

# **TRANSFORMATION OF KNOWLEDGE MANAGEMENT IN MINE PRODUCTION**

by

Edwin R. Desjardins

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**APPROVAL**

Name: Edwin R. Desjardins  
Degree: Master of Business Administration  
Title of Project: Transformation in Mine Production

Supervisory Committee:

---

Dr. Ed Bukszar  
Senior Supervisor, Associate Professor  
Faculty of Business Administration

---

Dr. Neil Abramson  
Associate Professor  
Faculty of Business Administration

Date Approved:

*August 10, 2004*

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## **ABSTRACT**

Ongoing success in the gold mining industry requires the replenishment, and preferably expansion, of proven and probable ore reserves. This is achieved by combinations of discovering new mineral deposits, acquiring known deposits from others, and reducing operating costs (making larger volumes economical to mine). Furthermore, control of cash costs carries the obvious short term benefit of maximizing profits.

The strategy pursued by Newmont Mining Corporation is one of low cost / adequate quality. With this strategic objective, and considering the extremely high capital costs in mining coupled with rising production costs, maximum operational efficiency is a critical success factor.

Currently, the gold mining industry is enjoying an environment of rising gold prices, and demand outstripping supply. The threat of complacency exists in this positive atmosphere and can lead to the deterioration of operating efficiency, and in turn a deviation from the strategy. Vigilance in the form of continuous improvement facilitated by innovative ways and means of performing the mine production activity is necessary to remain focused.

The magnitude of the role played by knowledge management in operational efficiency, and how well it is adapted in general terms by Newmont, and in specific terms by Minera Yanacocha is considered. This analysis was built relying on widely available industry information, input from key Newmont personnel (including: financial, information solutions, and operations personnel), and on the personal experience of the author.

The direct implication of transforming and optimizing knowledge assets within mine operations at Minera Yanacocha reveals an immediate potential annual benefit of \$14M US in terms of increased production for the same cost thereby lowering the cash cost per ounce produced and enhancing Newmont's ability to increase its proven and probable mining reserves.

## **DEDICATION**

This project is dedicated to my spouse and my parents in recognition of their unconditional support.

## **ACKNOWLEDGEMENTS**

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## 1 INTRODUCTION

Mine operations have traditionally been slow and disjointed adopters of real-time knowledge systems. These technologies are often deployed simply based on the notion that technology will solve all problems without due consideration for fit within the organisation as a whole including communications and integration. Furthermore, many implementations are made without considering the importance of the tacit knowledge that exists within an operation with the effect that dynamic skill based on experience can be stifled. This strategic analysis examines the effectiveness of knowledge systems deployed in a typical open-pit mining operation by exploring implementation, functionality, and integration with other systems within the mine site value chain with a view to providing motivation for effective transformation of how technology is applied in a real-time sense. Whilst the nature of the issues to be introduced are somewhat typical across open pit mining operations, and can be considered to be mineral independent, the primary notion is the requirement to shift relatively static knowledge systems to be tactical operating tools.

This paper provides context by introducing Newmont and the roles of two major operations (Minera Yanacocha and PT Newmont Nusa Tenggara (Batu Hijau)) therein followed by an industry analysis focussed on mining and gold production in particular. From there, an internal analysis including a value chain analysis of both the mining industry and that found on individual mine sites is introduced. With this in hand, the key issues surrounding knowledge systems across operating sites and particularly relating to mine production are addressed with further exploration and recommendations. Minera Yanacocha (MYSRL) is used as a case study within this framework.

As with any real-time knowledge systems, the goal as applied to open-pit mine production is to sense and respond intelligently to dynamic operating conditions. Or put another way, it does not matter what you know, but rather what you do not know and how fast you can access and respond to it.

## **1.1 Newmont Mining Corporation**

Newmont Mining Corporation is the world's leader in gold production (and a major player in copper production by this by-product's association with gold). Achieving this distinction has been facilitated by striving to fit within its strategic vision of "Creating Value with Every Ounce". This is driven by the dual strategies of value realisation and value creation. The value realisation strategy is driven by efficiently operating the existing assets globally. This serves to increase the bottom line, and also increase the volume of reserves by making more mineral economic to mine through lower production costs. Value creation as a strategy is aimed at exploration for new assets and merchant banking. Merchant banking in this context comprises the management of marketable securities including gold royalty holdings and interest in other entities including gold refineries. Working within a commodity industry that carries a high minimum efficient scale, Newmont pursues a generic strategy of low cost / adequate quality. With assets and operations on five continents, ongoing global exploration efforts, and the owner of substantial precious metals royalties, Newmont is well positioned to compete in the gold mining industry. These operations comprise both underground and open-pit operations and include leaching operations that produce gold Doré<sup>1</sup> bars and operations with processing plants that produce concentrated minerals. 2003 production highlights include equity gold sales of 7.4M ounces at an average cash cost of \$203/ounce. From an investor's perspective, it is particularly attractive with the world's largest SEC reportable gold reserves (91,300,000 ounces at the end of 2003 based on a gold price of \$325US/ounce), zero forward hedging of gold production, and presence as the only gold stock on the S&P 500.

## **1.2 Minera Yanacocha (MYSRL)**

Located in the Andes Mountains near the Peruvian city of Cajamarca, Minera Yanacocha is the largest producing gold mine in South America. Newmont operates and holds

<sup>1</sup> Doré bars are a metal alloy comprising anywhere from 60% to 95% gold and also containing silver, copper and other metals; Doré bars require further refining to produce bullion that meets the market standard of 99.95% pure gold.

a 51.35% interest in this traditional truck/shovel open pit mine that produces gold Doré through a leaching process. This world class deposit was discovered in 1985, and commenced operations in 1993. Currently, mine production is sourced from two major pits (La Quinoa Pit and Yanacocha Pit), with each feeding two leaching pads. A third pit (Cerro Negro) is being developed and will replace the Yanacocha Pit's production contribution as it is depleted. Total gold production for 2003 was 2,900,000 ounces at a cash cost of \$120US/ounce, with Newmont's share comprising 1,500,000 equity ounces. MYSRL is renowned for its large reserves, high production, and low cash costs; the mining activity is introduced at depth below and serves as a case study within the notion of transformation in mine production. Other significant interest is held by the Peruvian mining firm Compania de Minas Buenaventura S.A.A. with a 43.65% stake; the remaining 5% is held by an arm of the World Bank (the International Finance Corporation).

### **1.3 PT Newmont Nusa Tenggara (Batu Hijau)**

The Batu Hijau mine is located on the remote Indonesian island of Sumbawa. Newmont operates and holds a 45% equity interest in this traditional truck/shovel open pit mine that produces primarily copper concentrates with gold being a very significant by-product. Batu Hijau was brought into production in 1999 and has rapidly ramped up production. Gold production for 2003 was 585,000 ounces recoverable from concentrate. Newmont's share of this production totalled 329,000 equity ounces. Batu Hijau is a joint venture with the Indonesian mining firm PT Pukuafa Inda which, in turn, is largely held by Sumitomo Corporation, of Japan.

### **1.4 Gold**

Gold is a unique product in that it is both a commodity and currency. Historically, paper money collapses over time and has always been replaced by gold or silver based currency. Since it is relatively rare, and has special characteristics, it is also in great demand for jewellery, dental, manufacturing (electronic and other industrial uses), and other investment.

Gold is a finite resource. The United States Geologic Survey (USGS)<sup>2</sup> reports some interesting statistics. As of 2002, they estimated that the global, un-mined reserve of gold stood at 49,000 tons versus 128,000 tons mined to date. Of this 128,000 tons, approximately 34,000 tons are held as official stocks by central banks, 74,000 tons are privately held (jewellery, bullion, etc.) with the remainder considered to be lost (destructive industrial uses, etc.).

At this point, a limited number of producers dominate global gold production, with Newmont, AngloGold Corporation (South Africa), and Barrick Gold Corporation (Canada) leading the way.

<sup>2</sup> USGS; <http://minerals.usgs.gov/minerals/pubs/commodity/gold/300.pdf>.

## 2 INDUSTRY ANALYSIS

With its dual role as currency and as a commodity, gold production is attractive in the current environment of increasing consumer demand, a weakened U.S. dollar, and uncertainty (from terrorism to the economy). In recent years, the demand for gold (~3,500 tons per year) has been exceeding the production of gold by mines (~2,500 tons per year)<sup>3</sup>. This gap between gold demand and mine supply has been filled by a combination of recycling “scrap” gold, banks leasing portions of their gold stocks to producers who then hedge their future production and other financial speculators. The result is that potentially 30-50% of the reported banks stocks have actually been consumed by manufacturers and physically do not exist<sup>4</sup>. To mitigate this, and due to a concern that the uncoordinated sale of gold by central banks was destabilising the gold market, 15 European banks, the United States, Japan and Australia entered into an agreement to limit their aggregate sale of gold (to 400 tonnes per year for 5 years), and to not increase their levels of leased gold in September 1999<sup>5</sup>. This agreement accounts for approximately 87% of the world’s official gold holdings. China and Russia carry the most significant gold holdings of those countries whose intentions with respect to gold sales are not known for certain. Both of these countries do, however, have policies of increasing the amount of gold that is held in their reserves and likely pose little threat should they undertake massive gold stock selling<sup>6</sup>.

This agreement, known as the Washington Agreement on gold (WAG), came as a surprise to the market and initially resulted in a spike in the price of gold (see Figure 1), however settled out within 6 months and featured a major element of uncertainty (out of control gold sales by central banks) removed. The WAG is expected to be renewed in 2004, albeit with

<sup>3</sup> GoldEx – Pacific Gold Exchange, 2004.02.01; <http://www.goldex.net/whygold/gold-fundamentals.html>.

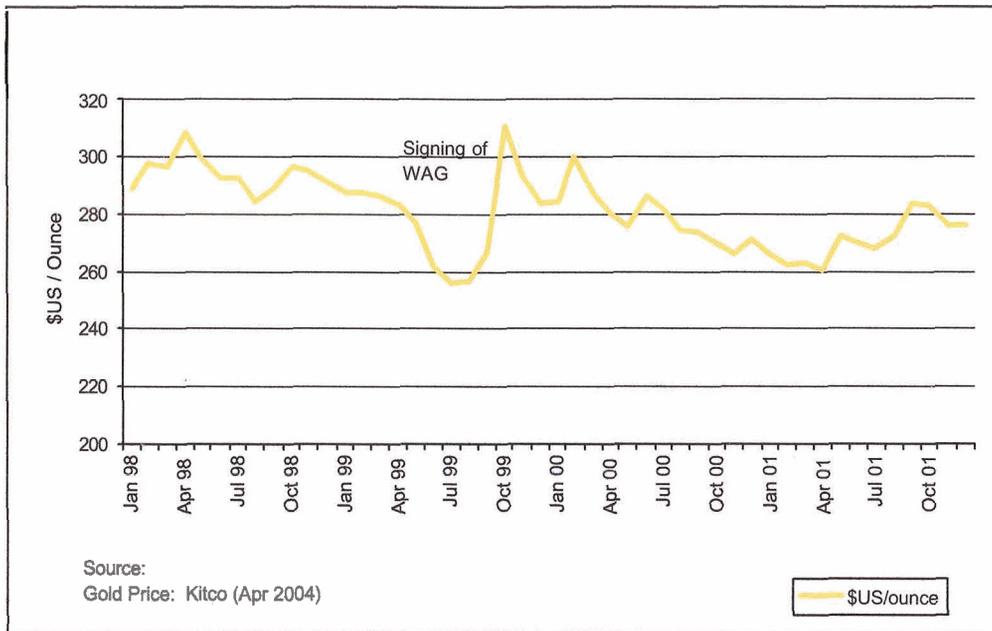
<sup>4</sup> Austin Rare Coins & Bullion. 2004.02.01; [http://www.austincoins.com/austin\\_report.htm](http://www.austincoins.com/austin_report.htm).

<sup>5</sup> “Joint Statement on Gold; aka The Washington Agreement (WAG)”, European Central Bank press release 1999.09.26; <http://www.ecb.int>.

<sup>6</sup> Phillips, Julian, “Chairman Greenspan confirms that Gold has a place in support of a decaying Dollar”, 2003.01.01; [http://www.gold-eagle.com/editorials\\_03/phillips010103.html](http://www.gold-eagle.com/editorials_03/phillips010103.html).

with potentially a small increase in annual sales, owing to the fact that it is not in the best interests of the central banks to dramatically increase the supply of gold and risk depressing the price of gold, and in turn the value of their reserves. Given that the demand for gold is rising, and the release of gold from the central banks is limited, all this serves to put pressure on supply from the gold producers.

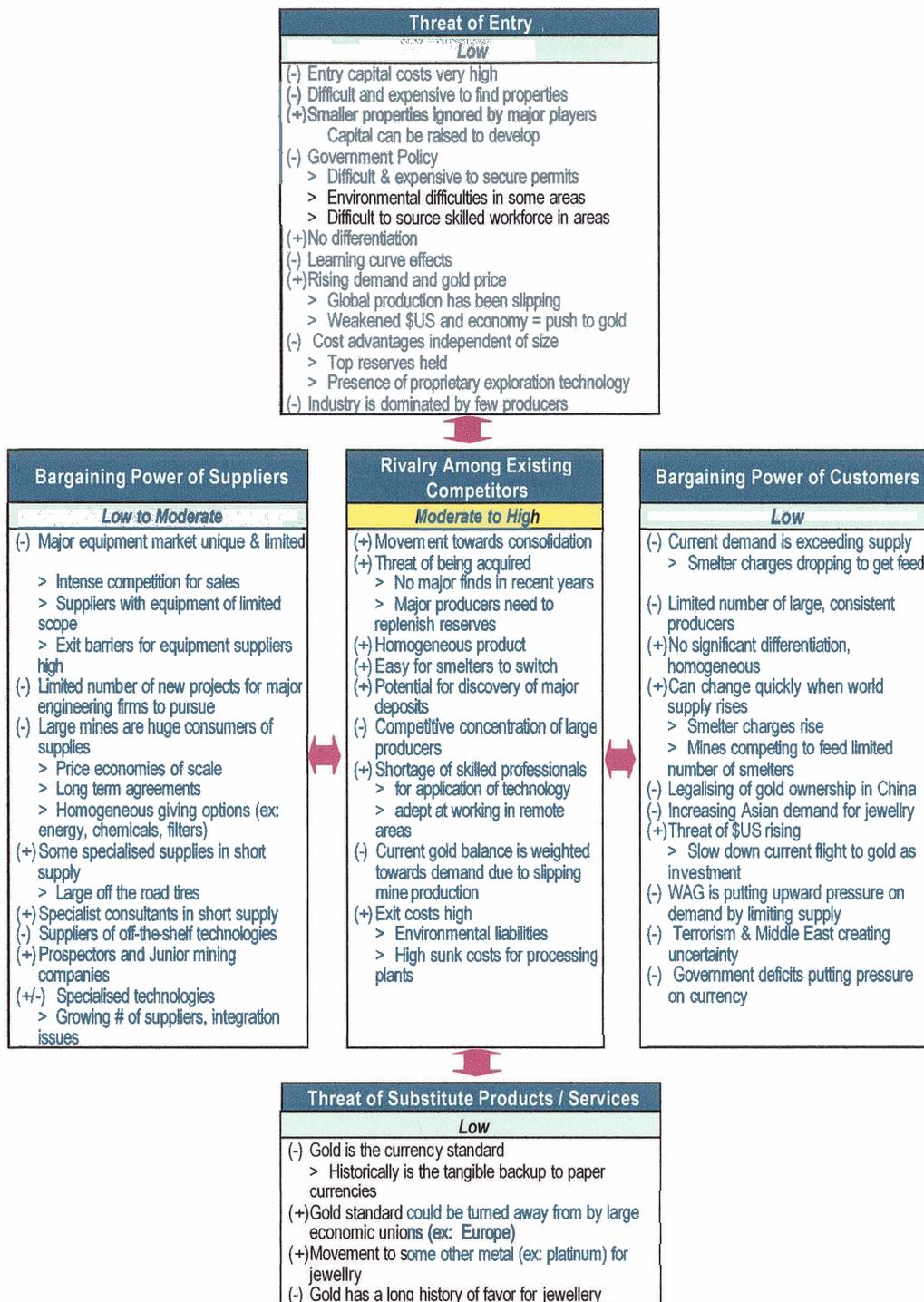
Figure 1: Gold Price Surrounding the Washington Agreement on Gold



Exacerbating the gold demand/mine supply problem is the fact that the “easy” gold reserves have already been found and are being mined or have already been depleted. New supply is increasingly difficult to find and is often located in remote and challenging to develop locations. This has also led to a trend of mergers and acquisitions as the larger players in the industry work to ensuring that reserves are replaced as they are depleted.

Figure 2 following summarizes the relative strengths of the competitive forces shaping the gold mining industry.

Figure 2: Competitive Forces in the Global Gold Mining Industry



Combined, these competitive forces serve to define the underlying structure of the gold mining industry and identify focus areas for strategy formulation. Threat of new entrants, rivalry amongst the incumbent competitors, the threat of substitutes and the relative power of suppliers and customers are all explored.

## **2.1 Threat of Entry**

The threat of large-scale entry into the gold mining industry is minimal, even in the current environment of excess demand and rising gold prices.

First, substantial gold reserves are hard to find and are very expensive to develop. Ongoing exploration is costly, and only rarely produces a mine-able ore reserve. Exploration is undertaken by producers of gold to augment their reserves (Newmont is forecasting expenditure of \$145M on this activity in 2004) and by small exploration companies (generally classed as junior mining companies). In the event that these junior mining companies find a desirable reserve, and due to the extreme cost of developing an operating mine, most of these discoveries are acquired by or jointly pursued with existing producers. To put development cost into perspective, Newmont spent in excess of \$2B U.S. to develop its Batu Hijau project in Indonesia. On the other hand, smaller properties are of minimal interest to the major producers and do enter the industry on a small scale.

Mines are located in a diverse range of physical locations, and by their nature have unique problems. For example, open pit mines in the Rocky Mountains must deal with severe temperature changes, and a large amount of snow, while mines in Indonesia must deal with extreme rainy seasons and associated pit stability problems. With this, experience becomes a major factor in regional mine development efforts. Porter<sup>7</sup> notes that technological advances can reduce the experience curve effects, and they do to an extent in mining, however mitigating physical environment problems such as those highlighted requires “hands-on” experience.

<sup>7</sup> Porter, Michael. “How Competitive Forces Shape Strategy”. *Harvard Business Review*, March-April 1979.

Government policy further exacerbates the mine development problem. Issues herein range from strict environmental laws and requirements, to royalty payments based on mineral extracted, to working permits and the potential for forced divestiture of ownership. Working permits can be particularly problematic in developing countries. Oftentimes, these permits carry a requirement to employ a specific percentage of their nationals, which inevitably results in the appointment of people carrying lower than desired skill levels and an increased reliance on advanced technology.

Other cost advantages that are independent of size include the fact that the best reserves are already held, and the major producers (particularly Newmont) hold proprietary exploration techniques which allow them to identify and evaluate prospects quickly. Also, given that the best reserves are already held, prospective producers are forced into developing less desirable and higher stripping ratio reserves. This has the effect of magnifying the impact of economies of scale where larger operations are forced to mine an increasing amount of waste material to obtain the same amount of gold.

As noted, the gold industry currently enjoys an attractive position with respect to supply and demand. This combined with an uncertain global environment has pushed gold prices upwards 54% in the past three years and has allowed both the survival and introduction of small producers. Furthermore, gold is a homogeneous product with no differentiation at quality levels. In this sense, the entry barrier is low, however ultimately the facts that the costs of entry are so high and that there are a limited number of major producers that tend to quickly acquire emerging reserves makes large-scale new entry very difficult.

## **2.2 Rivalry Among Existing Competitors**

Mining reserves are finite and demand is exceeding mine production. Joseph<sup>8</sup> is predicting that the world will run out of new gold to mine within 20 years. With technology advances allowing the treatment of lower and lower gold grade minerals, the situation is not

<sup>8</sup> Miller, Joseph. "Gold Outlook from 2000 to 2020". 2004.02.01; [http://www.gold-eagle.com/editorials\\_00/jmiller060700.html](http://www.gold-eagle.com/editorials_00/jmiller060700.html).

likely this bleak. That is, given that gold ore is a non-renewable resource, gold reserves must be replaced as they are depleted through mining; the possession of, and ongoing addition to mineable gold reserves is critical for large gold producers. The competition for customers is not the major source of rivalry amongst the competitors; the major competition is for reserves (the raw materials).

As this has become more important, consolidation through acquisitions and joint ventures on specific projects has become prevalent. The absence of any world-class new discoveries for several years has intensified competition for what is available. Lassonde<sup>9</sup> underscored this with: "...at this point, the pickings are very slim" during his interview with Howard Green.

Acquisitions provide both superior land positions with respect to reserves and access to higher quality professionals. Professional employees with the skill and ability to perform at a high level in dynamic operating locales are increasingly difficult to find and have provided a point of competition amongst the major producers.

Even if the pressure on reserves is reduced (either through the discovery of several major ore deposits or a fall in gold demand) the intense rivalry will remain. In this case, and given that gold is homogeneous, the rivalry focus would merely switch to one for access to smelters for refining of concentrated minerals. Smelters have little difficulty switching between sources of feed and can pick and choose between gold producers. This can be problematic for operations such as Batu Hijau as the smelters enjoy a certain amount of leeway in the application of treatment and refining charges (TCRC's) and will force higher payments in times of reduced demand. That said, the opposite is true in periods of high demand. In these times, TCRC's may be eliminated, and even become negative.

Operating mines carry a tremendous amount of sunk costs and with that, a high exit barrier. The fixed infrastructure required to process ore, maintain equipment, ship product, and receive high volumes of energy and supplies is only suitable for that application. Other more

<sup>9</sup> "Interview with Pierre Lassonde, President Newmont Gold Corporation." *The Business News*. ROB-TV. Toronto. 2004.01.22.

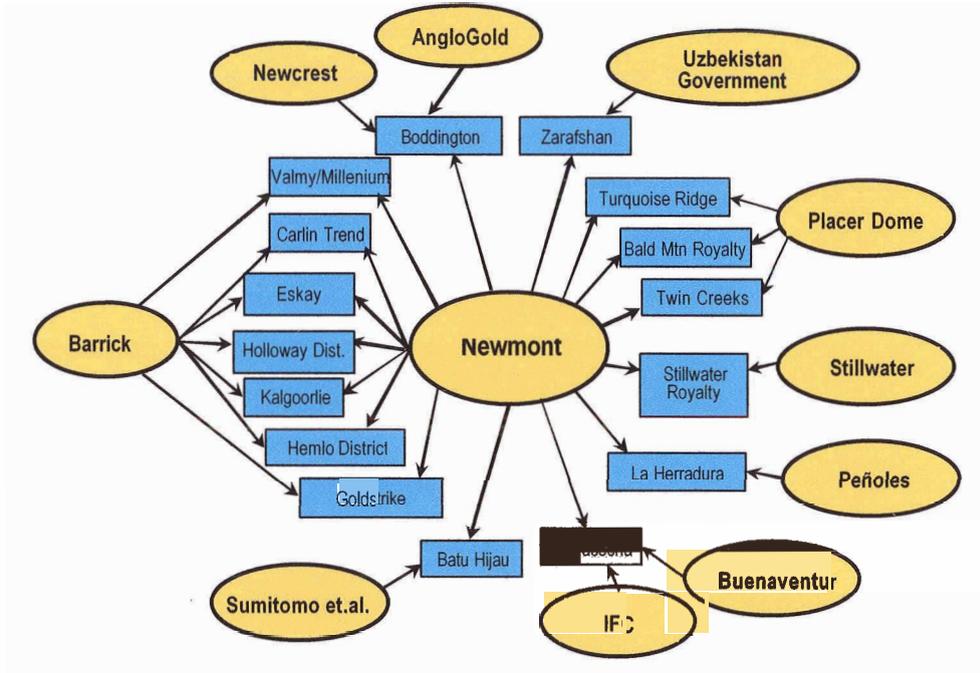
mobile equipment (such as trucks, electric shovels and large front end loaders) may be transferred from site to site, however given their size, they are still only suitable for this type of application. Individual trucks cost in the range of \$3M US with shovels topping the bill at ~10M US each; a large operating mine will have in excess of 70 trucks and 6 shovels.

Another significant exit barrier is the environmental liability associated with decommissioning a mining operation. More and more, mining permits carry an explicit requirement to return disturbed land areas to a very specific state. With this, the incentive to keep a site in operation through to complete reserve depletion is high.

The foregoing would imply that rivalry amongst competitors is bordering on extreme. An interesting aspect is that the reality of the situation, particularly combined with the scarcity of reserves and the cost to develop them, has induced a degree of cooperation highlighted by joint project ownership of specific operations with royalties being fed to the non-operating lead entity. Examples of this include the Kalgoorlie “Super Pit” mine in Western Australia, which is jointly (50/50) held by Newmont and Barrick, and the Boddington mine in Western Australia, which is held 44.4% by Newmont, 33.3% by AngloGold and 22.2% by Newcrest Mining. Figure 3 illustrates the prevalence of this cross-ownership.

Other cooperation is evident in the sharing of operating practices and productivity benchmarking between major producers. There are several motivations for this type of cooperation. First, with respect to cross-ownership of operations, the drivers include: mitigation of risk associated with high cost development, the scarcity of reserves, and most importantly, adjacent claim ownership by different companies spanning a single economic mineral deposit. In this case the cooperation is driven by pragmatism. Regarding the sharing of information, this tends to be driven by the notion that it pays to share best practices, particularly during times of high metal prices. Furthermore, the sharing of equipment performance information allows the mining companies to identify problems and collectively put pressure on the equipment manufacturers for resolution. As such, the rivalry amongst competitors is best described as moderate to high.

Figure 3: Ownership Synergies



### 2.3 Threat of Substitute Products

Gold carries a unique and almost mystical role. Owing to its scarcity and beauty, it has long been a symbol of wealth and is displayed in the form of jewellery and objects of interest. As a tangible and non-deteriorating asset, it has been and continues to be, the basis for currency. With unique physical characteristics, such as high conductivity and malleability, gold is useful in: the production of electronic devices, dentistry, and other industrial applications.

Threats could lie in a movement away from gold as the currency standard in places like the European Union but that is highly unlikely, particularly given the commitments made through the WAG. As history has shown, paper currencies inevitably devalue and even implode. The fallback has always been to gold.

With respect to jewellery, it is conceivable that there could be a wholesale movement away from gold to some other precious metal, particularly if prices skyrocket. While this eventuality could represent a substitution of sorts, it would in reality just serve to reclassify gold possessions as a more opulent display of wealth.

New materials, and more economical material will undoubtedly be developed to replace gold in the manufacturing sector, however the impact of this would be marginal given that this aspect only demands a small portion of gold production. Furthermore, it would help to mitigate the destruction of global stocks of gold (given that much of the gold used in manufacturing is ultimately lost).

The threat of substitute products to gold is undoubtedly low in the foreseeable future.

## **2.4 Bargaining Power of Suppliers**

There are five primary types of suppliers to the mining industry. In broad strokes, these include suppliers of capital equipment, engineering/technology firms, providers of consumables (including energy products), exploration/Junior mining companies, and specialist consultants. It is important to note that the type and function of these discreet suppliers is not unique to the gold mining industry. Primary production equipment, knowledge systems and specialist skills are, as a rule, mineral independent. Mineral processing equipment may be specific to the mineral mined, and even the specific mineral deposit (due to unique rock characteristics); however, this is also sourced from a common set of firms. As discussed at length below, the gold producers exist in a favourable environment with respect to the bargaining power of suppliers, and this can be further extended to mine operators in general.

### ***2.4.1 Capital Equipment***

Capital equipment suppliers can be further subdivided into providers of mining equipment and providers of fixed plant.

Mining equipment includes primary equipment that is used to extract the minerals (trucks, shovels, loaders, and drills) and secondary support equipment (graders, bulldozers, etc.). Whilst most of this equipment is specific to the mining industry at large, there are several

equipment manufacturing companies vying for sale of these capital-intensive machines (dominated by Komatsu and Caterpillar Inc.). Competition is stiff due to the misguided notion that once a mine has committed to a specific brand of equipment, they will likely stay with that brand for the life of the mine. Making the problem worse for the equipment suppliers is the fact that mines are not hesitant to mix their fleets (albeit at a cost in terms of additional maintenance skills required) in order to operate them head-to-head or to move forward to new generation and larger equipment. Designing and manufacturing this equipment is risky for these suppliers in terms of lead-time from drawing board to production, and the potential that the equipment does not perform. As noted above, achieving economies of scale is critical to mining operations and any shortfalls in performance are magnified and advertised throughout the mining industry, and not just limited to gold producers. Exit barriers for equipment manufacturers are high due to their sunk costs in plants and machine design efforts. This has led to some interesting alliances being formed (such as Newmont with Caterpillar Inc.) where suppliers are providing total solutions (at times including maintenance) at favourable prices and even having cross-representation on their respective corporate Boards of Directors.

Fixed plant in this context refers to the components required to operate an ore processing plant (such as crushers and grinding mills), and can include power-generating plants in remote areas. These are one-off costs that only repeat as the major components reach their useful life and need replacement. There are also a limited number of suppliers in this field, however given that there have been a limited number of new mines opening in recent years, the competition amongst the suppliers is brisk. Unlike the mine production equipment however, once a mine has committed to a certain design it cannot easily change suppliers as time goes on.

#### ***2.4.2 Engineering/Technology Firms***

This category may also be further subdivided into firms that design the original infrastructure, and those that provide emerging technologies that enhance mining operations.

Mining houses retain engineering firms (such as Fluor Daniel and SNC-Lavalin) to design and construct their major facilities/plants at new operations. Not unlike the providers of fixed plant, limited major project development has given them a limited number of opportunities

to provide their services. The 70's-80's period saw many new mining ventures undertaken and resulted in an expansion of the plant-engineering field; the result now is intense competition in this area for the limited number of new opportunities that arise.

Technology providers supply equipment ranging from process control in the plants, to fleet management and surveying systems in the mine operations. These various systems are best described as knowledge systems and serve to facilitate real-time management of their focussed areas. In the case of fleet management systems, they have the potential to increase primary production equipment (haulage trucks and loading equipment) productivity rates by up to 35%. With respect to process control system, the plants literally could not function without their presence. The technology providers face a similar situation as the providers of mining machines. That is, they initially proceed with the notion that once an operation has committed to their technology it will stick with it as their product evolves. Their situation is even worse however as the switching costs are even smaller than that for changing equipment suppliers. Furthermore, any deficiencies in their products are extremely visible given that these tools are integrated with a multitude of activities from production to finance, giving rise to potentially snap replacement decisions. Integration in this sense can be particularly problematic for these suppliers. In an ever tightening information technology environment, the information that these systems provide must be easily accessed from several locations to assist sound decision making. As an example, real-time information gathered by equipment fleet management systems includes production data required by mine planning and ERP systems, and also equipment physical operating performance data required by maintenance planning systems. To extend this example, mine planning systems in turn update mineral reserve models, and maintenance planning systems may communicate directly with equipment manufacturers to notify them of predicted component failures.

#### ***2.4.3 Providers of Consumables***

Mining operations require a large and diverse amount of consumable materials to function. This includes items ranging from energy (diesel fuel, coal) to lubricants, office supplies

and shop supplies. In remote operating sites, this expands to include food and other camp related supplies.

These types of supplies are generally homogeneous and not unique to the mining industry. Given that the mines consume tremendous volumes of these sorts of supplies, and prefer not to deal with the distraction of negotiating for them on a routine basis, they tend to enter into longer-term bulk supply relationships. This is also a convenient relationship for the suppliers to enter, and contributes to spirited initial competition. One exception to this is the suppliers of off the road haulage truck tires (which currently command ~\$20,000US per tire). Tire manufacturers, not unlike equipment manufacturers, face tremendous design and manufacturing costs for new products. Making things more difficult is the fact that they are tied to, and lag behind the equipment manufacturers in terms of bigger products. That is, it is risky for them to design and build a tire until the truck manufacturer has designed, built and sold their new models. Given that trucks cannot operate without tires, they are given a favourable supply/demand situation during the initial period of larger truck availability – and can command a premium price if they have a product available. That said, they face the reverse scenario if they are carrying excessive stock of a tire size that is no longer required. Interestingly, tire costs tend to diminish with the age of a truck fleet – but again, the relative power of tire suppliers is high in the presence of new generation haulage trucks.

#### ***2.4.4 Exploration/Junior Mining Companies***

Given that the acquisition of new reserves is the primary source of rivalry amongst the major gold producers, exploration and junior mining companies can find themselves in a strong position in the event that they are fortunate enough to make significant finds independently. The problem that these companies face is raising the capital required to perform costly and risky exploration in the first place. As such, they are continually seeking sources of funding and often end up held to a significant degree by the larger players before they actually make important mineral finds. In this sense, their relative power is very much dependent on good luck.

#### **2.4.5 *Specialist Consultants***

Like most industries, mining requires the retention of specialist consultants to help them deal with troublesome operational issues that arise from time to time. These can cover issues as far reaching as change management with the personnel to process improvement in the mining and mineral processing activities. The accelerated emergence of new technologies has put pressure on a limited supply of professionals that are capable of dealing with the sophistication associated therein. Depending on the task at hand, professionals of this ilk can be in short supply and do provide a source of competition amongst rival gold (and mining in general) producers. In these situations, the supplier may be able to command obscene fees for their services, however in the larger picture this represents a trivial cost to the gold producers with the larger issue herein being competition with their rivals.

#### **2.5 *Bargaining Power of Customers***

In the current environment of gold demand outstripping mine supply, the gold producers are in a favourable position with respect to customers. In light of this, it is worth revisiting what gold is and how its value is impacted by not only consumer demand, but also world events. To reiterate, gold is both a product and money, and is currently undergoing major factors that impact both of these aspects. The discussion following largely focuses on demand factors with the notion that there will always be a customer – it is just a matter of what prices are set. Arguably the only point of threat lies in smelters commanding high refining charges in the face of dramatically lowered demand and gold price given the homogeneous nature of gold and the variety of gold producers. Currently, smelters are competing for feed from the gold producers to the extent that they are waiving TCRC's and even charging negative TCRC's in order to keep their plants operating at a higher capacity in a favourable demand environment.

As the basis for currency, gold's value is currently under a series of events that are putting upward pressure on its price. Gold has always been the safe haven for assets. It is rare, non-deteriorating (theoretically, all of the gold that has ever been mined is still available), and has carried value for thousands of years. It is the benchmark by which currencies are measured. World events that are impacting this include: the falling US dollar, extreme government deficits,

government deficits, investors seeking better returns and safety with gold, increased printing of money to combat deflation (especially in the US), legalized gold ownership in China, and the uncertainty generated by heightened tension in the Middle East and the ongoing war on terrorism.

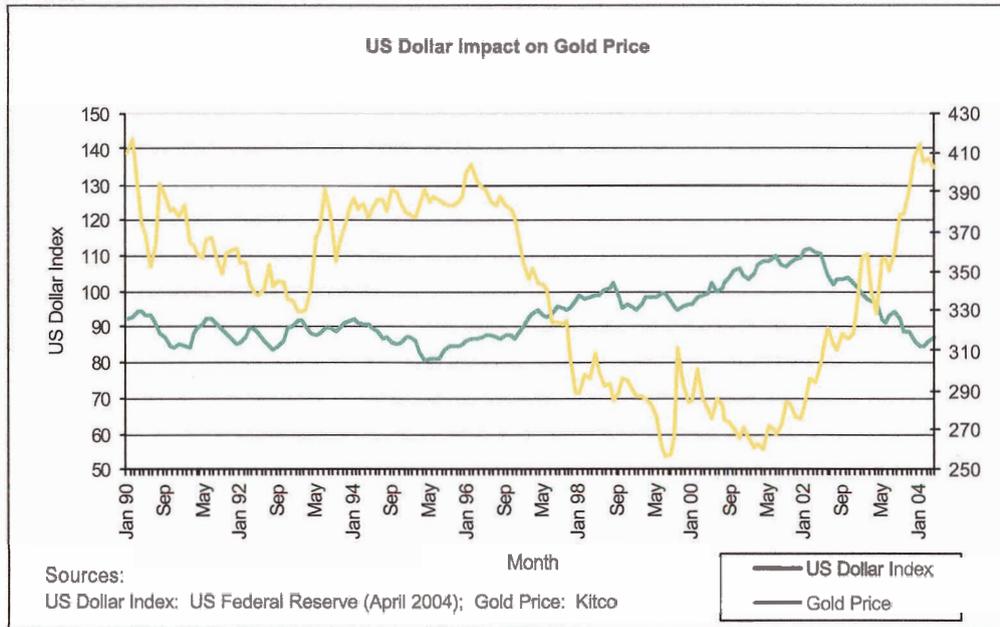
Whilst all of these are serving to increase the demand for gold and continue to widen the gap between demand and mine supply, it is worthwhile considering several of them independently. First is the impact of the relative value of the U.S. dollar with respect to the price of gold as illustrated in Figure 4. The obvious conclusion to be drawn with this is that the U.S. dollar, as a global currency, is currently a prime determining factor for the price of gold. The impact of terrorism and conflict in the Middle East is also highlighted with the continued rise in gold price since America's operation Desert Shield and subsequent occupation of Iraq.

The legalisation of gold ownership in China is of particular interest. The barriers to ownership were lowered in late 2002 with the establishment of the Shanghai Gold Exchange and the cessation of the Chinese central government buying gold directly from their producers. This barrier was completely removed in March 2003 allowing gold holding and ownership by Chinese citizens. The Chinese have coveted gold for thousands of years, and although much of this population is poor, there is a growing middle class that is expected to accumulate gold given its status as a symbol of wealth. Annual demand is expected to increase from 200 tons to 500 tons annually<sup>10</sup>.

The outcome of the other events described is yet to be determined, however at this point the demand situation appears to be steadily marching up. The result has been a 54% increase in gold price over the past 3 years, and many gold analysts predicting continued and even accelerated growth with diminishing new supply and increasing demand.

<sup>10</sup> Austin Rare Coins & Bullion. 2004.02.01; [www.austincoins.com/austin\\_report.htm](http://www.austincoins.com/austin_report.htm).

Figure 4: US\$ Impact on Gold Price



Concern has been raised that this could be indicative of a bubble situation similar to late 1979 / early 1980, however that period was different in that the price was largely driven by inflation problems. Figure 5 provides illustration of the bubble experienced in the late 1970's in contract to what appears to be a more controlled price movement currently.

Figure 5: Current Gold Price vs. Bubble of 1979/1980



## 2.6 Success Factors

Ultimately, the primary success factor in this industry is access to, or possession of, mineral reserves. Owing to the requirement for cost control, efficiency of operation is critical for keeping cash costs low. As equipment is reaching its maximum practical size, both in terms of capital cost and practical management of a mine, this efficiency is largely driven by the introduction of knowledge management technology. Those that implement the correct technologies and succeed in effectively integrating it throughout the value chain are better able to realize these efficiencies. Achieving this further requires the presence of skilled professionals, and potentially the entering of strategic alliances with suppliers of technology.

## 2.7 Industry Analysis Summarized

A study of the relative strengths of the competitive forces that shape the gold mining industries reveals an overall favourable operating environment for those that are established in the game.

The threat of new, large-scale entrants is low given the high cost of finding, developing, and operating new operations. Furthermore, the strength of the existing major players allows them to acquire potential entrants as they appear.

Rivalry amongst the existing competitors is moderate to high, with much of the focus being on competition for new reserves to replace depleted reserves as they are mined out. Competition also lies in the sourcing of high quality professionals that have the ability to operate in difficult and regionally diverse locations. Whilst the competition for reserves (including acquiring emerging interests) is brisk, the industry is marked by a large degree of cooperation between the producers in the form of cross-ownership of operations and the sharing of best practices and productivity benchmarking information. The presence cross-ownership is largely a function of convenience attributed to ownership of adjacent properties making it independent of market cycles. Sharing of information, on the other hand is more prevalent in the face of higher metal prices.

The threat of substitute products is very low. Gold is unique, and stands on a dual platform of being both a product and the currency standard. Replacement materials may dislodge its place in manufacturing to a degree, however in the larger scheme, this loss would be relatively trivial.

Even though there are few suppliers providing a narrow spectrum of very specialized equipment, the suppliers bargaining power is somewhat limited given the intense competition amongst them. Suppliers of operating consumables carry limited power as well given the homogeneous nature of their products and their desire to secure the longer-term and consistent supply contracts that the mines are willing to enter. The exception to this is specialist consultants who are able to command high prices due to their scarcity and large impact on the operations. Considered in the larger picture however, these costs are insignificant.

The strength of customers is really determined by demand factors, which in turn are largely determined externally by world events. Currently, a series of factors including: the devalued US dollar, increased government deficits, government policies to combat deflation, the legalisation of gold ownership in China, limits on the sale of gold by central banks (through the WAG), and uncertainty created by Middle East tensions and the war on terrorism are all

contributing to an increase in global gold demand. With this, and considering that the amount of available gold is finite reveals a situation where the gold producers enjoy a strong position with respect to their customers.

Success in this industry is largely determined by gaining access to mine-able reserves. That said, ongoing operational success is driven by the control of cash costs. More and more, this is achieved by the effective introduction of knowledge systems that provide both guidance in real-time operations, and integration with other systems throughout the value chain. This is of particular importance in mine production.

### **3 INTERNAL ANALYSIS**

As a rule, the purpose of an internal analysis is to look inward for insights into those specific aspects of the business that are strategically important. This chapter pursues this objective by first working to understand the overriding generic strategy employed by Newmont. From there, the focus shifts to introducing the value chain that is in force across the mining industry as a whole and also experienced within individual mining operations. This is further refined to describe the value chain apparent within the mine production activity at MYSRL.

Newmont's core competencies are then evaluated from both overarching corporate and individual site standpoints with a view to identifying capabilities and any lack thereof. Again, the ultimate focus is on mine production and the drivers required therein to achieve, and maintain long term success.

#### **3.1 Generic Strategy**

Expressed as a generic strategy, Newmont's vision can be described as low cost / adequate quality strategy. Figure 6 following illustrates its position within the general parameters defining a generic strategy.

The theory of fit describes success in aligning strategy, organizational capabilities, core competencies, and markets. Pursuing a generic strategy of low cost / adequate quality puts Newmont at risk of losing a focus on the innovation required to keep costs under control in an industry that demands mass production and requires discipline to maintain.

Figure 6: Generic Strategy Map<sup>11</sup>

Parameters	<u>Cost Based</u>	<u>Differentiation</u>
	Low Cost / Adequate Quality	High Quality / Adequate Cost
Production Strategy	Innovative (6)	
R & D Expenses	R&D (5)	
Structure	Centralized (5)	
Decision Making	Autonomy (6)	
Production		Economies of Scale (1)
Labour		Mass Production (4)
Marketing	Push (5)	
Risk Profile		High-Risk (9)
Capital Structure		Conservative (10)

### 3.1.1 Production Strategy

Over its 81 year history, Newmont has proven to be an innovator in the mining industry, and in gold mining in particular. Differentiating gold as a product is not possible; however differentiation in terms of innovative ways and means of identifying new mineral reserves and bringing them into production has proven to be a Newmont strength. Process technologies, including the development of heap leaching and mill process techniques have allowed Newmont to provide value to its operations in the form of more efficient and economic gold recovery processes, and the licensing of patented technologies to other mining houses. This has further allowed the consideration of difficult ore deposits previously deemed uneconomical by the exploration group. Innovations in exploration technologies have been ongoing since 1945. Recent advances include Bulk Leach Extractable Gold (BLEG) technology<sup>12</sup> and proprietary

<sup>11</sup> Bukszar, 2004, EMBA Class notes.

<sup>12</sup> An analytical technique applied to stream sediment samples in broad-scaled reconnaissance exploration.

Electromagnetic (EM)<sup>13</sup> mineral exploration systems. These advances have served Newmont well by allowing it to identify and quantify new reserves to replace those depleted in existing operations. Other innovations and technology adoption are visible in the mining and processing areas, and include the latest in process control and fleet management technologies. Given the bulk nature of mining and its associated high minimum efficient scale, these advances are essential to facilitate an environment of continuous improvement (discussed below), but are not currently deployed in a coordinated fashion. This applies both within and across operating sites. Reportable ore reserves are determined using inputs that include gold price and production costs. With this, production cost control becomes a critical factor. In an environment of larger and more expensive mining equipment fleets, the identification and deployment of technology that facilitates optimized process control is becoming more essential for ongoing success. This may also be expanded to include the absolute requirement to manage the knowledge that exists (both tacit and from systems) to ensure that the right information is getting to the right operating personnel for real-time decision making.

### ***3.1.2 R&D Expenses***

R&D expenses, expressed as a percentage of expenses are, as a rule, low in the mining industry (3-5% including exploration). In these terms, Newmont is consistent with the other major global gold producers (Barrick Gold and AngloGold). As mentioned above, various technologies have been developed within Newmont and have been effective by introducing innovative ways of dealing with operational constraints, and identifying new exploration opportunities. Continued improvements related to both exploration techniques and operational efficiency demand ongoing investment in R&D.

<sup>13</sup> Technology used to locate massive sulphide deposits, by mapping resistivity variations in the earth by introducing a magnetic field for electric current flow in one area and measuring the change in voltage at a second area.

### ***3.1.3 Structure***

The structure of Newmont is largely centralized and hierarchical in form. Structured as a holding company, Newmont has operating divisions and legal entities located on 5 different continents, in addition to its corporate presence in Denver that includes umbrella technical, legal, treasury, merchant banking, gold marketing, and information technology leadership functions in addition to operating division leadership. Each of the remote entities is directly accountable to a Vice President Operations located in the corporate offices in Denver. As such, the corporate office serves as a base for corporate activities and strives to maintain consistent adherence to corporate policy and values across the various groups. On the downside, this structure is not particularly conducive to the transfer of ideas between the operating sites, which do face a large amount of common issues. This sort of cross-pollination is only obtained from outright transfer of employees.

From a cost point of view, this structure provides the advantage of allowing various overhead functions, such as those handled by the treasury group, to be dealt with in a more efficient manner and allows the operations to focus on the unique aspects presented at the individual operating areas. In keeping with this, after the acquisition of a major competitor (Normandy Mining) in 2002, Newmont promptly rationalized the acquired management structure to fall into line with its centrally based structure and managed to realize the synergies to be obtained from these acquisitions.

### ***3.1.4 Decision Making***

The various entities have a large degree of autonomy with respect to decision making within their operations. This is held back to a degree by a requirement to receive corporate approval before implementing annual operating budgets (production and financial), or manipulating financial instruments. However, within the framework of day-to-day operating decisions, the operations have complete control. This allows them the latitude to develop their own innovative ways and means of dealing with the commonly unique issues faced in mining and processing a diverse range of ore bodies, and within an assortment of different cultures. That

said, opportunities to share information across the operating entities can, and are being missed due to inward focus at the operating levels, and the absence of coordinated integration of operating control systems across the operating sites.

### ***3.1.5 Production***

Without question, mining depends on very high levels of scale efficiencies. Newmont is very adept at exploiting this with an ongoing focus on achieving continuous improvement within its large-scale mining operations. This is accomplished by deploying larger, and industry proven, production equipment and applying production innovations in areas that positively impact the flow of this equipment. Given the cost of this equipment, tied with the difficulty of operating it in a practical sense, the effective application of various technologies that facilitate decision making without sacrificing the intrinsic tacit knowledge in mine operations is critical. On the mineral processing side, volume of throughput has been identified as a critical success factor and continually rises with changes in blasting techniques and other enhancements within the processing activity. Newmont has formally implemented a company-wide system of continuous improvement dubbed Gold Medal Performance. This system includes a number of different tools that help everything from bringing ideas to the forefront to systematic methods of organizing meetings and different sponsored initiatives.

Through purchases and sales of mineral assets with a view to strengthening asset mix quality, and importantly rationalizing mining districts, Newmont has been able to generate further economies of scale by consolidating smaller scale operations.

### ***3.1.6 Labour***

Owing to the large-scale of most of the operations, labour costs as a percentage of cost of goods is relatively low. That said, there is a marked difference in the magnitude of this cost depending on geography. In first-world based operations (Canada, U.S.A, and Australia) the costs of labour (including benefits) is relatively high with the requirement for skilled employees in maintenance and process operations who are able to command a premium for their work (due to demand). This is offset to a large degree by ~50% of Newmont's 14,000 employees based

in developing countries and of which ~97% are sourced from indigenous peoples who are available at a much lower wage rates. The relative cost of labour, however is not reflective of Newmont's employee strategy. Following the concepts introduced by Collins<sup>14</sup>, Newmont undertakes a "systematic process to fit the right person, in the right job, at the right time, and in the right way". This philosophy has strengthened its ability to be innovative in its approach and provides an environment for achieving the required efficiencies of scale.

### ***3.1.7 Marketing***

With its position as the market leader in both the production of gold, and reserves held, Newmont is realizing some influence over the gold market and is able to pull it to a small degree. Currently, the value of gold is somewhat tied to the strength of the U.S. dollar (see Figure 4). As the U.S. dollar weakens, the price of gold strengthens accordingly given gold's role as the reserve currency. Supply and demand also impacts the price of gold, however is overshadowed by the global economy, and the U.S. dollar in particular. With the continued strengthening of the Asian economies, this may change with increased demand for both manufacturing and jewellery. To enhance value creation of its primary product, Newmont has also embarked on a joint venture in gold marketing and refining through its merchant banking division. The objective of this initiative is to promote gold in all of its forms, ensure distribution channels for its product, and to place Newmont closer to its market for insight into gold demand. The products produced include gold bullion, jewellery and products manufactured from gold and other precious metals.

### ***3.1.8 Risk Profile***

Substantial risk and uncertainty is sourced from several different areas in the gold mining industry including: operating costs, production ability, ongoing environmental concerns, interest rate changes, and revenues.

<sup>14</sup> Collins, Jim. *Good to Great*. New York: HarperCollins Publishers Inc, 2001.

Operating costs variability poses the smallest risk, and is generally limited to costs associated with energy (diesel fuel and electricity) and exchange rate fluctuations in the different operating regions. This second risk is mitigated to a degree by forward hedging of the currencies and attempts to source operating supplies locally and in the local currency. The application of appropriate technology in the mine production area can help to smooth some operating cost variability, however is more directed at lowering operating cost by facilitating a higher degree of operating efficiency.

Production ability risk is found in the nature of the mining process. In open pit mines, failures of pit walls due to adverse weather, seismic activity and rock stability have the potential to disrupt production for months on end. Additional risk lies in equipment availabilities, particularly in remote sites where both parts and skilled labour are often difficult to obtain. This particular risk has been addressed by the fostering of a strategic alliance with the global leader in earthmoving equipment (Caterpillar Inc.), and equipment purchase deals that include site based servicing and guaranteed equipment performance and availability.

Unstable governments in developing countries can hinder and even prevent ongoing operations by pulling work contracts or forcing divestiture of an asset.

By its complexion, mining carries environment risk. This ranges from changing reclamation requirements for large tracts of disrupted land area to the potentially disastrous effects caused by the accidental introduction of chemicals used in the mill process (such as mercury) into the local environment. The potential costs associated with any of these eventualities can be catastrophic to an operation's viability. Newmont places substantial effort in this with the executive level appointment of a Vice President responsible for environmental awareness, and the establishment of major environmental departments at each of its operating sites. These groups are responsible for ensuring that reclamation efforts are undertaken throughout the life of the mines, for continuous monitoring of water derived from all sources to ensure that it meets acceptable threshold limits, and ensuring that indigenous wildlife disruption is minimized.

Due to the capital investment required to develop and operate a mine, operations are often forced to carry a heavy debt load. As such, rapidly rising interest rates can quickly turn

profitable mines into unprofitable mines. Following a focus on debt reduction, Newmont has mitigated this risk by reducing debt to total capitalisation by 52% to 20% in 2002 with a plan to further reduce it to 10% during 2003.

Revenue risk lies in both market price, and penalties that may be automatically applied to a sub-standard product. As noted above, the relative value of the U.S. dollar is the primary determining factor for the price of gold with supply and demand currently playing a more minor role. Again, the potential of increased Asian consumption may alter this picture significantly causing an accelerated rise in gold price. To mitigate price risk, companies in the past have entered into hedging agreements by pegging volumes of gold at a specific price. The downside of this practice is when the price of gold is rising (as it has been), the operator runs the risk of not enjoying the increased price and suffers from compromised operating margins. Newmont has eliminated all of its gold hedges. Penalties may be assessed in the event of quality problems, such as impurities found in concentrated ore. These tend to be automatic in nature and are applied by downstream refining processes.

### ***3.1.9 Capital Structure***

Given the risks associated with the necessity to invest very large sums of money to develop a project in this industry, the capital structure is forced to be conservative in nature. As such, in most cases up to 50% of these investments are funded through bank debt tied to the identified assets (both mineral and physical) or the issuance of new shares.

As described above, Newmont has been aggressively reducing its debt to capitalization ratio and has succeeded in eliminating its *net* debt with cash exceeding debt by \$237M at the end of 2003. With the recent jump in gold prices, Newmont has been able to fund all operations from revenues and finds itself in a very conservative position with a debt to equity ratio of 0.45. That said, if gold prices were to take a major fall, this enviable position would be compromised.

In the event that capital is required for operations or other investment, a \$750M US revolving credit facility is available. As of December 31, 2002 there were no borrowings against this facility.

### **3.1.10 Overall Fit**

Newmont is, to a large extent, achieving fit within a generic strategy of low cost / adequate quality. This is especially evident in its ability create value through the identification and acquisition of new reserves. Its capital structure, featuring low debt allows it to react quickly to new prospects as they arise. The identification of prospects is enhanced by the internally developed technologies in both exploration and ore processing techniques.

As noted, the mining environment demands a high minimum efficient scale. This is exacerbated by ever increasing costs for both mining equipment and the fuel to operate the fleets. To remain effective within the defined generic strategy, a coordinated effort aimed at innovation within the context of mine production is essential across all of the operating sites. Making this more difficult is the current environment of high gold prices, which has the potential to dull the focus on cost control. Increased investment in innovation directed at optimising the mine production process and managing the knowledge that exists is necessary to solidify the fit within the generic strategy and remain consistent with the stated vision of creating value with every ounce through value realisation and value creation.

## **3.2 Value Chain Overview**

Mining companies are largely vertically integrated within the mining industry. The scope of this industry ranges from the actual locating of a mineral reserve through its development, exploitation and sale to customers such as smelters and refineries. At the completion of a property's useful life it is divested and must be rehabilitated to an acceptable level. Inputs from others in the form of consultants, contractors, and other professionals are required in varying degrees throughout this value chain.

The primary focus herein is on the complexity of the value chain in effect at a typical metal mine site. Once again, the mining company has competencies in differing degrees throughout the value chain, but also requires input from outside sources in all activity areas to be efficient. The evolution and implementation of knowledge systems and technology is becoming increasingly important in all areas of the value chain, and particularly in mine operations. This specific primary activity has suffered from both a lack of available technology and a reluctance of

of mine operations to embrace and exploit the benefits that it has the potential to accrue.

The following sections describe the mining value chain in general with a further focus on that found on an individual mine site.

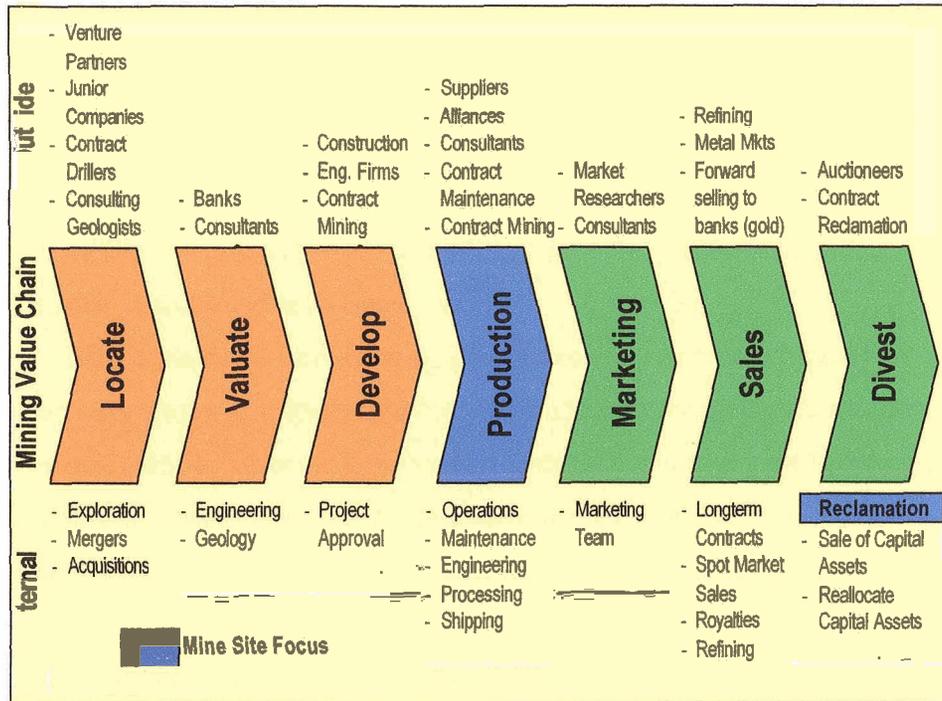
### **3.3 Mining Industry Value Chain**

The mining industry is largely vertically integrated with large mining houses, such as Newmont, providing input at each of the major activities along the chain. Given the complexity of the various activities, significant input is obtained from third parties such as heavy equipment suppliers and engineering firms. Figure 7 following illustrates the mining industry value chain.

#### ***3.3.1 Locate***

Determining the presence of a viable mineral deposit that contains saleable commodities is the first step in the mining value chain. One of Newmont's core competencies is the ability to identify new reserves to replace those that are depleted and even expand them. From within, this is achieved through a combination of acquisitions from others, and exploration using methods that include geologic surveys and diamond drilling. Exploration expenditure has increased annually from \$55.5M in 2001 to \$115.2M in 2003. This has been driven by the incentive offered by increasing gold prices, as well as the increased difficulty in finding new properties. Outside contribution to this activity is sourced from venture partners, junior mining companies offering properties, contracted exploration services and consulting geologists.

Figure 7: Mining Industry Value Chain



### 3.3.2 Valueate

Valuation entails determining the profitability of a project based on the identified mineral resources. The primary input to this activity is a mineral resource model that delineates the deposit into blocks describing the mineral characteristics including grades and location. This activity is performed internally by corporate level engineers and geologists, and/or by 3<sup>rd</sup> party consulting engineers. Banks may independently verify this if financing is involved. The output of the valuation process is a bankable feasibility.

### 3.3.3 Develop

The planning and development of the mineral deposit follows. This activity, which is generally performed by construction and engineering firms, includes the design and construction of site infrastructure (processing plant, shops, and other facilities) and the exposure of the ore body following a long-term mine plan. A mining company's role in this process is normally

limited to acceptance of the proposed plans, and may include involvement in the early development mining.

#### **3.3.4 Production**

The production activity is centered on the safe removal of the mineral resource and its conversion into a saleable commodity. The primary activities of production are mining, beneficiation, and shipment of the commodity.

Mine production is focussed on the physical removal of the mineral from its in-situ position. This is either accomplished through open pit mining with large shovels and trucks or by underground methods. Given the large volumes of material that must be moved, particularly in open pit mines, operational efficiency at this stage is of utmost importance and depends on a delicate balance of equipment selection, application of appropriate technology, and usage of the tacit knowledge held by skilled employees.

Beneficiation comprises the liberation of minerals from their host rock, and the appropriate disposal of residues. Depending on the nature of the ore deposit, this comprises the concentrating of minerals in a plant to be sold as a concentrated product for further refining, or the leaching of metals directly from a mined ore. Again, this process is dependent on efficiency of scale, however once a processing technique is in place, the potential for operational improvement is somewhat less than that in the mine production area.

Shipment of the product is, as a rule, performed by others. The nature of this activity is determined by both location and nature of the product. In the case of the Batu Hijau operation, concentrates are produced on the island of Sumbawa, and then shipped by ocean vessel to smelters around the world. MYSRL, on the other hand, produces gold Doré which is shipped to market via armoured carrier.

The mining company undertakes production with significant input from equipment suppliers, consultants, and contractors. This activity is explored in depth below.

### **3.3.5 Marketing**

The mining company's marketing team, with the involvement of market researchers and other consultants, works to maximize the profit of the commodity produced. Depending on the commodity produced, this involves market targets that include smelters (metals), steel companies and power plants (coal), manufacturers (industrial minerals), and jewellers (precious stones).

### **3.3.6 Sales**

Sales are made within the contexts of long-term contracts, and spot sales. In the case of concentrated metal producers, these sales are generally made to refineries and smelters. Gold producers may also forward sell their gold production at a fixed price as a hedge. Furthermore, and given the widespread presence of joint ventures and partnerships, the non-operating partner mining companies receive royalties at this stage of the value chain. Most of Newmont's revenue comes from the sale of refined gold in the international market. The end product at each of Newmont's purely gold operations (including MYSRL), however, is Doré bars, which are sent to refiners to produce bullion that meets the required market standard of 99.95% pure gold. Under the terms of refining agreements, the Doré bars are refined for a fee, and Newmont's share of the refined gold and the separately-recovered silver are credited to Newmont's account.

### **3.3.7 Divest**

The final stage in the mining industry value chain is the curtailment of operations after mineral reserve depletion or a Board of Directors level decision based on a change in the economic environment. This may include sale of the operation to a third party for continued operation. Beyond asset disposition (reserve and capital equipment) this process includes the final reclamation of the tracts of land that have been disturbed by the mining operation. Sale of assets is normally facilitated by others, however often includes significant input from the mining company at the mine site level. Reclamation is an ongoing effort during the life of the mine and is

performed by the site; final reclamation during the divestiture stage is performed by either the mining company or contractors (or both).

### **3.4 Mine Site Value Chain**

Individual mine sites are focussed on converting the mineral reserve into a saleable commodity, and winding the mine down at the end of its useful life. The primary activities in this process are: mine operations, beneficiation, outbound logistics, and divestiture. This is supported by an overarching series of support activities. The following discussion explores these various activities with specific support activities included with the primary activities, and those that are overarching addressed independently. Figure 8 below serves to illustrate the value chain at the mine site level.

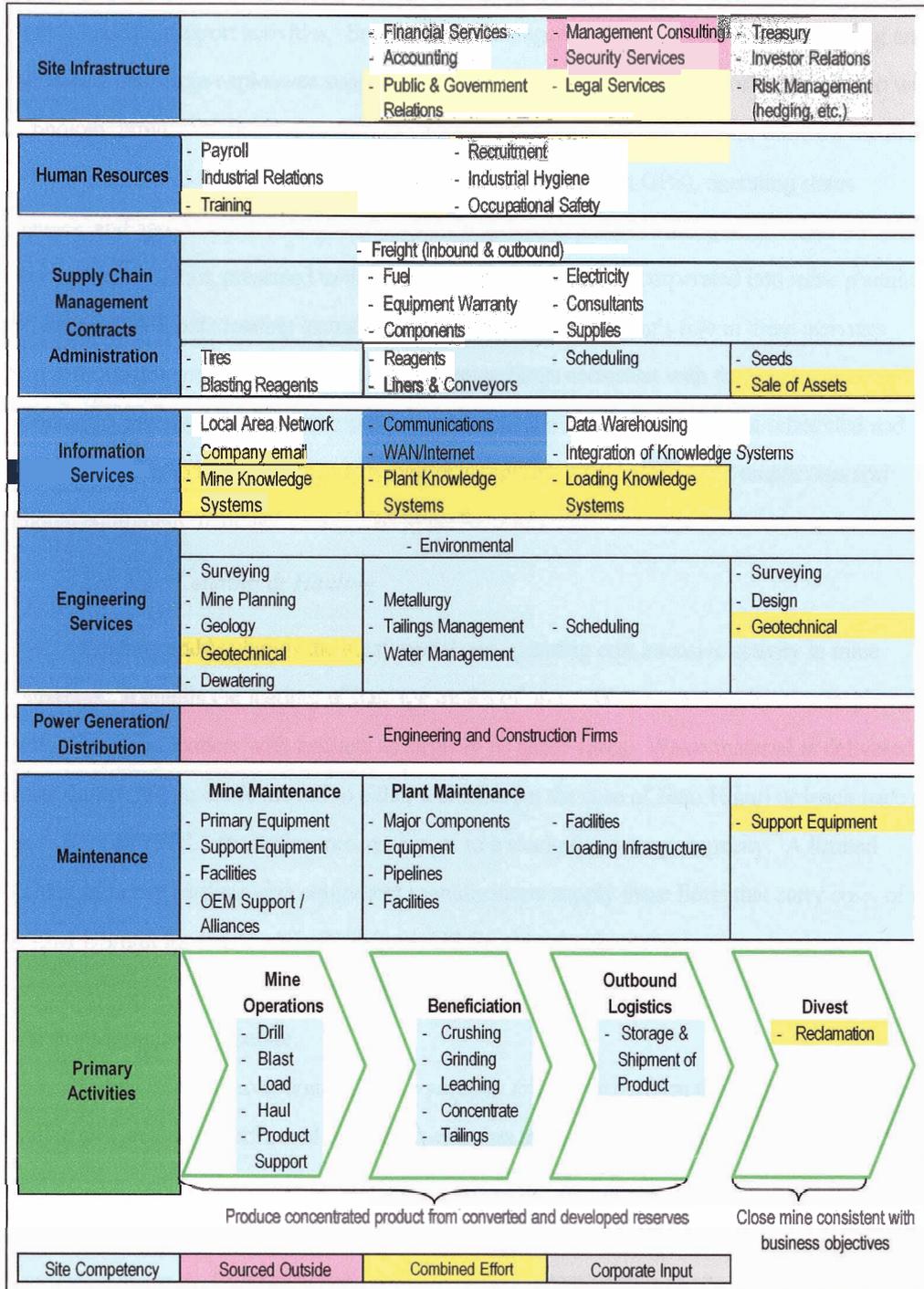
#### ***3.4.1 Mine Operations***

The mine operations activity encompasses the processes required to safely remove the mineral resource and present it to a plant or leaching area for beneficiation. The major processes involved in this effort are: drilling, blasting, loading, hauling, and production support.

##### ***3.4.1.1 Drilling & Blasting***

Drilling and blasting are the first steps in the removal process and serve to fragment the mineral deposit and host waste rock. Mine employees, using large rotary drills boring holes that range from 10"-17" in diameter, perform the drilling activity. Bulk explosives are loaded into these holes and provide the energy required for fragmentation.

Figure 8: Mine Site Value Chain



Supply chain management, information services, engineering, and maintenance all provide specific support activities. Supply chain management provides service by sourcing and negotiating long-term explosives supply contracts. Information services, working in concert with technology providers implements integrated knowledge systems that are used onboard the rotary drills to collect real-time information relating to hole location (via GPS), operating status changes, and assorted drill hole parameters such as hole depth and drilling time. This information is, in turn, presented to the engineering group and is incorporated into mine planning software and drill hole loading instructions for blasting. Engineering's role in these activities ranges from surveying drilling patterns, to designing blasts consistent with the mining plan, and maintaining inventories of broken material. Maintenance is required on both a scheduled and breakdown basis to keep the drills operating at an optimal level. Both mine employees and original equipment manufacturers (OEM's) perform this service.

#### *3.4.1.2 Loading & Hauling*

Loading and hauling is the most capital and operating cost intensive activity in mine operations. It entails the loading of haulage trucks of up to 400 ton capacity by electric shovels and/or front-end loaders with buckets as large as 70 cubic yards. Waste material is delivered to waste dumps, while ore is moved to either a crusher (in the case of Batu Hijau) or leach pads (in the case of MYSRL) for further processing, or to a stockpile as surge capacity. A limited number of heavy earthmoving equipment manufacturers supply these fleets that carry costs of up to \$3M US/unit for trucks and ~\$10M/unit US for shovels. Large operations, such as Newmont's Batu Hijau project, have fleets of over 70 trucks and 6 electric shovels that cost over \$60M/annum to operate.

Inputs from different sources are required to efficiently perform this activity. The actual loading and hauling is performed by mine employees or contracted miners. Mine employed engineers provide field surveying of material moved, and short horizon material loading plans and sequences to ensure that the business objectives, as they relate to ore feed for further processing, are met. By their nature, open pit mining activity results in pits with high (and potentially unstable) walls and a propensity to trap water. Geotechnical engineers are employed

to monitor stability issues and often call upon specialist engineering firms in serious situations. Engineers address the dewatering of working areas by designing and installing pumping and drainage systems. Geologists are required to delineate ore and waste boundaries in active mining faces, and also to develop sectional plans that illustrate ore body definition for the mining engineers. Following the notion that one of the keys to knowledge management is to provide fast access to events as they are occurring, opportunity for increased value add from information systems is possible by deploying remote sensors on pipelines and wall movement detection devices that signal appropriate personnel of a developing situation, thereby allowing early mitigation efforts.

Supply chain management carries a critical role in the sourcing of off the road tires. Tires for the haulage trucks and front-end loaders cost up to ~\$20,000US per tire, and are available with varying rubber compounds and tread designs. The challenge in sourcing tires is not merely finding the best price, but also determining which manufacturer's offering is best suited to the often unique conditions experienced at individual mining operations. Once again, a potential area of improvement is the integration of real-time operating parameters, such as tire pressure and temperature, into a mine wide knowledge system.

Varying combinations of mine employees and contract maintenance workers provide maintenance of the loading and hauling equipment. Over the years, maintenance philosophies have evolved from one where the equipment was fixed when it failed, to scheduled preventative maintenance, to reliability centered maintenance (with a focus on mean time between repairs and mean time to repair), to the current trend towards predictive maintenance. Predictive maintenance relies on input from OEM installed equipment health monitoring devices that measure and store real-time information for parameters ranging from fuel consumption rates to oil pressures. Currently, this information is, for the most part, manually downloaded at a set interval and is largely ineffectual for real-time prediction.

Knowledge systems sourced by Information Services have the potential to play a major value-adding role with the emergence, and gradual acceptance, of new technologies. Current knowledge systems facilitate fleet management both in terms of operating data collection and haulage flow optimisation. These systems comprise a central computer that communicates with

equipment mounted field hardware via a radio-based communications backbone and attempt to exploit technologies such as GPS and OEM developed equipment health monitoring via interfaces. These systems generally account in excess of 10% gains (and up to 35% in extreme cases) in operational efficiency versus manual truck flow allocation, however are currently unable to provide sufficient levels of pertinent real-time information to maintenance (including the provision of real-time streaming health monitoring information required for predictive maintenance) and front-line supervisors. Emerging technologies are largely centered on increased communications bandwidth and carry the potential to correct this shortfall, but are yet to be integrated effectively into the loading and hauling activity and out to the related activities.

#### *3.4.1.3 Production Support*

The primary activities require other production support input in the form of haul road maintenance, blast pattern preparation, loading area cleanup, dumping area repair and other development projects. Mine employees using graders, bulldozers, and small front-end loaders perform these activities. Direction for these projects is dynamic and is sourced by demand in real-time and from engineering designed development plans. Mine maintenance provides service and repair to this equipment based largely on the scheduled maintenance/emergency repair model.

Existing knowledge systems add some value with respect to status hours collection and working plans for bulldozers, however could be better integrated in real-time with other engineering and enterprise systems.

#### *3.4.1.4 Other Mine Maintenance*

Beyond the requirement to maintain the primary and secondary mining equipment discussed above, mine maintenance also carries responsibility for maintaining its shop facilities and in many cases other facilities housing engineering and other mine management personnel.

### **3.4.2 Beneficiation**

Beneficiation refers to the optimal extraction of concentrated minerals or Doré and the safe disposal of residue (tailings). This activity comprises crushing, grinding, concentrating or leaching, and the handling of tailings. Relating this to the sites introduced herein, Batu Hijau produces a concentrate by crushing, grinding and concentrating ore, while MYSRL's operation is limited to leaching gold solution from leach pads and extracting metal from this solution to ultimately produce Doré.

#### **3.4.2.1 Crushing and Grinding**

In very simple terms, the crushing and grinding activities serve to size the ore to a level whereby minerals may be liberated from their hosts and concentrated. Ore from the hauling activity is fed into a large-scale crusher component where it is reduced by physical compression to a manageable size fraction. From there, the resized ore is fed to a processing plant where it is further reduced in size using mediums such as metal balls or rods in grinding mills.

Mine-site employees maintain crushing and grinding components on a routine basis; periodic major rebuilds may also be performed in-house, however are often effected by contractors. Special challenges for supply management lie in the sourcing of medium for the grinding mills and liners for both the crushers and grinding mills. This can be particularly challenging in remote areas such as Batu Hijau owing to the heavy mass and large volumes of this grinding media required.

#### **3.4.2.2 Leaching**

In certain mining operations, notably low-grade gold and copper, there may be opportunity to bypass crushing and grinding and move directly to commodity production via heap leaching. Heap leaching is a process of placing run-of-mine (ROM), ore on piles over an impermeable liner and then spraying the ore with a weak cyanide solution that dissolves the metal into solution for recovery. This "pregnant" cyanide solution is then stripped of the metal by methods such as carbon-in-leach. Knowledge systems are used to track the placement of specific ores onto specific leach pads. This information is then relayed back to the mine planning

planning activity for reconciliation and verification of ore deposit models. Although MYSRL cannot be considered a particularly low-grade gold mine, other physical attributes of the ore deposit make it conducive to heap leaching techniques.

#### *3.4.2.3 Concentrating*

The most common means of concentrating liberated minerals is through a method known as flotation. Flotation is a method of mineral separation in which a froth is created in ground and slurried ore by the addition of a variety of reagents (chemicals) designed to float the mineral into a concentrate and sink waste materials into a tailing. In some gold mines, this tailing is reprocessed through leaching methods. Operated by mine employees, the flotation components are sourced commercially and maintained by a plant based maintenance team. Engineering services are in the form of metallurgists who monitor the varied grades and attributes of the received ores to determine optimal reagent levels and grinding sizes. The final stage in concentration is dewatering the concentrate to a point appropriate for shipping by either ocean going vessel or train.

Knowledge systems are used to control the addition of reagents and measure the flow of material (feed, concentrate and tailings) throughout the process. These systems are also used to provide on-line analysis of quality attributes such as primary and secondary commodity grades (for example: a copper mine would also be interested in gold levels as a secondary product).

Supply management's unique role in this activity is to ensure the adequate supply and quality of reagents necessary for flotation and potentially leaching.

#### *3.4.2.4 Tailings Disposal*

Tailings are the refuse materials that have resulted from the concentration of the ground ore in the previous processes. Its safe disposal is critical from an environmental perspective given the nature of the chemicals used in the processes and the potentially unstable physical properties for placement (it needs to be contained). Disposal is effected via pipelines from the concentrating plant to designated sites. Knowledge systems play a role in the collection and

analysing of tailings effluent, which add value in the sense that it ensures compliance with environmental regulations.

### ***3.4.3 Outbound Logistics***

Broadly speaking, outbound logistics rationalizes the anticipated production of concentrates with the scheduling of either trains or ocean vessels and includes the loading of stockpiled concentrates. Whilst this activity is not as complex as beneficiation and mine operations, it is critical as the revenue generating position in the mine site's value chain. Scheduling concentrates shipments accurately is not a trivial task owing to the relative infrequency of shipments and the requirement to schedule them well in advance (particularly in the case of ocean shipments). Delay of vessels can result in significant demurrage charges. Incomplete shipments result in reduced unit value of the concentrate (due to absorption of shipping cost into a smaller volume), and worse, can erode the customer's (generally a smelter) faith in the mine's ability to deliver.

Physical processes within this activity are centered on the actual loading of the ships or trains and include infrastructure such as conveying, weighing and loading systems. As with infrastructure in mine operations and beneficiation, this infrastructure requires routine and scheduled maintenance to remain in operation; this maintenance is normally sourced from mine site employees.

Knowledge systems play a large role in the scheduling of shipments with schedules requiring forecasts from the concentrator and mine operations, and the tallying of ready-to-ship inventories of produced concentrates.

### ***3.4.4 Reclamation***

Reclamation is an ongoing effort during the life of the mine, with a final push at mineral deposit depletion. This activity is aimed at rehabilitating large tracts of land that have been disturbed by the mining activity and involves the use of heavy equipment, support equipment (mine owned or contracted), engineering and consultants (for design), maintenance of the

equipment, and information systems for record keeping. Supply management has the additional task of sourcing foliage indigenous to the area that has been mined.

### ***3.4.5 Overarching Support Activities***

The operation of a mine site requires input from a variety of support activities that span the primary activities discussed above. These can be grouped as: site infrastructure, human resources, power generation and distribution, and other supply chain management, information, and engineering services. All of these activities are necessary to facilitate a smooth and integrated approach to the management of the mine site. The performance of these activities is generally a hybrid of mine resources, and outsourced professionals and service organisations, depending on the service's specificity to the mining operation.

#### ***3.4.5.1 Site Infrastructure***

Site infrastructure includes those activities required for general administration. Mine site competencies generally lie in financial services and accounting, and are augmented by third parties in the areas of public/government relations and legal services. Security services, which include site access guards and the like, are almost always outsourced for risk management reasons. Management consultants are often retained to help with business and operational strategy development and implementation.

Other corporate level inputs are received within the sphere of this activity and include (and are not necessarily limited to): treasury services, investor relations and risk management (in the form of instruments such as currency and commodity hedging).

#### ***3.4.5.2 Human Resources***

Mine sites employ workforces ranging from relatively unskilled labour to professionals. In developing countries these workforces can be as large as 5,000 employees at a single site. With this, a consistent approach to payroll, industrial/union relations, industrial hygiene, and occupational safety is required and is normally a competency of the mine site operator.

The diversity of equipment present at a mine site – from heavy earth moving equipment to concentrating components – demands comprehensive training programs. Training can be particularly difficult in developing areas where the pool of workers may be sourced from a relatively uneducated and potentially primitive pool. The training activity is performed by deploying mine employees as trainers with programmes developed with the aid of retained consultants.

The task of maintaining these large and diverse workforces demands an effective recruitment process. This is further exacerbated by a current high demand for competent workers, which has induced competition amongst rival mining companies for their services. Whilst internal competencies exist in this area, mines often retain recruitment companies to aid them in this effort.

#### *3.4.5.3 Supply Chain Management*

Beyond the specialized requirements discussed above, supply chain management is responsible for the procurement of products and services used throughout the mine site including fuel, office supplies, warranty agreements, light vehicles, shop supplies, and the like. Remote sites, such as Batu Hijau carry an additional requirement to outfit and supply camps or contained town-sites.

#### *3.4.5.4 Information Services*

Information Services, in today's environment of rapidly emerging technologies is playing an increasingly important role at mine sites. As discussed above, this role is critical in the optimisation of the primary activities and extends across all facets of the mine with the integration of knowledge systems and enterprise resource management systems. Other, more mundane inputs received from information services include: management of a local area network (hard-wired and wireless), communications in the form of land line telephones and cellular, internet services, integrating the knowledge and enterprise systems, data warehousing and company e-mail (with interface to corporate wide e-mail systems). Traditionally, these activities have been performed in-house, however, with growing competition amongst service suppliers and the

and the difficulty in keeping up with rapidly advancing technologies in these areas (which are not unique to the mining industry), outsourcing is becoming more prevalent. The greatest fear in this is that confidentiality of company secrets may be compromised. That said, both Batu Hijau and MYSRL are moving towards outsourcing in these areas.

#### *3.4.5.5 Engineering Services*

Engineering services are specialized to the primary activities with the exception of environmental engineering. Given that environmental regulations apply to the site as a whole, this aspect of engineering service is executed accordingly. In metal mines, this focus will typically be aimed at managing natural water and effluents to remain within published threshold limits for chemical and acid levels. Other areas of interest include monitoring dust and noise levels, the impact of the operation on wildlife, and the minimising of land disturbance and its timely rehabilitation.

#### *3.4.5.6 Power Generation and Distribution*

In remote areas, mines are often forced to generate and distribute their own electrical energy. Significant electrical energy is required to power all site infrastructure, and is extended to mining equipment for those operations utilising electric shovels. Since this activity is not normally a competency of a mining company, engineering and construction companies almost always perform it. Batu Hijau generates its own power with Fluor managing the generating plant.

### **3.5 Mining Activity at Yanacocha**

This section will serve to detail the specifics of the mine production activity at MYSRL. The insight obtained through this exercise will provide a basis for further understanding the issues faced in the pursuit of operational efficiency and the importance of the role played by the application of technology in achieving this.

As noted above, MYSRL is a traditional open pit mining operation. Within the context of the mine production activity, the primary value chain activities include drill and blasting, and loading and hauling. These primary activities are directly supported by mine engineering, mine

maintenance, production support, human resources, supply chain management, and information services.

Ultimately, the objective for mine operations is to produce tonnes as efficiently as possible. Given the cost of the primary production equipment, tied with the difficulty of operating it in a practical sense, the effective application of various technologies that facilitate decision making without sacrificing the intrinsic tacit knowledge in mine operations is critical.

The value chain for mine operations includes the primary activities of drill/blast and load/haul, however depends on input from secondary activities such as production support (in the form of road maintenance, pattern preparation, bench cleanup, etc), equipment maintenance, training, and mine planning. Additionally, mine operations is obliged to provide fundamental production information to downstream processing, ERP systems, mine planning, and for feedback to equipment suppliers.

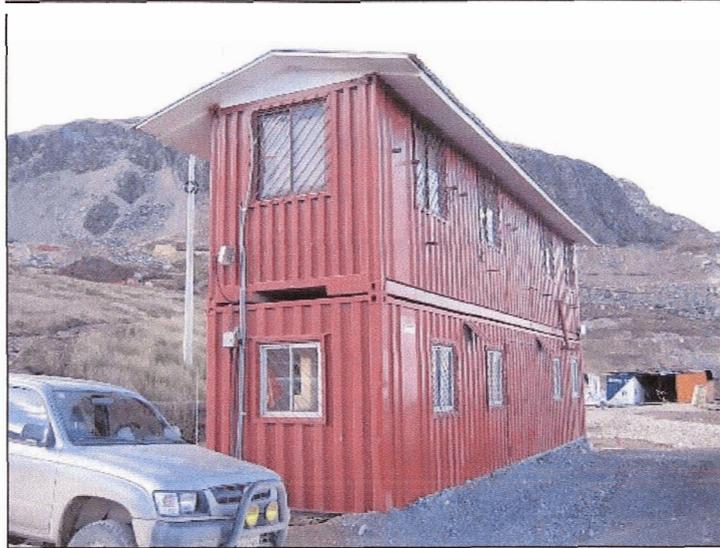
The role of knowledge management within the mine operations is both direct and overarching. Direct impact is exerted in the form of fleet management which is primarily focussed on optimising the flow of haulage trucks in real-time. Knowledge management is also effected in the form of several layers of communications – from historical and near real-time reporting, to the communication of daily objectives and other critical events that sense and allow an intelligent response to dynamic operating conditions. The most visible enablers of knowledge management include the installed fleet management system, the company LAN, assorted manually generated spreadsheets, cell phones, voice radios, and face-to-face contact.

### ***3.5.1 Fleet Management***

Optimisation of the loading and hauling activity is undertaken with a dispatch system supplied by Modular Mining Systems Inc (MMS). This system is driven by three major subsystems including a hybrid radio system (UHF and Spread Spectrum), a central computer operated by dispatchers, and equipment mounted hardware. Management of this system lies with the mine planning group.

The dispatchers and computer system are located in a container which is in an isolated area of Phase 0, north-east of the Yanacocha shop (see Figure 9).

Figure 9: Dispatch Container



(Photo by Ed Desjardins)

Currently, the radio backbone includes: 2 x UHF channels communicating with 68 haulage trucks, 5 front end loaders, and 12 production drills, and a spread spectrum network that is currently dedicated to high precision GPS hardware on 6 hydraulic shovels, 3 front end loaders and one tracked dozer.

The central computer is operated by a primary dispatcher with the aid of an assistant dispatcher for optimisation of the loading and hauling activities. This includes balancing the haulage truck flows, ensuring that mine plan priorities are followed with respect to loading equipment coverage, and management of delay time. In addition, there is a dispatcher dedicated to field maintenance with responsibility for tracking equipment downs and a dispatcher dedicated to status tracking of the auxiliary production support equipment. Management of the system is undertaken from the mine planning office which is located 25 km away in an office known as km24.5. This has the effect of distancing the operators of the system from the skilled professionals that can help to best optimize the system. Furthermore, the senior supervision is located in between these two facilities (in an office known as the La Quimua mine office) creating an additional disconnect in the fleet management process.

Fleet optimisation is pursued through the interaction of three algorithms within the dispatch system software. Simply, the first defines the best paths for hauling between all points within the mine. The second process defines a plan of optimal truck allocation based on the best paths, current operating parameters (loading time, dumping time, etc), and specified constraints (dumping capacity, defined priorities, etc). Finally, the actual assignments for trucks in real-time is performed by a heuristic which evaluates current and short horizon projected need, and lost tonnes that could be caused by making that assignment. The dispatcher has the ability to dynamically adjust specific operating parameters via a series of utilities. Other pit configuration information that is required includes all locations associated with loading, dumping, servicing (maintenance, fuelling, and tires), shift change, complete with paths (roads) connecting them. These updates are performed by the dispatcher using an electronic graphical representation of the mine and are guided by collected GPS data.

Lastly, other lists defining block grade attributes, operators and their qualifications, and equipment attributes are required. All of these are maintained manually with the exception of grade information which is transferred from the Newmont developed mine planning and modeling system (TSS) via ASCII file and automatically imported into the dispatch system.

To effectively perform the optimisation task, extremely low level (to the second) information is tracked and stored in MMS proprietary databases. This includes complete records of load attributes, equipment status changes, grade records, worker records, and the like which are then used for production and other reporting. The only automated transfer of data is equipment hours to the mine maintenance planning system (MIMS) using ASCII files. Information required in other areas such as mine planning and processing is transposed manually from printed reports or imported into Excel via flat files generated on demand.

### ***3.5.2 Communications***

Two broad forms of communications exist; the communication of performance in the form of data and reports, and the communication of operational directives such as priorities and other operational requirements.

### *3.5.2.1 Performance Reporting*

Currently, historical performance reporting is accomplished in several different ways. As noted above, historical information is stored and reported from within the dispatch system. Direct access to this requires the installation of “X” emulating software to connect to the dispatch system. This system also populates an add-on database known as PowerView™ which builds on-line analytical processing (OLAP) cubes and from which reports may be generated (however is currently under-utilized). Downstream reporting, that requires the inclusion of dispatch system collected information, generally receives this information via manual entry into spreadsheets. The exception to this is equipment hours for maintenance which is sent electronically via ASCII files.

Official production reporting is sourced from manually produced spreadsheets based on dispatch system generated data (with adjustments based on physical survey). Mine survey based reconciliations are used to adjust truck factors within the dispatch system going forward, however are not used to adjust historical data. The obvious risk of these multiple sources is the reporting and basing of decisions on different data.

Other production reports are generated on spreadsheets within mine operations to communicate various impacts on production such as average payloads, key performance indicators related to the dispatch system, and truck speeds.

Adjustments that may be made within MIMS are also not propagated back to the dispatch system. This has resulted in the generation of conflicting equipment availability and usage reports to the detriment of both credibility and decision making.

Real-time feedback is available to the dispatchers and other operations related supervision in the form of automatically updating snapshot views of the mining situation. This includes a utility that tallies production performance and efficiency in addition to currently contemplated haulage resource allocations. This allows the supervision to see situations developing and the ability to react to them before they become severe. An additional real-time utility linearly illustrates the current position of the operating haulage fleet with respect to the loading equipment and dumping areas. Presently, these forms of communication are only

available to the mine supervision when they are in the office and physically connected to the network. A pilot test of a wireless network within the mine operating areas is currently underway. This network will facilitate connectivity of wireless computing devices, such as laptops and tablet PC's for access to the dispatch system and its various reporting utilities.

#### *3.5.2.2 Operational Directives*

Operational directives include the communication of mining priorities based on the current situation in the mine, and also other operational requirements such as road repair, and cleanups. Weekly priorities are determined by the mine planning group, and communicated to mine operations in the form of a spreadsheet that highlights priority mining areas and options for dumping locations depending on the level of haulage trucks that are available. Weekly meetings are also held within the operations management group to review priorities, performance and obstacles. The priorities are reinforced, and adjusted during daily face-to-face meetings within the operations group (excluding dispatchers). Dispatchers receive changing priorities via telephone or voice radio.

As situations change during the course of the shift, new priorities and/or other operational requirements are communicated to the field supervision largely via voice radio and to a degree face-to-face (at the project site or in the office). More senior pit management also depends on e-mail and the use of cellular telephones for this purpose.

#### *3.5.3 Opportunities*

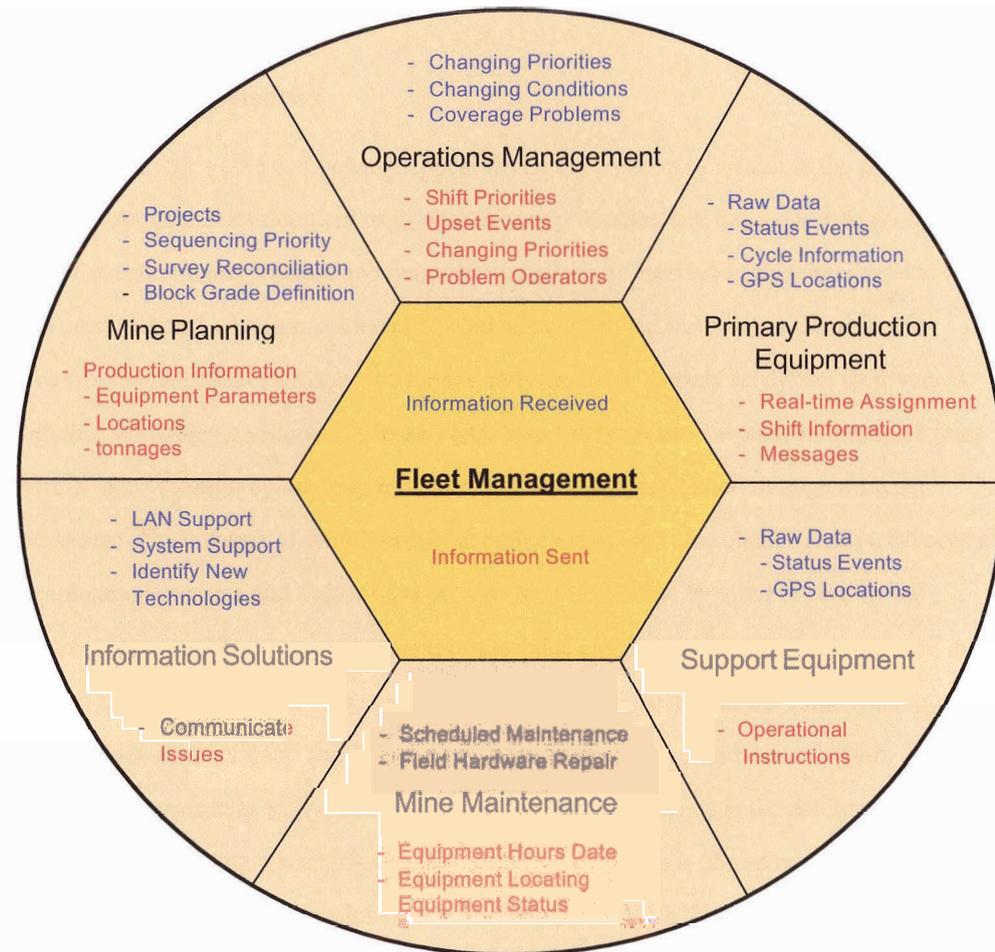
Significant opportunity to lift the level of knowledge management exists within mine operations at MYSRL. The most significant of these are found in effectively communicating and exploiting the knowledge assets that are already held. Assets held in this context include: the fleet management system, LAN, and the tacit knowledge of the existing personnel.

Given that the fleet management system is a focal point for knowledge management (see Figure 10) within mine operations, this is where the greatest opportunity lies.

The success of the objective to improve knowledge management in this sense can be described as transforming the current situation of “controlled chaos” to one of order and focus

on operational goals. With this, the fleet management role will be better integrated within the primary production activities and will be given the opportunity to effectively drive production. Consolidation of the location of the key roles, including operations management, fleet management, and pit planning would serve to solidify this integration.

Figure 10: Overview of Fleet Management



Opportunity also exists in the area of mine maintenance. The provision of better and more easily accessed tools will provide this activity with real-time information such as real-time status changes, equipment locations for field calls, and more efficient usage of onboard original equipment manufacturer (OEM) equipment health monitoring devices.

Finally, a focus on rationalisation of production data storage will provide three major benefits. First, consolidating data into a single source will eliminate the risks associated with reporting from several different sources. Secondly, if this data is migrated to industry standard databases, significant resources within the dispatch support group will be freed-up to pursue more operational related functions. Thirdly, ongoing upgrades of associated systems will be more easily integrated.

### **3.6 Core Competencies**

Newmont's core competency appears to be the creation of wealth in the gold mining industry through the development of its own mining properties, and the acquisition (in full or in part) of outside mining interests to continuously replace its reserves as they are depleted (and even expand them). An important strategic advantage derived from this is the ability to recognize the potential of prospective targets early and to accurately recognize their values. With this, the strategic vision to "Create Value with Every Ounce" is pursued through a joint effort of value creation by securing mineral assets and value realization through efficient operations. The creation of wealth occurs at both ends of the value chain. That is, the activities of exploration/mergers and acquisitions provide the information required to convert the resources into tangible assets. At the end of the value chain, wealth may also be created through timely disposal of the assets. Value realisation occurs in the middle of the value chain by competencies in developing and operating those properties in a world-class fashion.

As an operating entity, MYSRL's overarching competency is the ability to produce gold Doré efficiently. Being a leaching operation, a heavy emphasis is placed on moving ores efficiently from their in-situ locations to the leaching pads. With this, competency has been demonstrated in the area of equipment operation and management, however is not as fully developed in the understanding and application of appropriate technology. Given its location and its intrinsic environmental sensitivity as the headwaters for a large agricultural community, competency with respect to environmental assessment, risk mitigation, and communications has been thoroughly developed. This skill was put to the test and developed further with the occurrence of an accidental mercury spill in 1998.

### ***3.6.1 Yanacocha Mine Operations***

There is a wealth of tacit knowledge within the mine operations group. This is evident by the demonstrated ability to safely operate the production equipment and work towards achieving the overall production targets. It is equally apparent that in an environment of aggressive production targets, critical sequencing of mine plans, and sensitive geotechnical issues, the operational personnel needs to “know what is known” to reach their maximum effectiveness.

There is also strength in the various groups that support the production efforts from a knowledge management perspective including within information solutions, mine planning, maintenance, and dispatch system management. Recent employee additions have brought a broad range of experience from different mining operations and have solidified existing strengths within mine operations, dispatch system usage, data structures, mine planning, and project management.

Focussing on fleet management, the most significant competencies lie in the production of timely reports and the ability to keep the system operational. That said, and partially owing to system management falling within mine planning, the focus has been on report generation and system stability. This focus has compromised the effective driving of knowledge to the operational level. As alluded to earlier, there is strength in terms of tacit knowledge within the group responsible for the dispatch system, however it is not currently coordinated and focussed in an orderly fashion that accommodates mine optimisation. Exacerbating this is the fact that the group is somewhat fragmented – both from within and in its relationship to operations. This has been highlighted by a tendency to get focussed on single projects or system attributes at the expense of the bigger picture (which in the end is the optimisation of the mining operation) and has resulted in the prevailing perception that the role of the system (and its managers) is limited to report generation rather than drivers of production. Finally, a significant language barrier exists, which exacerbates the problem of communicating the more technical aspects of the system – particularly given the geographic distance between the players.

### 3.7 Organisational Capabilities

Newmont's strongest organisational capability lies in its financial position. This allows them ability to pursue interests as they come available, without a lot of worry about securing financing, and facilitates following the objective of value creation.

Value creation is also enhanced by Newmont's proven capability in developing innovative and effective exploration techniques.

From a production perspective, the centralized structure with a high degree of autonomy for the operations fosters not only friendly competition between the sites, but also provides the nimbleness that they require to deal with both their unique operating environments and their diverse cultures. Following a systematic process to fit the right person, in the right job, at the right time, and in the right way, key employees are transferred between sites as required when different operational challenges arise. This ability to cross-fertilize serves to both mitigate difficult situations and the transfer of tacit knowledge between the sites – albeit at the expense of the site losing the employee.

An area that could be improved is the approach to information technology and systems deployment across the company. Financial and other communications systems (such as e-mail) are standard across the board due to the requirement to communicate upwards in the hierarchy; however opportunity with respect to value realisation is lost with varying systems at the production levels. Significant decision-making ability at the sites has led to different production systems doing similar tasks. Negative effects of this include: difficulty in sharing operating techniques between operations, transferred production employees forced to learn new systems, and a diluted ability to put pressure on system providers (for cost, service and system refinements). At the executive level, information technology is responsible to the Vice President – Administration and Human Resources. At the site levels, the IT function carries its own management and is responsible to either a General Manager or an Administration Manager.

Newly created capability with its joint venture in gold marketing and refining extends its ability to create value. This is achieved through a combination of broader product scope, increased vertical integration, and the potential to receive early signals of increasing demand –

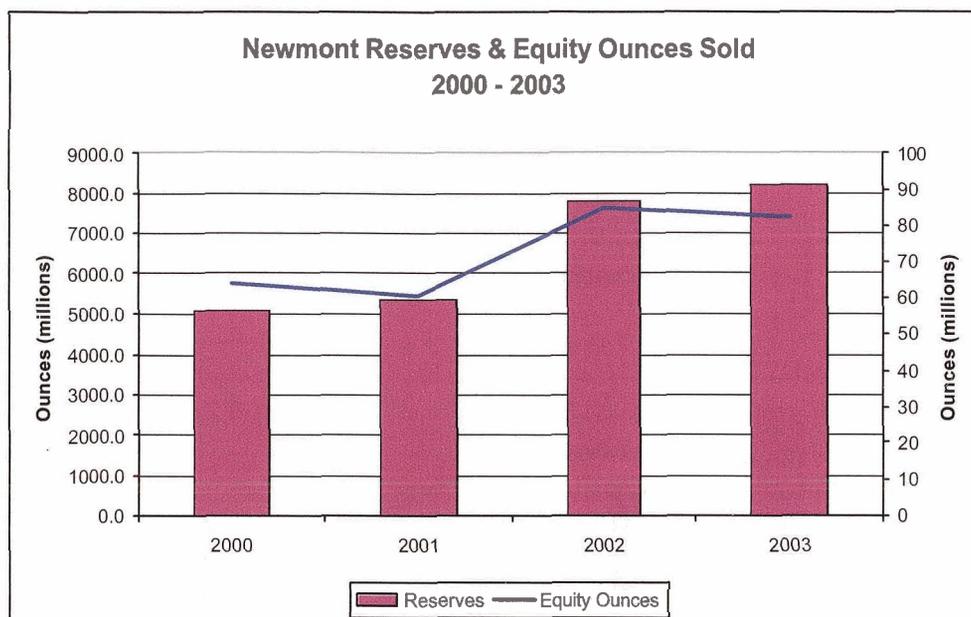
particularly from an economically recovering Asia. This downstream business opportunity, in which Newmont holds a 40% stake, is expected to process in excess of 500 tonnes of Doré annually, making it the world's largest refiner of gold, and importantly, the largest distributor of gold into Asia.

As the world-leader in both the production of gold and volume of reserves held, Newmont is well positioned in an environment of demand exceeding supply for a finite resource. Newmont's large reserves and gold marketing interest allows it the flexibility to react quickly in the event that the potential for increased demand (particularly in Asia) is realized. With its low relative cost per ounce produced, Newmont is also insulated to a degree from the risk of falling gold price and can maintain its existing rates of production.

### **3.8 Operating Performance**

Basic production and financial data follows in a consolidated fashion for Newmont, and independently for MYSRL. Figure 11 highlights the success that Newmont has had in progressively increasing its reportable reserves in the face of generally increasing levels of gold sales.

Figure 11: Consolidated Reserve & Equity Ounces Sold



An important measure of success in this industry is the ability to replace reserves as they are depleted or divested through either acquisitions or exploration. This becomes increasingly difficult as the volume of depletion increases. The reserves expressed herein are those reported through routine filings to the Securities Exchange Commission (SEC) and include both proven and probable reserves. Reserves are based on exploration drilling, sampling, mine modeling and metallurgical testing as inputs for economic feasibility. The price sensitivity of reserves depends on several factors including gold price used, production costs, and grade; estimates are thus determined using information available at the time the reserves are calculated. A simple ratio called the Reserve Replacement Ratio<sup>15</sup> is used to evaluate success in reserve replacement. Figure 12 highlights the increasing commitment made by Newmont to effectively grow its reserves and provides an interesting correlation between exploration dollars spent and ounces

<sup>15</sup> Reserve Replacement Ratio (RRR): a ratio calculated with the numerator comprising additions and adjustments to the reserves and the denominator including both depletion and divestiture of reserves.

ounces added to the reserves. That is, large increments in exploration spending are required for smaller incremental increases in reserves highlighting the difficulty of maintaining reserves as mineral depletion increases. The anomalous drop in exploration expenditure in 2001 is directly attributable to the low gold price during that year.

Figure 12: Reserve Replacement

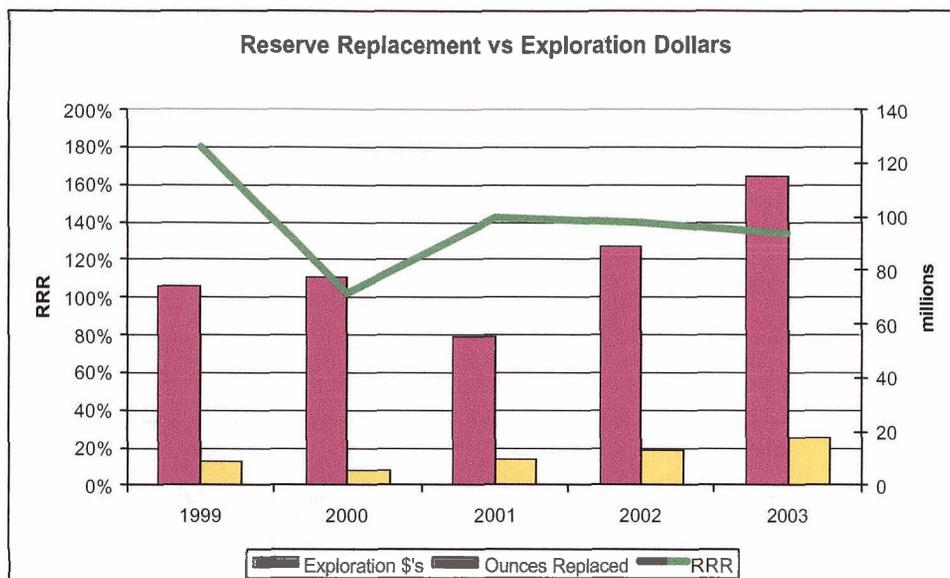


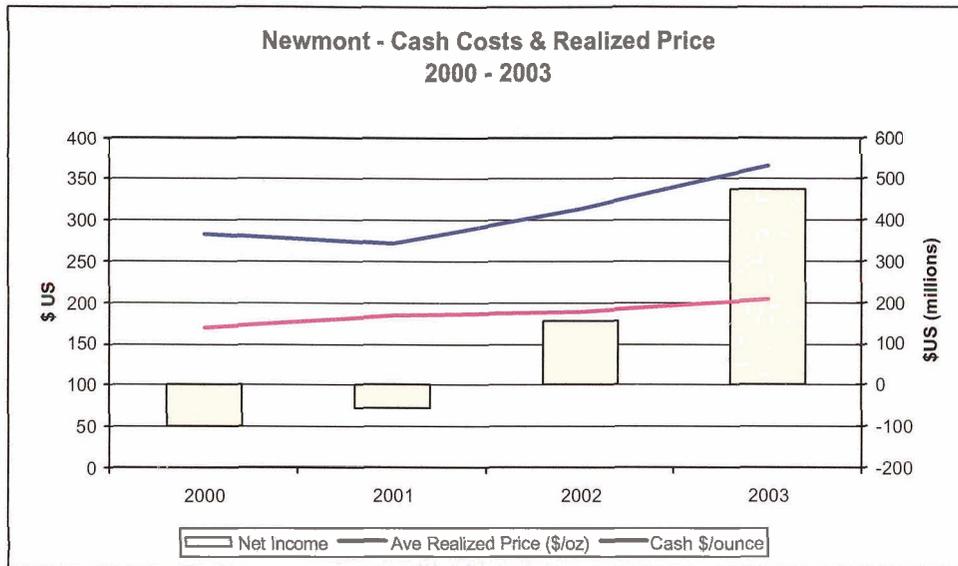
Figure 13 illustrates Newmont's dramatic improvement in net income. Unquestionably this has been aided by the increasing dollar per ounce received, however has required a focus on cash costs in the face of a weakened dollar and higher fuel costs during 2003.

Given that reserve replacement, whether through direct exploration or the acquisition of others is critical for long term success, Newmont's financial health is of utmost importance. Return on Equity (ROE), debt to equity ratio, and closing share prices are presented for the period 1999 through 2003 in Figure 14.

Figure 14 is particularly enlightening in describing the management of Newmont's assets with the simple metric of ROE, and clearly illustrates the success Newmont management has had in running the corporation. This is particularly impressive given Newmont's focus on eliminating

eliminating net debt and reflects the generation of a level of profits sufficient to overcome the lost leverage. That is, ROE has increased dramatically despite a reduction in debt to equity, and with this, market valuation has responded positively (see Figure 15).

Figure 13: Consolidated Cash Costs & Realized Gold Price



The positive trend in ROE is a direct reflection of how well Newmont is creating value for its shareholders. Gold price has helped in recent times, however, the 4 year trend of increasing ROE reflects stronger control on asset management and a steady improvement in financial leverage. Moving forward, this solid management of the company has provided a significant “war-chest” with cash and cash equivalents reaching \$1.3B at the end of 2003. Figure 16 displays the rapid increase in cash and cash equivalents since 1999. This positions Newmont very well to rapidly exploit emerging acquisition opportunities or further increase exploration activities as required.

Figure 14: Financial Performance

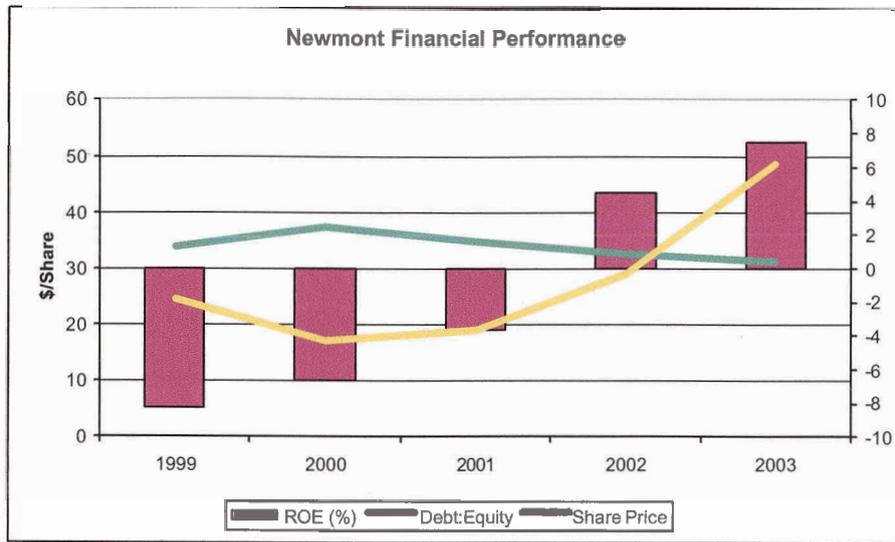


Figure 15: Newmont Historical Share Price

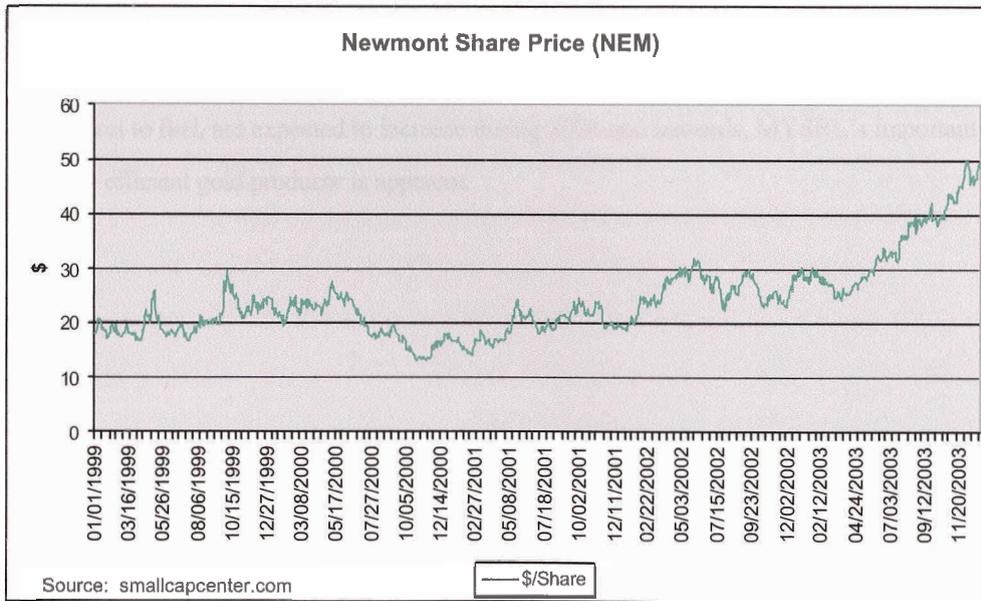
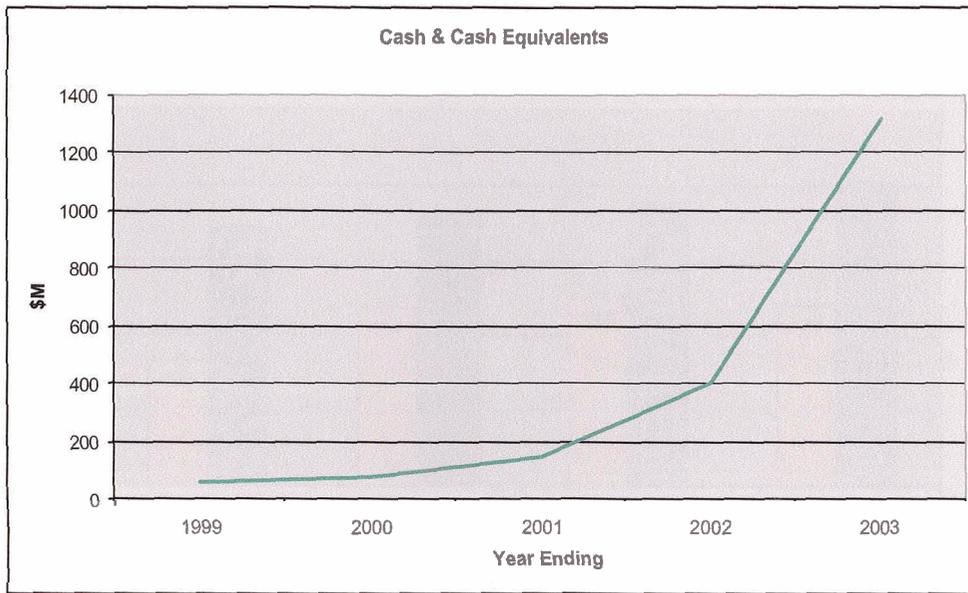
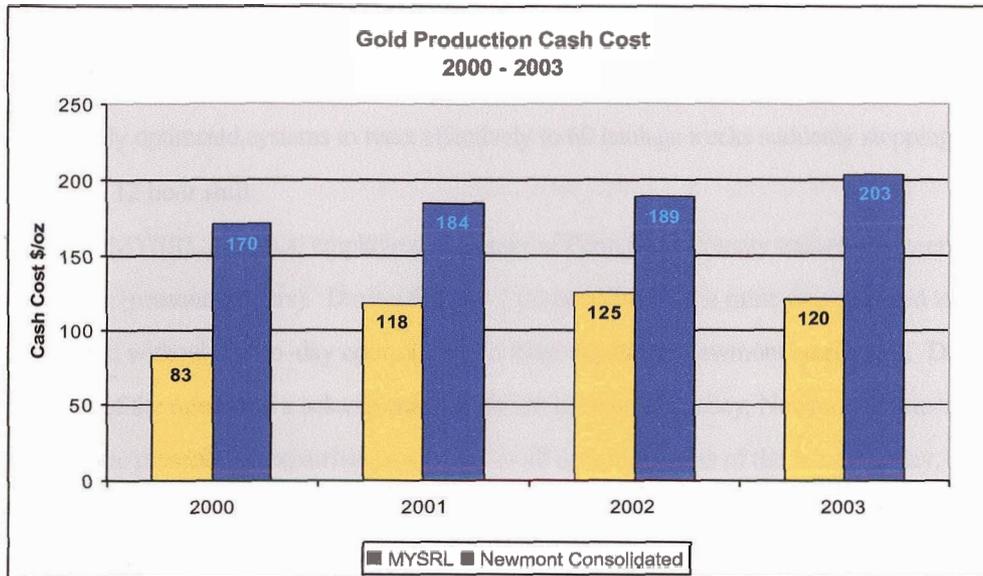


Figure 16: Cash & Cash Equivalents



In 2003, MYSRL's contributed 20.3% to the total of equity ounces produced by Newmont. MYSRL's relative performance within Newmont in terms of keeping overall cash cost per ounce produced in check is displayed in Figure 17. As operating costs, particularly with respect to fuel, are expected to increase during 2004 and onwards, MYSRL's important role as an efficient gold producer is apparent.

Figure 17: *Minera Yanacocha Contribution to Newmont*



### 3.9 Organisational Culture

Given the far-reaching locations of the operating sites, coupled with the corporate presence in Denver, the culture of Newmont is very diverse. As part of an overarching set of corporate values, Newmont strives to promote an entrepreneurial spirit by developing top quality people in the pursuit of excellence. This is extended by a stated goal to demand positive change within the operations by continually seeking out and applying best practices.

A primary goal of Newmont is to make all efforts to develop the indigenous people near the operations located outside of North America. With this, a range of cultures exists at the operations which are guided/advised by a core of expatriate employees (largely sourced from North America and Australia). Not surprisingly, this can lead to a learning curve for both sides. Whilst the expatriates fundamentally understand mining and the requirements for an efficient operation, it is often difficult to instil these practices into different cultures. For example, the local employees at the Batu Hijau operation are predominately Muslim. This introduces both the potential for conflict given the current world environment, and also practical issues

surrounding their requirement to pray at regular periods during the day and particularly during Ramadan. The result of this not optional practical issue is increased pressure on operational efficiency and knock-on pressures on cost control. Managing this in real-time is a challenge and requires fully optimized systems to react effectively to 60 haulage trucks suddenly stopping up to 3 times per 12 hour shift.

At MYSRL, the local employees are a mix of Peruvian university trained engineers and campesinos (peasant farmers). During the first 7 years of its life, the mine was operated to a large degree without day-to-day operating input from expatriate Newmont employees. Due to expansion of the mine, and a subsequent degradation of mine efficiency, Newmont dramatically increased the presence of expatriate employees in all operating areas of the mine. Today, this total stands at 65. This has brought a series of cultural issues, particularly in the early period, owing to resentment being felt on the part of the Peruvian engineers that Newmont felt compelled to send outside people in. Exacerbating this, a second wave was brought in beginning approximately 6 months ago and has resulted in the original cadre of expatriates feeling resentment of their own. That said, the corporate mandate from Newmont clearly demands ongoing increases in operational efficiencies (and its consequent impact on value realisation, and value creation with lower costs making more mineral economic); success in this quest requires the application of knowledge management tools in a non-threatening and visibly operations improving fashion given the cultural disparities.

## **4 ISSUES**

The most significant issue facing Newmont is its ability to continually create value by replacing and increasing depleted reserves. As discussed, this is achieved by exploration (in new areas, and also adjacent to existing operations), acquisitions, and by continually maintaining and reducing costs which impacts reserves by making larger volumes economical. The industry analysis described a difficult exploration environment where the easy to find mineral deposits have already been found; this is confirmed by the escalating exploration expenditure by Newmont.

Discussion also centered on the positive outlook for the price of gold. In the event that this comes to pass, then the existing volumes of reserves will increase accordingly as more mineral becomes economic and may be classified as proven and probable reserves. The risk in this situation is that the focus on operational efficiency may become dulled with the negative effect of rising costs resulting in both lost profit opportunity and reserves (due to costs overriding economic viability of some deposits).

If the future of gold prices is not favourable, then the effects could be disastrous if operational excellence is not strictly pursued. First, Newmont's adherence to its no hedging policy exposes it to dramatic price drops in the same way that it provides profit opportunity in environments of rising prices. More importantly, as gold devalues, both profits and reserves volumes are negatively impacted, making operational efficiency that much more important.

The issues raised in the following section are directed towards increasing the efficiency of knowledge management from the corporate level in terms of how this level can help the individual sites and also at the site level using MYSRL as a case study. These are introduced with a view to their respective impacts on maintaining a low cost with adequate quality strategy in line with value realisation.

### **4.1 Corporate Level**

At the corporate level, Newmont has demonstrated a strong ability to meet the key success factor of obtaining and developing new reserves. With respect to the key success factor

of producing efficiently while leveraging off of technology, a larger role could be played. This is particularly important in the face of the current difficulty in obtaining skilled professionals at the remote sites coupled with rapid advances in technology and its application in effective knowledge management. Minimal effort with respect to operational technologies, and their standardization (both in terms of systems and deployment), on the part of the information technology group is the result of the distractions caused by business system and other back-office requirements. Exacerbating this is the rigid corporate governance requirements dictated by the Sarbanes-Oxley Act.

The primary issue within this context is that sites are developing and deploying their own operational efficiency solutions from within the framework of a diluted pool of professionals. With this, sites using common systems find them deployed differently. Furthermore, there are no efficient ways and means of sharing the experiences that are obtained from real-time operation of these systems; all to the harm of operational efficiency, and the mandate to continually seek out and apply best practices.

#### **4.2 Yanacocha Mine Operations**

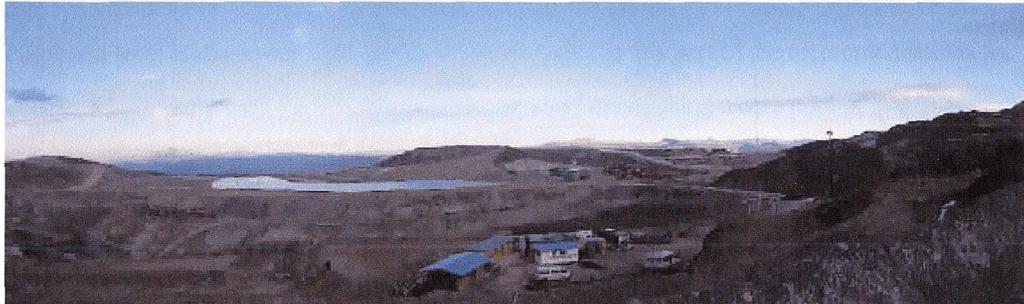
The primary issue is that knowledge management is occurring in a somewhat disjointed fashion to the detriment of both efficient mine operations, and the integrity of data (owing to several different sources). The specific related issues can be expressed in general terms as Operations Related, Reporting Related, and Administrative Related.

Operations Related issues include:

- Physical location of the fleet management system serves no useful purpose and is detrimental due to its distance from both the mining activity and its field supervision (see Figure 18);
- Structural and physical fragmentation of the fleet management system group – operation of the system is performed remotely, while management of the system is performed from km24.5 (in a steady state this may be appropriate, however is not at this point);
- Adequacy of the tools used to perform the fleet management task – the graphical interface, or “window into the mine” is limited to 2 x 19” screens;

- Mission critical dispatch system servers are unnecessarily located in the dispatch container exposing them to an unsavoury environment;
- Dispatch system servers are not effectively backed up;
- Effective real-time knowledge dispersion to the field supervision – field supervision is limited to voice radio or face-to-face communications for receipt of critical real-time operating knowledge;
- Deployment of wireless computing tools for the General Foremen level mine supervision – a wireless network is being piloted in the mining area and must be exploited; and
- Reporting lines of responsibility – dispatchers report to mine operations while management of the fleet management system is within mine planning;

*Figure 18: View from Dispatch Container*



(Photo by Ed Desjardins)

Reporting Related issues include:

- The presence of multiple data sources;
- A multitude of manually generated ad-hoc spreadsheet reports resulting in the potential for different production reported and the consumption of skills that are better focussed elsewhere; and
- Non-standard databases make integration with new and more current databases difficult

Administrative Related issues include:

- Development of Standard Task Procedures (STP's) that address specific issues related to the fleet management system; and
- Establishment of appropriate manpower levels, roles & responsibilities within the framework of knowledge management.

## **5 RECOMMENDATIONS**

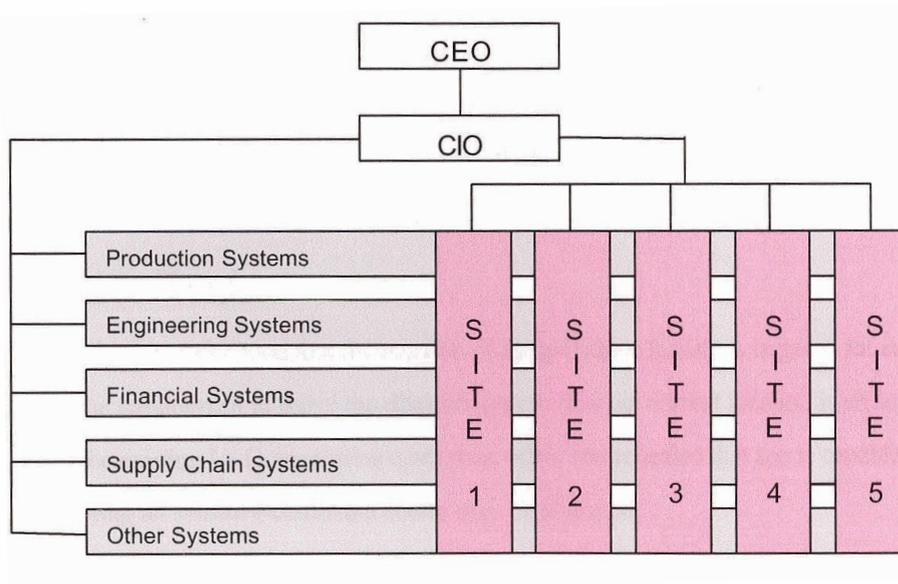
The issues that have been raised include those that are out of the control of the operating level such as dynamic gold prices and the build-up of reserves through exploration and acquisitions. Given that the focus of this analysis is on transformation of mine production, the proposed recommendations are all aimed at operational excellence and the resultant impact on production costs, and hence reserve building and profits; key components of maintaining the generic strategy. Since rapid advances in technology have provided and new and continually emerging pool of knowledge assets, the thrust of the recommendations offered is directed towards knowledge management. These are presented for the two distinct levels of corporate and site (operations). First, the overarching role of information technology as it applies at a corporate level is discussed. The issues to be dealt with in this part of the recommendations are concerned primarily with the efficiency to be gained by establishing a core pool of systems experts. From there, the focus is on rationalising and enhancing the role of knowledge management within the mine operations group at MYSRL. The recommendations presented in this context are focussed on addressing each of the issues raised in 4.1 and 4.2 above.

### **5.1 Corporate Level**

The primary issue to be resolved within information technology is the development of a stronger focus on operational technologies, and their deployment in a manner that allows the maximization of operational efficiency (and hence, minimization of production cash costs). The requirements dictated by the Sarbanes-Oxley Act, and their intrinsic impact on business information cannot be avoided, however other back-office functions, such as LAN and WAN management, e-mail and data warehousing could be outsourced. This would serve to remove the distraction of these functions, and also allow Newmont to minimize its in-house level of skills in areas that are not consistent with its competency requirements. Furthermore, outsourcing in this fashion allows Newmont to enjoy upgrading of these functions, which are not unique to the mining industry, without having to update in-house support skills.

That said, the specific issue directly related to knowledge management across sites is rooted in the presence of skills duplication for those that deploy systems without due regard to what is happening at the other sites. To mitigate this, a better approach to this aspect of the business would be a matrix structure. Whilst site based leadership for information technology in an overall sense is required, there are also benefits to be derived from a centrally based team of process specialists or officers with all (including site based managers) carrying a line of responsibility to a single, executive level officer such as a CIO. This modified structure within the information technology area would provide centres of excellence within the different core technologies and allow a common top level approach to solutions that are managed remotely. That is, the sites become end-users (with some ability to adapt) and the major development and deployment methodology is sourced from a central pool of experts. Figure 19 following provides a conceptual view of such a structure.

Figure 19: Conceptual Matrix Structure for IT



## **5.2 Yanacocha Mine Operations**

Recommendations are presented separately for the three discreet issue areas. Of the issues identified, the biggest opportunity with respect to mine operating efficiency lies within those that are operations related. Combined, these recommendations are expected to yield an approximate 10% improvement in the overall operational efficiency in the mine – representing a boost to both profitability and the ability to define lower grade mining reserves.

### ***5.2.1 Operations Related***

Drawing on input from mine operations, mine planning, mine maintenance, and information solutions, a three phased approach to mitigation has been developed. The first phase is centered on consolidating the team responsible for fleet management and providing appropriate tools for the effective optimisation of the loading and hauling activity. This can be characterized as the establishment of a command centre for directing mine operations. The second phase is focused on driving information down to the field supervision and providing them with ways and means of providing feed-back information. Finally, the third phase is directed towards providing positive confirmation of events in the mine through the deployment of remote cameras.

#### ***5.2.1.1 Phase I***

Whilst it is understood that the erection of an operations facility is targeted for early to mid 2005, the requirement to move the dispatch system from its current location is critical. Review of the existing La Quinoa mine operations office has revealed that space capable of accommodating an effective command centre may be allocated.

Figures 20 and 21 present tentative plans for both the layout of the building and initial layout of the command centre. These modifications will facilitate the first step of moving the dispatching operation out of the container. From there, two additional offices will ultimately be freed-up in the La Quinoa facility to accommodate the relocation of the remainder of the key fleet management system personnel from km24.5. With the fleet management group consolidated, the mitigation of dynamic system operational issues, and the provision of ongoing

hands-on training of the dispatchers will be possible. Furthermore, all of the key mine operations personnel will be located in a single facility. Those displaced by this move will move into either space in a nearby processing facility if available, or the vacated dispatcher container. In the event that this is required, the container will be moved from its present location to one adjacent to the La Quinoa operations office. Work required for this task is limited to some minor ground levelling and the connection of electrical and communications services directly from the La Quinoa office.

As part of this phase, the dispatch system servers will be moved to the newly created data center at km24.5 from where system duties such as routine backup and user administration will be performed by Information Solutions. Other tasks associated with the physical movement portion of this phase include radio system and network installation.

To complete this phase, new tools in the form of 3 large and high resolution monitors (and associated graphics cards and CPU's as required) will be procured. This will eliminate the limited view that the fleet optimisation dispatchers currently have by providing them with continuous views of all required utilities and graphical representations (see Figure 22 for conceptual mock-up). In conjunction with this, functionality will be developed to allow the dispatchers to see, in real-time, the progress of the mining faces versus the approved short term mining plans. Simply, this will be accomplished by providing a mechanism for importing the mine plan and displaying it with current excavator dig-lines (supplied by HP-GPS) on the pit graphics screen thereby dramatically improving positive communication of the plan.

Figure 20: Modification to La Quinua Office

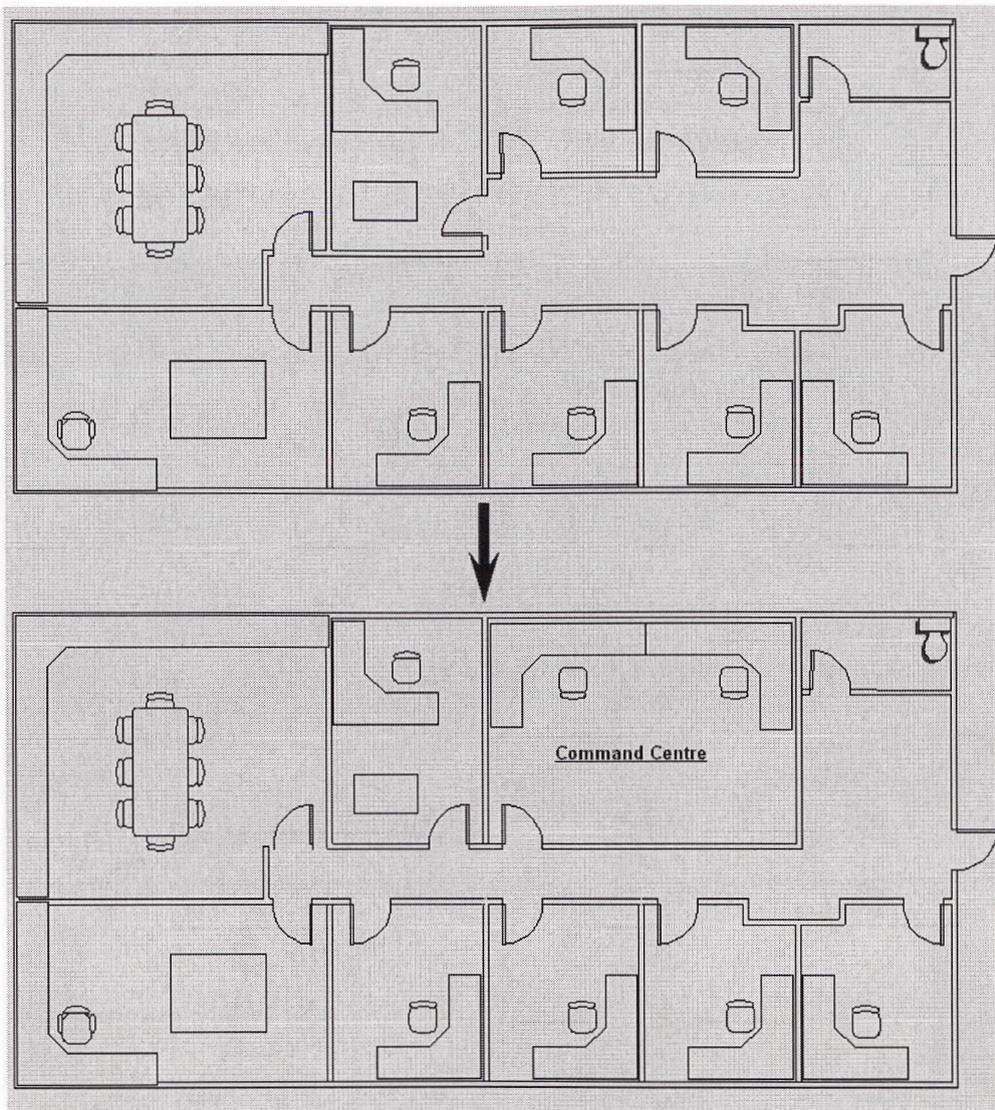


Figure 21: Tentative Layout for Command Centre

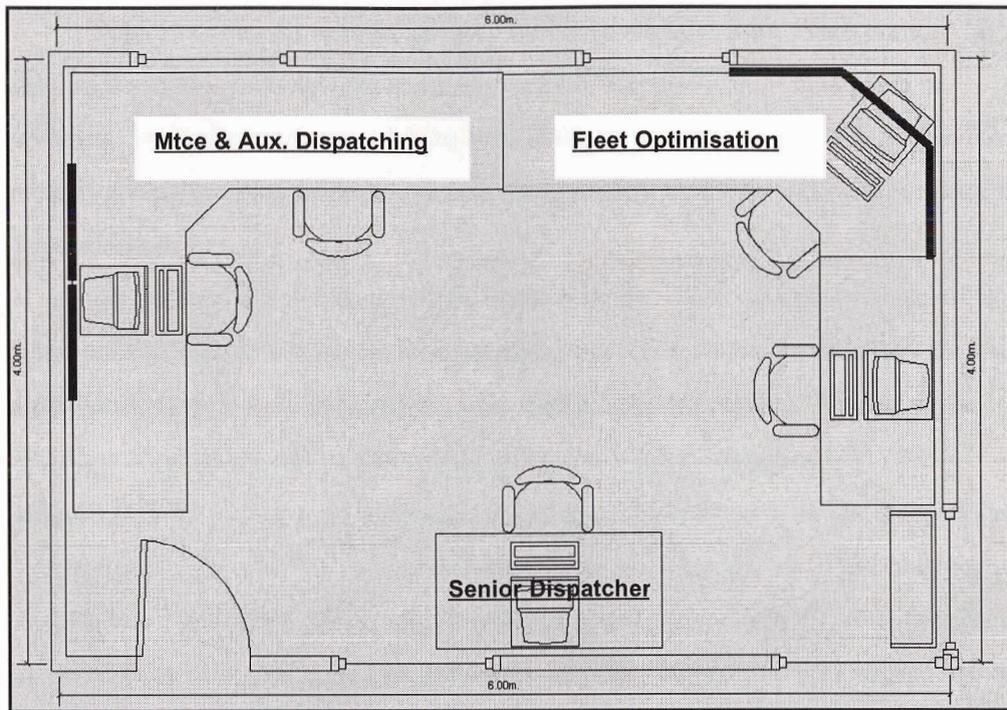
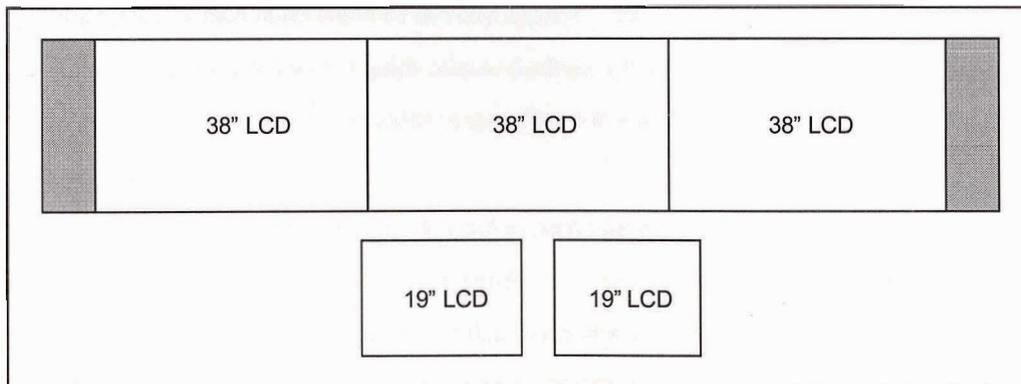


Figure 22: Typical 3 Screen Layout



### 5.2.1.2 Phase II

After correcting the physical set-up of the core knowledge asset, Phase II efforts are directed towards disseminating the knowledge to those that need it at the front line in the operation. This phase serves to exploit the forthcoming wireless LAN capabilities in the mining areas by providing mobile computing tools to the senior field supervision (General Foremen, and Superintendents).

Given the nature of their roles, the General Foremen will be equipped with tablet PC's. These units are both robust, and for the most part completely enclosed. As such, they are well suited for the dynamic and field intensive duties demanded by this position. Running on the Windows XP operating system, these tablets will be loaded with all applicable MYSRL standard software packages. A keyboard is not an absolute requirement for this group as they will be primarily querying fleet management information which is easily accomplished through a touch screen. Furthermore, tablets will allow sketching and noting of specific issues that arise in the field. These may, in turn, be e-mailed via the extended LAN to other field management or planning engineers for immediate address or comment. As the tracked dozer fleet becomes equipped with HP-GPS systems, the foremen will also be able to compare project progress to plan while in the pit. This functionality could be further stretched to include the ability to take photographs to which notes could be directly applied – and also e-mailed. The tablet PC's will be pickup truck mounted with a quick release docking station for activities on the ground. Docking stations may also be provided in the office for connection to a monitor, keyboard and mouse.

The Superintendent positions demand a much higher level of administrative duties in conjunction with a lighter direct field component. As such, the provision of wireless capable laptops is more appropriate. In the event that touch-screen laptops with sufficient power are sourced, the Superintendents will receive this functionality as well to simplify system queries while located in the field.

Whilst this analysis is primarily focussed on mine operations, this phase could be expanded to include mine maintenance. Application of this type of technology will serve to drive important maintenance related information such as status changes, direct connection to OEM health monitoring devices, and equipment locations to field service personnel, field maintenance personnel, and maintenance supervision. Additionally, it would provide “at the point of service” access to other applications such as MIMS.

#### *5.2.1.3 Phase III*

The third and final phase of the operations related initiative focuses on driving positive visual verification of events back to the fleet management system operators and other office bound field supervision. Simply, this phase contemplates the installation of remote cameras at strategic locations within the mining area. Ideally, these cameras will carry both panning and zooming capability. Cameras would be located in 2 locations within both the La Quinua and Yanacocha mining areas as well as on the leach pads for a total of 8 within the mining area. To better manage equipment in and around the shop, cameras will also be placed in three locations at the T1 shop facility. These will provide positive coverage of the shop bays, wash pad and ready line. The primary display and control for these cameras will reside within the command centre, however, access to current camera views will be provided through the LAN.

#### *5.2.1.4 Cost Estimate – Operations Related*

Figure 23 provides an estimate of the total commitment required to complete the mitigation of the identified operations related issues. Allocation of cost is expected to be split between operations, maintenance and information solutions, however is presented as a bulk sum for complete understanding of the combined project magnitude.

Figure 23: Cost Estimate

Project	Quantity	Cost
<b>Phase I</b>		
Office Modifications	1	15,000
Monitors and Related Hdwe	3	20,000
Phase I		35,000
<b>Phase II</b>		
Tablet PC's	4	14,000
Laptops	4	12,000
Phase II		26,000
<b>Phase III</b>		
Cameras - Operations	8	32,000
Monitors - Operations	1	2,000
Cameras - Maintenance	3	12,000
Monitors - Maintenance	1	1,000
Phase III		47,000
<b>Total</b>		<b>108,000</b>

#### 5.2.1.5 Payback

The sources of payback vary in each of the phases. Phase I, which is directed at improving the operation of the fleet management system, will provide direct benefit with respect to optimized system operation. The magnitude of this is estimated to be a 5% increase in haulage truck productivity and is based on the current relative levels of trucks queuing and loading equipment waiting time versus an achievable level. Phase II serves to drive knowledge out to the field and will provide benefit by allowing decisions to be made based on more timely information. It will also assist in identifying problems as they are occurring so that they may be addressed before they progress too far. Phase II should equate to a 3.5% increase in mine efficiency. Phase III supplies increased knowledge back to the operators of the fleet management system by providing visual verification of the situation within the mining and maintenance areas. Although difficult to quantify, the direct benefit of this will lie at least between 0-2% with respect to mine efficiency, and also provides a benefit for safety with increased levels of supervision able to see the operating conditions. Figure 24 summarizes the

productivity gains estimated in terms of Worst Case, Expected, and Best Case for the 3 Phases and the project as a whole.

*Figure 24: Project Sensitivities- Productivity Gains*

<b>Project Phase</b>	<b>Worst Case</b>	<b>Expected</b>	<b>Best Case</b>
Phase I	3%	5%	7%
Phase II	2%	3.5%	5%
Phase III	0%	1%	2%
Project	5%	9.5%	14%

For the purpose of expected NPV computation, Phase I is evaluated at 5%, Phase II at 3.5% and Phase I at 1%. This is further applied to the planned monthly prime tonnages to estimate the impact on production. From there, a value of \$0.90/ton and a discount rate of 15% are used to determine the expected NPV of \$14.6M for the period July 2004 through June 2005 as shown in Figure 25. Considering this from a Worst Case point of view where Phase I achieves 3%, Phase II achieves 2% and Phase III achieves 0%, the NPV of this project remains impressive at \$7.6M for the same period of July 2004 through June 2005. Such a large return for a relatively low investment comes as no surprise given that only small incremental improvements in the efficient flow of extremely large mining equipment (a single truck load yields 240tons at net \$0.90/ton) has a tremendous impact on overall production when a fleet of 65 haulage trucks is deployed.

Figure 25: Estimated Payback

Project Sensitivity & NPV		% Imp	Outlay	Jul04	Aug04	Sep04	Oct04	Nov04	Dec04	Jan05	Feb05	Mar05	Apr05	May05	Jun05
Planned tonnes (000's)			16,125	16,825	15,488	15,471	14,037	14,336	15,702	14,166	15,702	15,495	16,579	16,040	
<b>Phase I - Sensitivity</b>															
Worst - Tonnage Add	Value	3.00%	484	499	485	464	421	430	471	425	471	465	497	481	
	NPV		(35)	435	449	418	379	387	424	382	424	418	448	433	
Expected - Tonnage Add	Value	5.00%	806	831	774	774	702	717	785	708	785	775	829	802	
	NPV		(35)	726	748	697	632	645	707	637	707	697	746	722	
Best - Tonnage Add	Value	7.00%	1,128	1,164	1,084	1,083	983	1,004	1,099	992	1,099	1,085	1,160	1,123	
	NPV		(35)	1,016	1,047	976	884	903	989	892	989	976	1,044	1,011	
<b>Phase II - Sensitivity</b>															
Worst - Tonnage Add	Value	2.00%	332	342	319	319	289	295	323	292	323	319	342	330	
	NPV		(26)	298	308	287	260	266	291	263	291	287	307	297	
Expected - Tonnage Add	Value	3.50%	593	611	569	569	516	527	577	521	577	569	608	589	
	NPV		(26)	533	550	512	464	474	519	469	519	513	548	531	
Best - Tonnage Add	Value	5.00%	863	889	829	828	751	767	840	758	840	829	887	858	
	NPV		(26)	778	801	746	676	690	756	682	756	746	798	772	
<b>Phase III - Sensitivity</b>															
Worst - Tonnage Add	Value	0.0%	(47)	0	0	0	0	0	0	0	0	0	0	0	
	NPV		-46												
Expected - Tonnage Add	Value	1.0%	(47)	0	181	168	153	156	171	154	171	168	180	174	
	NPV		1,457												
Best - Tonnage Add	Value	2.0%	(47)	0	374	348	315	322	353	318	353	348	373	360	
	NPV		3,061												
Worst Case NPV			7,607												
Best Case NPV			21,829												
Expected Project NPV			14,622												
Note: All tonnages and \$'s expressed in 000's													Annual Disc. Rate:	15%	
													Monthly:	1.25%	
													Value / ton:	\$0.90	

### ***5.2.2 Reporting Related***

Various methods of consolidating the detailed production information are currently being investigated. At this point, the most attractive option is to leverage off of the upcoming process department introduction of a Pi data warehouse. As an operations level system it is better suited to process and generate information suitable for operational reporting purposes. Conceptually, the dispatch system raw data will be drawn out of each shift and subsequently eliminated from the dispatch system servers. Another option under consideration is storage within with the enterprise resource planning system (Ellipse), however, as a business intelligence tool it is better suited for that arena.

Rationalisation of data storage in this fashion will facilitate the development of reports using standard report writing tools, will eliminate risk associated with reporting from different sources, and will free-up scarce fleet management resources for more valuable contributions. Furthermore, maintaining the production data in standard database form will make integration with new and updated related systems simpler.

### ***5.2.3 Administration Related***

Administration related issues are currently being addressed with the recent completion of several STP's dealing with tasks ranging from system problem notification to the practical movement of wireless access points. By necessity, this will be an ongoing effort as problematic and operational impacting issues are identified.

Roles and responsibilities must be clarified somewhat with the forthcoming structural changes within the Operations Department. Once in force, individual roles and responsibilities must be redefined within this new framework.

As the current deficiencies in the fleet management system physical set-up are addressed, the manpower requirement within the command centre will be re-evaluated. At this point, one and potentially two dispatcher positions may be reduced per shift and further increase the estimated payback.

## 6 CONCLUSION

The industry analysis has revealed an attractive industry for those that are already in the game. The current environment is particularly attractive with rising gold prices and demand outstripping supply. To be successful in the long term, gold producers must continually replace depleted mining reserves through methods that include exploration, acquisitions, and reducing operating costs (to make larger volumes of minerals economic to mine).

Newmont is successfully pursuing a low cost / adequate quality strategy, however must continue to be creative in its approach to exploration techniques and production operations. This requires increased vigilance given the current environment of high prices which carries the risk of removing the urgency from operational efficiency and causing a deviation from the strategy. In the event that prices drop in conjunction with increasing operating and capital costs, the results can be devastating for an inefficient operation.

Transformation of knowledge management in mine operations provides a strategic advantage for Newmont, and particularly Minera Yanacocha, by facilitating an innovative improvement in operational efficiency. Aligned with Newmont's strategy, the recommended three phased project for Minera Yanacocha provides an immediate potential annual benefit of \$14M US in terms of increased production for a relatively minimal cost. This is directly reflected in the cash cost / ounce produced, and allows the identification of more proven and probable mining reserves.

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