



Strategic mine planning—communicating uncertainty with scenarios

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Synopsis

This paper introduces and defines the concept of a linkage between long-term planning parameters ('global assumptions') and possible future world views as conceived in scenario planning. Scenario planning, the tool that is used to arrive at plausible future world views, is described in the context of the platinum industry. The interpretation of the scenarios into long-term planning parameters is made, followed by an illustration of how the long-term planning process has been adapted at Anglo Platinum to include the notion of uncertainty.

Introduction

Developing an understanding of the uncertainty inherent in the external and future environments and testing the robustness of any strategic plans against a set of possible futures, is a critical component of long-term and strategic planning. For most companies the reality is that the business environment is increasingly complex and dynamic. Hence, the appreciation that 'the only certainty about the future is the uncertainty'. Analysing key global trends and seeking to influence the future(s), requires a widening of perspective to a range of possibilities and discontinuities. This requires an intellectual leap of imagination.

In the evaluation of mining projects, a view has to be taken of the future and associated parameters that will influence investment decisions. This view, which at Anglo Platinum is encapsulated in long-term planning parameters (the 'global assumptions'), can and does change in line with macroeconomic drivers. While a project team correctly focuses on ways to mitigate risks associated with 'local assumptions' (being project specific technical uncertainties), it is imperative that decision makers are aware of, and understand the significance of global assumptions that have a bearing not only on specific project investments, but rather on the portfolio of investments in the business.

The complexity of long-term planning

parameters (typically forecasts of exchange rates, inflation rate, metal prices, cost escalations, capital escalations, working capital, etc.) and the relationships between each other and events that occur in the global economy, require that inherent uncertainty in investment decision making and portfolio planning is communicated through scenario planning.

Defining key concepts

Strategic and tactical mine planning (Smith and Ballington, 2005)

Until recently, the mine planning function has generally been viewed as an engineering function, primarily concerned with the design of access and stoping excavations and the sequence of orebody extraction. Traditionally these planning elements have been considered in two broad groupings: one primarily concerned with the accuracy of estimates (conceptual, prefeasibility, feasibility studies), the other with time frames (short-medium- and long-term plans). In reality the elements of these two groups should be applied across two categories of planning over the life cycle of mining operations—strategic mine planning and tactical mine planning.

- *Strategic mine planning*—deals with those components and decisions that largely affect the value of the business over the long term. Central to this is the development of a business model and plan to maximize value from exploitation of the entire mineral resource available to the organization. This is achieved through consideration and optimization

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of the key elements of the value chain: exploration strategy, extraction method, mining sequence, cut-off grade/pay limit, scale of operations, metallurgical processing route, social and labour plans, environmental and sustainable development philosophy, and marketing/sales strategy. The efficacy of the selected strategy and business model, initially defined at the beginning of any business cycle, should be periodically reviewed as internal and external aspects of the business environment are continuously changing. In operating mines, the scope of strategic mine planning is related to the continuous revision of medium- and long-term business plans (replacement and expansion projects) to ensure that short-term operations are consistent with long-term strategic objectives. The strategic mine plan is thus necessary to provide consistent direction but also to provide a base against which to assess new exploitation options and projects.

- **Tactical mine planning**—encompasses the routine planning activities required to sustain existing operations and implement new projects. This implies continuous reworking of short-term plans, preparation of budgets, production scheduling, and process optimization to meet changes in the external environment. Every tactical activity needs to be assessed such that it is not detrimental to the long-term strategic objectives of the business.

In essence strategic mine planning is concerned with decisions that determine the value of the business as a whole, whereas tactical mine planning is concerned with the tasks required to achieve that value. The two processes are not mutually exclusive but rather interdependent and should therefore not be separated at any time. However, the respective emphases need to be understood and acknowledged.

Value creating strategies

According to van der Heijden (2004), strategy involves a goal, a vision, a blueprint of the future, and a plan on how to get there. It is based on the principles of predicting and controlling. Strategic planning is changing from a detached, analytical, prediction-orientated endeavour, to a dynamic process that combines a vision of the future, the collection and interpretation of extensive information on a real-time basis, and a combination of top-down and bottom-up processes (Cunha, *et al.*, 2006).

For any organization, value that is the core driver of all business, is created in at least three different ways—all occurring simultaneously and continuously through time (Raynor, 2007). It is about cash generated in delivering to a plan; it is about strategic commitment by beating competitors; and it is about strategic options that create value by reducing risk.

Raynor (2007), very eloquently identified two kinds of strategy that add value in very different ways; these are competitive strategy and corporate strategy. Competitive strategy is about creating and capturing value. It is about commitment to what we do and how we do it as we compete for revenue and profits. Implicit in this kind of strategy is the assumption that we have correctly identified where to create value and how to capture it. If we look a little closer, we see

that the assumptions stem from how we see the world in the future. The other half of the equation is about uncertainty in that strategy. What if those assumptions were wrong? What uncertainty is there in our assumptions of the world that if played out, could change our ability to deliver on the commitment? What if the commitment were reasonable, but wrong? According to Raynor (2007), this is the realm of corporate strategy. In addition to being a conduit to capture inter-divisional synergies, corporate strategy is about how the organization identifies and manages strategic uncertainty. In summary, whereas competitive strategy is about the 'what' and the 'how', corporate strategy is about 'what if' and 'how then'.

Scenario planning

Scenario planning can be described as:

- An internally consistent view of what the future might turn out to be—not a forecast, but one possible future outcome (Porter, 1996)
- That part of strategic planning that relates to the tools and technologies for managing the uncertainties of the future (Schwartz, 1996)
- Stories describing plausible futures that are developed using methods that systematically gather perceptions about certainties and uncertainties (Selin, 2006)
- Scenarios are narrative stories that follow particular paths into the future (Korte and Chermack, 2007).

Uncertainty and complexity

Uncertainty means opportunities (van der Heijden, 2004). How does an organization find its way in an environment full of uncertainty? Exploring uncertainty, allows an organization to identify points of familiarity when moving towards the future. On the contrary, we also know that the future is uncertain and any form of prediction and forecasting is likely to be wrong. Without futuristic work geared towards unpacking uncertainty, how do you decide on the next move? The process of building new understanding through scenario planning and other futuristic methodologies becomes key in this process. This allows the organization to engage in a process of learning.

Using the uncertain future in strategic conversations through scenario planning seems a practical way of managing rationalist assumptions (van der Heijden, 2004). This is acceptable based on the rationale that the future is uncertain and considering multiple futures ring-fences this uncertainty.

Global assumptions (Smith et al., 2006)

Global assumptions are a set of long-term planning parameters that have been identified by Anglo Platinum as best encapsulating the external drivers of value in the production of platinum group metals. In a sense, the aggregated parameters provide a descriptor of a current and future world view and transition between the two. When investment decisions are made in the context of these global assumptions, these decisions are positioned with the expectation that this future world view would play out.

The context in which mining investment decisions are made

Directors, executives and strategic planners all have a

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fiduciary responsibility for oversight in the organization (Taylor, *et al.*, 2003). This entails identifying, evaluating and managing risks and uncertainties that the organization may encounter. The ability to manage short-term risks to stabilize earnings and long-term risks to ensure survivability is critical. In respect of major investment decisions in the complex platinum industry, this can be daunting. The contexts within which such decisions are made are twofold.

Firstly, decision makers have to contend with project uncertainty defined by project specific parameters, the 'local assumptions'. Typically, for a minerals projects these are mineral resource (e.g. size, delineation, grade), mining method and efficiencies, processing method and efficiencies, project ramp-up rate, initial capital requirements and operating costs. Getting this right is about committing to and implementing a competitive strategy—clearly what needs to be done and how it should be done is known.

However, investment decisions are also about other uncertainties, primarily the business environment in which the project will operate in ten or more years hence, following the initial capital investment. In this context, decision makers need to develop foresight to consider future circumstances and how these might affect the organization (Taylor, 2003), and the investment made to date. This is where the value of a well-structured set of global assumptions is realized.

Global assumptions—key drivers of future value estimates

A critical step in understanding the future is an understanding of the key drivers that determine future developments (Postma and Liebl, 2003). These so-called driving forces or causal factors are many and are often complex in their relationships. The relationship of these driving forces or causal factors for the platinum industry are indicated in Figure 1, which highlights elements of complexity and interdependency.

A useful framework for simplifying them is to classify these factors as either constant, predetermined or uncertain

(Porter, 1985). Constant factors are those structural factors that are unlikely to change. Factors that are fairly predictable and can be forecasted with reasonable accuracy are classified as predetermined. Both their outcome and their probabilities are known. Schwartz (1996) best describes these factors as either slowly moving trends or a result of constrained situations. Uncertainties are those factors whose outcomes are known, but their probabilities are not. Taylor *et al.* (2003), propose a similar framework, using the terms known (predictable), unknowns (uncertainties), and extend the definition to include the 'unknowable'. Unknowable are those factors that are simply not on the radar screen.

The relationships in Figure 1 can be rearranged, as in Figure 2, whereby the key uncertainties are located at the outermost sphere, their determination being based on the possible future world view (a scenario). These less predictable factors (unknowns/uncertainties) are used to infer the parameters in the next inner shell, which in turn influence the parameters in the core sphere. The logic is that once a view of the outermost parameters has been established (from a scenario), the parameters of the inner shells can be progressively inferred, creating a consistency in the parameter logic that is driven by the possible future world view.

This framework provides guidance as to which parameters ought to constitute the global assumptions, keeping in mind the purpose of the global assumptions is to create a link between the vagaries of a future world and actual parameters that are quantified for investment analysis. In this context the development of alternate global assumptions to align with alternate future world views is not so much a forecasting exercise, but more a means of understanding the implications of uncertainty and facilitating the testing of investment decisions in the context of future uncertainties. Consistency in the logic of generation of parameters associated with alternate future world views is therefore paramount. Table I summarizes the core parameters that currently comprise the global assumptions at Anglo Platinum.

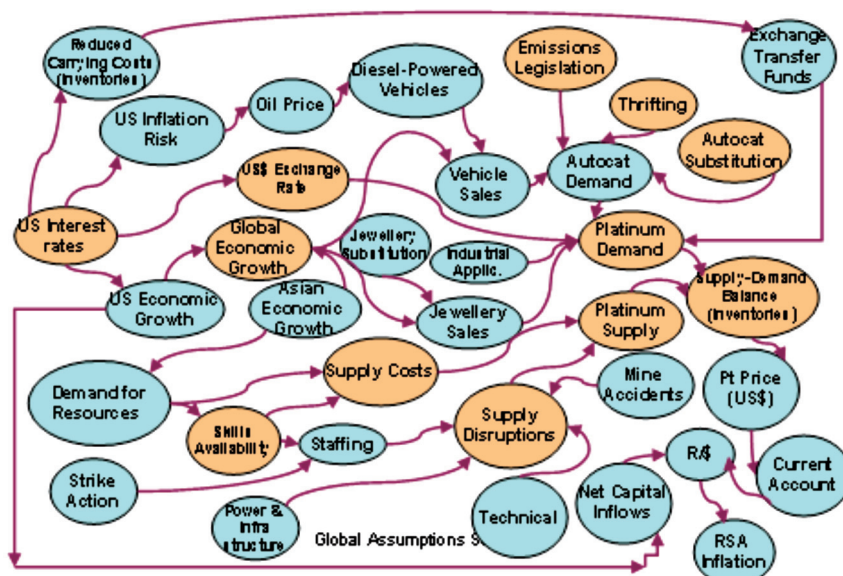


Figure 1—Schematic depiction of key drivers or causal factors of change, their relationships and complexity in the platinum mining industry

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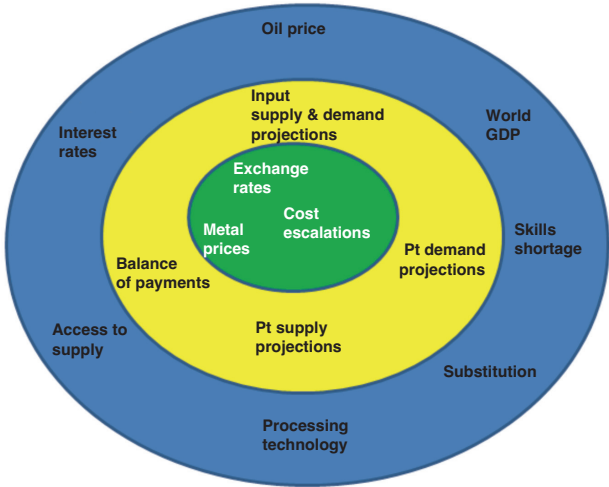


Figure 2—A simplified depiction of key drivers or causal-effect factors of change in the platinum mining industry

Scenario planning

The complexity of strategic problems and the need to find acceptable solutions requires using methodologies that are innovative, rigorous and participatory. However, regardless of the sophistication of techniques used to get an understanding about the future, it still remains a fact that the future is uncertain. Futures work is still relevant as it helps

organizations in developing macroscopic perspectives about their environments (Cunhaa, *et al.*, 2006).

The concept of scenarios and scenario planning is well established in human history. As a strategic planning tool, scenario planning is rooted in military strategies, in the form of war game simulations (Brown, 1968) and although scenario techniques have a long history, their application in strategic planning in the business context is a relatively new phenomenon (Bradfield *et al.*, 2005).

According to van der Heijden *et al.*, (2002):

- Scenario work can either serve specific once-off content needs, or an ongoing general process aimed at longer-term survival capability
- And/or the work can be undertaken either to open up an organizational mind for exploration, or to achieve closure on specific decisions and actions.

However, being explicit about the purpose of the scenario development is critical to ensure logic alignment. Van der Heijden *et al.*, (2002), identified four main areas of purpose in scenario work: making sense of particular puzzling situations; developing strategy; anticipation; and adaptive organizational learning, as indicated in Table II.

Scenario planning concepts and context

The prefecture of scenario planning is wide ranging. It includes:

- Early warning system for natural disasters and other humanitarian responses

Table I
Global assumption parameters

Economic	Fiscal	Revenue	Costs	Technological
<ul style="list-style-type: none">• US CPI• RSA CPI• R/US\$	<ul style="list-style-type: none">• Income taxation• Secondary taxation on companies• Royalties	<ul style="list-style-type: none">• PGM price• Base metal prices• Other metal prices• Working capital factors	<ul style="list-style-type: none">• Capital expenditure• Capital escalation• Operating cost escalation	<ul style="list-style-type: none">• Smelter recoveries• Refinery recoveries• Metal pipelines

Table II
Scenario planning categories

Class of purpose	Dimensions	Discussion
Making sense	Thinking—content	The aim is to acquire new understanding of aspects of the environment. The scenario exercise helps in defining the key research questions, a key requirement in generating new understanding and possible new action. Examples where scenarios helped define the important questions are Pierre Wack’s original oil price scenarios and the Mont Fleur South African project (Van der Heijden <i>et al.</i> , 2002; Wack, 1985; and Kahane, 1991).
Developing an optimal strategy	Action—content	The aim here is to develop a preferred strategy. According to van der Heijden <i>et al.</i> , (2002), most failures are here, because strategic options generated as part of single cycle scenario projects are often perceived as unsurprising. Van der Heijden <i>et al.</i> , (2002), have concluded that stand-alone scenario projects aiming for a deliverable of a specific optimal strategy often change the strategic direction and are difficult to turn into a success.
Anticipation	Thinking—process	The aim is to enhance the quality of the ongoing multi-level strategic conversations. The purpose according to Van der Heijden <i>et al.</i> , (2002) is to enhance the shared understanding of the macro-economic and business environment, and thereby of the anticipatory capacity of the organization
Adaptive organizational learning	Action—process	They aim to motivate the organization to engage in new actions—action-based organizational learning, that will make the organization aware of the new options of what works and what does not. Organizational learning is an action-driven way of learning from experience on how to navigate the business environment (Van der Heijden <i>et al.</i> , 2002).

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- Crisis management such as civil defence exercises in which scenarios are used in simulations of future crisis situations, to design and test the reliability and suitability of systems and equipment to respond to the situations, and to increase response preparedness
- Use of scenarios as a means of communicating the increasing degree of complexity of scientific models and theory in a more readily and widely understandable format. For example, climate change scenarios
- Long-range planning for businesses
- Spreading ideas about critical trends that will shape the future and
- Public policy makers who are increasingly using scenarios as forum to involve multiple stakeholders in policy decisions, enabling joined-up analysis and creating an accommodation platform to assist policy implementation (Bradfield *et al.*, 2005).

Scenario planning is thus done with the broad goal of reducing and understanding the uncertainty latent in the decision-making and finding rationale for decisions (Selin, 2006).

As the future is uncertain, scenario planning is deemed a thinking style and a detailed methodology (Van der Heijden, 2004). It is a methodology that allows reliability in capturing opinion of a large and diverse group of experts; and exploration of future environments, which would permit various policy alternatives and their consequences to be investigated (Bradfield *et al.*, 2005). It requires close interaction with peers and a wider audience, debate, dialogue, and challenging one's assumptions as well as those of others (Kortea, and Chermack, 2007). Scenarios make a statement about the future (Van der Heijden, 2004). The process paints different futures, and allows the discussion of options and testing of their robustness. A further advantage, according to Van der Heijden (2004), is the tone of the conversation that reflects a context of anticipation and doing the right thing for tomorrow.

According to Chermack (2004), there are four core interrelated causes for unexpected decision error: bounded rationality; the tendency to consider only exogenous variables; stickiness and friction of information and knowledge; and mental models with decision premises. Scenario planning has the potential to address all four core causes of unexpected decision error. It stimulates creative thinking, reduces risk, develops a consistent framework, and provides a means of translating strategy into action (Dortmans and Eiffe, 2004). It is a tool that fosters reflection, challenges the status quo, and adaptation. According to Kortea and Chermack (2007), scenario planning facilitates self-analysis and challenges the organization's shared assumptions, beliefs, and values.

As a result, scenario planning has established itself as an effective technique used by decision makers to develop long-term strategic plans (Schoemaker, 1995 and Schwartz 1996). According to Cunha, *et al.* (2006), decision makers need insight into the competition, stakeholders, business, organization and how they all fit together. Leaders coordinate the elaboration of strategic plans, imagine visions, craft strategies and implement them. Therefore, scenario planning provides a template for the exploration of a prospective future problem space (Dortmans and Eiffe, 2004).

Scenario planning challenges current perceptions about the environment through examining future states by discounting present realities. One of the key espoused outputs of scenario planning is a change in the individual mental models of the participants (Kortea, and Chermack, 2007). The rigorous methodology of scenario planning allows individuals to construct alternative futures and to examine the beliefs, perceptions and values informing those futures (Kortea, and Chermack, 2007).

As indicated by van der Heijden (2004), the scenario method makes use of multiple futures as alternative and potentially more relevant perspectives on the business situation. These enrich the 'portfolio of possible strategic initiatives', leading to action and new experience, that, in turn, leads to new understanding of the business environment and new and up-to-date scenarios and success formulae. As such, scenario planning is a tool, with great potential to develop an organization that is dynamic and adaptable, elements that are vital for organization survival (Kortea and Chermack, 2007).

In strategy design, scenario planning is effective in analysing puzzles in the business environment through a more effective integration of fragmented disciplinary knowledge and viewpoints (Van der Heijden, 2004).

The scenario planning process/methodology at Anglo Platinum

The objective of scenario planning is to gain a clear understanding of the possible drivers of future change. During the Anglo Platinum scenario planning process fundamental questions about the platinum business are explored, typically:

- What will be the needs, choices and possibilities that will shape the global 'platinum system'?
- How will the 'platinum system' look in next three, 15 years and beyond?
- What roles will governments, society, employees and the different components of the organization play in shaping this 'system'?

This process:

- Stimulates of imaginative dialogue around possible futures
- Prepares for the nature and extent of possible future challenges
- Creates anticipation of possible circumstances and exploration of potential outcomes
- Develops a platform to pressure test possible strategies
- Enhances the strategic planning learning process.

The approach taken is largely that articulated by Schwartz (1996), and comprises eight iterative steps, namely:

- Identifying the issue
- Identifying key factors
- Researching driving forces
- Ranking key factors and driving forces
- Developing scenario logics
- Developing scenario details
- Considering implications and identifying indicators.

Once the scenarios have been developed, the implications of each of the scenarios is considered and the initial key issue is 'wind tunnelled' through the scenarios, a process that further examines the robustness of each scenario.

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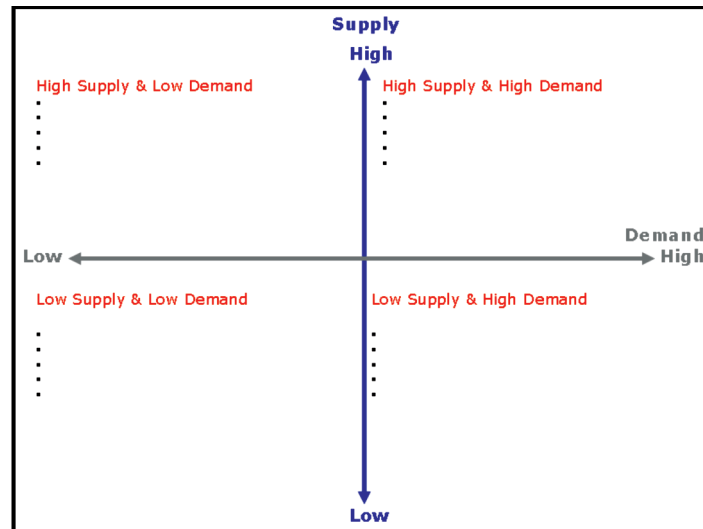


Figure 3—2 x 2 scenario matrix, showing supply and demand as the key drivers of change

Of critical importance in this process is the identification and selection of 'leading indicators' that could provide advance warning that events may be evolving towards a developed scenario.

Scenario output

The outputs of a scenario planning process is typically a 2×2 matrix, that has on each axis the drivers with the highest uncertainty and the highest impact on the organization. A hypothetical example of such a matrix is presented in Figure 3, with each quadrant representing a possible future world view.

Generally, the scenario in each quadrant is described in a few paragraphs that convey the essence of the different future world views. Importantly, each quadrant is not only described by the axes, but also by some of the driving forces so as to create a richness of interpretation while retaining internal consistency. For the purposes of the global assumptions, these descriptions need to be interpreted into numeric parameters associated with the core driving forces.

There is often a guarded response to turning scenario planning (possible world views) into a forecasting or predictive tool through adoption of numeric parameters. The approach taken at Anglo Platinum is based on the logic that conversion of the scenario descriptions into related numerical values, as per the logic outlined in Figure 2, helps frame the scenario, and provides perspective as to the position within a quadrant that the scenario may be placed. It is not uncommon that there could be very different perspectives within a particular quadrant until an association with quantities is made and alignment reached.

Interface with global assumptions

Derivation of the specific global assumptions associated with each scenario is normally conducted separately from the scenario development process. Various technical experts are identified (internal and external to the organization) from different disciplines (economics, marketing, finance, supply chain, capital projects, estimators, etc.) and presented with

the scenarios with a request for relevant inputs. In some instances, certain parameters become inputs to other parameters. For example, the view on GDP and inflation is used as input into the expert opinion about cost escalation. On collation, the scenario global assumptions are circulated within the same expert group for final comment and alignment as necessary. This approach creates better understanding of parameter interdependency and clarity on the scenario structure, while testing internal consistencies.

An example of the scenario to global assumption linkage is indicated in Figure 4.

How does uncertainty fit into the planning process?

The strategic long-term planning process at Anglo Platinum has been described previously (Smith *et al.*, 2006). Enhancements to the process with respect to incorporating uncertainty are shown in the three white boxes embedded in the circles in Figure 5 whereby the process has been modified to:

- Include scenarios into the strategic directive provided to the operation in the development of the mine extraction strategy
- Provide for alternate mining right plans by scenario, if warranted
- That the long-term plans for each mining right area incorporate contingency plans aligned with agreed scenarios.

Although this enhancement requires additional effort, it does allow the development of contingency responses that are aligned with possible future world views and so creates robustness for the planning of long-life, long lead time mining assets.

The final result of the application of scenarios in the long-term planning context is to arrive at a set of alternate production profiles aggregated from appropriate combinations of the supply portfolio that are optimally positioned for the anticipated scenarios. These are best represented in the following schematic (Figure 6), where each scenario has three production profiles.

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	KEY SCENARIO PARAMETERS	Low Supply & Low Demand	Low Supply & High Demand	High Supply & Low Demand	High Supply & High Demand
Global Economic Drivers	World GDP (CAGR : 2008-2018)	X%	Y%	Z%	M%
	Pt Demand Growth (CAGR: 2008-2018)	w%	W%	S%	S%
	ZAR/US\$ (2008 Real)	R X/US\$	RY.50/US\$	RY.50/US\$	RZ.0/US\$
	US Inflation Rates	T%	T%	P%	P%
PGM Demand Drivers	Substitution	Available and in high usage	No substitution, Pt success in Fuel Cell Technology	Available and high usage	No substitution, Pt success in Fuel Cell Technology
	Environmental thrust for more stringent legislation	No legislation	Stringent legislation	Stringent legislation	Stringent legislation
PGM Supply Drivers	Supply Disruptions & Constraints	Infrastructure constrained	None	Infrastructure constrained (power, water)	Limited, as constraints are overcome
	Supply Costs (opex, capex)	Cost escalations are very high	Low escalations due to high availability	Cost escalations are high	High
	Skills & labour availability	Readily Available	Readily Available	Low Availability due to high economic growth environment	Readily Available expat labour at lower cost

Figure 4—Example logic demonstrating the linkage of scenarios to global assumption parameters

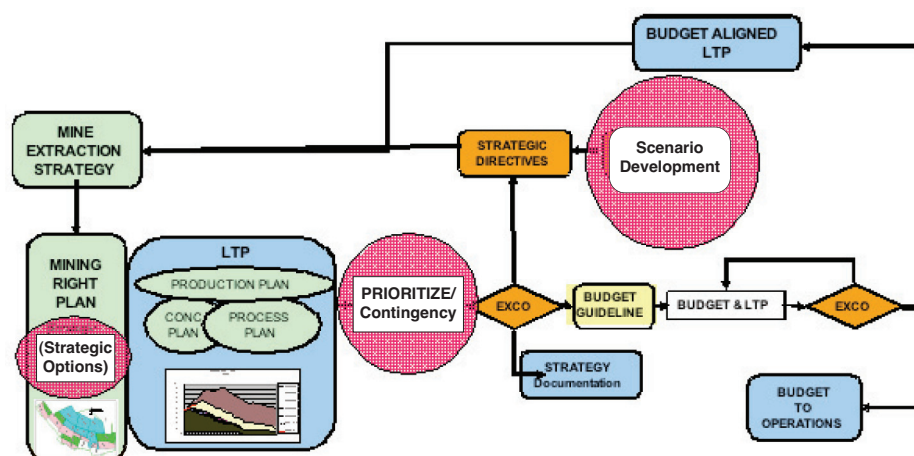


Figure 5—Schematic: incorporation of scenario development into the strategic long-term planning process applied at Anglo Platinum

These are the base production (unchanged between scenarios), which represents the operations in current production or projects in execution phase; the growth production that represents the production profile (unchanged between scenarios) that assumes implementation of all projects within a portfolio; and finally the target profile that matches the optimal production level defined by the global assumptions for each scenario. Optimization of the target profile per scenario is driven by value maximization principles.

The ability of such a representation to convey to decision makers the impact of future world views may have on the growth of the organization is powerful. Besides serving both to temper and enthuse actions, while still keeping a check on reality, it initiates risk mitigation activities.

Conclusion

Central to the success of any mining business is the ability to effectively manage capital investment so as to ensure acceptable stakeholder returns within an overall strategic context. Typically a mining company investment portfolio

would encompass options ranging from geological exploration through to market development. A key challenge is thus to ensure the alignment of long lead time investment with strategic intent whilst ensuring that the day to day viability of operations is not compromised. Critical to this process is the effective selection and implementation of a strategically aligned project portfolio that enables optimal resource exploitation whilst operating within mandated strategic bounds and identified constraints.

The ability to realize future value is dependent on developing an understanding of possible future world views in which the business could operate. This is the critical function of scenario planning within the strategic mine panning domain—the development of alternate production portfolios, from the same mineral resource, that are consistent with plausible future scenarios in which the business may find itself.

These world views are developed using a scenario planning methodology, and are interpreted into a set of long-term planning parameters called the 'global assumptions'. These global assumptions are the basis for the formulation of alternate project portfolios, and provide a mechanism through

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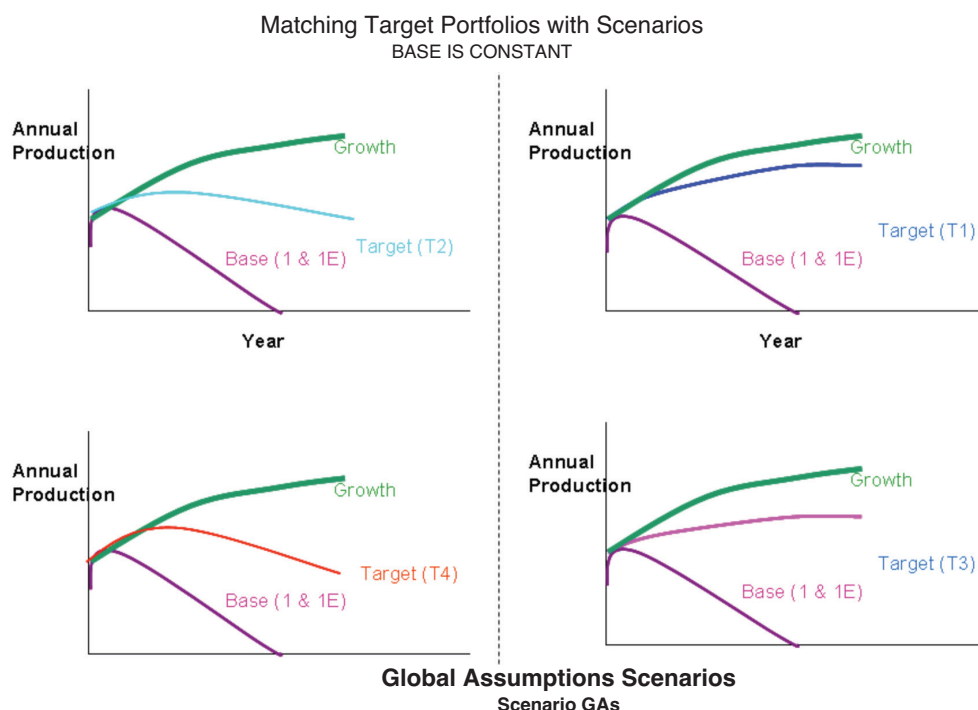


Figure 6—Schematic presentation of alternate production profiles aggregated from each scenario

which executive action can initiate a series of actions for risk mitigation and contingency planning, while retaining flexibility to maximize value.

The ability of the executive to respond to anticipated changes in the business environment so as to minimize risk to the long-term viability of the organization is a competitive advantage that only good foresight can provide.

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