are dealing with root causes or symptoms; there are no provable right or wrong answers they are only good or bad relative to each other; every time we attempt to solve the problem we change its structure so that the problem cannot be replicated."

These characteristics suggest that despite the best efforts of consultants, we cannot bring a template of something that worked elsewhere, implement it and expect good results. Experience shows that processes and structures that are adaptive, iterative and bottom up, deal better with this problem than the centralised, vertically controlled (over constrained) systems most mining companies are relying on.

Given this backdrop, we could state the problem as follows: "How do we create an environment where innovation is actively embraced, where it quickly delivers financial (increased productivity) results, where employees at all levels volunteer to contribute and align their activities for the common good?" We must change tried and tested tools, systems, processes and more important the way we measure, manage and reward employees.

And to achieve this, how do we delegate decision making authority to the lowest level without losing control, impairing safety or profitability? What are the new measurements, new culture and new decision-making processes we need and how do we introduce this? How do we develop our current talent?

This leads us to the most important obstacle to our stated aim. Our organisation cannot sustain effective innovation without radically changing itself.

We will argue that successfully incorporating new technology into mining companies are best done through creating a Hyper Productive Knowledge Work environment in mining, as explained in the following section. We have 15 years of experience in doing exactly this:

We believe that the most productive innovation is driven bottom up, incrementally and continuously. Big bang processes may work, if those choosing these have a profound understanding of the operation of the mine where this will be implemented. And this understanding will only arise where there is daily horizontal coordination amongst all departments on the mine as to what is constraining the system and what therefore needs to be addressed. Only effort focused on the bottleneck department will have a substantial immediate impact, working on other areas results in a dilution of effort, resources and limited employee motivation. This is one of the reasons why successful innovation in one mine is difficult to reproduce in another using a big bang approach with external consultants. The "best practices' used in many mines hide these bottlenecks.

**The need for radical management paradigm change**

Liberating the energy and talents of mining employees and embarking on a continuously bottom up, effective improvement drive will not happen under the old paradigm (measures, mental frameworks etc.) It requires a new paradigm as shown in numerous Hyper Productive Knowledge Work Systems. Effective change will not happen with classical change programs.

The disabling effects of current mind sets, assumptions and beliefs are still not being dealt with. These issues are central to day to day activities since they are incorporated in departmental KPI's and efficiency measures using budgets and ERP based information.

## What are Hyper Productive Knowledge work environments?

When looking for innovative solutions it is often useful to reframe the problem we face so that the standard solutions and experience of many years do not constrain our thinking. Mining operations can be considered as a continuous series of projects, stretching from blast to blast, burdened with technical debt (every step affects future parts of the cycle) and a need to bring the project (cycle) to completion in the shortest period (lower cost), at the right quality (grade) and at the lowest cost. Problems in any department may increase cycle time and affect the cost and quality of work of departments next in line (technical debt). Software and product development share many of these

characteristics and provide insights as to what can be done to increase innovation and productivity in mining.

The Borland Quattro Pro development for Windows, in the early 90's set the standard for subsequent Agile software development efforts. A team of 8 people developed 1 million lines of C++ production code in 31 months. This translates to 1000 lines of code per programmer per week for three years. To compare, the Microsoft Vista project delivered 1000 lines of code per developer per year. A factor 52 difference.

In studying this remarkable feat Coplien[4)] coined the phrase "hyper programming". (The term "Hyper Productivity" appeared later in Jeff Sutherland's papers on Scrum) He found that what we now call hyper productive groups are structurally different from average groups regarding roles and social network of communication and collaboration. This means that methods are not transferable to other organizations since the social structures differ. Coplien found that in hyper productive groups almost every member of the team communicated with every other member, everyone was aware of what was happening in the project at every moment. He found two foundational patterns which are necessary conditions for success, called Unity of Purpose and Community of Trust.

### Unity of Purpose

Unity of purpose requires a shared vision of the goal and how to achieve it, what each department's role is in this (in real time), removing obstacles such as inappropriate mental models, measurements and reward systems. Everyone needs an understanding of all changes that are happening or are being contemplated. Stopping the planning and budgeting[4)] system from forcing certainty on what is inherently uncertain removes much of the present interdepartmental /employee conflicts.

**Uncertainty creates problems with command and control management styles**

When we operate under conditions of uncertainty and complexity traditional planning and control can become counterproductive[4)]. In low uncertainty environments future outcomes can be predicted from the past, scope, cost and timelines can be established. In such an environment it is logical to hold managers accountable for meeting the numbers. When uncertainty increases people start to distort estimates, even numbers and targets that had no significance to begin with will be hit, and it will

The biggest problem in importing best practice processes/templates into organisations is that they are often foreign to the organisational culture. It is more effective to set up a new structure in line with the current social values of the organization.

### Community of Trust

The latter (Community of Trust) requires a new way of interacting with team members, at all levels. Management needs to let go of command and control and instead become senior participants in the process. By providing full visibility of what is happening, using dialogue instead of debate, focussing on supporting each other in reaching the common goal and having participants experience the joy of the new way of working a Community of Trust can be built quickly.

# The Productivity Platform - Creating a Hyper Productive Knowledge Work environment

Stratflow developed the Productivity Platform (PP) more than 15 years ago to create a work environment which is almost identical to the Hyper Productive Knowledge Work environment. In more than 80 interventions it has achieved output increases of average 20%, and have reduced operating cost per tonne by 10-30%, typically within 3-5 months[5]. It introduces new ways of measuring and managing employees and building a new culture where dialogue is valued and where decision making can be safely delegated to the lowest level possible. It provides the platform to change the beliefs, mental models, ways of interacting, planning and execution of mine management and workers. Silos are broken down, and employees and managers become able to coordinate from end to end, to achieve "superflow in a spirit of calmness". It introduces stability to the production chain and the reduce cognitive load on managers and employees, frees up time and helps to focus the innovation process in the areas where it will have the most immediate returns. Feedback and communication on the overall status of the system happen daily and allows management and workers to act proactively and in an agile fashion. This creates system-wide predictability (the parts are not predictable), drastically reduces the number of critical indicators and enables managers to manage proactively. The principles of flow and dialogue, practised in the daily PP flow meeting, allow managers and employees to identify the critical leverage points and focus improvement efforts there. It is now possible to rectify the factors restricting production flow, leading to improved results and increased intrinsic motivation

Stabilising production flow at an increased output, making bottlenecks visible and highlighting the degree of risk posed in different departments to maintaining stable flow are necessary conditions to enable innovation.

Now we may focus management attention on innovation and be assured that employees will deliver continuous improvement, concentrating on the most crucial (bottlenecks) areas first and thus sustaining the momentum.

# How the Productivity Platform enables innovation

A simplified version of Systems thinker Russel Ackoff[6] rules on system interdependence may be summarised as "we can optimise all the parts of a system, but then the overall system will not be optimised; or we can optimise the overall system and then all the parts will not be optimised". Most mines are run today as if it is possible to optimise the parts as well as the overall system regarding cost performance. This disconnect makes it difficult for managers and workers to deliver to the full capability of the system they are responsible for. Management and workers are overloaded, trying to optimise/improve all areas under their control. Only improvement on the bottleneck departments will translate into substantial productivity and profitability improvements for the mine. But as the bottleneck department improves the bottleneck may shift, and the focus must change once again. Managers and employees need forewarning of these impending shifts to maintain smooth production flow and then to start improving the new bottleneck.

The Productivity Platform system creates a base from where we can shift the prevalent paradigm of trying to optimise all the parts to one where we optimise the system. We reduce interference, we reduce the number of control measures and enable those who know what to do, those who understand the impact of variation in an interdependent chain. We do the counter intuitive; we put in buffers and protective capacity and stabilise the flow on a much higher level. We put the essential players in a room, and we look for creative solutions, using only a few of the vital measures that tell us what is happening in the production chain. We develop pro-active, early warning signals that enable us to respond before things go wrong. We abandon the local optimisation or silo mentality and promote alignment, people engagement. Out of the collective ingenuity, energising from people's beliefs, self-worth, and a spirit of engagement a new culture of excellence develops.

**Productivity Platform Benefits**

- Focus on leverage points and system stability leads to quick financial rewards, creates calmness which frees up management time for other issues and more innovation.
- Improved leadership and empowered/engaged employees
- Creates Unity of purpose, Community of Trust which is necessary for continuous improvement and innovation
- Implementation causes little disruption, limited involvement by consultants
- Managers and supervision know crucial information, flow of right information at right time- silos broken down

In this manner all managers and employees know which information is crucial for running the overall system (silos broken down), what information is crucial to the overall system and which departments needs this, how changes to the system will affect this information, work proactively and can react quickly or to changes in the system, know which skills are required, what systems are already in place and which ones have the potential to be adapted, which improvement programs need to be fast tracked and prioritized, which measurements need to be abolished and what alternatives are to be introduced, since employees are part of the process of ongoing improvement there is no resistance.

# Conclusion

Mining companies have started to invest heavily in big data, digitalisation and automation as ways to improve mining profitability and safety. Many have found this journey to be difficult and achieved disappointing results. Despite its promise innovation strategies have not managed to deliver substantial productivity improvement.

We argue that in some cases "innovation" (The way ERP systems were introduced and the use of information originating from this source) have decreased overall productivity and have become an impediment to further improvements.

This is the logical outcome of using new technologies to become more efficient at implementing outdated operating models and paradigms. More data will not solve this problem, in fact, if the old view remains prevalent the ERP, budgeting and information systems will be implemented in ways that constrain improvement and prevent miners from becoming agile.

Incorporating new technology and innovation into a company displays many characteristics of wicked problems. These characteristics suggest that despite the best efforts of top consultancies, we cannot bring a template of what worked elsewhere and simply introduce that into a new one. Standard change management programs are also not sufficient.

To find a solution, we state the problem as "how do we create an environment where innovation is actively embraced, where it quickly delivers financial results, where employees at all levels volunteer to contribute and take ownership of the improvements?"

And to achieve this, how do we delegate decision making authority to the lowest level without losing control, impairing safety and profitability? What are the new measurements, new culture and new decision-making processes we need and how do we introduce this? How do we incorporate new skilled employees effectively while developing our current talent?"

Successfully incorporating new technology into mining companies can be done through implanting elements of a Hyper Productive Knowledge Work System.

Hyper Productive Knowledge work environments require Unity of Purpose and Community of Trust: all employees understand what is happening in the organisation and they can and want to align their activities around this. By allowing participants the experience the joy of the new work of working, full visibility of the impact of what they are contributing, and achieving success by supporting one another, the community of trust is quickly built.

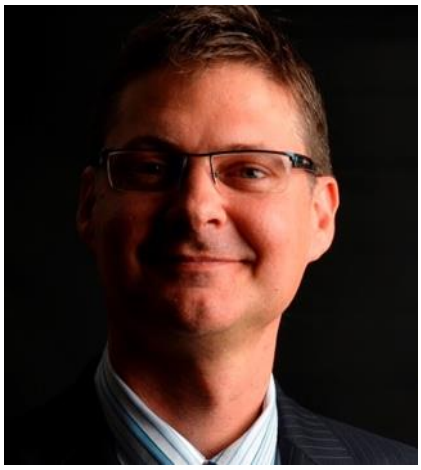
The main obstacle to achieve this is the need to get rid of inappropriate mental models, measurements and reward systems.

The Productivity Platform was developed to do exactly this. It provides the platform to change the beliefs, mental models, ways of interacting, planning and operating of both mine management and workers. Silos are broken down, and employees and managers become able to coordinate from end to end, to achieve "superflow in a spirit of calmness". It introduces stability to the production chain and the reduce cognitive load on managers and employees, frees up time and helps to focus the innovation process in the areas where it will have the most immediate returns

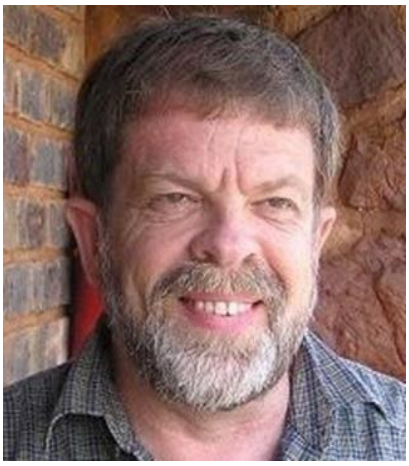
In this manner all managers and employees know which information is crucial for running the overall system (silos broken down), what information needs to be available to which department, how changes to the system will affect this information, can react quickly or preferably proactively to changes in the system, know which skills are required, what systems are already in place and have the potential to be adapted for what is required, culture and measurements are in line with the new way of doing, since employees are part of the process of ongoing improvement there is much less resistance.

# About Stratflow

Hendrik and Arrie have been working together since 2009 in using Systems Thinking (TOC) and principles of Dialogic Organisational Development to achieve breakthrough results. In 2013 they decided to partner in delivering TOC Production Flow. Subsequently, they developed the Productivity Platform for mining. Stratflow Australia was founded in 2016.



Hendrik Lourens
127 Perry Street, Matraville,
Sydney, 2036
+61290995720
hendrik@stratflow.com.au



Arrie van Niekerk
330 Theunissen Street, Centurion,
Johannesburg, 0157
+27126532377
arrie@stratflow.com.au

# References

1) Lala, A. and Moyo, M. and Rehbach, S. and Sellschop, R; Productivity in mining operations: Reversing the downward trend, May 2015, McKinsey & Company.

2) Tendon, S., Mueller, W. Hyper Productive Knowledge Work Performance, J. Ross Publishing, 2015.

3) Scott, A. Edinburg Business School MBA Module, Strategic Planning, Module 1 pp 13

4) Coplien, J.O. and Harrison, N. B., Patterns of productive software organisations, Bell Labs Technical Journal, pp 138-145, 1996McGrath R.G. and MacMillan I., Discovery Driven Planning, Harvard Business Review, July-August 1995

5) Lourens, H., Blakemore, J., Turning Mining performance around: From Efficiency to effectiveness, Australian Mining Magazine, May 2017.

6) Gharajedaghi, J., Ackoff, R.L. (1984). Mechanisms, organisms and social systems. Strategic Management Journal, Vol 5: 1-15