

**STRATEGIC ANALYSIS OF  
AN ENGINEERING SERVICES FIRM**

by

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# **ABSTRACT**

The purpose of the paper is to analyze a large mining and metals engineering services firm's strategy and assess how it helps or hinders the firm's ability to compete successfully. As part of a much larger global company, the business unit examined offers full engineering, procurement, and construction management (EPCM) services to the mining sector.

The focus is on identifying the firm's strengths and weaknesses and understanding how these factors can be used to take advantage of opportunities and deal effectively with threats. A comprehensive yet detailed approach is used to analyse the firm's current situation and strategy. An industry analysis and discussion of macro-environmental trends, together with a thorough examination of the firm's attributes, help to formulate a clear picture of where the company stands at 2Q 2004 and where it needs to go in order to attain future growth and prosperity.

There are two main recommendations. The first is to in the short term, emphasize specific business development activities using a coordinated approach to obtaining large project EPCM work so that it is more comprehensive yet remains focused. The second recommendation is to over the longer term, develop innovative and proprietary process technologies and project execution procedures that will truly differentiate the firm's offerings from those of its competitors.

## DEDICATION

This paper is dedicated to my late grandmother Florence Augusta Sproule Cardinal, who long ago shared with me her love of books and reading. *Thanks Gram, for instilling in me a passion for life-long learning.*

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# 1 INTRODUCTION

A strategic analysis of a mining and metals business unit (referred to as ‘the BU’<sup>1</sup>) is presented. The BU is an engineering services firm and is part of a division (D) in a geographic sector (GS) that in turn reports to a parent company (PC). The BU is part of the Americas GS or region; three of the four other GSs represent other geographic regions of the world that the PC services. Headquartered outside of North America, the PC is a large and diversified global operation with over 45,000 employees and more than 640 offices around the world. With the March 2003 acquisition and consolidation of the outstanding 54% of a major European construction company, the PC became one of the largest E&C (engineering and construction) firms in the world. Based on 2002 revenues, it ranked 14<sup>th</sup> in Engineering News-Record Magazine’s ‘150 Top Global Design Firms’ category (Engineering news-Record, 2003) in July 2003.

Although the GS performs significant EPC (engineering, procurement, construction) work, the BU competes in the closely related EPCM (engineering, procurement, construction management) sector of the engineering services business, focusing exclusively on the mining industry. Engineering offers a full spectrum of multi-discipline design and management services that include mechanical, electrical, controls, civil, structural, architectural, and process specialties. Procurement generally includes sourcing and buying equipment, expediting, inspection services, onsite receiving, and preparation of work package contracts. Project management refers to the management of studies, projects and overall responsibility for construction management. Construction management is a group of services that includes actual job site construction management, safety management and coordination, materials receiving and management, and contracts coordination.

For some, mining can represent a promise of incredible wealth obtained through investment on a stock exchange or it can mean a miserable daily subsistence spent toiling in the largely unregulated tin mines of Peru. Many depend on the large supply chain supporting the industry for their livelihoods. Still others are attracted to mineral exploration as it satisfies their free-spirited outdoor mind-sets and sense of adventure. But *all* of us, in every walk of life,

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<sup>1</sup> All company and related names have been changed. All opinions expressed throughout the text reflect the understanding of the writer and do not necessarily agree with nor represent those of the company’s business unit (BU), division (D), geographic sector (GS) or parent company (PC). Every effort has been taken to offer a fair discussion and objective interpretation of the BU’s strategy. Any factual errors and omissions remain the sole responsibility of the writer and are unintended.

depend on metals in our everyday lives. As such, the BU is in the business of supplying EPCM services to the mining industry – employing the latest technologies, methods and means – in the most efficient and profitable manner. According to the well-respected African mining news service MBendi, (MBendi, 2004, para. 1), “in 2001, the mining industry produced over 6 billion tons of raw product valued at several trillion dollars” and that over the last decade of the twentieth century, the “application of new technology has led to productivity gains across the value chain.” The article continues with “traditional mining countries such as the USA, Canada, Australia, South Africa and Chile dominate the global mining scene” and that exploration and development has opened up as “funding has changed over the past few years with emphasis shifting to areas that have been poorly explored or have had poor access for reasons of politics, infrastructure or legislation.” Certainly, the recent development of remote gold, diamond, and platinum group element properties has been emphasized and this will continue.

The mining industry also faces many challenges. These include large mining property development expenditures, long lead times – often 10 years or more – from initial exploration to final plant start-up, and continuous pressure by investors to improve returns. Coupled with volatile metals markets, uneven supply and demand, and the fact that mine sites are often located in remote and logistically difficult to access geographic locations, the industry is inherently risky.

General engineering activities encompass three sequential phases of work: ‘up-front’ geological and mine planning studies, metals processing feasibility<sup>2</sup> studies, and detailed engineering work necessary for actual construction. Overall, risk management is fundamental to successfully develop a mine that will be safe, operable and economically attractive. Subsequently, an astute choice of EPCM firm to undertake any or all of the initial resource assessment, feasibility studies, and project work, will lay the foundation for a successful project outcome. Combining the unpredictable mining industry together with the differentiated EPCM services business that is needed to develop properties economically, results in a high degree of uncertainty. This idea of ensuing ‘lumpiness’ will surface repeatedly throughout the following sections.

This paper analyses how well the BU is situated within the mining EPCM industry, how well it functions within its own organization, and how well it plans and conducts its business versus actual results. The first few sections are primarily descriptive but take on a more

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<sup>2</sup> A feasibility study assesses whether a mineral deposit can be mined profitably. Various technical concepts are examined and trade-off studies performed at this time. The capital and operating costs of a mine are estimated usually to within +/-15%.

analytical tenor as the discussion progresses. A systematic examination of various factors' performance is conducted in order to make a thorough assessment in support of the analysis. The analysis was conducted to provide a deeper understanding of how the BU operates and it is hoped that this work will be useful to others in the organization.

Section 2 describes the company's overall organization, markets, and the services the BU offers. This is followed by descriptions of the metals and minerals with which the firm is involved. A brief financial discussion precedes an examination of the industry's value chain and the BU's place in it. Section 3 concentrates solely on competitors. Section 4 presents a competitive analysis covering a wide range of topics having to do with the EPCM mining industry. Dominant economic characteristics are discussed and then an industry analysis using Porter's Five Forces model is performed (Porter, 1979, p. 6). Industry attractiveness, success factors and key issues facing the industry round out this section. Section 5 considers how macro-environmental trends affect the mining industry that in turn affects the associated mining EPCM industry. Section 6 conducts an internal analysis of the firm and appraises how well its strategy aligns with core competencies. Finally, Section 7 is concerned with key issues facing the BU and offers recommendations that address these so that the firm is better positioned for success.

## **2 SERVICES, MARKETS AND OVERVIEW OF THE FIRM**

Section 2 introduces the BU's organization and corporate structure and then describes the EPCM services it offers. The target markets – key customers, geographic locations and metals – are discussed. The metals and metals the BU is involved with are explained in some detail because they are at the very core of the industry. Market share is described in terms of sources of billable work, win rates, and proportion of work that is won sole-source by the BU. A general financial overview of both the PC and the BU follow. Finally, a value chain analysis for the mining EPCM industry is presented. The BU's 'footprint' is outlined and it gives a glimpse as to how the BU fits into the industry. This is just the first of a number of analyses to assess the BU's competitive position.

### **2.1 ORGANIZATION DESCRIPTION**

At the close of 2003, the PC was comprised of 54 wholly owned subsidiaries, 14 joint ventures and one associate firm. These were divided into five market sectors and cross-matrixed with three 'home markets' groups and an investment group (PC, 2003, p. 80). The GS 'home market' of the Americas has its own functional matrix that includes five divisions, each with separate business units. The functional services at the GS corporate level include Business Development, Commercial, Finance and Accounting, Human Resources, Information Technology, Legal, and US Government Relations. These shared services groups administer PC policy and provide corporate services to all of the geographic sectors including GS UK, GS Asia Pacific, GS Continental Europe, and Investments.

There is significant vertical integration in the mining and metals BU as shown in its company organization chart in Figure 1. For instance, the BU relies heavily on the Engineering Services group for multi-discipline engineering design and drafting support. The BU might also choose to seek financing for projects<sup>3</sup> through the corporate level investment group. Strong horizontal integration also exists within the corporation as many divisions depend on each other to augment the scope of services they supply. As an example, the BU often uses geo-technical, water management, and environmental resources from the 'E' division.

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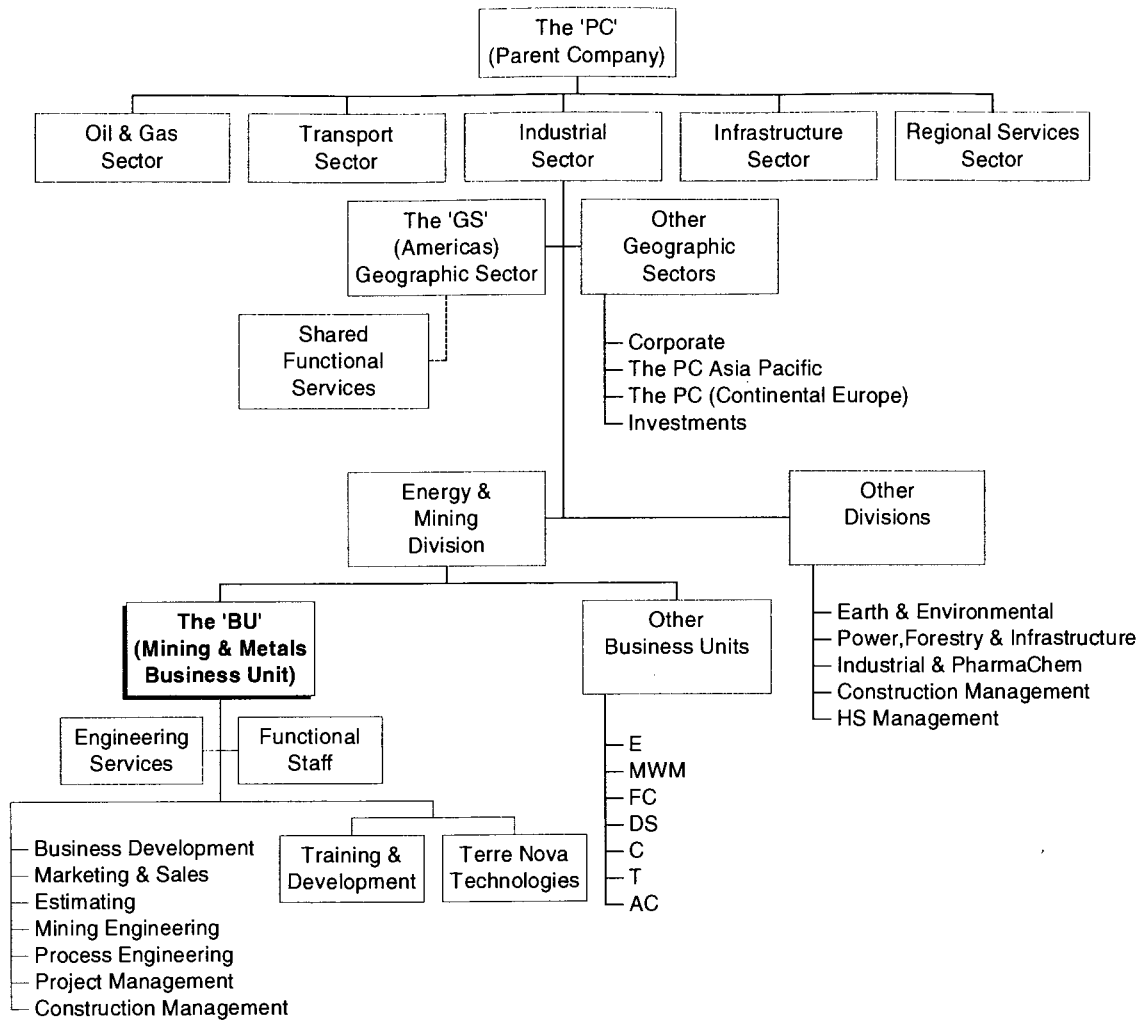
<sup>3</sup> A 'project' implies construction or capital cost expenditure of some sort.

At the beginning of 2Q 2004, two other business units in addition to the mining and metals BU shared the resources of the engineering services group. Engineering Services pays for itself by billing clients but when there is a lack of work or certain general and administrative functions must be fulfilled, the overhead is prorated and allocated between the three business units.

The Division that the BU belongs to is headquartered in Canada and has almost 7,000 employees in over 170 offices. As part of the Division, the BU's head office is also in Canada, and world wide, there are 10 main offices with over 600 staff. The Vancouver office is a major centre for technical and project management expertise. Regionally, there are pockets of specialized expertise and knowledge such as pyrometallurgy in various locations throughout North America.

Like the corporate structure, the BU is based on a matrix format whereby people belong to functional technical or management groups but are assigned to projects. In effect, they work for two different bosses: their department manager and a project manager. This is normal in the industry and works well in a consulting environment where clients are billed for project hours worked and overhead hours are allocated to the functional departments through the BUs. The company trades resources between offices as needed but sharing of lower value, commodity type work whereby employees actually work in another office is fairly limited. This is because each profit centre will strive to keep its own staff busy and billable before it brings in outside help. On the other hand, specialized knowledge can sometimes be difficult to find and will readily be sourced from throughout the organization when certain capabilities are needed, whether it is for a nearby field assignment or work in another office on the other side of the world.





Data Source: Company marketing brochures (2003), PC intranet (2004) and website (2004)

Figure 1 Company Organization Chart<sup>4</sup>

## 2.2 SERVICES OFFERED

The PC provides design, project delivery and maintenance support to clients in the oil and gas, transport, industrial and infrastructure sectors. It works at local, national and international levels, and with 2003 revenues in excess of US\$8 billion, the company is one of the largest EPC firms in the world. The BU limits its scope of supply to EPCM services in the mining industry although other parts of the company engage in full EPC. This scope includes, but is not limited to, those general services shown in the Product/Customer matrix in Table 1.

<sup>4</sup> Company names have been changed to protect privacy.

EPCM includes BU technical design, project management and work program execution, as well as equipment and materials purchasing and construction management. The customers listed are a representative sample in the four different categories of firm of the many that the BU deals with: ‘Top 3 Global’ have significant holdings around the world and work with a variety of metals; ‘Large Single Commodity’ refers to companies with significant holdings in primarily one metal – for instance, Canada’s Placer Dome currently operates 18 gold mines around the world; ‘Large Multi-Commodity’ describes firms with significant holdings in more than one metal, and ‘Mid-Tier’ infers companies with medium-sized holdings in one or more metals. The products listed cover the main services offered. A revenue breakdown for each firm’s product was not available.

<b>MAJOR CUSTOMERS &gt;&gt;&gt;</b>	Rio Tinto (incl Freeport, Kennecott)	Anglo American (incl HBMS, De Beers)	BHP	Inco	Phelps Dodge	Barrick	PCS	Placer Dome	Newmont	Noranda/Falconbridge	Teck Cominco	Ivanhoe	Berna Gold	Kinross	Aur Resources
<b>PRODUCT (by type of contract)</b>															
<b>Engineering</b>															
>Mining Feasibility Studies	X	X	X	X	X	X		X	X	X	X	X	X	X	X
>Process Feasibility Studies	X	X	X	X	X	X	X	X	X	X	X	X	X		X
>Detailed Engineering	X	X	X	X	X	X	X	X	X	X	X				
> Maintenance Services	X			X	X				X	X					
<b>Procurement</b>	X	X	X	X			X	X	X	X	X				
<b>Construction Management</b>	X	X	X	X			X	X	X	X	X				
<b>Construction</b>			X		X				X						
<b>REGION (where The BU has worked)</b>															
North America	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Central & South America	X	X	X		X	X		X	X	X	X		X	X	
Western Europe/Turkey	X										X				
Eastern Europe/Former USSR													X	X	
Africa	X	X	X												
Australasia/China/Mongolia	X	X	X	X								X			

Data Source: Customers’ company websites (2004)

Table 1 Product/Customer Matrix for EPCM Services

The Product/Competitor matrix shown later in Table 10 gives a more detailed list of specific services and capabilities that make up the primary activities in the overall mining EPCM value chain. The BU performs general EPCM functions but it must be noted that a group

separate from the BU performs the actual procurement (P) tasks.<sup>5</sup> Additional differentiated and value-added engineering services that the BU offers are Enhanced Systematic Planning (ESP), operations technical and business optimization, Best Value Decision-Making (BVD), project websites, integrated project management system software, Capital Efficiency Optimization (CEO), and National Instruments 43-101 technical reporting to satisfy Canadian securities law.

Engineering, procurement and construction management may be contracted out individually or together but separate EP and CM or full EPCM arrangements are all common. Projects can vary from a few thousand to hundreds of millions of dollars. The term ‘mega-project’ is generally reserved for EPC projects of a billion dollars and beyond. Since engineering work typically progresses in sequential phases and separate parts could be awarded to more than one firm, it is unusual for discounted rates to be negotiated even when more than one phase of the work has been won on a project, as the parts are contracted separately. Considering the high level of risk mitigation offered by using a well-respected engineering house and the differentiated value that the BU’s services offer, its prices are well in line with those of its larger competitors. A premium offering commands a premium price and the company is in the business of providing a highly specialized service.

### ***2.2.1 Engineering***

The BU engineers perform what is referred to as ‘process’ engineering. This encompasses primarily geo-technical, mineralogical, chemical, and metallurgical specialities. Since technical innovation is a core competency, it warrants further description. The BU uses state of the art technologies to solve challenging metallurgical problems and welcomes opportunities to showcase its expertise. For instance, in the last two decades, the use of SX/EW<sup>6</sup> technology has made a new source of copper available and the BU has done significant work with this technology. Historically, it had been difficult to process copper oxides in a satisfactory manner using traditional flotation methods. Another example includes refractory gold ores that will not leach in cyanide by themselves. For these ores, pressure oxidation in autoclaves facilitates their leaching by cyanide. Still another case involves an extension of the gold

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<sup>5</sup> The BU does not actually perform this activity directly. However, it does lend substantial technical expertise to the Purchasing functional group (part of Engineering Services). The Purchasing group prepares bid documents and purchase orders for expensive, long-lead time equipment on the critical path.

<sup>6</sup> Solvent extraction/electrowinning uses an electrolytic process to extract or ‘win’ almost pure metal such as copper from an acid leach solution bearing the dissolved metal.

refractory example to copper. Similar use of an autoclave can now be used to leach copper sulphide concentrates and has recently been proven commercially by an American operator. The BU has significant autoclave technology design capability to offer clients and this is an area of potential growth.

Many of the process engineers also act as their own study managers. Almost all of them have significant field experience with 'hands on' operating knowledge. They supervise laboratory test work for front-end studies and lead the process engineering teams on projects. They might also go to site to lead the commissioning and start-up aspects of a project. This combination of intellectual, managerial and practical skills is quite unique and provides added value for the client.

The BU's project managers also have strong technical backgrounds but tend to work solely as project managers. On large jobs these leadership positions demand all of an individual's time and effort. The same description applies to construction managers.

### ***2.2.2 Procurement***

Specialists in the project controls group perform the procurement function. Starting with a procurement plan built from the equipment list and together with contract packages, procurement personnel coordinate the competitive bidding process for all equipment as well as bulk items such as structural steel and pipe (if the constructor is not doing this itself). Procurement specialists prepare bid packages and conduct commercial evaluations, 'conditioning' them to create a basis for common comparison and assessment. Engineers make their own separate technical evaluations and recommendations. Procurement negotiates terms and conditions, incentives, and price improvements. Their negotiating and contract preparation skills are integral to obtaining competitive pricing and attractive terms and conditions. The company uses proven bidders' lists and preferred suppliers. Of course, if a customer wants to use its own favourite equipment vendors, the company will oblige. Unlike major competitor Fluor, the BU does not have key supplier arrangements. Rather than limit itself to a single vendor for say, large expensive grinding mills, the BU will competitively bid the equipment on the open market in order to receive the latest technical innovation available and the best possible price. The sacrifice is some lead time but this can be mitigated with careful planning. The competitive bidding process usually provides the most effective approach overall.

The BU benefits from the scale effects generated by the GS's buying power. This comes from either the sheer volume or the large dollar value of orders placed with equipment vendors in

many different industries that source similar materials. One example of the benefits of good supply chain management is where the BU can rely on a sister company to order steel plate directly from a steel mill rather than going through a third party fabricator. This saves precious lead-time – often a month or more on a six-month delivery. There is a large supply chain of key equipment and bulk commodities suppliers and freight forwarders that the procurement group relies on to order and deliver equipment to different sites – on time and in a cost-effective manner.

Procurement’s buyers do their own expediting and perform periodic inspections during equipment production or coordinate inspection through outside contractors. Procurement does not have its own quality control capability and could benefit from having someone who administers quality control measures on vendor’s equipment in their own shops. Finally, it is the procurement group that coordinates receipt of equipment and supplies on a construction site as part of the construction management function. It is necessary to account for all goods to not only ensure that the client is receiving what it’s paid for, but also to avoid expensive construction delays caused by damaged goods or incorrect deliveries. The BU ultimately is the one to pay the bills for goods it has bought and received on behalf of the client. Managing the materials receiving function is one way of proactively maintaining control.

The complexity of larger projects necessitates the use of integrated project management software. The procurement group uses such a system to keep track of purchase orders and check expediting status – these are just two of the many functions possible. Common complaints about the package, which was developed in-house over many decades, are that it is not easy for novices to learn and use, is unwieldy, requires that data repeatedly be entered in different locations, and is not suitable for smaller projects. Unless all its features are implemented, its value is questionable as significant data re-entry is required and the system is inefficient, particularly for small projects.

### ***2.2.3 Construction Management***

The construction management mandate covers a wide range of activities that are handled by a construction management team. These activities initially include logistics planning, mobilization of resources and materials, and site orientation for incoming field personnel. Coordination of construction camp facilities, site security and field office administration are also important responsibilities of the construction manager and his team. Drawing and document control, numerous reporting documents for tracking progress, deficiencies and status, as well as

construction progress photographs must be coordinated in a timely fashion. The many supply and construction contracts involved need to be closely supervised and the associated cost controls and fieldwork orders also require close monitoring. Typically, a project controls individual does this. Construction liabilities – environmental, safety, design changes and contractor claims – need to be minimized and the interests of both the BU and the owner protected. Quality control is very important and is addressed during every step of material and system installation by following specifications and standards and through regular, frequent inspection. By the time construction is underway, the value already added in a project is enormous. Therefore, every effort is made to avoid having to fix mistakes or omissions in the field and also by using a well-run quality control program.

Site safety is paramount. On a large project, an overall integrated safety, health and environmental management plan is essential. It requires significant foresight, planning, implementation, and agreement between client and engineer. At the day to day operations level, one or more site safety coordinators will be required to instruct personnel in basic safety rules and special task and equipment training, coordinate first aid facilities, maintain safety statistics and perform monthly reporting, as well as provide and enforce safe work procedures.

## **2.3 TARGET MARKETS**

The BU focuses on providing EPCM services primarily for the gold, copper, zinc, nickel and diamonds markets. Metal prices' inherent volatility and sensitivity to both the supply and demand sides of the mining EPCM business means that service providers are forced to operate in a predominantly reactive mode and are not always able to pursue their work of choice. Nevertheless, the BU carefully develops relationships with major mining clients to strategically position itself for all phases of EPCM work. It is still dependent on a strong market for various metals and when the metals market is weak, as it was between 1999 and mid-2003, feasibility study work is prevalent. This is because owners are conserving cash, are reticent to spend major capital on new assets and have time to turn their attention to feasibility studies. The reverse is true when metals prices are high and owners want to get a quick return on their investment.

The BU's head office was moved two years ago to be closer to a greater number of major mining companies and investment houses whose head offices are in Toronto. While many junior mining companies operate out of Vancouver, as do a few major players such as Placer Dome and Teck Cominco, it was felt that the move to Toronto would be beneficial overall. The BU does not pursue EPCM work in specific geographical locations but accepts appropriate work wherever

customers and their mining properties are located. For instance, nickel laterite<sup>7</sup> typically occurs in tropical zones so most of that kind of nickel project is located in Indonesia, Australia or Africa. Likewise, diamond-bearing kimberlite ore can be found in volcanic areas of colder northern regions. Many of these projects have significant logistical challenges. The BU works closely with others groups in the company's highly integrated organization to offer specialized expertise and capability in such things as cold weather work or working in remote regions. The BU targets clients who have these kinds of projects the BU can competitively service.

The BU prefers to work with key customers who may be more willing to sole source even large bodies of work as this reduces SG&A<sup>8</sup> costs. There appears to be a trend toward lump sum (fixed price) contracting for EPCM work and the BU is not adverse to this kind of arrangement. However, the general workforce is not experienced in fixed price and needs to learn more about how to work competitively in this more aggressive and demanding environment. They are used to cost reimbursable (cost plus) work where actual hours worked are billed according to a budget. There is no reason to think that lump sum will supplant cost reimbursable contracts in the foreseeable future but for anything more than the largest all-inclusive EPCM projects. Finally, the BU chooses to work with what are referred to as 'sophisticated' clients. These companies know what they want, have a credible team of their own, do not micro-manage their engineering services supplier and pay their bills on time.

## **2.4 METALS AND MINERALS OVERVIEW**

The major metals and minerals that the BU is involved with are described below with respect to production, amount of reserves and related information; it is desirable for the reader to appreciate the breadth, scope and some detail about these key metals and minerals. Certainly, it is imperative that EPCM service providers understand this well so they can strategically target what areas of expertise to develop for different metals and where the greatest incentives lay. For example, there is now (and has been historically) a lot of potential in gold and diamonds and its subsequent mine and processing facilities development, but not much in the tin industry. Therefore, tin has not been, nor will it likely be a key area of interest for the BU. The tables show that just a very small percentage of the world's known reserves were under production at the close of 2003. Additionally, these tables do not indicate how economically viable it is to extract

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<sup>7</sup> This is a nickel-bearing, mud-like ore found on or close to the earth's surface in temperate zones.

<sup>8</sup> 'SG&A' refers to Sales, General & Administration costs that collectively are referred to as 'overhead'.

the deposits. Only carefully conducted feasibility studies carried out for a specific set of conditions can be used to confidently make such predictions.

### 2.4.1 Gold

Gold has been revered as the most precious metal for thousands of years. Although the world's monetary system no longer relies on the 'gold standard', investors still follow its price – a key indicator of global economic health – on world stock exchanges. Gold is used in electronics requiring non-corrosive contacts, as a dental restorative material and for jewellery. The jewellery trade is a permanent and global marketing initiative for bullion, and has for thousands of years gone hand in hand with un-worked metal in promoting gold as a store of material value. It creates a significant barrier to entry for any rival material and contributes to the security of gold, in bullion form, as a form of money.

Gold usage for 2003 can be broken down as follows: jewellery and arts 84%, dental 8%, electrical and electronic 7%, other 1%. Approximately 95 tonnes or 50% of new consumption was recycled in 2003. Substitutes include palladium, platinum and silver. Often, other base metals are clad in a thin layer of gold to conserve the precious metal. Table 2 summarizes gold production and reserves in 2003 (United States Geological Service, 2004, pp. 72-73).

Country	2003 Reserves (t of Au)	% of Reserves	2003 Gold Production	
			Mine Production (t of Au)	As % of Reserves
Australia	5,000	11.6%	275	5.5%
Canada	1,300	3.0%	165	12.7%
China	1,200	2.8%	195	16.3%
Indonesia	1,800	4.2%	175	9.7%
Peru	200	0.5%	150	75.0%
Russia	3,000	7.0%	180	6.0%
South Africa	8,000	18.6%	450	5.6%
United States	5,600	13.0%	266	4.8%
Other Countries	17,000	39.4%	760	4.5%
<b>Total</b>	<b>43,100</b>	<b>100.0%</b>	<b>2,616</b>	<b>6.1%</b>

Data Source: USGS 2003 Mineral Commodities Summaries

Table 2 2003 Gold Production and Reserves

Peru is the major gold producer with respect to exploiting its own reserves, followed by China and Canada. An excerpt from the Aden Forecast (Aden and Aden, 2004, para. 9) sums up



the general prediction for gold at the end of April 2004: “The bottom line is, nothing has really changed. Gold’s major trend, which is the most important, remains up and the dollar’s major trend is still down.”

The price of gold is linked directly to the strength of the American dollar, general health of the world economy, inflation and global political situation.

### 2.4.2 Zinc

Zinc is used to galvanize other metals against corrosion, (primarily in the automobile industry) and zinc compounds are used in fertilizers, chemicals, paints and rubber. Zinc usage for 2003 can be broken down as follows: galvanizing 55%, zinc-base alloys 17%, brass and bronze 13%, and other 15%. Substitutes include aluminum, steel and plastics for galvanized steel and various coatings for corrosion protection. Table 3 summarizes world zinc production and reserves in 2003 (United States Geological Service, 2004, pp. 188-189).

Country	2003 Reserves (1000 t of Zn)	% of Reserves	2003 Zinc Production	
			Mine Production (1000 t of Zn)	As % of Reserves
Australia	33,000	15.0%	1,600	4.8%
Canada	11,000	5.0%	1,000	9.1%
China	33,000	15.0%	1,700	5.7%
Kazakhstan	30,000	13.6%	350	4.4%
Mexico	8,000	3.6%	500	3.1%
Peru	16,000	7.3%	1,250	2.1%
United States	30,000	13.6%	770	2.6%
Other Countries	59,000	26.8%	1,300	0.6%
<b>Total</b>	<b>220,000</b>	<b>100.0%</b>	<b>8,470</b>	<b>3.9%</b>

Data Source: USGS 2003 Mineral Commodities Summaries

Table 3 2003 Zinc Production and Reserves

At the close of 2003, it seemed that zinc, overshadowed by the other base metals and undervalued by investors, was finally recovering (Metal Bulletin, 2004, para. 1). A combination of price-driven cutbacks and closures, improved demand in the galvanizing sector, and dramatically reduced exports from China to fuel booming domestic demand were responsible for this reversal. Zinc consumption rose by over 2% in 2003 and continued growth is forecast in 2004 and 2005. After three years of surplus, a zinc deficit is likely in 2004 and analysts expect

the metal to perform well through 2004. Elsewhere in the world, consumption within the automotive, construction and industrial goods sectors is healthy.

### 2.4.3 *Platinum Group Metals (PGM)*

PGM refer primarily to platinum, palladium and rhodium. All occur naturally together and are used as air and chemical catalysts<sup>9</sup>. Platinum is used in automobile catalytic converters for air pollution abatement. PGM are also used in jewellery and dental restorative materials. Only about 6 tonnes of metal were recovered from new and old scrap in 2003. Table 4 summarizes world PGM production and reserves in 2003 (United States Geological Service, 2004, pp. 124-125).

Country	2003 Reserves (kg of PGM)	% of Reserves	2003 PGM Production	
			Mine Production (kg of PGM)	As % of Reserves
Canada	310,000	0.4%	18,000	5.8%
Russia	6,200,000	8.7%	110,000	1.8%
South Africa	63,000,000	88.5%	199,800	0.3%
United States	900,000	1.3%	18,700	2.1%
Other Countries	800,000	1.1%	12,000	1.5%
<b>Total</b>	<b>71,210,000</b>	<b>100.0%</b>	<b>358,500</b>	<b>0.5%</b>

Data Source: USGS 2003 Mineral Commodities Summaries

Table 4 2003 Platinum Group Metals (PGM) Production and Reserves

World platinum and palladium markets faced a big shake-up after an announcement from Belgium's Umicore of new technology that may cut the cost of cleaner exhaust systems for diesel engines (Brown, 2004, para. 2). The Belgian metals and specialty materials group said its new technology could result in a quarter of all the platinum currently used in diesel exhaust control systems being replaced by much cheaper palladium. Precious metals market analysts said the approximate US\$600 per ounce gap between palladium and platinum prices would likely narrow as a result. The new palladium-based technology – until now the metal has been suitable only for use with gasoline engine systems – could go to market in 2005. It would be at least two years before any real impact was seen from the technology and could mean that roughly half a million ounces less platinum demand and at least half a million ounces more palladium demand.

<sup>9</sup> A catalyst hastens a chemical reaction without itself being consumed or changed in any way.

#### ***2.4.4 Copper***

Copper is the 'red' metal and as a superior conductor of electricity, it is used mainly for wire and cable. Its market rises and falls with the level of residential and commercial construction. Mixed with zinc, it becomes brass and mixed with tin, it becomes bronze. Brass is used for decorative ware and brazing, while bronze is used for metalwork and plating. Recycled scrap comprises about 9% of total consumption. Copper usage for 2003 can be broken down as follows: building construction 46%, electric and electronic products 23%, transportation equipment 10%, industrial machinery and equipment 10%, and general products 11%. Substitutes include aluminum for electrical power cables and other equipment, automobile radiators and cooling/refrigeration tubing. Titanium and steel are used for heat exchangers and steel is used in artillery shell casings. Optical fibres can substitute for copper in some telecommunications applications. Plastics are also used for piping, plumbing and structural members. Producers exploring new mining properties are always looking for technological breakthroughs to make it cheaper to extract the ore. They will also want to know how their operations may be affected by currency volatility in other producing countries. Table 5 summarizes world copper production and reserves in 2003 (United States Geological Service, 2004, pp. 54-55).

While Chile has the largest reserves, in 2003 Canada produced the most metal based as a percentage of its reserves. This may in part be due to Chile's unpopular new mining tax that could hinder international investment. Both Chile and Peru, worried about their livelihoods when mineral resources are depleted in the future, are in the process of introducing a royalty or alternative taxation on mining as compensation for foreign companies' use of the non-renewable resource. Canada does not have such a tax. On the supply side, shortfalls were posted for both 4Q2003 and 1Q2004 at about 500,000t each ("Copper deficit", 2004, para. 1).

Country	2003 Reserves (1000 t of Cu)	% of Reserves	2003 Copper Production	
			Mine Production (1000 t of Cu)	As % of Reserves
Australia	24,000	5.1%	870	3.6%
Canada	7,000	1.5%	580	8.3%
Chile	150,000	31.6%	4,860	3.2%
China	26,000	5.5%	565	2.2%
Indonesia	32,000	6.8%	1,170	3.7%
Kazakhstan	14,000	3.0%	480	3.4%
Mexico	27,000	5.7%	330	1.2%
Peru	30,000	6.3%	850	2.8%
Poland	30,000	6.3%	500	1.7%
Russia	20,000	4.2%	700	3.5%
United States	35,000	7.4%	1,120	3.2%
Zambia	19,000	4.0%	330	1.7%
Other Countries	60,000	12.7%	1,500	2.5%
<b>Total</b>	<b>474,000</b>	<b>100.0%</b>	<b>13,855</b>	<b>2.9%</b>

Data Source: USGS 2003 Mineral Commodities Summaries

*Table 5 2003 Copper Production and Reserves*

On the demand side, there are fears that China, the driving force behind the April 2004 rise in copper prices to an 8-1/2-year peak, will not be able to sustain its current high level of consumption. Chile is the world's major producer. With the sale of stockpiled copper by its state-run Codelco, it is expected to shape price forecasts for the rest of 2004. All of these factors impact the development of new copper projects that in turn increase the need for EPCM mining services.

#### **2.4.5 Diamonds**

Aside from their industrial uses for abrasion, drilling, polishing, cutting, and in computer microchips, better quality diamonds are marketed as gemstones. Industrial diamonds constitute the lion's share of all production and synthetic diamonds accounted for 90% of this segment in 2003. Although over 4.8 million carats of diamond grit and dust were recycled in 2003, this amount is expected to decline as synthetics increase in market share.

Substitutes for certain applications include cubic boron nitride, fused aluminum oxide and silicon carbide as well as synthetic diamonds. Synthetic diamonds are significantly less expensive than real ones and their quality can be controlled and properties selected for specific

requirements. A low-pressure technique to produce diamonds using chemical vapour deposition drew worldwide attention in the mid-1980s. In the mid-1990s, several new mass-production technologies for producing diamond films emerged, including those coatings used for razor blades.

Table 6 summarizes world industrial diamond production and reserves in 2003 (United States Geological Service, 2004, pp. 56-57; Werkiuk, 2003, p. 17). The Canadian figures include gemstone quality diamonds. The 2003 production data suggest that Canada is poised to become the world's third largest diamond producer with almost 15% of the world's diamonds by value.

'Conflict' or 'blood' diamonds, so-called due to the exploitation of diamond miners working the deposits in certain third-world countries, are a distressing issue tarnishing the industry. Also, the incredibly stringent environmental hurdles that must be overcome in Canada's Northwest Territories where diamonds were first produced in 1998, is a major commercial challenge. The outlook for industrial diamonds is relatively good while that for gemstones is excellent.

Country	2003 Reserves (million carats)	% of Reserves	2003 Diamond Production	
			Mine Production (million carats)	As % of Reserves
Canada	48	7.7%	11.2	23.2%
Australia	90	14.4%	19.0	21.1%
Botswana	130	20.9%	9.0	6.9%
China	10	1.6%	1.0	10.0%
Kinshasa	150	24.1%	15.0	10.0%
Russia	40	6.4%	11.8	29.5%
South Africa	70	11.2%	6.7	9.6%
Other Countries	85	13.6%	3.0	3.5%
<b>Total</b>	<b>623</b>	<b>100.0%</b>	<b>76.7</b>	<b>12.3%</b>

Data Sources: (1) USGS 2003 Mineral Commodities Summaries (2) Canadian Mining Journal (2003)

Table 6 2003 Diamond Production and Reserves

#### 2.4.6 Nickel

Nickel, a 'white' metal, is added to steel for strength and enhanced corrosion resistance, making it 'stainless'. Nickel usage for 2003 can be broken down as follows: transportation 32%, chemical industry 14%, electrical equipment 11%, construction 9%, fabricated metal products 8%, machinery 7%, household appliances 6%, petroleum industry 6%, and other 7%. About 93,

000 tonnes or 57% of total reported consumption were recovered from scrap in 2003.

Substitutions include aluminum, titanium, coated steels and plastics. Table 7 summarizes world nickel production and reserves in 2003 (United States Geological Service, 2004, pp. 114-115).

LME<sup>10</sup> nickel prices may have fallen from a high of US\$ 17,770/tonne in early January 2004 but some analysts are still predicting higher prices before the end of the year. One of the reasons behind the recent price fall is due to de-stocking of scrap. Latest statistics confirm growth in stainless crude steel production in all the major regions of the world and global production increased by 10.4% in 2003. However, there are doubts whether the stainless steel industry boom will continue into the second half of 2004 as the Chinese market softens and prices stabilize. China represents the largest nickel market in the world and market information suggests that demand could be slowing due to a reduction in apparent consumption of stainless steel products and to the fact that manufacturers have been switching to products with lower nickel content. However, demand in the Far East and India for higher-nickel stainless scrap has been steady.

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<sup>10</sup> 'LME' refers to London Metal Exchange.

Country	2003 Reserves (1000 t Ni)	% of Reserves	2003 Nickel Production	
			Mine Production (1000 t Ni)	As % of Reserves
Australia	22,000,000	35.6%	220,000	1.0%
Botswana	490,000	0.8%	18,000	3.7%
Brazil	4,500,000	7.3%	46,000	1.0%
Canada	5,200,000	8.4%	180,000	3.5%
China	1,100,000	1.8%	56,000	5.1%
Colombia	830,000	1.3%	65,000	7.8%
Cuba	5,600,000	9.1%	75,000	1.3%
Dominican Rep.	740,000	1.2%	39,000	5.3%
Greece	490,000	0.8%	23,000	4.7%
Indonesia	3,200,000	5.2%	120,000	3.8%
New Caledonia	4,400,000	7.1%	120,000	2.7%
Philippines	940,000	1.5%	27,000	2.9%
Russia	6,600,000	10.7%	330,000	5.0%
South Africa	3,700,000	6.0%	40,000	1.1%
Venezuela	610,000	1.0%	21,000	3.4%
Zimbabwe	15,000	0.02%	8,000	53.3%
Other Countries	1,300,000	2.1%	12,000	0.9%
<b>Total</b>	<b>61,715,000</b>	<b>100.0%</b>	<b>1,400,000</b>	<b>2.3%</b>

Data Source: USGS 2003 Mineral Commodities Summaries

Table 7 2003 Nickel Production and Reserves

Consumers have been buying all available quantities at market levels, resulting in lower nickel and ferrous scrap values (Recycling International, 2004, para.1). This trend appears likely to continue beyond 2004.

#### 2.4.7 Iron Ore

Iron is used primarily in the production of steel. By itself, iron is brittle and will rust or corrode but alloying iron with carbon transforms it into 'carbon' steel that is much stronger, tougher and slightly less prone to corrosion. Steel is used in construction and transportation—aircraft, automobiles, ships and rail. Iron ore is not itself recycled. There are no real substitutes for iron ore as it is the only source of primary iron. Table 8 summarizes world iron ore production and reserves in 2003 (United States Geological Service, 2004, pp. 84-85).

Country	2003 Reserves (t) (million t of Fe Ore)	% of Reserves	2003 Iron Ore Production	
			Mine Production (million t of Fe Ore)	As % of Reserves
Australia	18,000	12.2%	190	1.1%
Brazil	7,600	5.2%	215	2.8%
Canada	1,700	1.2%	32	1.9%
China	21,000	14.3%	240	1.1%
India	6,600	4.5%	80	1.2%
Iran	1,800	1.2%	11	0.6%
Kazakhstan	8,300	5.6%	18	0.2%
Mauritania	700	0.5%	10	1.4%
Russia	25,000	17.0%	92	0.4%
South Africa	1,000	0.7%	38	3.8%
Sweden	3,600	2.4%	21	0.6%
Ukraine	30,000	20.4%	63	0.2%
United States	6,900	4.7%	50	0.7%
Venezuela	4,000	2.7%	17	0.4%
Other Countries	11,000	7.5%	40	0.4%
<b>Total</b>	<b>147,200</b>	<b>100.0%</b>	<b>1,117</b>	<b>0.8%</b>

Data Source: USGS 2003 Mineral Commodities Summaries

Table 8 2003 Iron Ore Production and Reserves

Skyrocketing demand has created one of the tightest international iron ore markets in recent times, leading to the highest prices in more than a decade (AME, 2004, para. 1-3). China's voracious appetite for iron ore and steel is powering this global boom. Its infrastructure and manufacturing expansion will catapult Asian steel output to almost equal the rest of the world's entire production by 2009. The tight and lucrative market has producers scrambling to expand capacity as the burgeoning Chinese economy draws heavily on domestic and international steel supply. The enormous increases in Chinese steel production from 2000-2003 gave rise to substantial growth in imports, which doubled to 112 million tonnes between 1999 and 2002 and were 44% higher in the first quarter of 2003 than in the same period the previous year. That rapid growth appears to have taken the world's iron ore producers by surprise and, coming at a time when steel production in most other countries is also growing, has eliminated any surplus of iron ore output and exerted upward pressure on finished steel prices which increased significantly during the first quarter of this year (Recycling International, 2004, para.3). The world's largest steel group, Arcelor, has advised its customers of further base price increases for the second



quarter. These repeated, large price increases are making life difficult for end users who have to quote their own prices to customers three or four months forward.

Ten countries account for 90% of world production. Recent years have seen a flurry of merger and acquisition activity that has concentrated much of the world's iron ore production capacity in the hands of a very few corporate groups. CVRD, Rio Tinto and BHP are now responsible for 30% of world iron ore production (The-Infoshop, 2004, para. 4). Although iron ore producers are rushing to bring new capacity on-stream, the supply situation is likely to remain tight until at least mid-2005. It is improbable that there will be any major changes to the pattern of world supply in the immediate future.

#### **2.4.8 Potash**

Potash is a mineral that is used primarily to make fertilizer. Canada is the world's largest potash producer and the largest single producer is Potash Corporation of Saskatchewan, based in Saskatoon. About 90% of potash is consumed as fertilizer and the rest is used in a variety of industrial and chemical applications. Potassium chloride, known as muriate of potash, is most widely used in fertilizers. More specialized potash fertilizer products are potassium sulphate and potassium-magnesium sulphate. The largest non-agricultural potash product is potassium hydroxide (caustic potash), which is used to make soaps, detergents, perfumes and water softeners.

Plant facilities can swing between caustic potash and caustic soda production as needed. Potash supply closely tracks demand. In times of potash overcapacity, the industry cuts back on production to maintain balance. Since the fixed costs of potash production must be allocated over lesser product actually sold during such mine closings, profits are eroded when capacity is reduced.

There are no substitutes for the potassium component of potash but manure and glauconite are low-potassium alternatives that can be shipped over short distances in a cost-effective manner. Table 9 summarizes world potash production and reserves in 2003 (United States Geological Service, 2004, pp. 126-127).

Potash demand is heavily influenced by world crop prices, political and financial conditions in individual markets and the weather. Historical annual growth for caustic potash (1996-2001) tracked at nearly 3 percent annually and producers differ with analysts on the chemical's future growth, which has been projected between 1.5 and 4 percent per year. Generally, potash demand is predicted to grow steadily at this rate.

Country	2003 Reserves (1000 t of K <sub>2</sub> O)	% of Reserves	2003 Potash Production	
			Mine Production (1000 t of K <sub>2</sub> O)	As % of Reserves
Belarus	750,000	9.1%	4,000	0.5%
Brazil	300,000	3.6%	380	0.1%
Canada	4,400,000	53.2%	8,500	0.2%
Chile	10,000	0.1%	420	0.1%
China	8,000	0.1%	450	0.0%
Germany	710,000	8.6%	3,600	36.0%
Israel	40,000	0.5%	2,050	25.6%
Jordan	40,000	0.5%	1,200	0.2%
Russia	1,800,000	21.8%	4,600	11.5%
Spain	20,000	0.2%	470	0.0%
Ukraine	25,000	0.3%	10	0.1%
United Kingdom	22,000	0.3%	610	2.4%
United States	90,000	1.1%	1,100	1.2%
Other Countries	50,000	0.6%	-	-
<b>Total</b>	<b>8,265,000</b>	<b>100.0%</b>	<b>27,390</b>	<b>0.3%</b>

Data Source: USGS 2003 Mineral Commodities Summaries

Table 9 2003 Potash Production and Reserves

## 2.5 MARKET SHARE

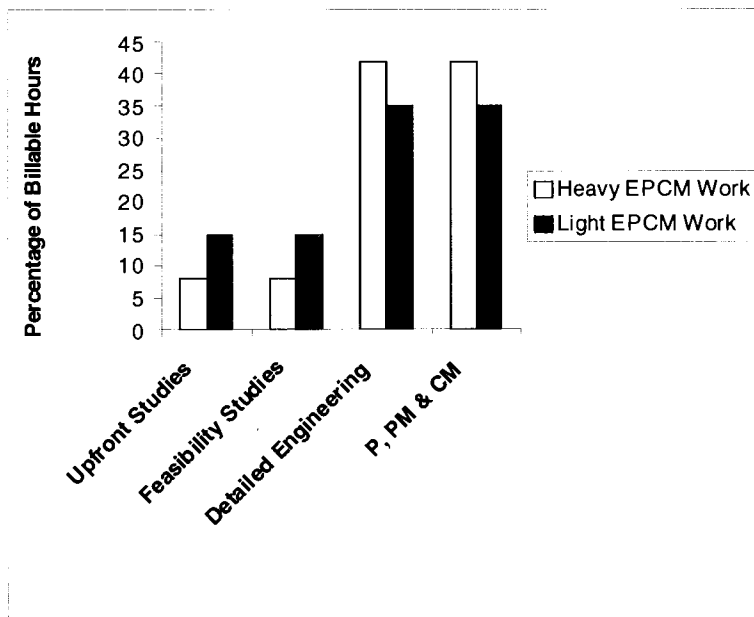
The BU's share of its 'biddable' mining and metals market is about 18% or about US\$1 billion per year (BU Strategy 2003-2007, 2003, p. 5). This market excludes Africa and Australia, which have 35% of the forecasted global expenditures. The BU's market appears to be strongest in gold and diamonds and weakest in iron ore, magnesium, steel and aluminum. The BU is considered a credible bidder for EPCM projects up to US\$500 million capital expenditure. The BU's top ten clients represent approximately 65% of annual revenue. The companies that comprise the main set of competitors are shown in Table 10, 'Product/Competitor Matrix'. Competitors are grouped in the following categories: Geology and Mine Plan Engineering Capability, Feasibility Study Engineering Capability and Detailed EPCM Capability.

Market share for mining EPCM work is difficult to assess, as almost all available data are for EPC work. When EPCM work is 'heavy', the BU has correspondingly more engineering, procurement, project management and construction management billable hours as shown in Figure 2. The reverse is true when the amount of EPCM work is 'light'. It is generally accepted

that the BU has strong capability in front-end mining and process feasibility studies and has a higher than average 'win rate' in those areas. The BU obtains more than its fair share of study work but needs to improve its win rate for detailed engineering, particularly for larger projects.

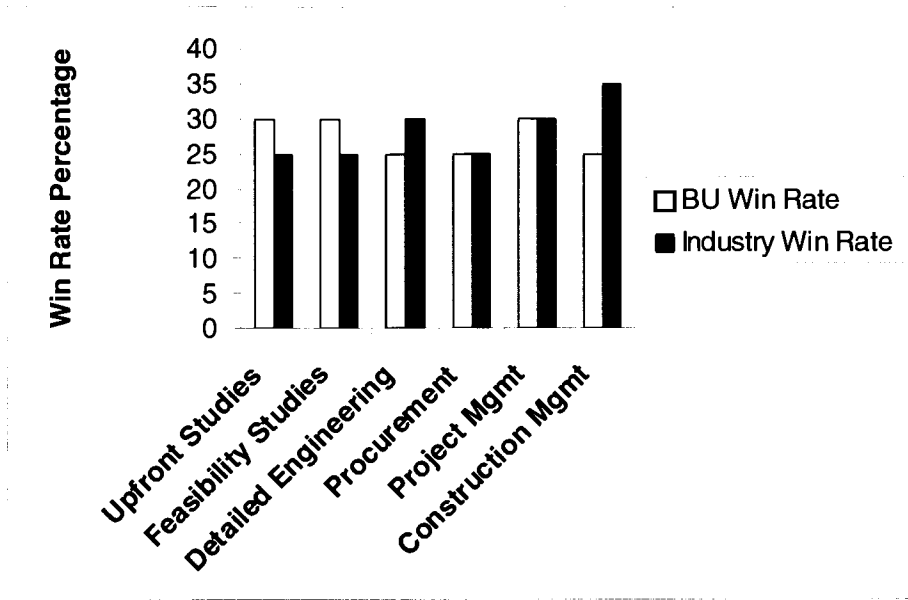
The potential biddable mining and metals market for EPC work was approximately US\$15 billion in 2003 (BU Strategy 2003-2007, 2003, p.5). Based on the standard rule of thumb that EPCM work comprises approximately 6-8% of overall EPC revenue, the range translates to US\$900 million to US\$1.2 billion. The BU's own estimated share of this potential market is about 18% or US\$162 million to US\$216 million in fees. A comparison is presented in Figure 3 of hours worked on different types of work based on percentage of hours resulting in various 'win rates'. When the number of contracts won by the BU is compared, the number of scoping and pre-feasibility studies outnumbers feasibility and detailed engineering work by 3:1 or more.

Refer to Figure 4 for a breakdown of the proposals produced. Typically, customers issue requests for proposals and the BU will bid against other competitors. The smaller the job, the more likely it is to be sole-sourced as fewer dollars are at stake and the risk is lower. This is also true for the BU offices in small centres serving a large client where a fairly regular stream of ongoing small project and maintenance work is generated and more work is sole-sourced.



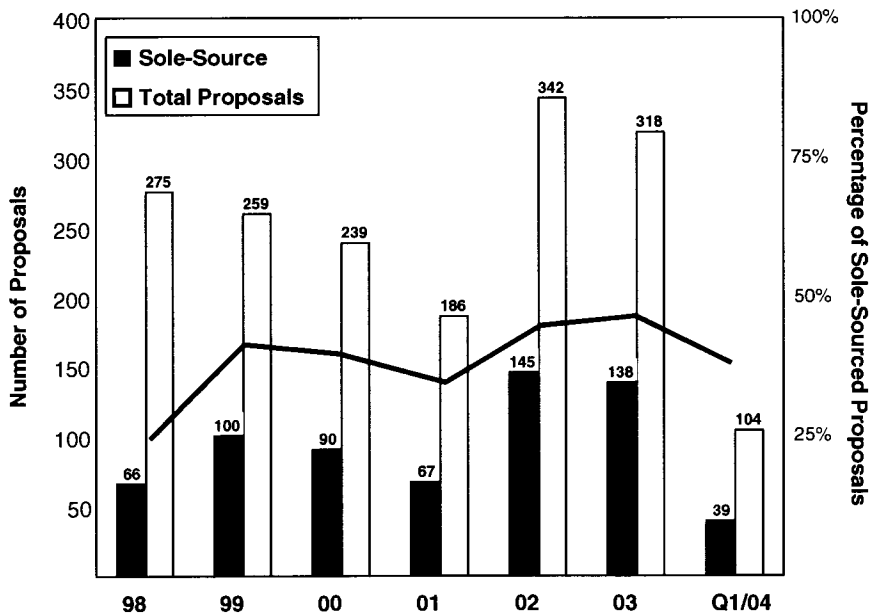
Data Source: BU internal documents (2003)

Figure 2 Sources of BU Billable Work



Data Source: BU internal documents (2003)

Figure 3 Win Rates<sup>11</sup> of Different Types of Work



Data Source: BU internal documents (2003)

Figure 4 Proportion of BU Proposals that is Sole-Sourced

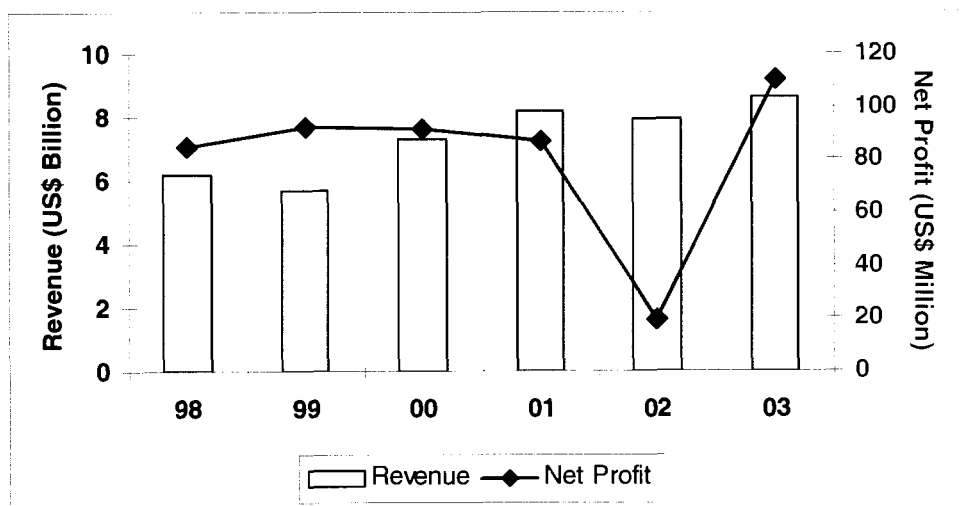
The BU's market share directly affects financial performance. Although feasibility study work is more profitable than detailed engineering, the latter generates a higher volume of hours

and therefore more revenue. The financial performance of both the company overall and the BU in particular are discussed in the next section.

## 2.6 FINANCIAL PERFORMANCE AND OUTLOOK

### 2.6.1 Corporate

In 2003, the GS turned over US\$1.1 billion in revenues and EBIT<sup>12</sup> of about US\$19.5 million. All business units in each of the GS's five divisions are run as profit centres. All profits are contributed to GS that in turn sends it to the PC's corporate office. The PC is a publicly traded company and its overall performance is reflected in Figures 5, 6 and 7. The cash flow was severely compromised by the acquisition of the final 46% of the shares of a European construction firm, Company 'MNO'. This purchase also affected return on equity (ROE) as illustrated in Figure 7.



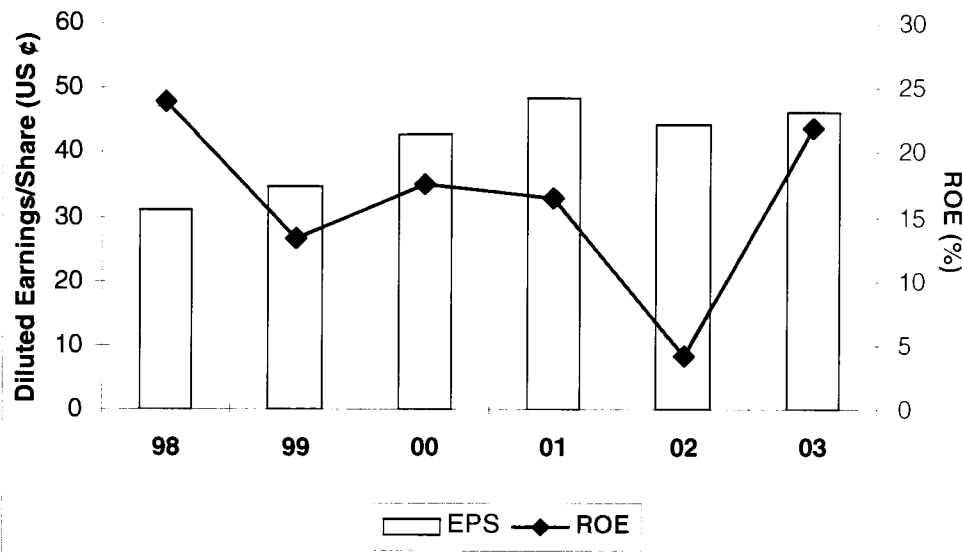
Data Source: 2003 PC Annual Report and Accounts

Figure 5 PC Revenue and Net<sup>13</sup> Profit

<sup>11</sup> The writer has estimated Industry Win Rates based on information from the BU's Marketing group.

<sup>12</sup> 'EBIT' refers to Earnings Before Interest and Taxes.

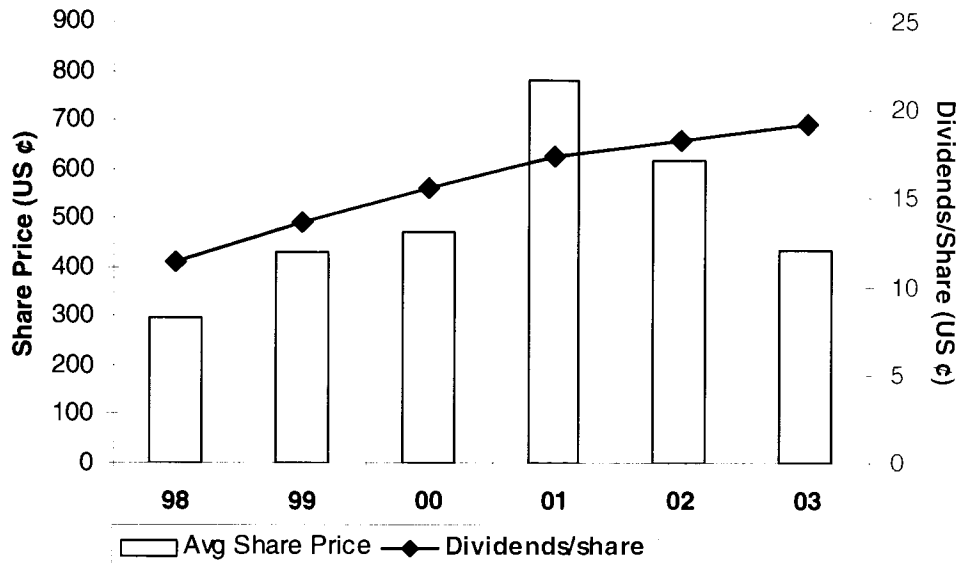
<sup>13</sup> After tax and exceptional items



Data Source: 2003 PC Annual Report and Accounts

Figure 6 PC Diluted EPS and ROE

At April 15, 2004, the company had a market capitalization of US\$1.54 trillion with about 2.81 billion shares outstanding and approximately 25,000 shareholders of record. The company's share performance is generally positive. Share price peaked in 2001 and has since retrenched. This is primarily due to a slow world economy. However, dividends per share have steadily increased providing real value to investors. The PC's dividend growth rate has increased 40% over the last five years and was 5% in 2003. In comparison, Fluor's 2003 dividend growth rate was 0% (Fluor, 2004, p. 2) and SNC-Lavalin's was approximately 10% (SNC-Lavalin, 2004, chart). In 2002, the PC started retaining equity in order to pay for its 2003 purchase of the European construction firm 'MNO' and dividends were subsequently cut to help the financing effort.



Data Source: 2003 PC Annual Report and Accounts

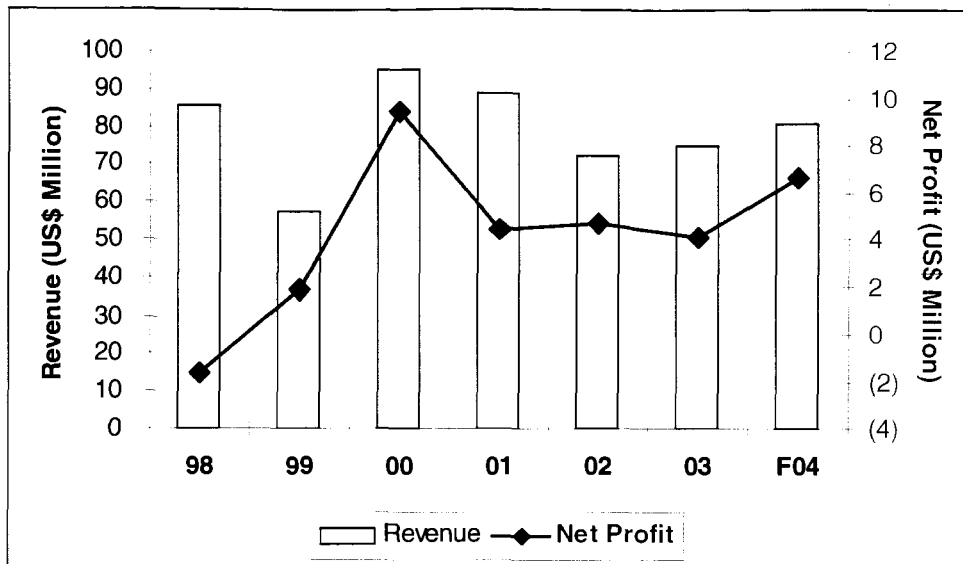
Figure 7 PC Share Performance

Financially, the corporate PC is solid and the BU's performance is improving as the metals market strengthens. BU revenues have expanded during the past five years but growth has been affected by periods of low customer capital spending and intense competition. After many years of global malaise, the medium term market outlook for the next three to five years is good.

### 2.6.2 The BU

As part of a large multi-national engineering and construction firm, the BU provides differentiated mining EPCM services. Its main core competency is in feasibility studies and strength is continually being developed in the other EPCM areas. The BU's Division contributed the largest percentage of the GS's revenues in 2003 at approximately 26%. As part of the PC, the BU's revenues accounted for just over 4% of the total. Coincidentally, this latter figure is similar for that in Fluor, AMEC and Bechtel, major competitors of the BU. Each business unit in the BU prepares an annual budget that gets rolled up to the division level and then up to GS and PC. Performance is tracked closely at all levels and according to key short term indicators – Accounts Receivable and Work in Process – the business is performing well.

The BU's historical financial performance is shown in Figure 8. Forecasted figures for 2004 are good and by the end of March 2004, the results were generally on track against budget. Full realization of actual goals will not likely happen until 2005.



Data Source: BU internal documents (2003)

Figure 8 BU Financial Performance

Company 'ABC' bought Company 'DEF' in July 1999 and the PC then acquired the entire entity in April 2000. The early '90's were particularly difficult for the company's mining EPCM business due to a stagnant economy. Company 'DEF' was forced to scale back a key, northwest U.S. office organization from about 70 to 15 people. There were similar layoffs throughout the rest of the business unit and ultimately about 40% of regular and contingent staff was let go. Revenues and profits started an upswing near the end of 2000 with two large and ultimately successful EPCM projects. This work made 2000 a highpoint to date for the BU business unit. By this time it had been acquired by the PC and become a part of the GS. However, the metals market once again plummeted and revenues and profits fell throughout 2002 to 2003. Some jobs that had already been awarded were delayed until late 2003, severely straining cash flow. Changing over to equal-length invoicing periods – originally, some periods had been as long as six weeks – helped to reduce the large cyclical drain on cash. A significant order book in 2004 will bring forecasted revenues up significantly. The BU's blended profit goal is 8.5% of gross revenue. Although the profit forecast for 2004 still falls short of this target, it is tracking in the right direction and assuming continued growth, the goal appears to be achievable by the end of 2005.



## 2.7 INDUSTRY VALUE CHAIN

### 2.7.1 *Mining EPCM*

A 'value chain' is used to analyze the specific activities that companies can use together to create competitive advantages. The mining EPCM industry value chain consists of nine service categories spread across the different phases of mine development planning, feasibility studies and projects. Refer to Figure 9. Early phase (light brown) includes feasibility studies. Mid-phase (yellow) includes engineering, procurement, project management, and construction management. Later phase work (purple) covers commissioning and start-up and operations and maintenance training. Ongoing work (pink) includes maintenance and support services as well as marketing, sales and business development.

The execution phases build upon one another through the recognized stages of EPCM work. Although the activities can be performed in isolation, there is increased value to be gained from being involved with more than one part of the chain. Geology and mine planning are included under Feasibility Studies. Firms participate a certain amount in each and fill in the gaps by going through the extended company network or externally outsourcing.

Typically, projects start with a number of progressively more detailed feasibility level studies starting at about +/- 20% to 25% for the capital cost estimate of a project. Additional design and further refinement of vendors' equipment quotes brings the cost estimate for engineering and actual construction to within +/-15%. These studies can sometimes span years and use the services of a number of different firms. The next step is called 'basic' engineering. It is required to tighten the estimate to within +/-10% to 15% of the final capital cost of the constructed project. Full-fledged detail engineering and procurement occur only after a +/-10% capital cost estimate has been produced.

95%			70%	90%			100%	100%
	20%	20%			15%	25%		
Feasibility Studies	Engineering	Procurement	Project & Construction Management	Commissioning & Start-up	Operations & Maintenance Training	Maintenance & Support Services	Marketing	Sales
Early		Mid-Phase		Later-Phase			Ongoing	

Data Source: Discussions with BU's Marketing group (2004)

Figure 9 Value Chain for the Mining EPCM Industry<sup>14</sup>

Front-end activities deal with estimating and feasibility studies. Usually, work is won via competitive bid although it is not uncommon for a client to sole-source a firm for certain parts of a project. Companies usually perform one or more pieces of work in the value chain but these might not be directly related to one another. The business is knowledge-based and to some extent, EPCM firms are in the business of selling 'person' hours although front-end consulting is based more on a differentiation strategy rather than a cost-based one. Front-end consulting is highly technical and deals with the big questions such as how ore bodies will be accessed and how they can be most economically exploited. These decisions affect the work to follow.

Mid-phase activities include project management, procurement and engineering of major equipment and contracted deliverables. Requests for equipment quotation and technical bid analysis and recommendations must be performed. General engineering is a large and important component of EPCM work. Construction management often overlaps with design activities and projects are so-called 'fast-tracked' as their schedules become squeezed.

Project managers are involved in and responsible for all aspects of project delivery – technical, financial, and dealings with contracts and clients. While construction managers are in charge of the construction effort in the field and lead a mixed team comprised of people from their own firm as well as that of the construction company, they still report to the project manager. In some cases, the project manager undertakes the construction management duties in addition to their primary role. This takes an exceptional individual to accomplish both roles successfully. The construction manager who can deliver superior results is always in demand by

<sup>14</sup> Percentages refer to the BU's footprint in the overall mining EPCM industry value chain.

construction contractors. While good design is a precursor to minimal rework during construction, efficient management and cost control in the field epitomize successful project delivery.

Late-phase work includes commissioning and start-up of the facility. Typically, the lead process engineer heads the commissioning team that conducts operational trials and pre-tests all systems and equipment, as he or she is intimately familiar with all aspects of design and intended operation. Start-up goes through many stages, each designed to bring the mine or plant to the next capacity or throughput level. Final project handover is achieved when pre-determined performance tests are met or exceeded over certain periods of contracted operating levels or throughput. Once the owner signs off, the liability changes hands and the project is complete.

### ***2.7.2 The BU's Footprint***

Many EPCM firms have separated their core mining and mineral processing engineering activities from regular engineering such that the single sector 'business unit' model is prevalent in the EPCM industry. In this regard, the BU's footprint in the industry value chain is fairly standard.

It is easy to confuse the total multi-discipline engineering effort required to execute all phases of EPCM work with the specific roles and functions that pertain only to the mining and metals BU. The proportion of key categories in the mining EPCM industry value chain that the BU engages in compared to the total required EPCM services are highlighted in light blue in Figure 9. For example, the process engineering that the BU performs constitutes about 20% of *all* of the firm's EPCM engineering work. The other 80% includes electrical, instrumentation and control, civil, structural, mechanical and piping engineering.

The BU performs almost all of its own feasibility study process work. Like most firms, it out-sources a small bit of specialist technical help as well as laboratory work. Studies are important for positioning the firm to win subsequent phases of work. The BU employs core process staff comprised of technical specialists and study managers who are experienced with the many different mining and processing technologies necessitated by a range of metals. Process engineering comprises about 20% of all the EPCM engineering design performed on a project.

Procurement is a critical part of the EPCM offering and most firms recognize the desirability of closely aligning the procurement function with that of the mining and metallurgical core engineering functions. In the case of the BU, procurement is theoretically a

secondary activity as the group is not actually part of the BU. However, in reality, the two groups work closely alongside one another, hence the 20% given to 'Procurement' shown in Figure 9.

The BU performs virtually 100% of its study and project study management and perhaps 50-60% of the ensuing construction management for an overall figure of about 70%.

Construction management strength is an area that needs to be developed primarily from a safety perspective. Additionally, many construction managers are currently leading projects or will soon retire. There is no guarantee that clients will choose the same engineer to perform a project even after it has delivered an excellent study or phase of a project. This happens for many reasons. One is because clients wish to 'keep their engineers honest' and therefore tender each phase of work separately, thus putting the job back out on the market. Sometimes the desired project team may not be available or perhaps the owner simply has a policy of spreading the work (and risk) around different providers. Of course, choosing the same engineer for new phases of work does provide greater continuity with the least amount of disruption. It also ensures some level of cost-effectiveness as the team is familiar with the details of the job and the learning curve has flattened.

The BU could develop its 'design-build' capability further, particularly with respect to modular construction. At the simplest level, 'modularization' is a technique whereby chunks of a plant are pre-assembled or pre-constructed and shipped to either an intermediate staging area for further assembly with other pieces, or sent directly to site for installation. Shop labour is usually cheaper than that done onsite in remote locations but the biggest benefit is the much greater control that can be achieved which ultimately affords cost savings. Currently, the BU incorporates some elements of this approach into its projects but there is much room to expand and refine the practice.

Leading quick and uneventful commissioning and start-up efforts is one of the BU's key differentiators. Clients want to avoid a slow start-up as it means longer downtime and lost revenues. The BU has a lot of bench strength in this area and a good track record. Alternatively, commissioning and start-up need to be done correctly so that problems are not just shifted to some date in the future. The owner may participate in these efforts but liability still resides with the BU until the project is successfully completed and handed over. The BU group performs 90% of its own commissioning and start-up work. The owner usually handles the other 10%.

The BU provides operating and maintenance training as well as maintenance support services at customers' own facilities, or ones that the BU has designed. This is part of the total life-of-asset extra value that the BU offers. It is striving to grow this business from the respective

15% and 25% it currently performs although the potential growth in this area may be limited by clients' unwillingness to have outsiders get involved in running their operations.

Finally, the BU performs 100% of its own marketing and sales. These two categories are closely linked and they fit equally well at either end of the firm-level value chain. Situating them at the right hand side infers that efforts are aimed at winning the next new project.

## **2.8 SUMMARY**

As a standalone business unit of a large, global engineering services firm, the BU continues to excel at providing feasibility studies but is focusing more on building its EPCM strength. The BU targets key clients who are developing mines and processing facilities for certain metals that are predicted to be in demand and where the BU has core competencies in meeting these needs. The BU's conservative financial structure allows it to take on substantial risk; its projected increases in revenue and profit are on track for the near future. The BU fits the industry's standard value chain model but needs to focus on its EPCM, safety, and construction management.

### **3 COMPETITORS**

Three general groups of competitor are considered in Section 3. They are divided according to the market sector(s) they support: geology and mine planning, feasibility study engineering, and detailed EPCM. The BU competes in all three sectors that correspond with the different phases of EPCM work. Although most of the competitors listed in certain sections of the Product/Competitor Matrix in Table 10 do in fact compete in more markets than what is shown, the breakdown is a general representation for comparison purposes. Services offered are cross-referenced against contract type.

Overall, the BU tends to compete with mid-range firms such as Golder, Hatch, AMEC and SNC-Lavalin, although it has bid successfully against giants Fluor and Bechtel, albeit admittedly not on very large jobs. The BU participates in all three of these market segments but only the main players who repeatedly compete in one or more particular segments are discussed. Each competitor is described with respect to how it functions in its competitive category.

All of the BU's existing key competitors are established, committed, and plan to be around indefinitely. They have demonstrated their staying power as they have been in business for many years. Small and mid-size firms are more vulnerable to takeover by larger ones looking to expand their value chain, and who can afford to buy expertise outright. Often niche providers are an attractive buy for a larger firm and ideally, are left pretty much alone to continue their speciality work.

SERVICES OFFERED >>>	Geology & Mine Plan Engineering Capability						Feasibility Study Engineering Capability						Detailed EPCM Capability						
	BU	SRK	Hatch	Golder	AMEC	Snowdon	BU	Kvaerner	M3	Minproc	Ausenco	SNC-Lavalin	AMEC	Hatch	BU	Bechtel	Fluor	AMEC	SNC-Lavalin
<b>CONTRACT TYPE</b>																			
Engineering																			
<b>&gt;Scoping &amp; Feasibility Studies</b>																			
Geological Exploration		X	X		X	X													
Resource Evaluation	X	X	X		X	X													
Reserve Estimation	X	X	X		X	X													
Mine Planning & Design	X	X	X	X	X	X													
Mining Simulation	X	X	X	X	X	X													
Permitting & Compliance	X	X	X	X	X														
Environmental Assessment	X	X	X	X	X														
Water Treatment/Management	X	X	X	X	X														
Mine Audits	X	X	X	X	X	X													
Due Diligence Analysis	X	X	X	X	X	X													
<b>&gt;Process Feasibility Studies</b>																			
Mineral Processing Simulation							X	X	X	X	X	X	X	X					
Mining Materials Handling							X	X	X	X	X	X	X	X					
Acid Rock Drainage							X	X	X	X	X	X	X	X					
Paste Backfill							X	X			X	X	X	X					
Tailings Disposal							X	X		X	X	X	X	X					
Pressure Oxidation							X	X			X	X	X	X					
Hydrometallurgy							X	X	X	X	X	X	X	X					
Bacterial Oxidation							X	X			X	X	X	X					
Smelting & Pyrometallurgy							X	X		X	X	X	X	X					
Flotation & Concentration							X	X	X	X	X	X	X	X					
Northern Expertise							X	X	X		X	X	X	X					
<b>&gt;Detailed Engineering</b>																			
Mining Materials Handling															X	X	X	X	X
Acid Rock Drainage															X	X	X	X	X
Paste Backfill															X	X	X	X	X
Tailings Disposal															X	X	X	X	X
Pressure Oxidation																X			X
Hydrometallurgy															X	X	X	X	X
Bacterial Oxidation															X	X	X	X	X
Smelting & Pyrometallurgy															X	X	X	X	X
Flotation & Concentration															X	X	X	X	X
Water Treatment															X	X	X	X	X
Northern Expertise															X	X	X	X	X
<b>Procurement</b>																			
Buying & Expediting															X	X	X	X	X
Transportation Logistics															X	X	X	X	X
On-site Receiving															X	X	X	X	X
<b>Construction Management</b>																			
Contracts Management															X	X	X	X	X
Project Controls															X	X	X	X	X
Engineering Field Assistance															X	X	X	X	X
Safety Planning															X	X	X	X	X
<b>Construction</b>																			
Construction Activities																X	X	X	X
<b>REGION</b>																			
North America	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Central & South America	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Western Europe		X	X	X	X			X	X	X	X	X	X	X		X	X		X
Eastern Europe/Former USSR		X	X	X			X	X	X	X	X	X	X	X		X	X		X

Data Source: Competitors' company websites (2004)

Table 10 Product/Competitor Matrix

## **3.1 GEOLOGY AND MINE PLAN CAPABILITY**

'Up-front' geology and mine planning include ore reserves assessment, geological modelling and mine facility and operation design, once exploration data have been collected. Computer simulation and modelling are used extensively to optimize the design for ore extraction.

### ***3.1.1 The BU***

The BU is a strong competitor for geology and mine planning work but also pursues feasibility study and detailed engineering EPCM work as described in Sections 3.2.1 and 3.3.1.

### ***3.1.2 SRK***

SRK<sup>15</sup> is a private firm that was established in 1974 in Johannesburg, South Africa, offering services in soil and rock mechanics and tailings disposal (SRK, 2004). Financial information is not available. Through a mix of planned acquisitions and organic growth, by 2001 it had over 500 employees in 25 offices on six continents. Its services have been expanded so that SRK now provides specialized services mainly in the fields of mining, geotechnics, water, waste and the environment.

SRK's independence is ensured by the fact that it is strictly a consultancy organisation, holding no equity in any project, and with ownership primarily by staff. This permits its consultants to provide clients with conflict-free and objective support on crucial issues. This is particularly important for due diligence and all levels of feasibility studies, which form a large part of SRK's business.

### ***3.1.3 Hatch***

While Hatch offers geology and mine planning capability, it is also a major competitor for feasibility studies as described in Section 3.2.8. Based in Toronto, Ontario, it is a leading global consulting, engineering, technologies, information systems, and project and construction management organization (Hatch, 2004). It is an employee-owned company with more than 4,000 employees in over 64 offices worldwide. Hatch greatly expanded its mining division in

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<sup>15</sup> Founded by Oskar Steffen, Andy Robertson and Hendrik Kirsten



1993 when it acquired Vancouver's Rescan Engineering, an offshoot of Kilborn Engineering (now owned by SNC-Lavalin). In May 2004, Hatch purchased Acres International and may re-establish its mining presence in Vancouver. This is a particular threat to the Vancouver office of the BU.

The business units and affiliates of the Hatch Group provide a full range of services to clients in the mining, minerals, metals, manufacturing, infrastructure, and energy sectors. The process group's size and depth would be equivalent to those of the BU. The firm undertakes feasibility studies, new process development, pilot plant assessments, process design, environmental control projects and start-up of major industrial facilities. The process group consists of chemical, metallurgical, environmental and mining engineers with extensive research, development and operating experience. The firm is recognized for its strength in the application of pyrometallurgical processes for steel and aluminum. It also provides broadly based due diligence services to the financial services sector around the world.

The 2003 order book exceeded CDN\$15 billion and fees for 2003 were expected to exceed CDN\$400 million (Hatch, 2004, para. 2). Hatch was the first major engineering firm in North America to have its management systems certified on ISO 9001-94 standards and is one of the very few that apply it to their mining EPCM projects. The Financial Post has named Hatch as one of the '50 Best Managed Private Companies in Canada' in recent years.

### ***3.1.4 Golder***

Golder Associates ('Golder') specializes in ground engineering and environmental science (Golder, 2004). Operating as an employee-owned group since its formation in 1960, Golder has experienced steady growth for more than four decades and has more than 3,000 employees with offices on six continents. Golder provides a full range of environmental, reserve estimation, ground engineering, geotechnical engineering, mine design, waste management and water resources services. Golder is a leader in water resource management studies and much of the work that it competes against the BU for is slanted toward environmental issues. The BU uses the services of the GS's environmental group for much of this kind of work.

### ***3.1.5 AMEC***

The mining and metals group of AMEC Americas Limited ('AMEC') offers substantial consulting expertise from initial exploration through to feasibility studies in its geology and mine

planning capability. With over 50 years in the business, AMEC has over 600 employees in about a dozen offices around the world. It is based in Oakville, Ontario but a main centre of technical and project management excellence is found in Vancouver, British Columbia.

The firm performs resource and reserves estimation, valuations and mine planning and design. It is a strong competitor for geology and mine planning work. It also pursues feasibility study and detailed engineering EPCM work as described in Sections 3.2.7 and 3.3.4.

### **3.1.6 Snowden**

Snowden Mining Industry Consultants ('Snowden') provides a comprehensive range of services and independent advice to mining companies, banks and legal institutions (Snowden, 2004). Its services include geological and resource modelling, mine planning, optimization, scoping and feasibility studies, geotechnical and rock engineering, preparation of independent expert reports, valuations and due diligence reviews. It has a strong focus on the analysis and interpretation of exploration data, particularly as it is related to the definition and assessment of ore bodies. Snowden's expertise includes management of exploration programmes, including large deep drilling projects, sampling quality protocol design and audit, detailed assessment of multi-element geochemical data employing the most advanced software tools, and the collation and synthesis of information using GIS methods. The BU has used Snowden as a sub-consultant on occasion.

## **3.2 FEASIBILITY STUDY ENGINEERING**

Companies competing for feasibility study engineering work use pre-feasibility and other evaluative work as a starting point to prepare full conceptual assessments including capital cost estimates. Sometimes 'basic engineering' – the step between feasibility and detailed engineering that brings the capital cost estimate for the final, constructed project to within +/-15% – is included in this category. Feasibility studies typically involve engineering staff in all the disciplines but the BU provides process engineering and study management staff to drive the effort.

### **3.2.1 The BU**

The BU's strength lies in producing full feasibility studies. It has a demonstrated track record in this area, primarily in minerals and metals processing and hydrometallurgy. It also competes for geology and mine planning work, and detailed EPCM work, as described in Sections 3.1.1 and 3.3.1, respectively.

### **3.2.2 Aker Kvaerner**

Aker Kvaerner ('Kvaerner') is a leading provider of engineering, construction, technology products and services. The group's activities span a number of industries, including oil and gas production, refining and chemicals, pharmaceuticals and biotechnology, mining and metals, power generation, and pulp and paper. By the close of 2003, Kvaerner had aggregated annual revenues of approximately US\$4.5 billion and over 22,000 employees in more than 30 countries.

As of 1Q 2004, the Aker Kvaerner group (Aker Kvaerner, 2004) was in the process of a three-way restructuring that will result in three separately listed companies. Kvaerner is an industrial holding company and the principle shareholder in the two industrial groups Aker Kvaerner and Aker Yards (Europe's leading, and the world's fifth largest, shipbuilding group). Kvaerner's main activities will be to manage its ownership positions and continue the development of its various existing operational and non-operational interests. Aker Kvaerner was listed on the Oslo Stock Exchange on 2 April 2004.

Aker Kvaerner has provided services to the mining & metals industry for more than 150 years, beginning during the industrial revolution in England. Today, it provides nonferrous and precious metals, industrial minerals, and iron and steel with full life cycle services. The firm executes various types of project development studies, followed by engineering, procurement and construction management (EPCM), direct hire construction, commissioning and start-up, and services for operating plants. It also supplies metallurgical acid plants and specialty mining equipment. Aker Kvaerner differs from the PC in that it holds several proprietary technology licenses, although not in mining technology.

### **3.2.3 M3**

Since its inception in 1986, M3 Engineering & Technology Corporation (M3, 2004) has provided architecture, design engineering, procurement, manufacturing and construction services

for industrial, institutional, public and commercial projects. It performs its construction activities primarily in Nevada and Montana, although it has been involved with limited international construction work. The private firm is based in Tucson, Arizona and with its other two offices in Nevada and Mexico, has over 200 employees. Financial information is not available.

M3 performs feasibility studies for a variety of industries including mining and metals. It is competitive primarily in the copper and gold sectors that have a significant presence in the American southwest and is a major competitor of the BU's Phoenix office.

#### **3.2.4 GRD Minproc**

GRD Minproc ('Minproc') is a leading Australian company specializing in advanced technical and development solutions, project delivery and advisory services (GRD Minproc, 2004).

Since its establishment in 1978, the company has built a solid reputation both in Australia and worldwide for its well-rounded project execution capability. In April 2000, the company was acquired as a wholly owned subsidiary of its major shareholder, GRD NL. Merging with the GRD Group provided Minproc with the backing of a strong balance sheet. In early 2004, a market capitalization in excess of AUS\$200 million ensures the company of the financial resources it needs to successfully execute large-scale development projects.

Headquartered with 400 people in Perth, Australia, Minproc has spread its geographical reach with growing offices in the mining centres of Johannesburg, South Africa and Santiago, Chile. Although it is positioned to deliver the entire project development cycle, it competes with the BU by providing services in mining and geology conceptual feasibility studies. Minproc has established a track record as one of Australia's premier mining consulting groups. The company's mining team includes highly qualified geologists, resource analysts and mining engineers, with extensive experience in exploration, mine design and development. It has been recognised by leading institutions, such as the IFC, World Bank, EBRD, and Rothschild and Macquarie for adding credibility to the bankable status of projects.

#### **3.2.5 Ausenco**

Ausenco (Australian Engineering Company) was formed in 1991 and is a public, unlisted company (Ausenco, 2004). Its main offices are in Brisbane and Perth where it performs project engineering but it also handles project financing. Ausenco is currently implementing quality

management processes that comply with the quality management system ISO9001. The company is strong in the mineral processing and pyrometallurgical areas. Since March 2001, it has been strategically allied with the BU whereby the two companies share resources, loan personnel and perform selected feasibility studies together. The BU has been able to supply hydrometallurgical expertise to Ausenco on a number of occasions.

### ***3.2.6 SNC-Lavalin***

While SNC-Lavalin offers feasibility study capability it is also a major competitor for EPCM work as described in Section 3.3.5. SNC-Lavalin Inc. is a leader in the provision of a full spectrum of engineering, procurement, construction and management services for the mining industry worldwide (SNC-Lavalin, 2004). The company has been active internationally for nearly 40 years and employs over 15,000 people in offices across Canada and in 30 other countries. Working from a network of offices in Toronto, Montreal, Perth, Brisbane, Santiago, Johannesburg and London, the Mining and Metals group has over 1000 staff that can successfully execute mining projects anywhere in the world. The Mining and Metallurgy division has expertise in all aspects of the mining industry. This expertise includes mining, mineral processing, smelting and refining, as well as hydrometallurgy and pyrometallurgy. It also has the ability to advise and assist in project financing through SNC-Lavalin Capital Inc. and SNC-Lavalin Investment. SNC-Lavalin offers full ISO accreditation for quality assurance and quality control.

### ***3.2.7 AMEC***

AMEC is a recognized leader in performing feasibility studies and it also competes for geology and mine planning work in addition to detailed EPCM projects, as described in Sections 3.1.5 and 3.3.4, respectively. AMEC is particularly strong in hydrometallurgical and mineral processing technologies that include SX/EW, water and wastewater treatment, paste backfill and others. The firm is also highly experienced in providing valuations, audits, technical reviews and risk assessments.

### **3.2.8 Hatch**

While Hatch offers feasibility study capability it is also a major competitor for geology and 'up front' mine planning studies and conceptual work as described in Section 3.1.3. It is particularly noted for its pyrometallurgical strength. In this paper, although it is not listed in Section 3.3 as a detailed EPCM competitor, Hatch does indeed compete in this category.

## **3.3 DETAILED EPCM**

Companies compete for detailed EPCM that can include any combination of detailed engineering, procurement and construction management activities. Note that most, but not all of the companies shown in this category in Table 10 do provide actual construction services to the mining industry. However, the focus in this section is on EPCM.

### **3.3.1 The BU**

Although many parts of the PC, GS and Division actually perform EPC work, the BU concentrates solely on EPCM. The BU is becoming a strong contender for larger project detailed engineering EPCM work and continues to offer strong mine plan and geology services and feasibility study expertise as described in Sections 3.1.1 and 3.2.1. Major EPCM projects include Canada's first diamond mine as well as gold, zinc and PGM projects for major mining companies. The BU has significant cold weather engineering project experience.

### **3.3.2 Bechtel**

Founded in 1898, Bechtel is privately held and has been under the leadership of its founding family for four generations. The family still owns a controlling share in the business (Bechtel, 2004). Bechtel's corporate headquarters are located in San Francisco, California and it has over 50 large offices and 44,000 employees worldwide. The mining and metals headquarters were moved to Brisbane Australia in 2002. Bechtel is the largest engineering and construction company in the world based on various rankings. It was the first major engineering and construction company to embrace Six Sigma, a methodology that uses statistics to identify and eliminate errors in work processes. This is a quality assurance differentiator that also increases the chance of a seamless transition between the construction and operations processes.

Mining and metals work represents just over 4.5% of Bechtel's revenues. The company can handle all phases of study and project work with its great breadth and depth of expertise. By the beginning of 2004, Fluor was Bechtel's sole serious competitor for EPC projects over US\$500 million. However, Bechtel competes with other firms such as the PC, ABB, Skanska, and Parsons on projects of less than US\$500 million total installed capital cost. With its growing capacity to build market share because of its large size and full vertical and horizontal integration, the BU will likely become a strong contender on the larger size projects over the next few years.

### **3.3.3 Fluor**

Fluor Corporation is one of the world's largest, publicly traded engineering and construction firm that provides services on a global basis in the fields of engineering, procurement, construction, construction management, operations, maintenance and project management (Fluor, 2004). The company serves a diverse set of industries ranging from oil and gas to infrastructure to healthcare and telecommunications. Headquartered in Aliso Viejo, California, Fluor is a Fortune 500 company with revenues of US\$10 billion in 2002. It has more than 30,000 employees spread throughout a network of offices in more than 25 countries on six continents. While the industry refers to EPCM as engineering, procurement, construction management, Fluor applies its own meaning to the acronym: engineering, procurement, construction and *maintenance*. Construction management is inferred with the construction capability. Engineering News-Record (ENR) magazine consistently ranks Fluor Corporation, along with Bechtel, among the top two on 'The Top Design-Build Firms' and 'The Top 400 Contractors' lists. In 2003, Fluor ranked 232<sup>nd</sup> on the 'Fortune 500' listing (Hoover's, 2004, Fluor).

Fluor's mining and metals group performs EPC mining work but does not specialize in 'up-front' geological or pre-feasibility studies. It does however perform detailed feasibility studies. The Mining and Metals group gained much of its mining expertise after it acquired Vancouver's private family-owned Wright Engineers in 1988. Fluor is capable of handling mining projects of all types and sizes around the world.

### **3.3.4 AMEC**

AMEC is a strong contender for medium to larger sized detailed engineering EPCM work. As described in Sections 3.1.5 and 3.2.7, it offers strong mine plan and geology services in addition to feasibility study expertise. The firm has significant diamond and cold weather expertise but has also performed projects covering a variety of metals and minerals on almost all continents and in all climates. AMEC entered the mining business by acquiring AGRA's mining group in 2000.

### **3.3.5 SNC-Lavalin**

While SNC-Lavalin is a major detailed engineering EPCM competitor it also has strong capability in feasibility studies as described in Section 3.2.6. SNC-Lavalin has the depth and scope of operations to undertake large, complex, and logistically challenging projects in remote locations.

## **3.4 SUMMARY**

There are just a few companies in each of the three competitor categories listed that repeatedly vie for the same projects. They provide somewhat homogenous services overall but do have their areas of expertise as noted in Table 10. In order to build market share, the BU is following a strategy of pursuing larger detailed engineering projects. It is competing against the most highly respected, experienced, largest, and well-financed mining EPCM players in the world.

While the BU has demonstrated repeatedly that it can successfully compete for up-front mine planning and general feasibility study work, this excellent reputation has almost worked against the firm in its effort to win detailed engineering work of truly a larger size.

The BU still must develop its detailed engineering capability as well as its business development approach for projects greater than US\$500 million. Since only the top few players have longevity in any competitive venue, it is necessary that the BU do this successfully.



## **4 COMPETITIVE ANALYSIS**

Section 4 describes dominant economic characteristics of the mining EPCM industry in order to set the stage for the industry analysis that follows. Porter's Five Forces model (Porter, 1979, p.6) is used as template around which to structure this analysis. Discussions about key success factors, general attractiveness of the industry, and important issues it is facing, complete the section.

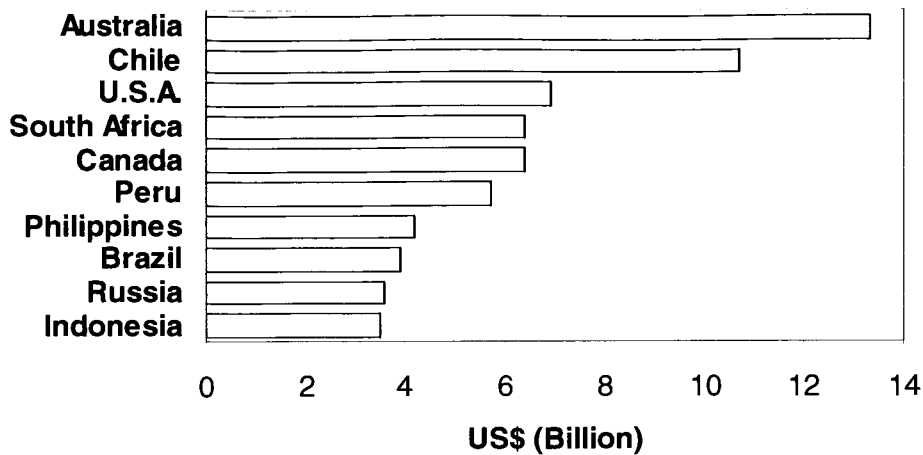
The mining EPCM industry provides engineering (E), procurement (P) and construction management (CM) services to the mining industry. Companies specializing in actual construction handle that aspect of EPCM firms' projects. The BU's differentiated expertise is most apparent in geology and mine planning work and feasibility studies but is also an important part of detailed engineering. Procurement, project management and construction management are part of actual project work where a mine or facility is actually going to be built, refurbished or retrofit with new equipment. Procurement deals with the purchase, inspection, logistics planning and transport of equipment and materials. Project and construction management deal with the management and control of the design work and on-site installation, respectively.

### **4.1 DOMINANT ECONOMIC CHARACTERISTICS**

#### ***4.1.1 Size of the Industry***

Global mining capital investment of US\$98 billion was planned in 2002 (Engineering and Mining Journal, 2004, para.1). Loosely translating this into the same amount of gross revenues for the engineering and construction industry, and allowing for about 3% annual growth (refer to Section 4.1.2 below), the amount was approximately US\$101 billion in 2003. This figure is for total installed project costs so it is difficult to ascertain exact numbers for the actual EPCM component. However, applying a rough rule of thumb that EPCM-related activity typically comprises about 6-10% of this figure, the range is about US\$6 billion to US\$10 billion for mining EPCM, worldwide. Generally, billing rates average US\$65 per hour, so it is estimated that between 92 million and 154 million hours of billable mining EPCM work were performed in 2003.

Figures 10 and 11 show how mining funding in 2002 was distributed between the world's countries having the highest levels of mining venture capital investment.



Data Source: Engineering & Mining Journal (2004)

Figure 10 2002 Worldwide Mining Investment Amongst Countries

Data Source: Engineering & Mining Journal (2004)

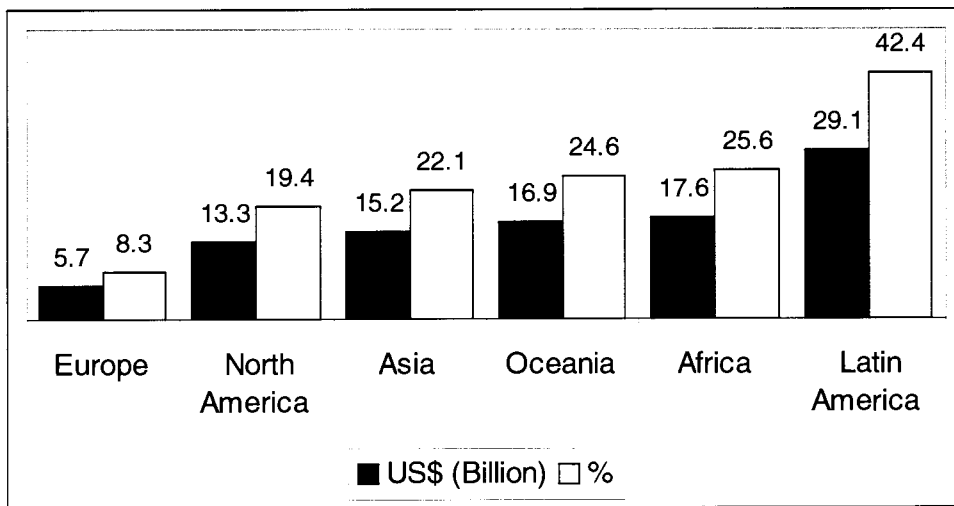


Figure 11 2002 Worldwide Mining Investment Amongst Regions

Mining-related EPC and EPCM work accounts for just 4.5% of overall revenues for each of Fluor, Bechtel, and the BU. Each is a global, multi-industry contender. Of course, mining EPCM work likely comprises a larger proportion of a smaller firm's work. Usually the bigger firms contend between themselves but there are situations where smaller 'niche' players are able to compete.

### ***4.1.2 Growth Rate***

According to U.S. Bureau of Labor statistics, the growth rate for management, scientific and technical consulting in the United States is expected to increase about 4.5% per year until 2012 (Berman, 2004, para. 8), while that for business and professional services is estimated at 2.7% per year (Berman, 2004, para. 4). Since mining EPCM consultants compete in a global market, this analysis can be extended to infer that the North American EPCM growth rate conservatively lays somewhere between 2.7% and 4.5%. It is realistic to estimate that the number for mining EPCM is at the lower end of the scale. That is because this industry represents a mature, somewhat commodity-driven, and competitive sector. Thus, the writer believes 3% to be a defensible figure.

### ***4.1.3 Geographic Scope***

The mining EPCM industry extends around the globe to service the development of mines that are found on every continent. Although mine sites are often located in remote regions, the planning and design work is usually performed in large urban centres. It is not uncommon for teams to consist of personnel from many countries, either because different parts of the EPCM's company are involved, or because it is allied with one or more international partners.

### ***4.1.4 Size and Number of Buyers and Sellers***

Mining companies constitute the majority of buyers for mining EPCM services. Other buyers include financial institutions requiring due diligence and expert third-party services as well as other EPCM firms that perform audit work. There are many hundreds of potential buyers for mining EPCM services but only few are truly qualified to initiate and complete the larger EPCM projects greater than US\$500 million. Likewise, sellers of EPCM services can be very small but the major mining companies are reluctant to use them as their primary consultant. Thus, there is perhaps only a handful of sellers worldwide capable of handling the larger jobs.

### ***4.1.5 Pace of Technological Change and Innovation***

The pace of technological change in the mining industry is fast. In recent years there have been, among others, new developments in oxygen pyrometallurgy, gold gravity separation circuit design, and SX/EW hydrometallurgy. While these innovations can improve project

economics, a new technology does not always apply to every situation and old methods and processes must still be used. More advanced computer applications and dynamic simulation improvements continue to enhance resource evaluation and process optimization.

#### ***4.1.6 Economies of Scale and Scope***

While scale economies play an important part in both multi-engineering discipline EPCM work that is performed by large teams and the large dollar value and volume discounts that associated equipment purchases can obtain, scale effects are not so important in the kind of work the BU performs in mining process development and design. This is because that work is highly differentiated and specialized. Individual specialists or small groups of process engineers apply their expertise to technical problems and create highly successful yet cost-effective solutions. As such, economies of scope come into play as they enrich the breadth of capability and address niche requirements.

#### ***4.1.7 Capital Requirements***

Significant capital is needed to compete with the larger EPCM firms as these companies have a global presence with dozens of offices to operate. Also, a high percentage of their employees are well-paid professionals. The capital structure needs to be relatively conservative in order to carry heavy risk appropriately and weather the business cycles. Ideally, EPCM companies have only modest levels of debt but plenty of cash and liquid securities on hand.

## **4.2 INDUSTRY ANALYSIS**

Porter's 'Five Forces' model (Porter, 1979, p. 6) is used to analyze the five main competitive forces that shape the mining EPCM industry's strategy. This model is relevant because it provides a useable framework for exploring five areas that contribute to the performance of an organisation. These include: rivalry among existing competitors, threat of entry, bargaining power of suppliers and customers, and threat of substitutes. The external environment around a firm is affected by the moves and strategies of its competitors and the model considers the changes in the general economy and other socio-cultural factors as they relate to a firm. Since risk-adjusted rates of return are not constant across the industry because competition is not perfect, this implies that anything that positively upsets the balance will

reward a firm with a competitive advantage over its rivals. Therefore, it is imperative that an organization carefully studies the opportunities and threats prevalent in its external environment, and knowing its strengths and weaknesses, crafts a strategy that will allow it to gain competitive advantage. A firm must understand and recognize competitors' trends and movements and learn how they work and affect the industry, as well as an individual entity. Refer to Figure 12 for a graphical representation of the analysis. A minus sign in the figure indicates the element decreases the impact of the competitive force and a plus sign increases it. Each element is described further in the following discussion.

The BU's main competitors are listed in the Table 10 Product/Competitor Matrix but suffice to say, there are roughly half a dozen competitors in each of the three categories that span geology and mine planning studies, feasibility studies and EPCM detailed engineering. These companies are international in origin and operate around the globe. General competitor profiles appeared in Section 3.

The basis of competition is one of differentiation with respect to mine planning and geology, and feasibility studies. It is primarily one of differentiation for detailed EPPM as well but it should be noted that when projects comprise hundreds of thousands of billable hours, the differentiation strategy sometimes gets negotiated to one of a cost-based model. A very few clients will award work only to the lowest priced bidder. Although it happens infrequently, clients may chisel EPCM service providers' prices throughout the life of a project, try to have extra services 'thrown in for free', refuse to sign change orders or withhold payment unless they get what they want. Recall, however, that differentiated process engineering provided by the BU comprises just a fraction of the overall detailed EPCM effort. Degeneration of the differentiation model for detailed EPCM work does not truly apply to the BU's portion and the high value of its contribution is generally recognized throughout the industry. Ultimately, operating in the middle of the generic strategy range is untenable, essentially because offering very high quality for a very low price is neither viable nor sustainable. The BU operates as a differentiated services provider.

#### ***4.2.1 Rivalry Among Existing Competitors***

The 'rivalry among existing competitors' is *high*. The general homogeneity of even highly specialized services, combined with low margins, volatile market cycles, the high degree of both horizontal and vertical integration required, high exit costs, low switching costs, consolidation and slow growth, all combine to increase rivalry. A firm's credibility and good

reputation, full project life cycle capability, plus the steep learning curve and diversification required to compete, round out the many factors that make rivalry among existing competitors so high.

Homogeneity of the highly specialized services offered exists between the major mining EPCM competitors in each of the three categories listed in Section 3. This tends to decrease rivalry between them because they need to differentiate themselves further in order to compete successfully. Firms do this by offering superior capability in certain niche areas. A single employee may have a particular interest or technique in a certain area. This is a short term benefit to be exploited but cannot be considered a sustainable competitive advantage because employees leave.

Overall, EPCM fees are approximately 6-10% of the total installed capital cost of a project and margins are about 7-10% of that. Larger EPC projects costing hundreds of millions of US dollars garner even lower profits of about 2-3%. Pre-feasibility, feasibility and due diligence work can earn up to 40% in margins but represent only a fraction of overall revenues. Low profitability characterizes the EPCM business. A competitor's ability to weather the financially difficult times becomes a differentiator particularly when weak market conditions prevail.

The mining EPCM industry follows the world economy in general, the LME in particular, and is dependent on senior and junior mining companies that tender work. Sometimes when a significant body of work, say the engineering and procurement responsibilities, is awarded to a firm, the construction management will be given to another. All else equal, this pattern repeats and those firms around for the long term will obtain their fair share of the work.

A high degree of both horizontal and vertical integration is needed with which to compete against the larger EPCM firms. Horizontal integration involves the breadth and depth of capability that includes multi-discipline engineering, project services, estimating, project and construction management and administrative support. Vertical integration involves a supply chain of equipment vendors, inspection services, and transportation logistics planners. It also can include services provided internally from other divisions of a company. Larger EPCM firms usually have a combination of vertically and horizontally integrated services. For instance, companies may draw upon another one of their own divisions to handle the freight and transportation of equipment it has purchased, or they can defer to their legal, finance and environmental regulatory groups for advice.



considerable if a company decides to exit the business. This is also an important issue as EPCM firms try to balance their ageing work forces by hiring younger talent and encourage older, more expensive staff to leave by offering generous severance packages. Closing offices can be expensive due to laying-off staff, settling rental leases and other administrative agreements, and dismantling an IT network system. Legal costs can be a significant additional expense. High exit costs can also stem from renegeing on contractual project commitments before a body of work is complete, resulting in severe legal and insurance implications. Certainly, a firm's reputation suffers damage and future opportunities to work with desirable clients are threatened. Severed major supplier relationships and the need to start over with new vendors also represent inefficiencies and increased costs.

Relatively low switching costs to change from one EPCM firm to another increases rivalry among competitors. While switching costs can include changing over to new computer software, training employees in new systems, and getting up to speed on previously conducted study work, there are few, large fixed costs to deal with. Although a client may award different parts of an EPCM contract to separate firms, it wants to avoid changing service providers mid-project, as it is costly, disruptive and makes shareholders wary. Finally, EPCM firms can enjoy greater synergies by partnering with one another. This entails setting overt rivalry aside and working together. Most competitors have done this in some fashion in order to leverage their own capabilities. Sometimes firms partner with one another to strategically shut out another player who might be vying for yet a larger, more lucrative contract. There are multiple risks that must be weighed carefully before entering into this kind of relationship.

The larger firms are relatively similar in size and capability and can compete more or less on an equal basis. The trend toward consolidation has increased rivalry between existing firms as competitors acquire smaller rivals and obtain in some cases, further niche expertise. Just the same, industry growth is modest when viewed over the long term.

Reputation is extremely important in building and maintaining trust in order for clients to return. This can be a significant barrier to entry for small or new firms. While perception or 'optics' plays an important part in portraying an image of stability, authority and competence to the market place, there must be real substance to back up that image. Investors, although they like to distribute risk, will not usually take chances when performing pre- and full feasibility work. The reputation of the EPCM firm who does up-front work is especially important to junior mining firms looking to secure financing or those more established companies who have more equity at stake. Ultimately, the quality of work is key to maintaining high credibility and an



excellent reputation. Engineering and business practices that produce high quality deliverables in a cost-effective manner add value during the design phase and this enhances a firm's reputation.

Full project life-cycle capability refers to the delivery of most if not all services required to develop the design from initial concept to final decommissioning. This includes the mine, processing facilities and tailings ponds, and possible site remediation.<sup>16</sup> It is competitively advantageous to be able to offer all these services to a client when it needs new and diverse help at different times. Obviously with EPCM, this does not include actual construction. However, the need to offer full project life cycle EPCM capability decreases the threat to entry as it eliminates those competitors who lack this particular capability for 'one-stop shopping'.

The conglomeration of engineering, procurement, construction management and mining knowledge as well as general project execution know-how is a function of the learning curve. Large EPCM firms act, or should act, like a well-oiled machine. They are highly complex with a rich and varied human resource base. The experience gleaned from every new project must be taken as a 'lesson learned' to continuously improve work practices and produce better services. All disciplines and roles are interwoven and in the best scenario, there is a constant and fruitful exchange of technical and execution knowledge between groups. Those firms that devote significant resources to training and developing their employees while fostering an open knowledge environment gain an edge over those who do not. This decreases the threat of entry as innovation has a better chance of flourishing in most open environments. Therefore, any effort to disseminate knowledge internally 'raises the bar' and tends to increase entry barriers.

The ability to add value through applied technological excellence, coupled with superior implementation, separates the average firms from those that lead the pack. Technical process innovation is important in developing economical metal extraction results and is discussed in Sections 5.2 and 6.1.2. Bankable<sup>17</sup> feasibility studies are relied upon to help gain investor confidence and obtain project financing.

#### ***4.2.2 Threat of Entry***

The 'threat of entry' is *low* due to high entry barriers. These include the volatile nature of the mining business itself, the high levels of differentiated capability and specialized knowledge

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<sup>16</sup> 'Remediation' refers to mine site cleanup practices that removes toxic waste and materials and leaves the site in its former environmental state.

required, extensive degree of geographic coverage, significant scale effects and relatively high exit cost levels that competitors must meet or overcome to contend in the mining EPCM industry on a global scale.

Natural resource industries are cyclical in nature and metal and mineral prices follow suit. There is typically a three to six month time lag between rising metal prices and the award of studies and projects. Most EPCM firms are consultants and employ only a small core staff. Contingent labour is hired to handle the peak requirements. Thus, there is a natural ebb and flow to the business. In addition, progressively more rigorous environmental permitting hurdles as well as greater consideration of aboriginal peoples' land rights in mining areas being developed, add further uncertainty and often delays to project time lines.

High levels of differentiation tend to deter entry. A key differentiator between firms is the ability to manage risk. Those that can balance the myriad technical, procurement, project execution and construction management pieces with a positive cash flow and minimal deviations from budget or schedule, add value for their clients by keeping risk in check. Larger firms can more easily satisfy risk aversion tendencies that many mining company customers have. This is because they have the depth and breadth of capability, solid financial footing and experience necessary to relieve clients' concerns.

In the case of EPCM work, there are many steps at which certain risks prevail. Ore reserve assessments and metallurgical processing feasibility studies are performed early on in the development of an ore body. These findings form the foundation upon which companies obtain financing allowing the project to proceed to the next level. It is crucial that analyses are accurate and thorough, as carrying misinformation, errors or omissions through to the next phases is costly. Technical experts are often engaged to assess mineral deposits accurately, assess extensive laboratory tests to identify exact processing requirements and apply suitable engineering design technology in the pre-feasibility stages.

The ability to either offer, or help to arrange financing and assist certain clients with obtaining the guarantees and underwriting they require, is key in the EPCM industry. In the EPCM business, this is required when metal deposits are being assessed and valued. Great liabilities are involved if the incorrect metal processing technology is selected during feasibility studies. During the engineering phase, the emphasis shifts to equipment ordering. Certain equipment can be enormously expensive and have rigorous performance criteria to meet during

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<sup>17</sup> 'Bankable' refers to feasibility study work or basic engineering compete enough for a bank to consider financing construction. Bankable studies are typically based on a +/-10% capital cost estimate.

start-up that are tied to payments. For example, electrowinning cathode stripping machines can cost US \$3-4 million each and primary crushers US\$2 million apiece. Careful cash flow planning and hedging funds against future foreign currency exchange rate fluctuations can help mitigate risk but this takes careful planning and foresight.

Size, geographic coverage by the firm, and breadth of capability are important factors affecting threat of entry by competitors.

Extensive geographic coverage is a barrier to entry. In order to compete and serve clients around the world, EPCM firms need to have project offices on every continent. They need to be represented in the major mining centres that are the source for significant pools of technical and managerial talent, as well as financial resources. Smaller regional offices in smaller centres or near remote project locations can advise project teams on local customs. They can act as language translators, make complicated transportation arrangements and co-ordinate meetings with local officials. Establishing and maintaining a large network of offices is expensive.

In order to compete on a global basis, EPCM firms need to be large enough to manage risk appropriately and have access to financial markets. Larger scale means that the firm owns and operates its own cost effective supply network. For mining EPCM, this includes the full complement of engineering capability, administrative assistance, estimating, procurement, project controls, project management, construction management and all ancillary administrative support services. Offering such a wide range of services mean that risk is distributed across the value chain and does not preferentially burden any one area. For example, if an EPCM firm cannot offer funding assistance to clients because it is too small to have investors interested in the results of its due diligence reports, then it cannot compete.

EPCM firms must be able to attract and retain competent core staff, as well establish and maintain a reputation for success in most, if not all, aspects of their business. Talented engineers, technical specialists, and project and construction managers are attracted to successful companies with a solid track record that can offer interesting, challenging and well-compensated employment. Smaller firms are disadvantaged, as they likely will not be able to win the bigger projects nor pay well enough to attract the best talent. They may be forced to take on riskier work and that does not entice many employees. Most investors tend to be risk averse and subsequently, small 'mom and pop' operations cannot contend in this market.

Diversification increases rivalry. Firms that offer a full range of services and have a variety of projects and studies underway at any given time are stronger and therefore better positioned for success and longevity.

### ***4.2.3 Bargaining Power of Suppliers***

Suppliers include equipment vendors, labour, and associated service providers in both the horizontal and the upstream vertical supply chain. The ‘bargaining power of suppliers’ is *moderate* as both labour and equipment vendors – alone and through their supply chains – can extract higher compensation when the market is strong, and vice versa.

During a strong market, equipment vendors will prioritise the clients they serve depending on the strength of the market. Of course, key supplier relationships offer some protection for both parties but in general, vendors will accept large profitable orders and schedule precious shop time accordingly. This is a situation where the big EPCM firms definitely have clout over smaller competitors. Capital cost aside, the impact on a critical path schedule can be huge if a key piece of equipment gets bumped from its production schedule. For example, some projects in Alaska rely on a winter ‘ice road’ that is open just a few months of the year. If production is delayed and the window missed, the equipment will have to sit in storage for twelve months until the road reopens.

During a weak market, equipment vendors will lower their prices to entice customers to buy. Likewise, EPCM firms will lower their labour rates so as to be able to bid more competitively. When that tactic is not sufficient to manage costs, EPCM firms will lay off staff. Usually the contingent workforce is let go first, then the regular employees. Every effort is made to retain technical experts, project managers and construction managers as together they form a core competency of process technology and project execution expertise.

Engineering talent goes where the work is. In Canada during the late –‘90s there was a strong migration to Calgary and the oil sands sites further north in Fort McMurray, Alberta. Salary uplifts and site allowances were generous and the work often challenging. Such a shift of workers depletes the supply in some areas and increases local demand, thus increasing the power of these suppliers to the EPCM industry. Areas of labour (supplier) concentration have been a characteristic of the industry.

Employees supply their services to the EPCM firms. During a weak market, there is increased price competition as firms lower their consulting fees in order to stay afloat but employees cannot expect to obtain top dollar. Associated with this, the period from mid-2001 to mid-2003 was particularly slow in North America and mining EPCM firms were forced to let go up to half of their general engineering staff. Core personnel such as those in the BU were for the

most part retained but many were under-employed, thereby reducing efficiencies. What little work that did appear was won through fierce bidding and cutting margins to almost nothing.

With the increasing age of 'baby boomers', a shortfall of senior technical staff is anticipated throughout the next 5 to 15 years. Spots that mid-career 40 year olds would occupy are now vacant as those engineers who could not get jobs in the mid-1980s left the profession to do something else. More recently, the IT technology boom of the late 1990s attracted many professionals to its ranks who might otherwise have entered the mining field. Although the ensuing technology bust left many computer engineers unemployed, they have not gravitated to the mining or EPCM fields in any great numbers. Significant gaps in the intermediate mining EPCM ranks are now apparent and a resource shortage is becoming critical. Those who do decide to enter the industry will have high bargaining power. This is described further in Section 4.5.2.

#### ***4.2.4 Bargaining Power of Customers***

The BU's customers are equipment vendors and the horizontally and vertically integrated service providers in the PC's organization. The 'bargaining power of customers' is *moderate* and depends on whether the market is currently strong or weak. The arguments are much the same as those for 'suppliers', but reversed.

During a weak market, price competition increases as firms lower their consulting fees in order to remain solvent. When customers award work during a weak market, there seems to be a sense of entitlement attached and an expectation that the service supplier will supply even greater quality at the same price than would be otherwise normal. Project managers and construction managers need to carefully manage their clients to educate them about the real value being produced and avoid injuring the relationships.

Feasibility studies are usually awarded during a weak market. Clients employ a staggered approach when balancing developmental studies with capital project work, as it is prudent to balance cash flows. It may also be easier to procure top technical personnel during slow times before they get busy again on longer EPCM projects and are not available for those extended periods. Finally, clients realise that unless they want to vertically integrate themselves and maintain expensive in-house engineering groups, it makes sense to keep the EPCM firms as busy as possible to ensure a strong and ever-available resource.

The reasons why there is increased competition for talent are the opposite of the argument given in Section 4.2.3. Similarly, EPCM firms become more selective in their work and

have more bargaining power when the market is strong. They can afford to be choosy and will turn down riskier work that they might do under different circumstances. Similarly, customers seem to be less price-sensitive during a strong market. There is little threat of backward integration whereby mining companies will choose to perform their own engineering as many have divested themselves of this activity over the past couple of decades, preferring to outsource it to mining EPCM firms.

#### **4.2.5 Threat of Substitutes**

The ‘threat of substitute<sup>18</sup> products and services’ is *low*. It is true that out-sourced commodity engineering does challenge the traditional in-house means but currently is not seen to be a substantial threat as most process engineering and project management skills are differentiated and are not easy to duplicate.

Specialized technical experts are integral to performing feasibility work that wins the detail engineering and construction management portions of a job. While junior staff can run design simulations and model new extraction processes by using sophisticated computer technology, there is no substitute for experienced process knowledge.

There is only a low threat that a client might substitute an EPC firm’s services for those of an EPCM firm. This is mainly because clients often award construction to an EPC contractor and the EPCM portion of the work to one or more other firms. Large EPCM companies have the breadth and depth of scope to be able to offer all the same EPCM services to their clients that the EPC firms do. Additionally, there is significant value in ‘one-stop shopping’ that an all-inclusive firm can provide and clients are aware that they can save costs by using one EPCM firm.

### **4.3 INDUSTRY KEY SUCCESS FACTORS**

Strategically necessary key success factors for *mining EPCM providers* over the long term include: (1) accurately identifying and mitigating risk, (2) solving complex technical and management challenges with innovative and cost-effective solutions, (3) meeting or exceeding

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<sup>18</sup> ‘Substitute’ as used in Porter’s context is not to be confused with an economist’s definition. That refers to the demand for a service or product being affected by the price change due to a substitute. Instead, it is the ‘price elasticity’ of a product or service that is affected by the substitute. Customers have more alternatives when there are more substitutes. This in turn increases the ‘elasticity’ of demand.

budget and schedule expectations, and (4) building repeat business with key clients. Strategic strength key success factors involve: (5) how well firms can ride out prolonged business down-cycles and adapt to the ever-changing competitive environment.

Accurate and thorough risk identification and mitigation (1) at every step of the EPCM or EPC process are essential to managing the business successfully. The ability to consistently accomplish this is a key differentiator as a poor choice of project or client, unforeseen technical problems, or any other kind of upset, can have disastrous financial consequences. Fluor is still reeling from its technical dispute with Anaconda Operations Pty. Ltd. over the Murrin Murrin nickel cobalt facility in Western Australia. Anaconda had contracted Fluor in 1997 to perform the EPC work for US\$680 million. Major technical problems ensued. Fluor finally settled with the owner in early May 2004, agreeing to pay them US\$123 million (Find Law, 2004, p.1).

This scenario highlights the need to be able to solve complex technical and management challenges (2), which apparently was not satisfied in Fluor's case on the Murrin Murrin job. Sometimes the mix of technical capability, management and leadership is inadequate or somehow not right in certain situations to avoid failure. There may be times when a tried and true solution provides the best risk-adjusted decision for a given situation, even though it lacks innovation. It may not be particularly cost-effective in the short term but an experienced project manager can confidently forecast future operating cost savings. This kind of expertise contributes to a firm's overall ability to successfully differentiate itself in performing cost-effective project execution.

Meeting budget and schedule goals is a key success factor (3) and a basic expectation of clients. Under-running budgets and beating schedules is not unheard of but is certainly unusual. This is true particularly on large EPCM projects, whose complexity makes this a challenge. Firms do not want to get a reputation as a service provider that cannot be relied upon to deliver.

Building repeat business with customers (4) is essential in winning EPCM work. Personal relationships, as well as high visibility of those relationships in the marketplace, are also important to gain a 'place at the table' and win work.

Key success factors change but important near term strategic strengths that help determine how well firms cope with the industry's volatility will be the ability to manage knowledge and implement a staff succession plan, as well as achieve an optimal mix of regular full time and contingent personnel on contract. The BU cannot afford to carry staff on overhead for very long during down periods and any arrangement that alleviates the situation will help. The challenge will be to find a way to encourage loyalty from highly valued contract personnel.

## 4.4 ATTRACTIVENESS OF THE INDUSTRY

At the beginning of 2Q 2004, the mining EPCM services industry was quite attractive for those already competing in it. Although there was intense competitive rivalry, established participants were well positioned to take advantage of a sizzling metals market and there was a backlog of work. The industry just started to come out of a six-year slump that started mid-1997. Normally, two full cycles would occur during this period. There appeared to be a significant increase in all facets of EPCM work that was expected to last for at least the next two years. This was due to increased demand for many key metals such as gold, copper and diamonds, higher LME metal prices, and investors' willingness to support the large mining companies in developing deposits and forging ahead with previously mothballed projects. There was also confidence in the junior firms who as yet do not own operating mines but are developing what appear to be attractive deposits. They needed expert technical help in producing bankable feasibility studies in order to obtain financing.

EPCM mining sector work will continue to be awarded in the short term but this buoyancy is moderated by the incessant volatility associated with the business. The longer term prospects for mining EPCM firms are uncertain and overall attractiveness is rated as moderate. Relatively low margins and high entry barriers such as the significant Minimum Effective Scale (MES) required to competitively undertake large EPCM projects will discourage new entrants.

Large engineering services companies have acquired many small to mid-sized EPCM firms over the past few years. Such consolidation will ultimately force smaller firms out of business, as they will not be able to offer the broad and deep services integration of the bigger players. The same is true for the mining companies as described by Placer Dome's CEO, Jay Taylor, at a Vancouver Board of Trade luncheon speech, May 19, 2004<sup>19</sup>.

Normal business cycle fluctuations greatly affect the mining industry and in turn the EPCM service providers. Despite periodic stockpiling and hoarding of various metals and minerals – diamonds, silver and copper are examples from the past decade – the world's need for these resources will continue to grow. The mining industry will remain relatively unpredictable and world economies will continue to fluctuate. Large, diverse mining EPCM firms that can best anticipate and meet the needs of the mining companies through superior risk management capability, will be successful in this challenging and competitive market place.

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<sup>19</sup> Entitled "Globalization's Impact on Mining: from many small players to fewer large producers"



## **4.5 KEY ISSUES FACING THE INDUSTRY**

### ***4.5.1 Mining Industry***

At the end of 2003, the mining and metals industry faces many challenges. The key issues are: (1) over-capacity in the industry, (2) availability of alternative products, (3) the fragmented and protected nature of the industry, (4) more stringent environmental regulations, (5) low levels of industry growth, and (6) high capital costs. The findings in a Pricewaterhouse Coopers study (Pricewaterhouse Coopers, 2004, para. 2) are consistent with this paper's analysis.

Although the world might be experiencing an over-capacity as referred to in (1) in selected metals, the condition is dynamic and at the end of 2003, key indicators for base metals were all trending upward, so the need for metals will continue to grow. With respect to availability of alternative products (2), there are many substitutes for metals as described throughout Section 2.4 and future technological advancements will increase this number. They are a relatively small but growing threat to the mining industry.

The roles of the government in developing countries where many mining properties are located (3) are generally both as an owner and a regulator. This is a conflict of interest situation and can create issues as the state attempts to maximize its position in relation to the risk-reward balance. Access to resources is often restricted for foreigners and creates additional difficulties in permitting. This fragments the mine development process. Security of tenure varies greatly around the world with sound systems in some countries and poor systems or poor application of reliable systems in others. Full commercial freedom is usually restricted to nationals and constraints on shareholding limits, limited foreign exchange exposure management opportunities, and a lack of available, genuine domestic risk capital, greatly complicates business for foreigners.

The tenuous economics of some developing countries mean that the financial constraints imposed by the host country government on multinationals are usually significant. This is because both profit based taxes and product based tax are payable fixed costs regardless of profitability. For example, in late May, 2004, the Peruvian government announced a 3% royalty on foreign-owned mining operations in Peru. This still has to be ratified by government. Barrick, Placer Dome and Newmont will all experience an adverse impact on the profitability of their gold and copper operations in that country and this royalty will create an additional barrier to entry. In early June 2004, Chile announced a similar tax. But it is not just the governments of

developing nations that are protectionist. The U.S. charges tariffs of between 8 to 30% on different types of imported steel (Cox, 2002, para. 2). China, now the world's largest importer of steel, retaliated in early 2004 with tariffs of up to 55% on cold-rolled steel imports (Chyen Yee, Forbes, 2004, para. 10).

With respect to more stringent environmental regulations (4), the often-imprecise environmental laws in third world countries create additional challenges due to a misunderstanding of what is involved with exploration and because different values of many foreign companies often are substantially different from those of specific local communities. The ever-increasing environmental protection steps required to develop, build, and operate mines and processing facilities, increases costs enormously. This effectively strikes some players from the industry, as they are not large enough or have deep enough pockets to compete.

Low levels of industry growth (5) are tied to the inherent volatility of this sector, fluctuating currency exchange rates, investor wariness and the general slump in the world's economy over the last few years. Finally, it is very true that enormous capital investment (6), coupled with high operating and maintenance costs, present significant hurdles to mine owners in their effort to create shareholder value. Moreover, mining companies must decide whether to concentrate on one metal or on several, taking into consideration the growth prospects for each. They must figure out how to structure the raw material value chain to achieve desired results and truly increase value. How far down the value chain they should venture must also be ascertained. Mines and processing facilities are not always located in easily accessible or ideal locations, thereby inhibiting development, distribution and supply. In 2003 a lot of older infrastructure requires increasing levels of maintenance and retrofitting just to maintain the status quo, let alone increase output. This adds to the overall cost of the end product.

A number of mining companies have divested their engineering groups over the past few years and now they outsource them from EPCM services suppliers such as the BU. Most large mining and metals firms that are publicly traded often become targets for consolidation and must plan strategically to protect themselves from being acquired, sold off, or disbanded altogether.

#### ***4.5.2 EPCM Services Suppliers***

The key issues facing EPCM services suppliers are: (1) 'lumpiness' of the business, (2) rapidly changing workforce demographics, and (3) steadily increasing project development costs.

The lumpy nature of the business referred to in (1) chronically plagues services suppliers as a 'feast or famine' scenario often results where work comes along in waves. These cycles are not too difficult to predict because contract awards tend to lag a few months behind metals industry upward trends. However, there are many other variables that can and often do come into play such as financing problems, permitting delays, labour strikes, political unrest, public uneasiness or dissatisfaction with local mine development plans, and even outright criminal activity. Recall the Bre-X Minerals scandal in 1997 where it was discovered that mine core samples had been tampered with and the quantity and grade of gold vastly exaggerated. Major macro-environmental trends are discussed further in Sections 5.1 through 5.5.

The workforce demographics issue in (2) refers to ageing of the present workforce and the increasing scarcity of qualified, experienced engineers and other professional personnel. Once World War II ended, there was a huge industrial escalation with plenty of work for all who wanted to help rebuild the world's infrastructure and advance the standard of living of both developed and developing nations. The 'baby boom' generation born from the mid-1940s to late 1950s was generally well educated (certainly in North America), and they continued in their parents' footsteps developing new technologies while at the same time, growing old industries. The mining and EPCM services industries were no exception. Senior workers in the mining and EPCM services industries are near to retirement. Few mid-career staff are available to fill their spots. During the early 1980s, the severe economic downturn forced many new graduates who could not get a job in their chosen field to leave their professions and change direction. Also, many experienced employees were let go, and never again rehired in their field. Adding to the staffing problem was the 'tech boom' of the early 1990s that enticed many young people into computer science programs to the detriment of others such as electrical engineering, geology, and mining. All these specialities are necessary for mining EPCM work. The result was a shortage of junior to intermediate engineers in today's North American mining EPCM firms. While the quality of present staff is high, there is real concern this will decline over the next few years as the supply of 'good' workers dwindles and firms are forced to perhaps settle for mediocre replacements.

Project costs are rising steadily as noted above in (3) and are discussed again in Section 7. There is increased emphasis on reducing capital, engineering and operating costs. Firms like the BU must put pressure on equipment vendors to provide further value. They can work together to 'modularize' equipment in the shop so as to avoid higher installation costs onsite. They can also ensure that engineers do not over-design equipment and plants, keeping the initial capital

investment as low as possible. For instance, building a facility that will stand for 50 years when the mine life is only ten is a waste of resources and capital. There are ways to design for maximum operational efficiency and reduced maintenance but it takes planning. Finally, comprehensive safety management systems are needed for large EPCM jobs and they are expensive to administer.

## **4.6 SUMMARY**

The dominant economic characteristics of the mining EPCM industry all intensify market rivalry. The industry analysis performed confirmed this and also indicated high barriers to entry and moderate bargaining power of suppliers and customers. While the industry is attractive to existing competitors, it may not be so attractive to those contemplating entry.

The key success factors for EPCM services providers follow the needs of the mining industry very closely. EPCM firms must be able to manage risk, keep abreast of technological innovation and know how to apply it, as well as execute projects safely, efficiently and effectively.

EPCM firms need to be able to manage their way through volatile business cycles, attract and retain key personnel during periods of rapid demographic change, and find ways to improve not only their own operational efficiency, but to also to reduce EPCM capital and operating costs for their clients.

## **5 MACRO-ENVIRONMENTAL TRENDS**

Section 5 examines macro-environmental trends representing some of the factors that influence the mining industry as opposed to the actual EPCM industry. Subsequent implications for EPCM work translate into specific opportunities and threats. How these in turn affect the BU's strategy, are examined in Section 6.

### **5.1 ECONOMIC FACTORS**

The dominant economic characteristics introduced in Section 4.1 are augmented here with further discussion about key economic issues facing the industry. Global prices for metals such as copper, nickel, zinc, lead, silver and gold have been rising dramatically. Steel prices have recently risen as well and some experts believe the trend will continue. Metal prices tend to fluctuate with the global business cycle. In the past ten years, business cycles peaked in 1994-96 and 1999-2000. Worldwide economic slowdowns followed, occurring in 1997-98 and 2001. The North American economy is still slowly recovering from the 2001 recession. Metal prices have paralleled these fluctuations quite closely and it is expected that prices will continue to rise through 2004. It remains to be seen how high they will go but the risk and volatility associated with the industry are readily apparent and continually pose a threat to the BU's business.

Many metals have seen huge increases from the lows experienced in 2001. Nickel prices have tripled, copper has doubled, zinc has risen by 40% and aluminium by 30% (London Metals Exchange, 2004). However, only nickel has risen above its mid-1990s cyclical high to date, and the others are still below those peaks. Metal prices have generally not kept pace with overall inflation for at least the past century, and each cyclical peak has usually been below the previous one, after adjusting for inflation. According to popular thought, there are three main reasons for this. First, the proportion of services in the economy increases as global wealth increases and these services use fewer natural resources such as metals to produce than do manufactured goods. Second, exploration, mining and refining efficiency have improved over time and through competition these benefits have been passed on to consumers by way of improved products and lowered prices. Third, when a commodity becomes too pricey, there is often a technological solution, operational fix or substitute that will reduce costs. Consequently, commodity prices have been declining relative to overall metal prices for the last century (Export Development Corporation, 2004, para. 2). The above factors continue to challenge the viability of the mining EPCM industry.

Industry capital expenditure in the medium term is expected to be greater than 5% (GS, 2003, p.13). For example, major mining companies BHP and Inco were expected to increase their 2003 spending by US\$1.5 billion and US\$680 million, respectively. Barrick is planning to spend US\$2 billion until 2006, or 20% year over year starting in 2003. Diamond mining continues to grow at 6-8%. De Beers leads the industry with three major projects in various stages of implementation. Mining companies raised over US\$3 billion in 2003. This is good news for EPCM firms such as the BU who depend on the mining firms for work.

Today, China's growing demand for goods is quoted as the main reason to expect world metal prices to soar in the next few years. It is possible that China's consumer growth explosion will result in an extended period of higher than average prices, perhaps around 1996 peak levels. Also, the bullish outlook for the world economy will almost certainly improve prices for many metal prices. However, in a non-inflationary environment where new mines and new technologies are regularly being developed, there will be a limit to how high metal prices can go but no-one can predict what this will be. This uncertainty poses a threat to firms like the BU.

There are two issues that span both economic and political arenas. First, the market often must contend with interference due to protectionism afforded by subsidies and tariffs. For example, beginning in May 2004, the Peruvian government tabled legislation that once ratified, will impose a 3% royalty on foreigners doing mining business in its country. Another factor that artificially skews the metals market is metal and minerals stockpiling. Diamonds were hoarded by the former USSR, both silver and gold have been stockpiled by many developing nations, and the Chinese have been amassing steel since 2003 to ensure a supply for their burgeoning infrastructure needs.

The second economic/political issue has to do with government ownership of mining properties. This is where the state, as a majority shareholder, has the upper hand with respect to vetoing a prospective takeover bid; this artificially slants the market. An example is the recent struggle between Newmont, Barrick, AngloGold, Rangold and others to buy Ashanti Goldfields, whose major shareholder is the Ghanaian government ("Big game", 2003, p. 57). Mining pumps huge revenues into many African nations and control of such significant resources is fervently sought after. Although the Rangold bid was the most lucrative, the Ghanaian government was apparently swayed more by AngloGold's offer to merge as it held additional appeal as a vehicle to enhance African economic integration aside from generating revenues. After the purchase in late April 2004, 'Ashanti Anglogold' became the world's largest gold producer.

## **5.2 TECHNOLOGICAL FACTORS**

Advances in technology offer new ways to explore for and access ore deposits, process the metals and minerals, treat water, air emissions and tailings, and reclaim mine sites. Technological change can often make some areas previously considered uneconomic, become worthy of reappraisal and further development. Extending the life of a mine by using different technological methods that might have once been previously uneconomic, depends on a number of factors. These include the state of the economy at the time of the investment, the cost of financing, and the efficiency and cost-effectiveness of the new process.

Significant exploration trends and developments in 2003 included a number of advances in airborne magnetic and electromagnetic surveying, but particularly in airborne gravity geophysical surveying. Mining companies that keep abreast of these developments and employ them appropriately stand to increase the efficiency of their exploration efforts.

Some of mining's technological development centres around scale – harnessing increasingly larger mine haul trucks, crushers, longer overland conveyors and the like – to move ore from either underground or open pit mines to processing facilities. Other developments focus on improved computer applications and the use of specialized dynamic simulation software.

Refer to Section 6.1.2 for further discussion of technical process innovations in mineral processing. The trend in this area is to continue developing technologies that increase efficiencies, reduce costs and protect the environment, in order to achieve a sustainable cost advantage. Many technologies that work well in a pilot plant or laboratory may be difficult to fully commercialize. Until there is economic impetus to do so, the final development work does not proceed. Junior companies that may be trying to develop a new technology around a single metal will find it tough to compete with large world-class mining firms running their own R&D testing. The risk is diluted in a large firm, while it can be overwhelming for the very small company.

## **5.3 SOCIOLOGICAL FACTORS**

Mine sites are found in usually remote locations around the globe in first world nations as well as third world and developing countries. Many of the latter are extremely impoverished, with limited skilled local labour, low literacy and educational levels, inadequate infrastructure, and poorly developed and enforced environmental and building regulations. Third world countries like Madagascar and Burkina Faso in Africa, and the islands of Irian Jaya and Sulawesi

in Indonesia, have phenomenal mineral resources but rely on external investment and expertise to develop them. There are plenty of investors and mining companies willing to work in these, and other depressed countries, but the cost of doing business and the associated risks are very high.

Usually with mining projects, foreign nationals manage resident labour to build a mine as the required expertise and know-how is typically not available locally. This approach is not likely to change until these countries are able to raise their levels of education and produce trained workers and managers. This is good news for the BU as it already has a wealth of experience using ex-patriot managers to lead foreign local project teams. This type of scenario will not likely be challenged for many years to come, as progress will be slow in most impoverished countries.

A small number of banks have adopted the Equator Principles, which are a set of guidelines encouraging better management of environmental and social issues in project finance. Projects are screened using a gradient system that identifies whether they are high, medium or low risk. Factors to be taken into account include development and use of renewable natural resources, how carefully human health and safety are considered, respect for cultural characteristics, consideration of endangered species and sensitive ecosystems, the use of hazardous or toxic substances, assessment of land acquisition and usage practices, the involuntary resettlement of peoples and the impact on indigenous communities, efficiency of production, and the development and incorporation of energy and pollution prevention measures (Euroweek, 2003, p.1). It remains to be seen how widely accepted these Principles become and whether or not they indeed do encourage socially enlightened project financing procedures.

An apparent trend toward choosing to respect the rights of aboriginal peoples, honouring archaeological burial sites, and preserving local communities' ways of living, has been bolstered by many countries' associated regulatory policy and legislation in recent years. On the other hand, dealing with the confrontation and delays that public hearings and information sessions may produce will continue to be a challenge for mine owners. Intervention by outside groups can severely affect project schedules to the point of making the projects uneconomic, if not end them altogether. Finally, many large mining EPCM firms incorporate design and operational practices demanded in first world locales even when their work is being done in third world countries where the regulations may be somewhat relaxed or higher standards not mandated by law.



## 5.4 ENVIRONMENTAL FACTORS

Trends in the mining industry are shaped in many instances by environmental concerns and associated pollution abatement legislation. There is increasing respect on the parts of the mining companies, governments, and society in general regarding how the environment is treated and how its health can be sustained. This is reflected in improved design and operation of mines and facilities. While it is important that the environment be respected in order to create sustainability and enhanced quality of life for all, a drawback is that it is expensive to implement. Permitting can take years and cost of millions of dollars to satisfy local, national and international bodies and project stakeholders. Environmental impact assessments also must be conducted once the project is underway and can be extremely expensive. A project runs the risk that as yet unforeseen problems will be uncovered and the project stopped altogether.

Mining can be a very dirty business due to its heavy use of diesel for equipment and trucks, its wear and tear on the land itself, acidic and heavy element discharge, noise pollution and potential air and water contamination. It places a significant burden on natural ecosystems, flora and fauna, and the air and water. Increasingly stringent regulations in many countries dictate that mine water and air quality not only be regularly monitored during mine operation but that the water and air systems must initially be designed to mitigate against pollution. This is not a new concept but requirements continue to tighten. With commitment and planning, many of the negative effects that mining causes can be alleviated through proper mine design and process plant design.

In December 1997, over 180 countries signed the Kyoto Protocol in Kyoto, Japan (Environment Canada, 2004, para.2). Kyoto is an extension of the United Nations' commitment called the 'Framework Convention on Climate Change'. It obligates 38 industrialized countries to lower their harmful greenhouse gas emissions such as carbon dioxide, between 2008 and 2012, to levels that are 5.2% below those measured in 1990. This means a transition to a 'lower carbon' future that will affect how the mining industry operates, at least in the member countries. Energy consumption in Canada for metals mining decreased 22% between 1990 and 2000; energy intensity<sup>20</sup> decreased 20%; green house gas emissions decreased 19%, and green house gas intensity decreased 18.5% (Paszkowski, 2003, pp.6, 10, 16). This is very significant progress but the end goal is still challenging. The plan is to reduce the emissions intensity (tonnes of CO<sub>2</sub> produced per tonne of ore) by 2010 to 0.6, or 40% from 1990 levels. The mining industry is

energy-intensive and will need to exploit technological innovation in order to meet its allocated total emissions target of 55 million tonnes in Canada alone. The BU is well positioned to offer specialized services in this area.

There are two American bodies that lead not only North America but others in the world in setting safety and environmental guidelines: California's Occupational Safety and Health Administration (OSHA) and the federal Environmental Protection Agency (EPA). OSHA has arguably the toughest set of industrial workplace rules in all of the United States and sets a high standard for the rest of the world. California requires most new industrial development to be critically studied through a Hazard and Operational Study (HAZOPS™) procedure before being built and operated. The actual technique was developed by the British firm Imperial Chemical Industries Plc. (ICI) in the late-1950s but has experienced particularly far-reaching acceptance and implementation in California. Most states and many other countries have followed suit, choosing to employ this, or similar hazard identification procedures, in their work. HAZOPS™ analysis identifies modes of plant safety and operation that deviate from the anticipated norm, thus allowing engineers to redesign a safer and more operable solution before construction is complete. The BU has incorporated HAZOPS™ into its general design practices and has many years of experience leading these studies for clients. There is an opportunity for the BU to grow this business further.

The EPA was formed in 1970 to protect human health and the environment. It creates environmental policy and enforces strict environmental laws within the United States. Although the Kyoto Protocol's content serves as an environmental framework for many other nations, it must be noted that the United States did not ratify the legislation. The reasons are outside the scope of this paper. However, not having the most powerful nation, and in some ways, one of the most environmentally progressive countries on earth endorse the proceedings, was a setback to the environmental movement.

Finally, and integral to safe mining operation, the Mine Safety and Health Administration (MSHA), which is part of the United States Department of Labor, sets out regulations and guidelines for the safe design and operation of mining facilities, as well as safe labour practices, within the United States. Much of its content has been adopted in other countries.

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<sup>20</sup> 'Energy intensity' refers to the how efficiently energy is employed; less intense requirements for the same result infer that a process has become more energy-efficient.

## 5.5 POLITICAL FACTORS

There is a very slow trend toward more socially equitable, environmentally conscious and more responsible mining practices in the developing world. In first-world nations, the political focus appears to be on managing environmental issues while poorer countries seem to be concentrating more on achieving economic gains.

In the developed world, instability and oppression are *not* the norm. The mining industry operates like any other business within the realm of law, ethical business practices, and what the civilized world generally accepts as rules of fair competition. However, much of the world does not enjoy high standards of personal safety and healthcare, equal access to fair legal representation (let alone an honest judiciary), freedom of speech and movement, or the right to observe certain religious and political beliefs and practices. There may be open crookedness and corruption, bribery, onerous taxation and currency fluctuation, and sometimes, outright war. Many of these countries however, do have substantial metals reserves and many trans-national mining firms operate within their borders because despite the enormous risks, it is still lucrative to do so.

Operating in a politically regressive country requires that a company adopt an appropriate strategy to match the business environment. Large projects take time to evaluate, develop and attract political interest. Firms must adopt what is likely a slower pace than they would like.

Mineral producing countries not bound by the Kyoto Protocol might not have set environmental emissions limits. Some mine owners operate responsibly while others exploit the countries' mineral and metal resources without including the many, often costly, checks and balances that produce an efficient, relatively clean, and safe facility. Until governments institute laws that require both local and international mining companies to design, build and operate mining facilities to a higher standard, some owners may continue to operate in an irresponsible fashion. It must be noted that many of the large EPCM firms do design mines and facilities to North American standards, no matter where they are located around the globe. This may be more of a reputation-maintaining strategy than one of short term financial gain.

Africa is blessed with a massive amount of mineral resources but much of the continent is plagued with HIV and AIDS. This is an enormous political challenge to deal with. In South Africa, some mining companies, in an effort to stem the spread of the disease, are trying to help stricken miners and their families. Often, individual mine workers support more than twenty dependents. When employees become infected and cannot work anymore they will often try to hide how sick they are and not get tested because their families need the income. One of

Canada's major mining companies, Placer Dome, is deeply involved with counselling victims, providing drugs and medical care, and feeding its mine workers a nutritionally sound diet. This is laudable but there is also a practical economic undercurrent. As George Paspalas, Placer Dome's executive vice-president for Africa, put it,

You can say it's the right thing to do morally, but also it's good business sense. Sometimes you have to forego short term profit and spend a little more money on a project like this that will win you huge benefits in the future ("Caring for", 2003, p. 15).

Canadian (and other) mining companies face moral dilemmas in all they do. As a country where the law does not say where or how much its mining companies can invest, the Canadian government exhibits very much a laissez-faire attitude toward international trade. Some firms take advantage of this expansiveness and Canadian miner Ivanhoe Mines, who has long insisted that it is not interested in politics, is a case in point. Ivanhoe has a 50-50 joint venture with Myanmar's (previously, Burma) military junta, the State Peace and Development Council (SPDC), on the Monywa Copper Project in north-central Myanmar. Although the SPDC has a history of human rights abuse and political oppression, Ivanhoe provides the SPDC with roughly US\$800,000 in annual royalties and the amount will increase significantly once construction loans have been repaid (McLeam, 2003, p. n/a). Needless to say, this is a case where pure economics have won out over business ethics. Another such example is the recent joint partnership between two large, global EPC contractors to help rebuild Iraq's infrastructure destroyed in the 2003 war. One of the firms is offering (what amounts to) bounty to its employees who successfully engage suitable external candidates to work in Iraq. The writer believes this initiative is truly deplorable.

Even though political will can bring great prosperity to a country – witness Peru, which is currently experiencing a period of intense economic growth – this is not a prescription for all of its ills. Even though Peru's mining revenues have increased greatly due to the soaring global demand for copper, zinc and iron ore, and the country's economy has expanded 4% annually in recent years, poverty levels are more than three times what they were when the president first was elected in 1985 (Millman, 2004, p. 17). Obviously, foreign nationals have reaped huge profits with little benefit accruing to the country itself. It is no surprise that the government will be instigating a royalty on outside mining firms doing business in Peru, by the end of 2004. EPCM firms such as the BU will not suffer directly but the mining companies will notice a drop in profits.

EPCM firms such as the BU do not directly influence countries' mineral economics policy or international dealings. However, they indirectly feel the effects of the relationships between governments and the mining companies. Depending on the strength and nature of those relationships, this can result in either opportunities or threats for EPCM firms like the BU, which have no obvious influence on countries' mineral economics policy or dealings.

## **5.6 SUMMARY**

Macro-environmental trends can be thought of as general sea changes so intricately interwoven that a shift in one affects one or more of the others. A substantial increase in planned mining industry spending is welcome news to service providers, and coupled with increased demand worldwide for metals and higher market prices, shapes a rosy outlook for at least the next couple of years. However, in order for metals to continue to be economically extracted and processed, technical process innovation must keep up. Companies that can successfully commercialize ideas as yet tested only in the laboratory or pilot plant will have a competitive advantage. Sociological, environmental and political influences are all slowly evolving – for the most part in positive directions – but will test the patience, staying power and commitment of even the most experienced mining companies and associated EPCM firms.

Almost all of the key issues that are facing the industry are a result of these macro-environmental trends and can be interpreted as challenges to its overall welfare. However, the firms that can use their strengths to turn these challenges into opportunities will prevail. For instance, more stringent environmental controls stemming from the Kyoto Protocol are a definite challenge to overcome but will present opportunities for innovative emissions technologies to be implemented. Companies that can be first to market or recognize occasions to apply even older technologies in a cost effective manner, will enjoy some success. Companies must stay aware of these macro-environmental trends, assess how their known strengths and weaknesses are affected, and regularly analyse the implications for their business.

## **6 INTERNAL ANALYSIS**

The purpose of Section 6 is to assess fit between the BU's activities and a generic model, as well as assess fit with its own strategy. Weaknesses in the BU's strategy that must be corrected and opportunities that can be taken advantage of in order for the BU to compete viably as a world class EPCM services provider are identified. A market overview, industry value chain and analysis, competitive analysis, and discussion of macro-environmental trends were provided in preceding sections as background. Understanding gained from these analyses sets the stage for an internal analysis of the BU.

The method used to analyse the firm's business is two-fold: the first step examines the BU's strategy against a list of generic strategy variables to assess fit; the second step studies the compatibility between primary and secondary activities in the firm's own value chain. The conclusions are based on the findings gleaned from these two steps, together with the industry key success factors identified in Section 4.3.

### **6.1 GENERIC STRATEGY 'FIT' CONCEPT**

The generic strategy 'fit' concept covers all parts of a well-rounded generic strategy and provides a framework within which to, for the most part, qualitatively assess a firm's general competitive health. The quantitative assessment is very rough. Michael Porter (Porter, 1996, p.70) stated that "fit drives both competitive advantage and sustainability". Creating a good fit between a firm's system of activities can produce a strong strategy resulting in a sustainable competitive advantage. Understanding how the BU is positioned as a competitor in the market place, how it is equipped to compete, and highlighting what its strengths and weaknesses are, leads into a focused discussion of the firm's key issues and final recommendations in Section 7.

The BU's 2003-2007 strategy detailed in Section 6.1.1 was agreed to by the Division and appears to reflect the strategic plans of both the GS and the PC. How well it fits with the Generic Strategy Variables 'Fit' chart is shown in Figure 13 below. Scores assigned to each variable reflect the writer's own subjective opinion of the quality of the strategic fit at the beginning of fiscal 2Q 2004. How well the BU is implementing its strategy, is discussed in the following sub-sections.

Criteria & Score	Cost Based					Differentiation				
	Low Cost / Adequate Quality					High Quality / Adequate Cost				
	1	2	3	4	5	6	7	8	9	10
Product Strategy - 7.0	Rapid Follower					Innovative				
R&D Expenses - 6.0	Low R&D					High R&D				
Structure - 8.0	Centralized					Decentralized				
Decision Making - 7.0	Less Autonomy					Autonomy				
Product Delivery - 9.0	Economies of Scale					Economies of Scope / Flexible				
Labour - 8.0	Mass Production					Highly Skilled / Flexible				
Marketing - 5.0	Comparative / Push					High Cost / Pioneering / Pull				
Risk Profile - 9.0	Low Risk					High Risk				
Capital Structure - 10.0	Leveraged					Conservative				

Figure 13 Generic Strategy 'Fit' Variables for the BU

A 'high quality/adequate cost' strategy is referred to as 'differentiated', while a 'low cost/adequate quality' strategy is said to be 'cost based'. Ideally, most variables will consistently side with one of the two strategies rather than hang in the middle. In the case of the BU, only a differentiated strategy will allow it to compete in the mining EPCM industry (particularly on larger detailed engineering projects) and it is doing that fairly well, as shown in Figure 13. The average score is 7.7 and the median is 8.0. When the highest and lowest scores are removed, the average still remains at 7.7. Ultimately, while a score of 7.7 is reasonable, there is room for improvement.

### 6.1.1 Product (Service) Strategy

The BU competes using a differentiated strategy to produce both technical and project management services. A score of 7.0 was assigned because the BU does provide an adequate cost, specialized, high-value product when compared to most other providers. However, all else equal, the strategy has an alarming lack of emphasis on innovation, either in the development or acquisition of new technology, its application, or in project execution techniques. The BU cannot

expect to achieve a truly sustainable competitive advantage that would allow it to grow detailed engineering market share, unless it can offer clients services superior to those of its competitors.

Overall, the BU has never been a truly innovative solutions provider but more of an applications engineer. Essentially, it buys its technological innovation and engineering through equipment vendors and attempts to use it creatively. The trend toward less in-house innovation is most pervasive in the engineering disciplines of the shared services group. There is a nagging concern that this trend is seeping more and more into the process engineering that the BU does.

Arguably, the BU provides good quality services that in some cases are highly specialized. The BU must maintain this high-value *Product Strategy* if it is to remain a preferred supplier to its key clients. Having an average external charge-out rate that lies mid-way in the range of what competitors charge is helpful. The firm does have a unique value proposition that distinguishes it from its competitors in its ability to deliver high-value *feasibility study* solutions. The BU has a multi-faceted strategy (not listed in any order here), which is to:

- 1) Develop relationships with the top three global mining companies while maintaining relationships with its existing clients
- 2) Develop opportunities with mid-tier mining companies
- 3) Expand its international presence in Australia, Chile and Peru, as well as expand its Canadian presence in Toronto
- 4) Grow EBIT to 8.5% of gross revenue
- 5) Develop its employees, and
- 6) Establish full 'life of asset' support capability.

Even though the BU is a top player in the North American EPCM market, it does not enjoy such a strong position in Chile, Africa or Australia, where over 50% of global mining capital spending is forecast in the next few years. In addition to continuing to leverage its alliance with Ausenco, the BU will look to buy a mid-size firm in Australia of about 100 people. It also plans to buy a similar-sized firm in Chile. There are no plans for any development in Peru and this must be addressed in order to align with the strategy or re-assessed altogether.

The BU also plans to build upon previous operations and maintenance experience that the PC has in the UK, and its current relationships with key clients, to continue to develop asset management services in the mining sector. This refers to placing a few staff at a mine site or processing facility where they become the resident engineers, responsible for coordinating maintenance, operations and optimization projects. It is no secret that when people are right there



and able to help with whatever the problem is, the client is much more likely to give them the work. The trick of course, is to get a team installed onsite in the first place; this is an area of opportunity for the BU's business development manager to address.

The BU has attempted to position itself as supplier of choice for four Canadian mining companies, mainly in zinc, gold, diamonds and nickel. But it needs to win projects beyond this group of companies and commodities to achieve its growth objectives. Therefore, the decision to expand the BU's capability in Toronto should yield the most immediate, cost-effective results. Currently, at the end of 1Q 2004, the BU has made fair to good progress in this, as well as all five other areas, and is well on its way to successful completion by 2007. With the upswing in booked work over the past year, more employee development funds have been spent on sending people to conferences, educational assistance and the like. As mentioned above, it is imperative that the BU's strategic plan be aligned with that of the PC whose overall aims are to achieve:

- 1) Continued growth in the proportion of earnings from higher margin services activities
- 2) Increased volumes of business with existing clients, and
- 3) Continued development of the business portfolio.

It is important that a strategic plan spanning more than one year, such as that for the BU, be revisited frequently to reassess progress and change direction as necessary. Senior BU management meets at least once a year to review the strategic plan. Overall, the BU has a high degree of fit with the Generic Strategy variables. A competitive advantage in producing feasibility studies exists because the BU's strategy, organization capabilities, core competencies and markets are in synch. This is not quite the case overall with regard to detailed EPCM.

### ***6.1.2 R&D Expenses***

Although the BU basically does not spend anything on R&D (which is done by the mining companies and equipment vendors), a moderate score of 6.0 was assigned. Since the BU has personnel working closely with clients to develop their test work – running pilot plants, supervising test work, performing mineral processing trials in independent laboratories, and such – the BU certainly benefits from this involvement and increases its knowledge base. The BU derives some large benefits from essentially no fixed-cost R&D investment. The BU can often leverage technological know-how resulting from this external, quasi-R&D involvement onto other projects but aside from the obvious benefits, there may be significant lag time in realising

the gains from these advancements. The BU must of course respect confidentiality agreements, patents and other contractual arrangements. Also, the personnel involved in the R&D may have left the company before proper documentation or knowledge transfer can take place.

In order to remain a leader in mining and metallurgical assessment and design, the BU should always strive to increase its involvement with R&D type work. Short of making the strategic decision to conduct its own technology development work and create patent-able mineral processing processes, it can do this by targeting these kinds of studies with its clients or promoting these services. Care must be taken to safeguard its ‘independent player’ status so that the BU can continue to market itself as capable of performing unbiased, third party, expert evaluation work. This will position its for making use of potentially more cost-effective technologies being developed for the future. The BU is currently well situated to take this approach because clients continue to request the BU’s help due to its excellent reputation in this area.

### **6.1.3 Structure**

The decentralised BU structure affords significant autonomy in running the business. The BU head office is in one Canadian city while its senior vice president resides in another. Likewise, the Division head office is based in a western Canadian city and the GS is run from an American city. When the BU first was started ten years ago, it was organized around a functional/project matrix structure to better focus on clients’ need by using dedicated teams. These teams are comprised of BU personnel – mining and mineral process engineers as well as project and construction managers – while remaining staff required to fill out project teams come from a multi-discipline engineering services group. This model has gained widespread acceptance throughout the organization since its launch ten years ago. The BU’s *Structure* serves its needs quite well and there is no plan to change it.

The BU benefits from its high degree of both horizontal integration within its own bounds and the backward vertical integration within various parts of the entire company. For example, the BU relies on the GS’s Earth and Environmental division (with its 90 offices around the world) for environmental, geotechnical and water resource planning expertise. As well, the BU sometimes uses the services of the BU’s Training & Development group to prepare operator training and maintenance manuals. In smaller firms, full project life-cycle capability is usually restricted to horizontal integration and the array of services is somewhat limited. This breadth

and depth of services, along with the high degree of successful decentralization justifies a score of 8.0.

#### **6.1.4 Decision Making**

The score of 7.0 reflects the general autonomy that the BU enjoys with respect to making decisions. Bound by higher corporate policy, it must align its strategies, goals, and budgets with those of the Division and GS. But when it comes to matters about how to best serve the mining and metals industry, it makes its own choices, certainly those involving technical issues.

#### **6.1.5 Product Delivery**

Manufacturing, as shown in Figure 13 refers to ‘service provision’ in the case of the BU. A high score of 9.0 was awarded because the BU offers a very flexible, deep, and broad range of services. It does a very good job of *Product Delivery* or what is referred to as project execution, i.e., providing its services. Refer to Section 6.2.2.3 for a detailed account of what this entails.

The marketing group records statistics on project ‘win rates’ as well as hours required for different types of contract and proportions of different contract types that comprise the BU’s work. An optimal amount of effort is required to achieve various targets and performance levels. The key is to not ‘give work away for free’ or unnecessarily over-design. More benchmarking of actual process engineering hours spent against industry standards would be helpful but since those standards are generally for other engineering disciplines, the utility of this exercise is questionable. The BU’s management understands how long certain process engineering tasks take to complete but there is always a push to do things quicker without sacrificing quality.

#### **6.1.6 Labour**

Much of the knowledge that the BU’s people have differentiates them from other providers – local, national and international. There are a number of individuals in or associate with the group who are renowned experts in their field. The use of internal and external labour is optimized to meet clients’ needs and the BU deploys primarily internal resources to deliver these services. External resources such as specialist consultants are used to provide services that further augment core competencies, adding to the BU’s strength in this area. The resulting score for this category is 8.0, but it is given with a cautionary note. Any competitive advantage (in feasibility studies especially) could dwindle quickly as many staff members consider retiring in

the next five years or so. The loss of specialized expertise and experience could leave huge holes in the group's capabilities. Neither the GS nor the division, together with the BU, has developed a practical and cohesive plan in preparation for this eventuality, or perhaps it has not been communicated at all levels of the organization. Nevertheless, an initiative aimed at identifying, capturing, and sharing knowledge between experienced employees and those coming through the ranks, is essential.

In recent years, the BU has participated in a graduate training program whereby new engineering graduates are rotated through a series of positions – within the BU and in the general engineering services group – to expose them to different parts of the company, round out their experience, and give them a chance to find something they would like to pursue further. It is the writer's opinion that this approach will only be truly useful for the BU if it participates directly in the candidate selection process. Successful recruits should not come straight out of school but have four to five years of mining or mineral processing *field* experience. Anyone not willing and able to travel extensively, work in remote sites for months at a time, and possibly have periods of no work due to the vagaries of the consulting life, should find another career.

### **6.1.7 Marketing**

A score of 5.0 was given in this area; a 'stuck in the middle' strategy is not usually an effective one. The reason for the lack-lustre rating is because the business development effort is understaffed and has generally not been achieving the desired large project EPCM results. Having said that, and to its credit, the BU has indeed won three larger EPCM jobs in early 2004. Whether this is due to improved marketing techniques or general buoyancy in the market remains to be seen. The business development/marketing group is terrific at winning more than its fair share of feasibility study work but a different approach might be required to consistently land large EPCM jobs. With any luck, the BU has turned a corner and is now becoming established as a highly regarded provider of detailed engineering services.

Developing a marketing culture is emphasized within the BU. Employees are encouraged to proactively seek new business opportunities in their work with clients. While the BU consciously uses a 'pull' strategy – there is no 'hard sell' – to attract customers and influence them to use its services, the reality is that the vast majority of work flows *from* the clients. BU employees are expected to be highly knowledgeable about their clients and the BU's full range of services so as to best be able to align the business to clients' needs. Clients' financial, environmental and social performance objectives are supported. The BU earns the privilege to be

its clients' provider of choice for engineering services by demonstrating its commitment to their success and by always providing recognised 'best-practice' levels of professional service. The aim is to at least meet, if not exceed, clients' expectations in terms of meeting cost and schedule.

The BU knows its industry and is well versed in the latest practices for mining, metallurgical engineering and construction management. It tries to interest clients in using new yet appropriate technologies and methods for their projects. The BU stays abreast of industry developments through its diversified work, personal contacts and participation in technical societies, professional associations, and industry groups. It clearly communicates that knowledge to its customers and uses it to provide value aligned with their needs. Strong relationships are maintained with past and current clients, and similar associations are pursued with potential clients. Client relationship responsibilities are assigned to in-house account managers.

The BU produces a marketing strategy as a road map to achieve future commercial viability and business success. The current strategy has been developed for 2003 to 2007. The BU also maps value and client chains, and performs a SWOT<sup>21</sup> analysis with each new customer to understand how best to add value as well as manage the client most profitably.

### **6.1.8 Risk Profile**

The firm's risk profile is rated as very high with a grade of 9.0. A moderately high value would be expected for an EPCM consultant in other industries but because the mining business is so volatile, this pushes the risk rating even higher. The BU does not have the same financial risk profile as the levels above it as the BU does not get involved with corporate financials. It prepares an annual budget, receives funds each year, and its performance is expected to meet agreed-upon targets. On a commercial level, the BU's business and technical decisions are made with an understanding of all threats and hazards, together with proprietary input from clients. This minimizes project risk to some extent, thereby maximizing the probability of meeting budget targets and delivering successful projects. There is no need to change the high *Risk Profile* but the BU needs to fully understand its business and how it operates within the industry in order to mitigate some of the uncertainty and volatility.

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<sup>21</sup>'SWOT' refers to Strengths, Weaknesses, Opportunities, Threats.

### 6.1.9 Capital Structure

The BU does not have its own capital structure per se as it operates with allotted funds that have flowed down through the GS and the PC. At December 31, 2003, the market capitalization of the PC was US\$268.5 million with ordinary shares allotted, called up, and fully paid for, at about US\$0.92 apiece (PC, 2003, p. 69). Historically, the PC's capital structure which includes long term debt, common shares, preferred shares and retained earnings, has been conservative with a debt to equity ratio in recent years of about 0.15. In 2003, due to the major purchase of a large European construction firm, this ratio jumped to almost 0.83. Average weekly net debt during 2003 increased to US\$659 million, largely reflecting the cash impact of acquiring that firm (PC, 2003, p. 29). This special transaction changed the short term financial structure because of a significant increase in short term debt and accounts payable. However, the situation is temporary and returning to a much lower debt to equity ratio will be a priority. This situation warrants a score of 5.0 but normally this number would be around 10.0 (as shown in Figure 13).

A conservative amount of debt financing can facilitate expansion strategies and provide for significant value creation. The PC will only participate in investments or acquisitions that have an appropriate amount of debt to begin with in order to avoid the cash strain of maintaining operations during down cycles. This allows the company to invest in any necessary capital expenditures or expansion strategies such as the major purchase of the large European construction firm.

From the PC's perspective, the higher cost of debt capital decreases its attractiveness to various stakeholders. Debt-holders have greater external control, which could interfere with the PC's ability to compete effectively. The PC has been extricating itself from some low margin business that it stayed in too long and is planning to engage in less risky business activities that have regular, repeat customers in order to earn higher margins. An optimal capital structure balances the higher risk incurred against the tax savings of debt (as the interest paid is taxed more favourably). This kind of capital structure should provide greater returns to shareholders than they would receive from an all-equity firm.

The BU will not feel any day-to-day operating repercussions from the PC making its recent large acquisition, as it will still receive the funds anticipated for fiscal 2004. Its own *Risk Profile* and *Capital Structure* are well balanced. In the end, the BU experiences a conservative financial situation that in turn helps to cushion it against the inherent volatility of the mining industry as well as the lumpiness of the EPCM consulting business.

## 6.2 FIRM-LEVEL VALUE CHAIN

The firm-level value chain in Figure 14 graphically depicts the activities through which a firm creates its competitive advantage. *Primary Activities* can be critical to generating that edge and include inbound logistics, operations, outbound logistics, and marketing and sales. The primary activities are supported by *Secondary Activities* that include firm infrastructure, technology development, human resources management and procurement. Figure 14 shows the activities that fall under these headings. Firms with well-aligned primary and secondary activities that address customers' needs appropriately, tend to earn superior margins.

From a firm-level value chain perspective, the BU creates value by leveraging *Primary Activities* to focus on its core competencies and effectively customizing the value chain to meet customers' needs. Emphasizing core competencies is the best way to earn higher revenues and increase profitability. *Secondary Activities* are efficiently employed through shared services in order to support this effort. Early in 2004, the BU's value chain is working quite well.

The core competencies by which the BU differentiates itself and generates a competitive advantage (primarily with feasibility studies) are highlighted in light blue in Figure 14. The graphic depicts the writer's understanding of the core competencies as well as primary and secondary activities aligning strongly with the BU's strategy of customer focus, increased profitability and improved life-of asset support services. The BU's value chain is fairly standard in the industry but at the same time is uniquely tailored to meet the needs of its specific business. Although there are shared services that the group indeed does draw upon, it has built its own specialized expertise in the financial, business development and commercial areas.

The BU's core competencies are risk management, sales and marketing, and project execution. Project execution includes estimating, process engineering, project management, engineering field support, commissioning and start-up. The BU performs these very well – particularly process engineering and project management – and is recognized by clients and competitors alike for doing so. Construction management is an area that needs to be developed further if the BU is to win the larger EPCM projects.

Since the risk management core competency is an integral part of everything the business unit does, it is shown extending across all of the other primary activities. The core competencies that overlap some of the value-creating primary activities are shaded in blue. Procurement is also a core competency but since it is technically not a primary activity, its text is shown in italics without the blue highlighting.

<b>Secondary Activities</b>	Energy & Mining Division	<b>Firm Infrastructure</b>				Finance Commercial	Business Development Quality	Human Resources Safety, Health & Environment
	Local Mining & Metals Offices	<b>Human Resources</b>		Local Benefits Admin Staffing/hiring	Staff Training Grad Training Program			
		<b>Technology Development: Information Technology</b>		Computer Network & Intranet Support	Hardware/Software (Purchase & Maintenance)		"Convero" Integrated Pm Software	
		<b>Engineering Services</b>		Engineering Design & Drafting	Project Controls CAD Support		Document Control Project Archiving	
		<b>Procurement</b>		<i>Purchasing &amp; Expediting</i> <i>Key Supplier Relationships</i>	<i>Inspection</i> <i>On-site Receiving</i>	<i>Contracts Management</i> <i>Transportation Logistics</i>		
<b>Mining &amp; Metals - Primary Activities</b>	<b>Risk Management</b>		Client Management Red Team Reviews Risk Analysis	Critical Path Scheduling Financial Analysis Currency Hedging	Team Selection Project Reporting HAZOP™ Design Analysis			
	<b>Marketing &amp; Sales</b>		<b>Inbound Logistics</b>		<b>Operations (Project Execution)</b>		<b>Outbound Logistics</b>	
	Business Development: Key Customer Relationships Pricing Contracts Marketing Sales		Set up JVs & Alliances Resource Allocation & Team Selection		Estimating Process Engineering Project Management Engineering Field Support Construction Management Commissioning & Start-up		Tangible Deliverables: "Bankable" Reports "Stamped" Documents  Site Team Deployment Project Handover Maintenance & Support <b>Outsourced:</b> Lab Work Expert Consultants	

**M  
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Figure 14 Firm Level Value Chain for the BU

### 6.2.1 Risk Management

The BU's over-arching core competency of risk management is applied to almost everything it does. The mining business itself is inherently risky due to historically unpredictable metals exchange prices, high entry and exit costs and the generally cyclic nature of the industry. The last down portion of the cycle of unusually low metal prices was unusually long – six years – which is typically the time for one complete cycle. Base metal prices have recently moved upwards but sustainability of this trend will depend on a strong US economy. Mining EPCM is subsequently 'lumpy' as it follows the ups and downs of the industry it supports. While on a macro-economic scale it cannot influence volatile economic cycles, the BU is able to mitigate many other risks for its customers. Thorough and precise estimates help minimize risk on projects.

Procurement is shown as a secondary activity because it is performed outside the BU group. However, senior BU management and process engineering staff get heavily involved with procurement in specifying expensive, critical path equipment that has a long lead time. The BU carefully estimates all phases of EPCM work prior to competitive bid and through scope changes.



Good estimates are essential for the successful completion of subsequent work. The BU uses vendor quotations as well as standard factors to build estimates. It also relies on historical data, past project lessons learned and plain good sense to continuously improve its estimating accuracy.

Monte Carlo probability techniques using @Risk™ or Crystal Ball™ software are used to statistically quantify financial risk on a project. However, these tools must be used with caution as they tend to over smooth autocorrelation data and therefore underestimate results. Financial models are built for a number of options and alternatives using NPV (net present value) and IRR (internal rate of return) analysis. Careful cash flow analysis is also performed on a regular basis throughout the life of a project or study to identify potential problem points and to ensure a smooth and even movement of funds at all times. Often on international projects it is prudent to hedge foreign denominations, particularly when the currency exchange rate is widely fluctuating or if large expenditures will not be made for some time into the future. The BU makes use of some or all of these risk reduction techniques as needed.

The risk management process begins early on. Once a Request for Proposal (RFP) has been received for a scope of work and a proposal prepared, larger jobs must pass a rigorous review from both a quantitative and qualitative perspective. An in-house team consisting of the study/project manager, lead process engineer and perhaps the estimator typically do the examination. This is a critical point at which a 'bid/no bid' decision is made whether or not to proceed. Key criteria that must be considered are the strength, availability and appropriateness of the team put forward. Sophisticated customers often demand the 'A team' – the best the BU has to offer – or insist that certain individuals be included. Well thought out resource allocation with respect to the BU's personnel, and to the rest of the engineering team, is critical for not only winning work, but also reducing risk. Note that *all* prospective work, large and small, must pass some minimum level of internal approval process before the decision is made to go forward.

Scheduling integrates the tasks to be performed by all parts of the organization and identifies the critical path and sequencing to be followed in order to achieve milestone targets. These are important dates as customers pay their invoices corresponding to the milestones achieved. A good project manager does not procrastinate because having even 95% of the work *almost* complete is not good enough. *Results* are what count when it comes to getting paid.

Another risk management tool that the BU uses for most feasibility studies and projects is HAZOPSTM analysis. While many firms use related techniques to identify safety and operability weaknesses in their engineering design, in the writer's estimation, the BU makes

more of an effort than most to do this. Of course, the BU recommends using HAZOPS™ but cannot force clients to comply. The BU maintains a small group of well-trained and experienced HAZOPS™ leaders.

For the most part, the BU excels at managing its clients. Clients expect their consultants to execute the work at hand but at the same time, act as advisors and guide them through difficult decisions. This often entails that the BU project manager ‘pushes back’ or carefully (but firmly) confronts clients with things they might not want to hear or face. Sometimes it means that the project manager has to remind a client that their invoice has not been paid. At this point, work might be stopped or a report held back until the client pays. It is definitely a tricky situation to manage. In the interests of good client relations, the project manager might decide to continue working even though it is doubtful whether the BU can expect timely or full payment. This is a judgement call that is left to the discretion of the project manager. The mining and metals VP might get involved only in unusual situations. Finally, this risk management network can only be effective if it is actually implemented. Sometimes there are situations where steps are skipped or processes hurried. It is the project manager’s responsibility to ensure that rules are followed and that only carefully assessed and justifiable changes are made to the normal procedures.

### ***6.2.2 Primary Activities***

The primary activities define the main services that the BU provides. These include sales and marketing, inbound logistics, operations (project execution) and outbound logistics. A ‘service’ category is not included in the value chain chart because clients typically run their own operations and for the most part, perform their own maintenance. The BU is trying to penetrate this business but it is not seen as a major area of growth at this time. However, it appears that the BU may be missing an opportunity for a steady stream of smaller retrofit ‘bread and butter’ jobs, by not working with mine owners to situate BU people onsite fulltime. This kind of arrangement is perhaps more common in the pulp and paper industry. The BU may be able to learn how to approach clients about this from other GS divisions who already do it successfully.

The primary activities shown in Figure 14 are appropriate because they are crucial, fundamental elements of mining EPCM work. Two of the four – sales and marketing, and project execution – are actually core competencies, while the remaining two – inbound and outbound logistics – are closely aligned with these core competencies. There is strong alignment between all the primary links of the firm-level value chain.

The BU is a mid-size firm that operates primarily<sup>22</sup> within the EPCM market. It is unique from its competitors in that it is part of a much larger firm that does perform a significant amount of EPC work around the world, yet it remains focused on EPCM. Although it could enter the EPC market, particularly with the backing of the GS, generally it does not, as this would not fit with its strategy. For the most part, the BU targets ‘front-end’ study and process engineering work to be performed by its own group that has EBIT of approximately 35%-50% and in some cases, even higher.

Although EPC revenues can be very large because of the huge numbers of hours involved, EPC projects typically produce modest margins for what is usually deemed to be higher risk work. Construction work is usually done on a Lump Sum Turnkey (LSTK) basis where the only way to earn significant profits is through tight control of the contingency fund or various bonuses and performance incentives. Since most EPCM contracts are done for time and materials on a ‘cost-plus’ basis, this particular risk element is minimal. Also, legitimate scope changes affecting the overall size of the job are covered by change orders. Of course, the BU puts its reputation on the line with every job it undertakes. Doing so engenders significant risk in its own right.

#### *6.2.2.1 Marketing and Sales*

Sales and marketing are core competencies the BU group carries out entirely by itself. Therefore it is rational for the BU to perform these activities in-house and not involve others. The BU’s business development group focuses on strategically developing key customer relationships while at the same time, maintaining existing ones. Typically, business development personnel are dealing with clients’ senior executives over long periods of time and it takes years to nurture the trust, understanding, and friendship needed to partner with key clients. Such relationships require careful planning and tending. Since the BU’s goal is to become their service provider of choice, business development personnel receive STARS (Strategic Teamwork and Relationship Skills) training to help develop the client intimacy skills needed to establish these solid relationships. By taking a proactive rather than reactive stance, the BU prepares itself to respond and deliver value most effectively. Strategic relationship management ‘customer plans’ are prepared for each client. They are used to help understand the client’s needs and identify

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<sup>22</sup> As a point of meticulousness, the BU *has* performed limited EPC work by partnering with outside construction firms, but not on ‘mainstream’ mining projects.

where the BU can close any gaps and better meet these needs. They also are used to profile rivals and develop strategies to compete against them successfully. Wins are celebrated with the proposal team and the good news communicated to the rest of the organization and throughout selected external media venues.

The business development group is responsible for pricing the BU's services. The entire cost structure including base rates, burden, overhead and profit, as well as contribution to the GS, is understood at the most detailed level. Recently, an initiative aimed at growing profits has shifted the pricing structure used with a major customer from a multiplier basis to that of a flat rate per hour scenario. This will be extended to other customers over the next 12 to 18 months and it is expected that this change will help achieve the desired 8.5% to 10 % return on gross revenues.

EPCM contracts are developed and customized by the business development group along with significant help from the shared services legal and finance departments. Long term 'evergreen' contracts are dynamic in nature, and terms revised as customers' and the BU's concerns change. The aim is to accommodate both parties' requirements within a mutually beneficial framework. Finally, business development personnel must learn how to close sales. These skills are developed on the job, through targeted workshop training, and by working alongside experienced mentors.

The marketing group, together with sales and technical personnel, may represent the BU at industrial trade shows and conferences around the world. Although many engineers might think otherwise, they are participating in a marketing exercise when they present a paper at a conference or attend a technical seminar. This contributes to the general body of knowledge available, keeps the BU's brand highly visible, and reflects favourably on the BU. It also allows key technical staff to network with others in the industry and share their knowledge.

The marketing group handles the final preparation of all proposals with input from technical, commercial and project services personnel. This results in skilfully written and professionally produced documents that not only look good and are complete, but also present a compelling rationale as to why the client should award the work to the BU. The marketing group also gathers market intelligence and produces glossy brochures, in-house publications and external 'qualification' documents that highlight capabilities and profile past projects. The group maintains up-to-date resumes that enumerate staff's BU work experience in great detail. This is important as clients want to know exactly what expertise and experience potential project team members will bring to their projects.

### 6.2.2.2 *Inbound Logistics*

It is important to make the correct team selection and resource allocation decisions early on in the EPCM process. The right mix of talent, experience and cost-effectiveness sets the tone for the project to follow. A cohesive team is needed to get the job done properly and have the client award more work. Therefore, assigning staff effectively is considered here to be an issue of 'inbound logistics'. This is because *people* and the intellectual property they bring with them really are the raw material that the final product – a study or project - will emerge from. Team members are chosen according to expertise, experience, and track record with a particular client, availability and charge-out rate. Certain team roles require leadership and managerial capability as well as technical expertise. Clients may want a process engineer who has worked with its company before and knows many of its people. Sometimes a client demands certain individuals be 'sprung' from their other commitments and if the client is important enough, that is what happens.

Often, projects and studies require that the BU work with other firms or consultants. Sometimes this is done to combine the strengths and know-how of one or more firms in order to win a bid. Other times it is done to mitigate a language barrier or unfamiliarity with local customs. A foreign partner may be able to act as a translator or wade through reams of bureaucratic red tape on the BU's behalf. Still on other occasions, partnering with an offshore firm may provide a cost-effective means of producing repetitious, commodity type design drawings. For instance, the BU has used the engineering staff in its Santiago Chile office on occasion in this regard. The management of the BU's local offices makes these decisions jointly at the BU level.

The BU teams are best situated in one spot but members often interact with and operate from multiple locations. Communications tools such as project websites, email, telephone, intranet connections, conference calls, and fax are indispensable for staying connected in lieu of actually meeting face to face. The BU has a proven track record of successfully coordinating diverse, widespread and multi-faceted international teams. While this is definitely a challenging way to conduct business and certainly less than ideal, just the same, it is an important selling feature.

### 6.2.2.3 *Project Execution*

Project execution comprises the backbone of the overall engineering effort and is a core competency. It refers to how, when, and where things are done on a project and includes estimating, process engineering, project management, engineering field support, construction management and commissioning, and start-up activities.

Estimators are integral to the BU's value chain as the thoroughness and validity of their work creates the basis for the work to come. The BU builds its estimates around a standard Work Breakdown Structure (WBS) that is carried through all phases of the EPCM work. It provides a consistent, repeatable and organized framework for estimating as well as controlling costs later on.

The process engineering and project management functions are truly at the core of what mining EPCM is about and why things are done in certain ways. They were described in detail in Section 2.2.1. Needless to say, new technologies and processing advances present an opportunity for the BU as it has the technical expertise and capability to exploit new innovations and apply them in a practical manner. The BU works with many large and sophisticated clients who will listen carefully when the BU makes suggestions. It is an opportunity to further differentiate itself and build credibility.

The procurement and construction management functions were described in detail in Sections 2.2.2 and 2.2.3, respectively. Managers leading these functions have important roles.

The BU takes advantage of knowledge and expertise gathered from its offices around the globe. It is also closely aligned with the Earth & Environmental business unit in another division and the two share related knowledge and lessons learned from past projects. Work sharing occurs between different offices both to capitalize on resident talent and to leverage the 'time zone effect'. For example, the Perth Australia office can post a new issue of approved design drawings to the project website; the Toronto office can then check the drawings and re-post them; and finally, the Vancouver office can plot, stamp and issue them for construction. This is possible all within a 24-hour period thanks to the Internet, which enables an increased rate of productivity.

The BU's major mining office in Vancouver is ideally located as a jumping off point to Austral-Asia and the entire Pacific Rim where it does much of its work. Likewise, the Toronto office has relatively easy access to Europe, Africa, and to South America, where most trans-continental flights pass through large cities on the East coast. Major Canadian mining company head offices are located in either Vancouver or Toronto, as are all the major banks and the Vancouver and Toronto stock exchanges.

#### 6.2.2.4 *Outbound Logistics*

In the case of a knowledge provider service organization, outbound logistics refers to various things. First, it includes the tangible deliverables produced by the BU, including ‘bankable’ reports and ‘stamped’ documents. The former refers to feasibility studies that have the BU’s name behind them such that it assists the owner in obtaining financing. Banks have higher confidence in studies prepared by large, reputable firms like the BU. Drawings and other design documents that have been ‘stamped’ have been reviewed and sealed by licensed, professional engineers. The BU provides this service as required although it is typically handled more by the engineering services group. Deliverables could also include process simulation analyses run on proprietary IDEAS™ software developed in-house. This software is used to dynamically simulate metallurgical processes through their full range of operability to test limits and design in order to mitigate failure before it happens in real life. Additionally, the software can optimize a process so that it operates in the most efficient and cost-effective manner. A few of the BU personnel are expert at using the tool.

Outbound logistics also refers to the deployment of individuals and groups, both on projects and studies. Handling large project teams comprised of people in different offices in many countries or in the field requires coordination and planning. Aside from the various cultural, language and country challenges, there are often daunting logistics issues to deal with. The BU has experience working on all continents, in a multitude of languages, and has overcome some of the harshest climate conditions imaginable. For example, its demonstrated cold weather design expertise on northern diamond, zinc and gold projects has convinced many clients that the BU can deliver differentiated value with its cold-weather engineering and logistics know-how.

Project handover, maintenance and support are other items that fit into the ‘outbound logistics’ category. Project handover requires skilful negotiation, shrewd timing and strong leadership. It represents a critical point in the project process whereby responsibility for the asset will change hands. The BU employs experienced construction and project managers who know how to handle difficult and demanding clients. They do this without dipping unnecessarily into contingency funds to meet contractual requirements. They also maintain good client relationships, all the while protecting the BU’s interests.

The BU can provide maintenance and support services for operating facilities but this is an area of opportunity that the BU is not fully taking advantage of. Customers benefit from complete life of asset service and targeted maintenance that is statistically calculated to provide

optimal care from both an economic and technical perspective. Out-sourced activities include assay laboratory work. The BU has solid long term relationships with the two major North American labs that perform metallurgical testing and assay work. It also currently employs a past lab owner/operator who can advise whether full value is being received from the out-sourced laboratory services.

Finally, the company hires outside consultants with expert knowledge in specialized fields that do not warrant a full time staff position. Many consultants are eager to work with the BU as it has an excellent reputation as a premiere feasibility analysis provider. The ability to preferentially attract recognised technical experts makes the BU stand out amongst other mining EPCM firms.

### ***6.2.3 Secondary Activities***

Secondary activities should effectively support the primary activities in a firm's value chain. The BU has a number of secondary activities that are appropriate for its value chain. Not only do they support the primary activities, but also they are strong differentiators in their own right. The secondary activities include firm infrastructure, human resources, technology development (information technology and engineering services) and procurement.

#### ***6.2.3.1 Firm Infrastructure***

There is a wide variety of shared services available to support the primary activities of both the Division and the BU. These include financial, commercial, business development, quality assurance, human resources and safety, health and environmental. Integrated business systems software provides a common systems platform for shared financial, project and HR services. It also links with the integrated project management software package that the BU uses.

The BU does not rely heavily on financial, commercial, business development or human resources shared services as it has developed in-house expertise and systems adapted to its own needs. However, these shared resources are available from the division, GS, and PC, when needed.

Although the BU does not follow the ISO-9001 quality assurance program that some of the other business units do, the engineering services group that works on its jobs does so. Therefore, the BU inadvertently derives additional benefit from consistently applied checking and review procedures on the work it gets done by the engineering services group.



The safety, health and environment group administers a program aimed at reducing, if not eliminating, lost time accidents and incidents on the job site. Its message to the rest of the company is that consistency and uniformity in approach will enable significant gains to be realized toward building a proactive safety, health and environmental culture. The group records these statistics and benchmarks the BU's performance against set industry standards. The BU depends on the training, support and information it receives from the safety, health and environmental group to prepare people for working safely on site.

#### *6.2.3.2 Human Resources*

The BU relies on a centralized human resources group in the GS for all policies and some shared services. However, local human resources groups situated in each BU office administer and coordinate benefits, hire staff, host a variety of training programs (mostly to do with safety) and assist in running a graduate training program. Human Resources also prepares the increasingly involved international travel documentation required by BU staff members who travel frequently.

#### *6.2.3.3 Technology Development*

Information Technology (IT) includes information technology such as computer and intranet support, hardware and software purchase and maintenance, as well as support for the in-house integrated project management software. In this discussion, it also includes all engineering services aside from those provided by the BU.

The GS maintains a sophisticated client-server network and intranet. The external website is maintained by the PC. Software packages and licenses are checked and tested for applicability before being approved for use by employees. A help desk is available 24 hours a day to help users with their computer problems. All hardware and software purchasing is done by the IT group, following approved company guidelines and budgets.

An integrated project management software package designed in-house is used for project management controls. It links estimating, scheduling, cost control, accounting, and materials management activities, allowing coordinated reporting. In the field, it is used to organize equipment and spare parts receiving, as well as control warehouse inventory. The BU uses it on all major projects. A mix of spreadsheet and database management tools is used to control smaller projects.

The BU generates significant value through the application of web-based technologies including project webs, project management systems and supply chain management tools. The company operates specialized technology businesses in the areas of geospatial data management, systems integration, web-solutions, operations analysis, process simulation and computer-based training. The GS relies on these services as part of its competitive advantage in offering full service capability. The company is also a leader in the development of e-based exchanges for the procurement of goods and services. There is an opportunity for the BU to exploit this further.

Technology development also refers to engineering services that include engineering, design and drafting, Computer Aided Design (CAD) support, project controls and document control. Local, common operations groups provide discipline engineering as a shared service to their respective BU offices. This engineering work refers to all of the main disciplines other than 'process' engineering and includes civil, structural, architectural, electrical, instrumentation, mechanical, piping, Heating, Ventilation & Air Conditioning (HVAC) and materials handling. All technical disciplines are available to work together and produce all parts of a detailed design job. Engineers and designers are also chosen from this group for field assignments.

CAD support ensures that project teams receive consistent and efficient project set-up standards and ongoing technical support. Project Design Management System (PDMS), a 3D CAD software package recently introduced on mining projects, was first implemented in 2004 on a major EPCM project. It is recognized that there will be a steep learning curve and the CAD group's mandate is to provide the training and guidance required to not only get designers to use the platform correctly but have them use it to its best advantage. Attaining expert user capability over the next year will provide value to the client in terms of improved drawing production efficiencies.

Project controls staff monitors job progress against budget and schedule, tracks deviation and scope change notices, monitors costs and prepare monthly reports for the client. Rigorous document control is necessary to organize the hundreds, sometimes thousands of drawings, design standards, specifications, and other documentation that flows through a study or project. Certainly, no project that is larger than a few thousand hours can be successful without a properly structured and consistently applied document control system. Project archiving occurs at the end of a job and consists of collecting all hardcopy drawings, documents and email, and putting them in off-site storage. Electronic data are copied from the server and stored on disc. Pertinent 'lessons learned' information from past projects is shared via an intranet website called 'Engineering Tools'.

#### 6.2.3.4 Procurement

Procurement is listed as a secondary activity because it is not actually performed by the BU business unit. However, it is extremely important to the success of projects and “acts as the conduit between engineering and construction”.<sup>23</sup> The procurement function and the BU’s experience have already been described fully in Section 2.2.2.

### 6.3 SUMMARY

The generic strategy variables ‘fit’ average score of 7.7 is significant, indicating that the BU has a fairly high degree of alignment with a differentiation strategy. This is the preferred type of strategy for this business. The main weakness is in marketing and sales as it needs to further develop an approach that ‘pulls’ clients to choose the BU’s services over those of its competitor.

The relatively low score of 6.0 for R&D is a concern, indicating that the BU is lacking in this regard. This is because there is a proven high correlation between innovation and competitive advantage. Given that EPCM firms do not as a rule perform their own R&D, the BU actually is quite involved in that it has close links to well-respected metallurgical laboratories, regularly assists clients with test work, and is consulted by equipment vendors doing their own research. In short, BU personnel stay abreast of new developments. Of course, this excludes most proprietary research during development stages unless the client has engaged the BU to lead the effort. However, in the end, the written strategic plan does not state anything about innovation and this needs to be addressed if the firm intends to increase its overall market share.

Finally, the essentially secure and conservative capital structure provides a solid base from which the BU operates. The downside is that funding is doled out from higher organizational levels such that the BU might not always be able to pursue its own initiatives without prior approval.

The firm-level value chain identified risk management as the overall core competency that affects everything else. Risk management techniques are built into every step of the BU’s project execution process. The BU uses an effective network of checks and balances. When used properly, they provide more than adequate protection against design and execution errors and oversights.

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<sup>23</sup> This is according to the BU’s Vancouver office Purchasing Manager.

There is good alignment between the firm's primary and secondary activities. Arguably, the procurement function could be transitioned to primary status but since the status quo works well, there is little reason to change. The company's integrated project management software that is mandated for use on larger projects is not always the best tool for the job. While there has been a lot of investment sunk into this effort, the package needs to be made more 'user-friendly'. The BU might also consider developing a simplified version for use on small projects.

The BU's construction management capability is thin with limited experience in larger projects. The BU has a tendency to segue its medium size project managers into construction management positions. However, for larger jobs, it will need to dedicate construction managers specifically to this task. There are few younger people in the company being trained in-house and promising, interested individuals should be hooked up with these senior construction managers to learn how things are done. As a final point, and as the BU is aware, opportunities exist to further develop onsite operating and maintenance support services for key clients. Since construction managers best understand those needs, they should certainly be involved in pursuing this work.

As a rule, the BU's key customers do not want to give up control of their construction projects by awarding LSTK work to an EPC provider. This is a major reason why the BU does not offer construction services and continues solely with EPCM. It might be a blessing in disguise, as the firm that spreads itself too thin compromises its ability to perform its primary business well. This is a case where choosing *not* to do something may be a very effective strategy.

The BU meets its strategically necessary key success factors most of the time. Although it does a thorough job of identifying risk it does not always do as good a one of managing it. For instance, sometimes a project manager will direct a team to continue working even though a client has not paid the last few invoices. Of course this is a judgement call but as a rule, it is not a prudent way to manage.

The BU typically approaches challenging technical problems with proven, well-accepted, and cost-effective solutions. There not only must be appropriate and available technology to implement novel solutions but a supportive client who will lower its aversion to risk. Often, clients will avoid any unnecessary gambles and are loathe to being first to do something new. It is somewhat of a dilemma to try and convince a client to do change in this regard.

The BU usually does a good job of meeting budget and schedule expectations but rarely surpasses them. This is always an area for improvement. The BU generally does a good job of

winning repeat business with its key clients. It must accept that there will be a stream of continuously changing client personnel whose relationships warrant close tending.

Threats can always be turned into something good. As such, there are terrific opportunities to foster innovation, create an optimal mix of talent, position the firm to best be able to win large detailed engineering projects, as well as develop the next generation of project managers and construction managers. The key issues facing the firm and recommendations intended to position the firm for success are discussed next in Section 7.

## **7 POSITIONING THE BU FOR FUTURE SUCCESS**

The information and analyses of previous sections have culminated in the key issues presented here. The recommendations ensuing from these conclusions are critical for the BU's future success.

### **7.1 KEY ISSUES FACING THE FIRM**

There are two key issues facing the firm. The first is that of winning large project EPCM work. The second key issue is the need for the BU to become more innovative. The EPCM concern must be addressed in the short term over the next year. The innovation matter could be dealt with over a longer term of three to five years.

#### ***7.1.1 Large Project EPCM Market Penetration***

Penetrating the large project EPCM market is a key issue because it is critical to growing the BU's overall EPCM market share and attaining larger revenues.

Since it is not likely to enter the EPC market in any significant way because this is something its major clients are not interested in supporting, the BU is forced to target ever-larger EPCM projects in order to grow. There are also increased economies of scale in executing larger projects. While the BU cannot afford to, nor would it choose to distance itself from the feasibility study consulting work it performs so well, at the same time, it needs to emphasize the total EPCM offering supplied in part by the engineering services group in order to grow that capability to large project status.

As countries like China surge forward and develop their natural resources, almost all of these projects will be of the large 'green field' variety, likely greater than US\$500 million in magnitude. The BU will not want to miss these opportunities. Australia and South America are also regions slated for significant growth. The BU is increasing its presence in both and is actively developing relationships with new and existing key clients.

Increasingly, new projects are located in remote locations and often in poorer, third world countries. Aside from the obvious mining aspects involved, there is often a significant portion of work that is related to infrastructure – roads, dams, airstrips, bridges, community facilities and the like – that can increase the breadth of the scope and the project's total capital

cost well beyond the US\$500 million mark. The BU is capable of handling this work using a mix of in-house and sub-contracted resources.

The BU is almost at a crossroads where it needs to win a large EPCM job to signal to the market place that it has indeed progressed to the next level of project execution capability. It is not only a purveyor of albeit first-class feasibility studies and mid-sized EPCM jobs but is also a credible contender for, and winner of, large world-class EPCM mining projects. The BU has all of the basic ingredients needed to perform large projects.

### ***7.1.2 The Need for Innovation***

Innovation is a key issue because in the longer term, although the firm is already providing its customers with high-value EPCM services, so are its competitors. As such, although the BU is a credible high-value EPCM services provider, it needs to differentiate itself even further from other large EPCM firms in order to build a true competitive advantage.

If the BU cannot introduce innovative products or services, failure to innovate will in time reduce it to what is known in the industry as a ‘job-shop’ and this will ultimately result in destructive, price-based competition. Although this scenario is more likely to happen with the engineering disciplines in the services support group, it is not altogether impossible that it could occur with the more high value-added groups that comprise the BU. Either way, an opportunity exists to leverage value, particularly with the BU’s process engineering and project management capability.

## **7.2 RECOMMENDATIONS**

The primary recommendation is aimed at the short term. It closely follows the key issue of winning large EPCM work and how the BU can best position itself to win these contracts. The secondary recommendation is designed to over the longer term, deal with building innovative proprietary technologies and practices. This sequence is necessary to revitalize the large project EPCM effort over the next year and also build upon that momentum to develop original technologies and project execution solutions in future years.

### **7.2.1 Short Term**

*Over the next year, emphasize specific efforts required to win larger project EPCM contracts.* Senior mining management must proactively lead a coordinated effort between the business development group, the rest of the BU, and the engineering services group, to address the key issue of winning large project EPCM contracts. At the same time, they must seriously consider the many supporting factors described in Sections 7.2.1.1 through 7.2.1.6.

There is no doubt that maintaining an optimal ratio of feasibility study to detailed engineering project work that considers revenue and profit targets *as well as staff development needs* is difficult to achieve. However, given that the BU's business is knowledge driven, knowledge comes from people, and it is increasingly difficult to find and keep the right people, this is obviously critical. This concept arises again in Section 7.2.1.2.

The inability to grow beyond executing feasibility studies and medium size projects up to US\$500 million continues to defy the BU's best efforts. The BU has not been as successful as expected in winning larger detailed engineering projects. There has been a perception in the marketplace that the BU does a great job with feasibility studies and a competent job with small to medium size detailed engineering work; still no one has awarded it a job greater than US\$500 million, let alone an actual 'mega-project'. The BU's services are just one part of the total EPCM offering, although the BU does lead this overall effort. It works together with the engineering services group to execute detailed EPCM projects – essentially, the BU provides higher value differentiated services while the engineering group does more commodity level work – but the two groups need each other. At the beginning of 2Q 2004 it appears that the BU might be poised to win one or more EPCM projects greater than US\$500 million, so perhaps change is imminent. The following supporting factors affect how the large project EPCM win rate can be improved.

Aside from the need to initiate a knowledge management program, no real change in the rest of the strategy is required. Incremental growth and implementation efforts in the various parts of the collective approach must be closely managed to attain desired results. Specifically, there is a need to increase the service capability in an area such as onsite safety where specific actions will increase the probability that the BU can win larger EPCM contracts.

#### **7.2.1.1 Emphasize Business Development Activities**

The commitment to hire two new business development managers by the end of 2004 is commendable. This will maintain and deepen new and existing mining client relationships. It will also reinvigorate efforts to direct research activities to identify emerging market opportunities,



monitor competitor activities and represent the BU within industry organizations. Stepped-up business development efforts to obtain onsite operations and maintenance support service contracts at existing mines or as part of new EPCM projects are needed to establish and grow constant revenue streams. This is an opportunity for the BU to expand upon. Increasing the BU's Australian, South American and Toronto presence sends a strong message to its competitors, reminding them that the BU is indeed a serious and capable threat. Once the BU has identified appropriate Australian and/or Chilean engineering firms to acquire in its effort to expand its presence in these regions, and has had its business plan approved by the Division and GS, financing will be made available to buy the companies. As an aside, although this will not likely happen in 2004, the BU is in the enviable position of not having to concern itself with servicing with any debt.

Challenges facing the BU emanate from both the mining industry and the EPCM services business. As such, the BU needs to understand the metals markets, its competitors and its clients very well in order to decide strategically where it can best support different sectors of the mining industry and win the highest margin EPCM work with the best chance of repeatability and longevity. The firm must also decide what metals and what single or multi-metal mining companies it should be targeting for the long term so as to not waste considerable effort. As a start, the type of information provided on metals in Section 2.4, on competitors in Section 3.0, and on customers as discussed throughout, is necessary to assess what markets to stay in, leave, or enter. It is the writer's opinion that the BU understands its customers very well and knows a lot about them but does not have the same level of understanding or knowledge of its competitors. This is an area of weakness that should be addressed.

Given the current resources allocation and anticipated workload in the different types of contracts it undertakes, the BU must constantly balance the ideal mix of feasibility and detailed engineering work in order to meet its revenue and profit targets. The writer is not convinced that this weighted total is scrutinized well for fit. Rather, the firm tends to take on whatever work comes its way, assuming the risk profile is acceptable. This is understandable during times of market weakness when the firm needs a positive cash flow to stay afloat, but in general, a targeted approach might yield more predictable results.

### *7.2.1.2 Improve the Safety Record*

The BU must commit to building up the safety, health, and environmental management capability and improve the firm's onsite safety statistics. It should initially focus on hiring seasoned managers to immediately improve the situation. It could also augment this effort by developing an in-house program to cultivate and train future construction site safety, health and environment managers from within the organization.

Safety, particularly onsite safety, health, and environmental management, is a possible Achilles heel in the BU's attempt to grow its EPCM business to include larger projects and improve market share. Its recent safety record has been poor, well below the levels reported by its competitors. The BU's statistics were not available for inclusion in this paper. Clients are extremely concerned about safety and this could be one of the reasons why the BU is not winning as much EPCM work as it could. Suffice to say, the BU is very aware of the potential consequences and is taking steps to correct this shortcoming. If the firm cannot bring its safety record up to par it will not be able to win large project EPCM contracts, and over time, even smaller ones.

### *7.2.1.3 Attract and Retain Personnel*

Like most other EPCM firms, the BU is facing the challenge of how to attract and retain key personnel. This is becoming increasingly more difficult. A carefully integrated plan is required to successfully deal with the issue as it is a seller's market and competition for appropriate staff is only going to escalate over the next few years. The BU must be prepared to remunerate new graduates and experienced professionals, as well as current employees, with very competitive and attractive compensation packages. More importantly, the firm must find a way to differentiate itself from others so that it becomes recognized as an employer of choice.

The BU is primarily selling specialized knowledge to manage clients' risk. As it does not sell patented intellectual property, its only real resource is its peoples' explicit and tacit knowledge. This is a precious commodity that can be leveraged by creating a work environment that is interesting, challenging, and innovative. This will ultimately help to attract and retain top talent.

#### *7.2.1.4 Manage Knowledge*

A wide-ranging plan is needed to establish ongoing communities of practice, implement programs to identify, capture and disseminate knowledge, create mentoring opportunities and initiate a phased, staff succession plan. A Knowledge Management (KM) manager should be appointed to create and lead a KM program across all BU offices and commence implementation by 4Q 2004. At the risk of sounding sensationalist, the writer believes that the BU must commit to a KM program in order to ensure its very survival over the long haul.

The BU does not have a formal plan in place to integrate KM practices with the changing demographic in the workplace. Currently, the know-how in the BU is not competitively sustainable. The prospect of many senior employees retiring over the next five years or so and the firm losing their tacit knowledge and experience is a sobering one. Hard copy files and electronic folders exist to save information and allow easy access but there are no formal in-house communities of practice set up within the BU to teach this uniquely specialized knowledge and to share understanding. The PC maintains a KM site on the company's intranet but it is directed primarily at its UK companies in industries other than mining. Of course, knowledge collection, including its storage and retrieval, forms but one facet of KM. Overall, sustainability is not being addressed adequately.

A more formalized, rich exchange of knowledge between older mentors and younger, less experienced staff has suffered in recent years and needs to be revitalized. The last business down cycle made it easy to turn the firm's efforts elsewhere but this is something that can no longer be ignored, whether or not the market is strong or weak. Mentors will not be around forever! There appears to be little forward planning regarding a comprehensive staff development, knowledge management, and technological development effort. Instead, greater emphasis is placed on day-to-day operations, meeting schedules and budgets. An excellent opportunity exists to not only ensure appropriate knowledge transfer takes place in its own right but also for the BU to gain an advantage over its competitors as many also appear to be taking a 'laissez-faire' attitude.

#### *7.2.1.5 Deal with Rising Mine Development Costs*

Firms that can significantly and consistently reduce clients' costs and schedule – and do the *right* things 'better, faster, cheaper' as a major competitor of the BU would say – will achieve a competitive advantage. There is a fine distinction to be made between reducing the BU's own operating costs and decreasing the clients' engineering costs and plant operating costs. The

former deals with the BU's own operational efficiency and productivity. The latter has to do with producing a competitive bid to win the project in the first place and then producing a design that is cost-effective from a combined capital expenditure, operating, and maintenance perspective.

Overall expenditures to develop mine sites and processing facilities are quickly becoming extraordinarily expensive due to ever more rigorous permitting requirements and rapidly increasing materials and equipment costs. There is also a tendency for owners to choose to accept work to develop remote and inhospitable sites far away from skilled labour, existing infrastructure and other support services. For example, a process plant in an isolated location such as a jungle in New Guinea or the far north might represent about 15% of the total installed cost (TIC) of a project. The other 85% represents all other costs required to achieve this. On the other hand, a similar plant in Nevada might represent about 60-70% of the TIC where the logistics, administration and infrastructure charges represent just 30-40% of the total. The greater elapsed time from start to finish also allows risk factors to increase and this greater uncertainty translates into higher costs.

#### *7.2.1.6 Manage in a 'Lumpy' Business*

The mining EPCM business has always been cyclical and this will continue. In order to mitigate the lumpiness, some of the components of the business that are particularly sensitive to, or react poorly to outside forces, could be removed. By maximizing certain known elements, the BU can control outcomes more predictably. These factors include employee demographics to some extent, use of contingent labour, possibly using a more highly dispersed workforce that regularly works via remote means, and capitalizing on more constant revenue streams.

The GS's senior management is very focused on increasing operational efficiency in an effort to reduce costs. For instance, during the weak market of the last few years, internal cost cutting generally involved cutting staff or asking them to accept reduced work hours, minimizing discretionary travel, and freezing computer purchases. However, this approach does not align with a differentiated strategy. The only way to ease the situation so as not to (however slightly) reduce revenue or profitability targets is to leverage efficiency through improved work practices. While this can be quite challenging to achieve, it will give managers a bit of room to manoeuvre so that they can retain and develop key personnel and continue to produce high quality and specialized services. This protects the firm's reputation, keeps morale intact and preserves core competencies.

Since the GS expects certain levels of both revenue and profits to be met, this entails that the BU respond with a mix of high margin, low revenue, feasibility work coupled with lower margin, high revenue, detailed EPCM projects. Those employees with broad experience in a variety of technologies and processes, who are able to work on assignment abroad, and who can shift between technical and managerial work, provide the flexibility required to soften the peaks and valleys of consulting work. They are valuable assets.

### **7.2.2 Longer Term**

*Identify process technologies and project execution techniques for further development and establish venues for proprietary revenue streams.* The writer believes that the first idea put forward in Section 7.2.2.1 is truly viable and something that the BU should develop fully. While the second idea described in Section 7.2.2.2 is more risky, unique, and controversial – as viewed from the perspective of the status quo – it too is offered for serious consideration.

#### **7.2.2.1 Develop a 'Modularization' Revenue Stream**

The BU has an opportunity to capitalize on its knowledge of 'modularization' or modular construction techniques and leverage this know-how to create a saleable, packaged service, consisting of a branded project execution method. It has incorporated modularization in the past but on an ad hoc basis. By developing a generic framework and methodology that integrates design, supply, logistics, onsite coordination, and inspection, and selling it as a system, the BU would be truly differentiating itself. Lessons learned from these previous jobs as well as the modularization study prepared for a key client in 1999 are a good point to start building a framework from.

In order to make this work successfully, the BU must commit adequate funds and assign a team to prepare a realistic and workable EPCM modularization 'method'. An overhead project to build a workable framework, enlist appropriate suppliers, and prepare an execution plan with the rest of the engineering services group, is required to accomplish this step change in approaching modularization work as a method and to raise it to the next level – that of a commercially viable, packaged, service 'product'. A parallel project would be to customize the framework for cold weather work or for projects located in tropical regions. Also, efforts could be focused on parts of mineral processing facilities that are present in most plants such as water

and sewage treatment units or filtration and filter cake load-out equipment. The BU could also consider patenting this know-how and selling it as a separate revenue stream.

#### *7.2.2.2 Develop Future Technology Innovations*

If the BU truly wants to differentiate itself and gain a competitive – preferably, sustainable – competitive advantage, it *must* go beyond the business of what is essentially selling billable hours. This means moving from being an applications engineer to include some form of R&D in its make-up. It also infers taking on greater risk and going in a totally different direction although this would not be meant to supplant the traditional EPCM work but to augment it with added value. A start would be to promote an entrepreneurial environment, recognize initiative, and encourage informed risk-taking. Over time, the BU could identify, develop and patent proprietary process technologies to be sold separately or incorporate them into appropriate BU EPCM designs.

In past years, another business unit in the GS produced a handful of chemical processing related patents but promptly sold them. In one case, another company bought its NCG (non condensable gas) patent, commercialized the process, and over the past couple of decades has built a very successful, global design-build business. One could look at this either as a lost opportunity on the part of that business unit or as ready cash in hand, sans risk. Or, perhaps the company was following a strategy of producing patents and then selling them, thereby choosing to forfeit its rights and control of possible future profits for assured current gains. The reason for highlighting this example is to parallel the BU's situation. The BU might consider pursuing this idea further by using its existing knowledge resources to either create patent-able proprietary process technologies and sell patents or acquire others' technology and commercialize it. The BU could do this through joint ventures with mining companies, partnering with an outside party or perhaps consider purchasing and operating its own laboratory. It might be appropriate to set up a separate company to do this and isolate the risk.

### **7.3 CONCLUSIONS**

It is recognized that further examination as to how, when, and where is needed to thoroughly prepare a revised strategy but it is something to be addressed outside of this paper. The BU will require additional operating funds from the GS and PC to enact most, if not all of

these recommendations and a thorough business case must be developed as justification. While a differentiated strategy can be expensive to apply, the future gains should make it worth the while.

Both the short term recommendation to revise the approach used to win larger project detailed EPCM work and the longer term recommendation to develop proprietary technology and project execution practices, will strengthen the firm's strategic focus and help to continuously improve its performance.

Improving its EPCM win rate in obtaining larger projects will take a concerted effort on the part of the BU. Bolstering the business development effort, improving onsite safety records, attracting and retaining key people, initiating a formal KM program are seen as primary steps in supporting this goal. Addressing rising mine development costs through improved operational efficiency and managing effectively in a volatile industry are secondary issues. Albeit important, they constitute normal, everyday management challenges.

Taking the firm to new levels of technological and project execution innovation is a longer term goal but one that cannot be ignored. Developing proprietary processes and techniques will help differentiate the BU from its competitors and create a competitive advantage. How thoroughly and quickly the firm addresses these strategic issues will have far-reaching effects.

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