

**ABSTRACT NUMBER: 002-0451**

**ERP SYSTEMS IN MINING INDUSTRY: STUDYING THE SOFTWARE  
FUNCTIONALITY AND THE VALUE CHAIN.**

**SECOND WORLD CONFERENCE ON POM  
AND  
15TH ANNUAL POM CONFERENCE  
CANCUN, MEXICO, APRIL 30 - MAY 3, 2004**

**Paulo Fernando Tardelli Sachs, B.Sc.(Eng), MBA**

Mining and Petroleum Engineering Dept. of the Polytechnic School, University of Sao Paulo.  
Av. Prof. Mello Moraes, 2373 – Sao Paulo, SP – 05508-900 – Brazil  
Email: psachs@uol.com.br – Phone 55 11 3091 6038 – Fax 55 11 3846 4501

**Fernando José Barbin Laurindo, PhD Professor**

Production Engineering Dept. of the Polytechnic School, University of Sao Paulo.  
Av. Prof. Almeida Prado, Trav. 2, 128 – Sao Paulo, SP – 05508-900 – Brazil  
Email: fjblau@usp.br – Phone 55 11 3091 5363 ext 454 – Fax 55 11 3091 5399

**Giorgio Francesco Cesare de Tomi, PhD Professor**

Mining and Petroleum Engineering Dept. of the Polytechnic School, University of Sao Paulo.  
Av. Prof. Mello Moraes, 2373 – Sao Paulo, SP – 05508-900 – Brazil  
Email: gdetomi@usp.br – Phone 55 11 3091 6038 – Fax 55 11 3846 4501

**Conference track:** Enterprise Resource Planning

## **ABSTRACT**

*ERP systems have been widely implemented nowadays in several industries. However, as ERP was originally designed to fit former MRP and MRP II users, mostly in discrete manufacturing, few related research has been focused on Mining industry.*

*On the other hand, process industry – and the mining industry in particular – presents many peculiar characteristics, which are difficult to comply with ERP systems standard functionalities, and very limited research has been developed covering this industry segment.*

*The objective of this paper is to identify how ERP systems manage the functional areas of the mining industry, and how they fit into the mineral value chain IT requirements. A secondary objective is to identify the gaps between ERP's functional capabilities and the mining industry business requirements, and to point out the perceived benefits they generate to the companies.*

*This paper employs a case study methodology*

## **ACRONYM KEY**

API – Application Program Interface

APS – Advanced Planning and Scheduling

CIO – Chief Information Officer

ERP – Enterprise Resource Planning

IT – Information Technology

KPI – Key Performance Indicators

LIMS – Laboratory Information Management System

MES – Manufacturing Execution System

MRP – Material Requirement Planning

MRP II – Manufacturing Resources Planning

## 1. INTRODUCTION

First initiatives to implement ERP (Enterprise Resource Planning) in Mining happened globally in the early 90s. Like in many other industry segments, legacy systems – mostly old fashioned and mainframe based – had their life abbreviated by the year 2000 bug, and were replaced at the end of the decade by commercial ERP systems.

In Brazil, maybe due to the conservative nature of the mining business in the country, it was verified a different situation:

- The main Brazilian mining company, and one of the largest in the world - CVRD (Companhia Vale do Rio Doce) – chose to adapt the mainframe based legacy systems, and to evaluate more carefully its business and IT (Information Technology) management model, while at the same time faced an important reorganization of the shareholders structure. Just recently this company decided to buy a commercial ERP package, which is still being implemented.
- Multinational companies – medium size subsidiaries of large global mining groups – took one of two apparently opposite directions: some adopted the same ERP solution used globally by the group, while others implemented local low-end solutions. The main reason for those who took the latter decision was the scope, complexity and cost of the high-end ERP project, compared to the size and needs of the Brazilian operations.
- Medium size national or multinational companies – stand alone mines or part of large industry groups more focused on other industry segments – decided mostly to implement ERP packages.

In all these cases, the objectives, results and benefits expected and obtained are very questionable, considering that the mining industry presents many peculiar characteristics, which are difficult to comply with ERP systems standard functionalities.

This paper explores the business characteristics of the mining industry, proposing a “Mining Value Chain” based on Porter’s business value chain (Porter and Millar, 1985). It also identifies – using the case study methodology – how ERP systems manage the functional areas of the mining industry, and how they fit into the mining value chain IT requirements. It also points out the perceived benefits they generate to the companies and identifies the gaps between ERP’s functional capabilities and the mining industry business requirements.

## **2. ERP SYSTEMS**

According to Hicks and Stecke (1995), Enterprise Resource Planning, or ERP, is a term first used by the Gartner Group. It is not a revolutionary conceptual breakthrough, a major technological advance, nor a truly new idea: instead, it’s a useful paradigm, essentially concerned with making sure that a firm's manufacturing decisions are made taking into account their impact on the supply chain, both upstream and downstream. Besides, production decisions are affected by and affect all other major areas in the business, including engineering, accounting, and marketing. In order to make better decisions, one needs to take into account all these important interactions within the business.

Davenport (1998) describes ERP systems as commercial packages promising seamless integration of all information flowing through a company – financial and accounting, human resources, supply chain, and customer. The systems imposes its own logic on a company’s strategy, organization, and culture: it pushes toward full integration when a certain degree of

segregation might be desired, and it pushes toward generic processes even when customized processes may be a source of competitive advantage. The central database, at the heart of the ERP system, draws data from and feeds data into applications supporting diverse company functions and departments. This single database architecture streamlines dramatically the flow of information throughout the whole business.

Correa et al. (1997) define ERP as integrated modules that provide information for the decision making requirements throughout the whole organization, from a single and non redundant database. The system, considered as an evolution of MRP II, controls all the resources of the organization, and not only the resources directly employed in manufacturing.

Langenwaller (2000) describes the evolution history of ERP, as a third generation of systems that started in the late 1960s with MRP (Material Requirement Planning), then superseded in the 1970s by MRP II (Manufacturing Resources Planning) which integrated material planning, purchasing of production material, accounting and the plant floor.

Ptak and Schragenheim (2000) point out that ERP is not just MRP II with a new name or running in a client-server architecture: ERP is the next logical sophistication level in the evolution of IT tools, bringing new integrated functions to the resource planning capabilities.

Laurindo and Pessoa (2001) state that ERP systems emerged in the early 90s as an evolution of MRP II (manufacturing resources planning) systems, therefore expanding their scope beyond manufacturing and production planning, and reaching other functional areas. As these systems covered all the activities within the company business scenario, they were generically named Enterprise Management Systems.

Zwicker and Souza (2003) defined ERP as integrated information systems, available as commercial software packages, with the purpose to support most operations of an industrial organization. These packages present some characteristics that differentiate them from legacy systems and other software packages, such as:

- They are commercial software packages;
- They bring incorporated business processes models, so called *best practices*;
- They are integrated information systems, using a single corporate database;
- Provide extensive functional scope;
- Require specific adjustment procedures to be properly used by one given organization.

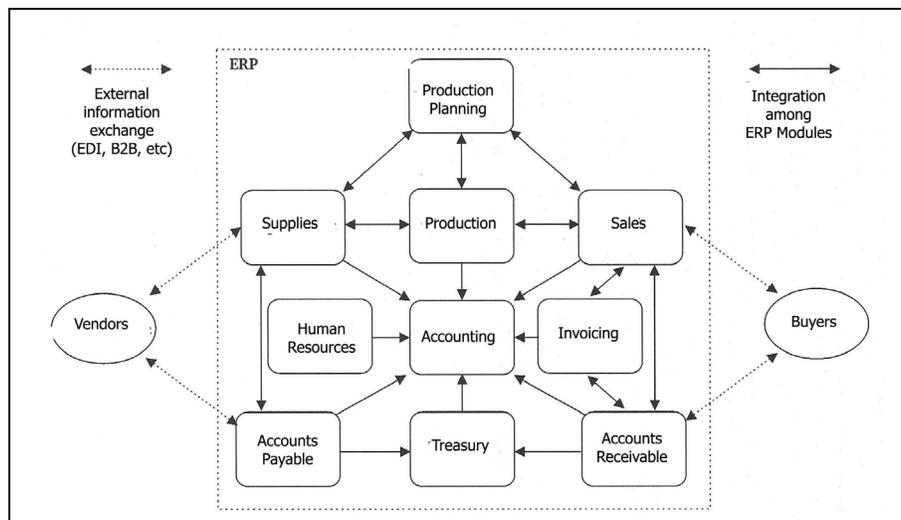


Exhibit 1: Main ERP modules in an industrial enterprise (Zwicker and Souza, 2003)

Most ERP packages are broken down in modules – sometimes even commercialized and implemented individually – that handle several functional areas, or departments, of the company. However, these modules interact as the business processes require information exchange among different departments. These interactions, performed in real time and using information stored in a single database, result in what is possibly the main benefit of the whole system: the integration and availability of consolidated, non redundant data throughout the whole organization.

### **3. MINING INDUSTRY CHARACTERISTICS**

Mining is part of the so called Process industry, that comprises about half of the manufacturers worldwide (Ptak and Schragenheim, 2000). Mining is typically a large capital intensive enterprise, with heavy equipment and large plants. In order to achieve the best return on assets – considering it's a capital intensive business – and lower production costs, mine equipment and plants normally run 24 hours a day, 7 days a week. Therefore, the main focus for any ERP in this industry should be keeping the heavy equipment and plants running, through effective capacity and maintenance management. Thus, avoiding idle time by accurate production scheduling, and avoiding unexpected breakdowns by scheduling preventive and predictive maintenance tasks, are crucial aspects for the business performance.

A unique mining industry characteristic, intrinsic of its own nature, is the fact that the main raw material – the ore – is originated from an internal source, the mine. Despite the development and high technology deployed in geologic modelling and geostatistics systems, estimated ore quality parameters – such as mineralogy, metallurgical and chemical grades, granulometry – will always carry a level of uncertainty and an estimation error, that will only be known after the exploitation, already in the production process.

The final product is typically obtained after the ore is submitted to successive operations of comminution (crushing and grinding) and classification by size, mineral concentration and metallurgical and/or chemical transformation.

Ptak and Schragenheim (2000) present the concept of “Plant A” and “Plant V” industries:

A “Plant A”, or a standard discrete manufacturing plant, employs traditional MRP planning and scheduling logic. The components of the bill of materials, their characteristics, and the timing

required for assembly are perfectly determined and broken down from the production plan or, ultimately, from the sales plan or sales orders.

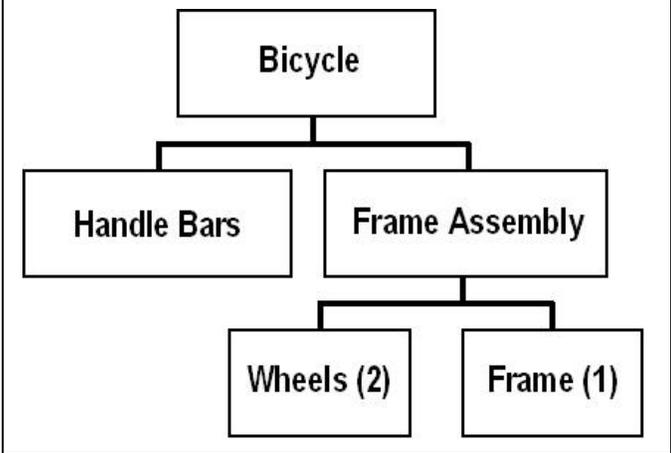


Exhibit 2: Bill of Material – Manufacturing (adapted from Heizer and Render, 2001)

In a “Plant V”, or a mining complex, MRP planning and scheduling logic does not fit. This plant takes a few raw materials to make several final products. The uncertainties in the production process require the existence of buffers, normally stockpiles of intermediate and final products. Mining companies normally produce commodities to stock, not to orders.

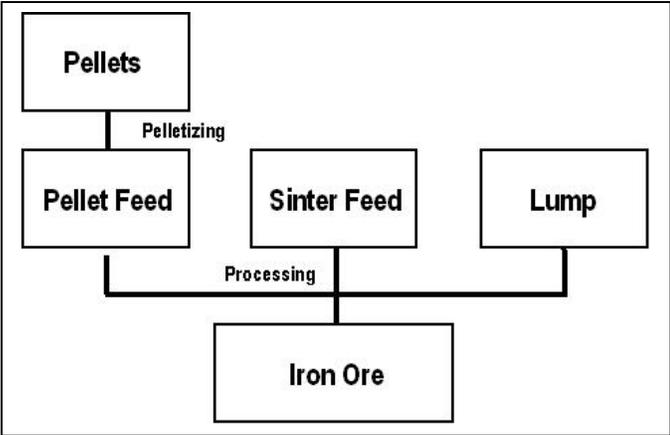


Exhibit 3: Bill of Material – Mining

Another important restraining factor for the planning and scheduling function is the sequencing of the mine exploitation: in order to be properly extracted, one specific ore block must be at the face of the open pit or underground mine, so mining equipment can have access to it. A manufacturing plant does not have this kind of restraining factor, as any component in a production material warehouse can be easily accessed at once and fed into the assembly line.



Exhibit 4 – Pallet racks with components in Manufacturing

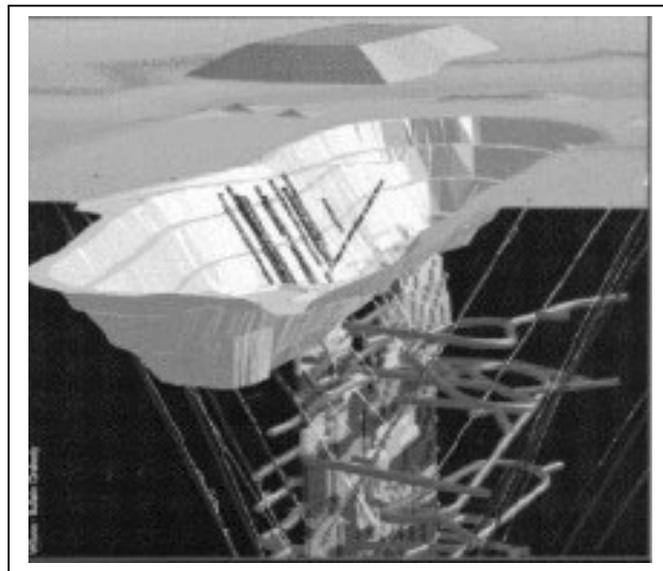


Exhibit 5 – Sequencing 3D model in an open pit and underground Mine

Even if process industries have always been a challenge for traditional MRP systems, some of the segments – such as pharmaceutical, chemical, food and beverage, etc. – could be served by standard or specialized MRP systems, reasonably suited to manage batch or simple continuous flow plants. However, as previously exposed in this chapter, MRP systems simply do not adhere to the mining industry production flow requirements.

Since ERP can be considered as an evolution of MRP and MRP II systems (Hicks and Stecke, 1995; Correa et al. 1997; Langenwalter, 2000; Ptak and Schragenheim, 2000; Laurindo and Pessoa, 2001), with a strong emphasis on production and production planning and scheduling, it is possible to understand the reasons why it is difficult to effectively use an ERP system in the most important business processes of the mining enterprise, that are related to the production chain.

#### **4. ERP SYSTEMS AND THE MINING VALUE CHAIN**

Porter and Millar (1985) state that IT is changing the way companies operate, affecting the entire process by which companies create their products and do their business. Furthermore, it's reshaping the way companies deliver products, services and information to their customers, therefore creating value for their buyers.

An important concept to highlight the role of IT in business is the “value chain”, that divides the company's activities into the technologically and economically activities it performs to do business.

A company’s value chain is a system of interdependent activities connected by linkages. These linkages exist when the way in which one activity is performed affects the cost of effectiveness of other activities in the value chain.

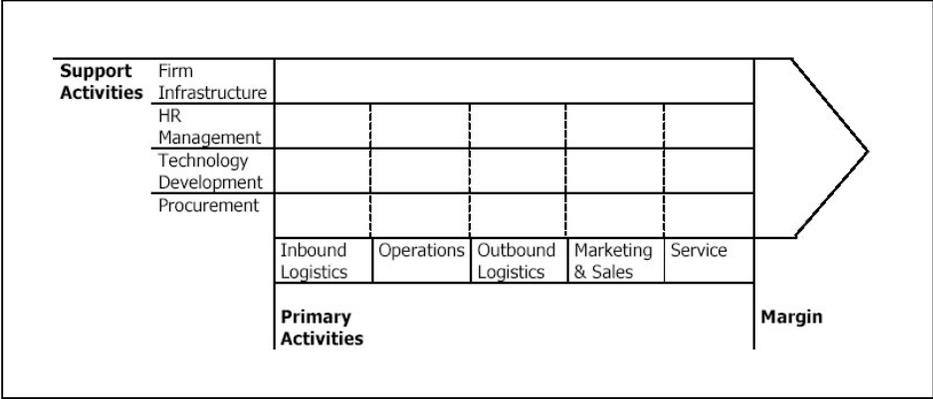


Exhibit 6 – Business Value Chain (Porter and Millar, 1985)

Primary activities are those involved in the production, or the creation of the final product, its marketing, sale and delivery to a customer, and its after sale support and servicing. Support activities provide the inputs and infrastructure that allow the primary activities to take place.

In the mining industry case, it’s proposed for the primary activities the following adaptation and further detail of the value chain:

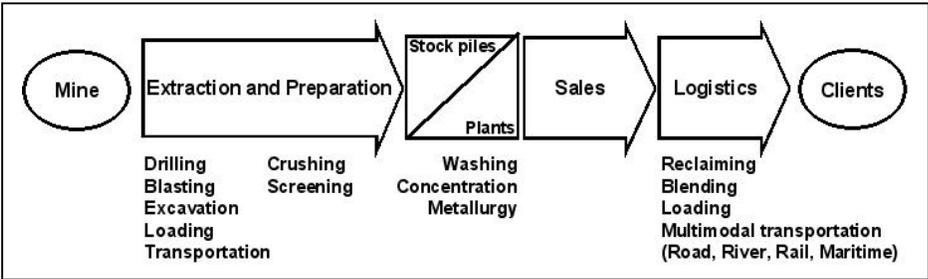


Exhibit 7 – Mining Value Chain

The Mining Value Chain presents the following peculiarities, compared to the generic value chain proposed by Porter and Millar (1985):

*Inbound logistics* are mostly performed through ore extraction unit operations, and its subsequent preparation to feed the transforming processes that follow. The reason why is that, as already seen, the ore is the main raw material in a mining enterprise, although other important products – fuel, explosives, chemicals, parts, lubricants, etc. – are also part of the inbound logistics.

*Operations* can involve all kinds of industrial operations, from small and simple crushing and screening plants (i.e. industrial minerals) to large and complex concentration (i.e. iron ore), metallurgical (i.e. gold, copper, aluminum, etc.) or chemical plants (i.e. fertilizers).

Information technology is permeating the value chain at every point, changing the way activities are performed and the nature of the linkages among them. Every activity in the value chain has both a physical and an information component.

The physical component encompasses the tasks – productive or clerical – required to perform the activity, usually well dominated by the industry. The information component involves all the knowledge required to do that task properly – what, when, where, how – and then bringing all the new information generated in that activity to other related or dependent activities, through the linkages.

In theory, as ERP promises seamless integration of all the information flowing through a company – financial and accounting, human resources, supply chain, and customer (Davenport, 1998), these systems should manage and integrate all these activities within the value chain. This affirmative will be investigated in the case study.

## **5. RESEARCH METHODOLOGY: THE CASE STUDY**

The key research question related to the aims of this paper is: how extensively can an ERP system be deployed and used in a mining enterprise, considering the industry's characteristics, requirements and limitations, *vis-à-vis* its business value chain?

An exploratory qualitative case study approach was adopted (Yin, 1994). Questionnaires and personal interviews were used to collect data. Secondary data were obtained in publications and academic work.

### 5.1 EXPLORATORY STUDY

Initially, a questionnaire was sent to CIO or equivalent level of eight Brazilian mining companies that followed the segmentation presented in Session 1, with the following questions:

#### Company Information

Company Name

Annual Revenue

Number of Employees

#### ERP Information

ERP System Vendor

Implemented Modules

SW and HW Platform (servers, database, etc.)

Go-live Date

Number of ERP Users

Why decided to implement an ERP System

### Mining or Strategic Systems and Integration to ERP

Which mining specific or strategic systems were kept, and if and how they were integrated or interfaced with the ERP system.

### ERP Benefits

23 closed questions were asked based on the work of Poston and Grabsky (2000), Souza, (2000); Colângelo Filho, (2001); Zwicker and Souza, (2003), and also in information collected in the preparatory interviews.

The respondent should rank with points the potentially obtained benefit, with the following criteria:

- (0) Not verified
- (1) Somehow verified
- (2) Significantly verified

The questionnaire assured full confidentiality and anonymity for the respondents.

## 5.2 EXPLORATORY STUDY RESULTS

As the aim of this paper is to identify how ERP systems manage the functional areas of the mining industry; how they fit into the mining value chain IT requirements; which perceived benefits they generate; and what is the gap between ERP's functional capabilities and the mining industry business requirements, all focus will be kept on these particular answers.

From the universe of eight mining companies, two are still implementing ERP packages and so did not qualify. Five out of the six remaining ones replied on time and were considered in the final results tabulation.

## ERP Modules Implemented

<b>FREQUENCY</b>	<b>MODULE</b>
100%	Finance
100%	Materials / Supplies
80%	Human Resources
60%	Maintenance

### Exhibit 8 – ERP Modules Implemented

One of the respondents runs a Distribution module. However, it's not related to the mining business, but to another industry segment, so it was not considered in this tabulation.

No respondent uses the ERP for Production or Production Planning.

### Mining or Strategic Systems and Integration to ERP

Most of the respondents decided to keep using dedicated systems for their geology and mine planning, production and sales needs, normally not integrated nor interfaced with the ERP.

Only one of them – from now on identified under the alias of Aquamarine Mines – decided to integrate their internally made mining management system to their ERP of choice. This specific mining management system managed production, quality, sales, final product inventory, and shipping.

## Benefits

---

<b>RANKING</b>	<b>FREQUENCY</b>	<b>BENEFIT</b>
1	100%	Productivity improvement
2	90%	Single and consistent database, less errors
3	90%	Data re-entry elimination or reduction
4	90%	Financial close cycle reduction
5	80%	Inter-departmental cooperation improvement
6	80%	Easy and immediate access to information
7	70%	More time spent in departmental core activities
8	70%	Re-work reduction
9	60%	Better business processes implemented
10	50%	Overall productivity improvement
11	50%	Internal processes flexibility improvement
12	50%	Procurement cost reduction
13	40%	Supplier relationship improvement
14	40%	Personnel reduction
15	40%	Overtime reduction
16	40%	Inventory reduction
17	30%	Equipment and Plants productivity improvement
18	30%	Business key performance indicators improvement
19	20%	Profit increase
20	20%	Image in the marketplace improvement
21	20%	Material loss reduction
22	20%	Maintenance cost reduction
23	10%	Customer satisfaction improvement

---

Exhibit 9 – Ranking of Benefits

### Effectiveness of the ERP Investment Perception

All the respondents believe that the company is satisfied with the ERP investment. Four of them believe that top management would approve the project as it is, and one believes that the scope would be increased.

However, it must be emphasized again that this is the perception from the CIO's stand point.

### 5.3 CASE STUDY

Considering the richness and consistency of the material provided by Aquamarine Mines, it was decided to proceed with the case study methodology, in order to better understand – specifically in this mining organization – the business value chain, and the information flow interconnecting the systems within the value chain.

An interview with Aquamarine Mines' CIO was scheduled and performed, having the main following questions in mind:

- How systems – either ERP or internally developed or package systems – cover the activities of the business value chain?
- Why ERP modules were not implemented to manage Production and Production Planning activities, and why the Company decided to keep the legacy system to manage these activities?
- How ERP system changed the internal (inter-departmental) and external (vendors and clients) chain of relationship?
- How is the level of integration and the information flow among all these systems?
- How is the Company satisfied with the ERP implementation? Why?

## 5.4 CASE STUDY RESULTS

In order to have an initial view of the enterprise and management systems, packages and legacy systems were placed over the activities of the value chain, as follows:

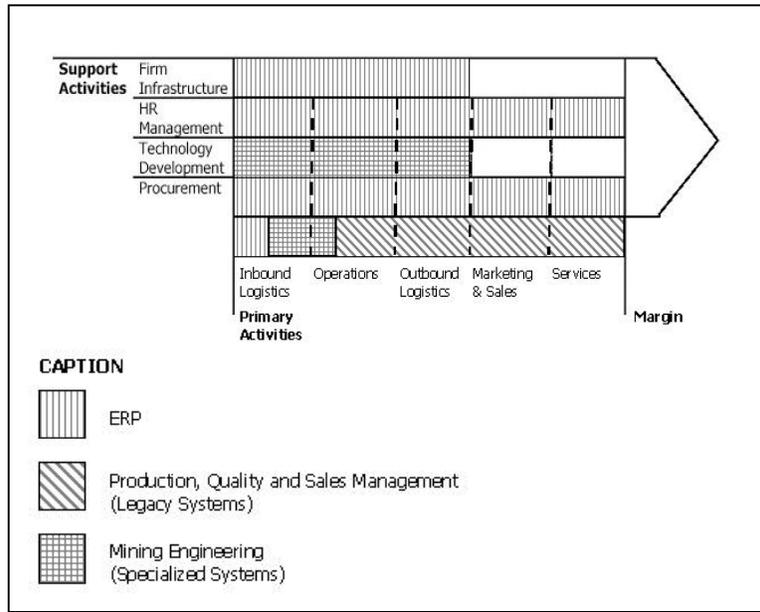


Exhibit 10 – Business Value Chain System Coverage

ERP package comprises the following modules and departments managed: inventory, procurement, maintenance, accounts payable and receivable, treasury, fixed assets, accounting, budgeting, and human resources.

The so-called Production, Sales and Quality Management System, totally in-house developed, handles production (tonnage and quality by product), inventory (tonnage and quality of each final product in the stock piles along the mining and transportation chain), shipping and simple “what if” shipping simulation, quality monitoring, sales and customer complaints. The system also provides some basic KPI’s, such as productivity, budget/actual, equipment failure, etc.

Mining Engineering packages involve typical applications, such as geological modelling, mapping, geostatistics, reserves calculation, mine planning, rock mechanics, environmental management and truck dispatching.

When Aquamarine Mines evaluated ERP packages, they did not find any vendor with the required features to handle properly their planning, operations and outbound logistics requirements. Although some of these vendors claimed they had the right solution, they were not able to prove, clearly demonstrate or to convince the project team about these features.

Sales and after sale services were not high priority areas regarding the new systems, due to the limited number of customers (less than a hundred), and the specific invoicing needs – containing both legal and technical mandatory information – for export and for the internal market.

As the Aquamarine Mines project team decided that their integrated legacy systems were far superior than any vendor in operations, outbound logistics, sales and services functionalities, they decided to keep it. That decision was clearly not taken to keep in-house developed strategic systems against commercial ones, but just as a matter of technical comparison, reliability and price-performance.

Just after the ERP implementation, the project team faced what should be a natural resistance from the users, that were satisfied with the former legacy system and complained about difficulties and procedure changes of the new ERP package. When maturity level was reached, however, benefits of the up-to-date systems architecture and better practices started to flourish. Special recognition was given to the following benefits: easy and immediate access to information; single and consistent database, with less errors; more time spent in departmental core activities; and productivity improvement.

Externally, it was verified a significant improvement in the procurement practices and in the relationship with suppliers: special focus was put on vendors systematic evaluation, with the goal to reduce the number of vendors and to keep only the ones matching minimum quality requirements. Long term contracts with selected vendors increased productivity and end user satisfaction, while at the same reduced overall costs and delivery time.

As the ERP system was not deployed in Sales or Customer Services, there was no impact in customer relationship.

All the applications have a significant level of integration, thorough on-line or batch APIs. Applications running in a lower hierarchical level feed data to applications in higher levels. Very limited information is provided from top tiers to lower tiers.

The following chart shows how these systems communicate:

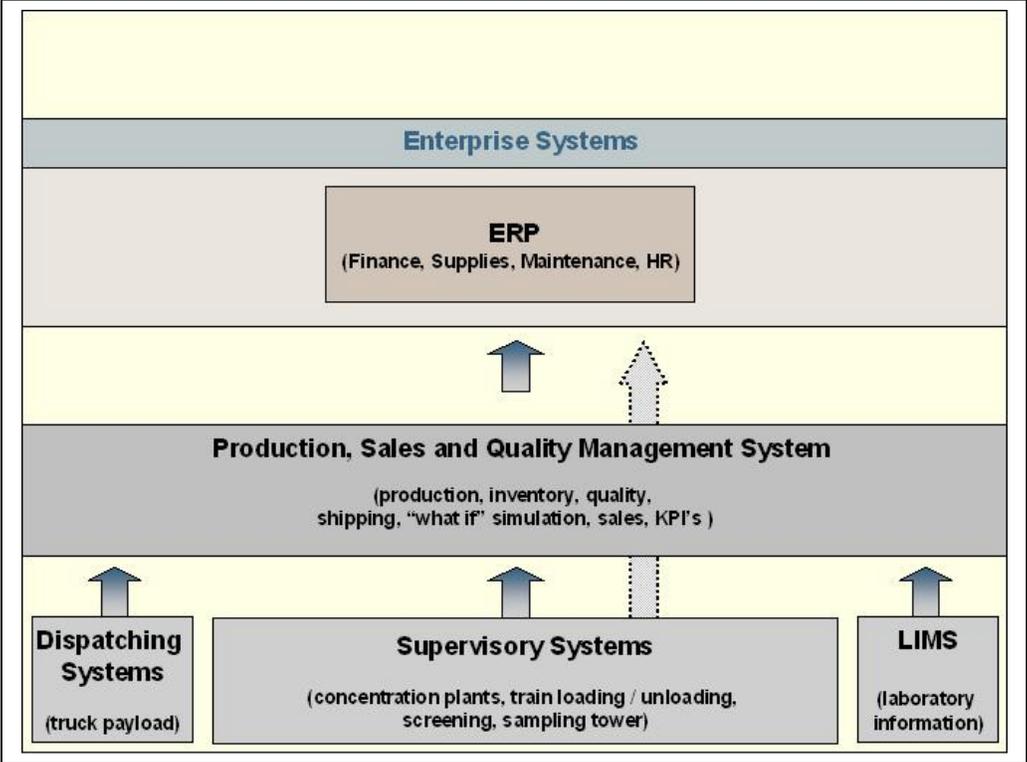


Exhibit 11 – Systems Integration and Information Flow

Aquamarine Mines has recently performed a benchmarking study, involving other mining companies and also similar enterprises from other industry segments. The result of the question to top executive level regarding their satisfaction with ERP systems showed only neutral to moderate satisfaction. The justification given was that the impact of ERP system on business performance and results was minimal. Benefits achieved affected much more punctually tasks performed at department level, than the business itself.

## **6. CONCLUSION**

It's clear that a standard ERP package cannot be considered a real enterprise system for a mining company: it's lack of functionality to fit the industry's requirements can be perceived since none of the studied mining companies used ERP modules in production, production planning, outbound logistics or sales, or the business primary activities (Porter and Millar, 1985). If the system does not manage the primary activities, much more business related, it will not result in significant benefits for the whole business.

On the other hand, ERP systems fit very well the secondary or support activities, such as finance, supplies, maintenance and materials – mostly, non-productive – and human resources. This observation matches with Laurindo and Mesquita (2000) statement that many ERP implementations involve only administrative modules, and not production ones. If in manufacturing the production specific functionality is usually provided by a MRP II package, this study did not identify a standard or predominant package or module that suits specifically the mining industry.

The most significant benefits mentioned – considering the ones in the first quartile, or: productivity improvement; single and consistent database, less errors; data re-entry elimination or reduction; financial close cycle reduction; inter-departmental cooperation improvement; and

easy and immediate access to information – appear to be very aligned with the ERP architecture (integrated application modules running on single data base) and the incorporated best practices, as mentioned in the literature (Correa et al. 1997; Davenport, 1998; Zwicker and Souza, 2003).

It was also clear in the studied case that the ERP covered mostly the support activities, with the exception of a minor participation in inbound logistics, as it manages all external supplies. The Production, Sales and Quality Management System – considered internally as a MES – performs partially this function without the classic approach of bringing down a long or medium term plan from the ERP or the MPR II, and then managing and scheduling the activities at the plant floor to match the plan (Langenwalter, 2000). The mining engineering systems, despite their importance to properly mine the right product, at the right time and on budget, are not integrated with any system within the value chain.

ERP did not change the way the company do business with vendors (Gereffi, 2001). However, it provided a consistent tool to better select and qualify vendors, strengthening the relationship with the ones with better measured performance.

Further studies will be done to identify and propose a better methodology to implement ERP systems in mining companies, providing more effective interaction with the primary activities.

It will be investigated how to better integrate key functions in ERP (such as sales, business planning and budgeting) with MES (production scheduling and production management) and with Mining Systems (mine planning), in order to get more synergy from all these key systems.

Other tools to streamline the process and to avoid high level of intermediate and final product inventory, such as APS (Advanced Planning and Scheduling), will also be investigated.

## REFERENCES

COLÂNGELO FILHO, L. “Implantação de Sistemas ERP: um enfoque de longo prazo.” São Paulo, Editora Atlas 2001.

CORRÊA, H.; GIANESI, I.G.N.; CAON, M. “Planejamento, programação e controle da produção: MRP II / ERP: conceitos, uso e implantação.” São Paulo, Editora Atlas 1997.

DAVENPORT, T.H. “Putting the Enterprise into the Enterprise System.” Harvard Business Review, v.76, n.4, p.121-131, Jul./Aug.1998.

GEREFFI, G. “Beyond the Producer-driven / Buyer-driven Dichotomy”. IDS Bulletin, Vol 32, No 3, p.30-40, 2001.

HEIZER, J.; RENDER, B. “Operations Management.” 6th Edition, Prentice Hall, 2001

HICKS, D.A.; STECKE, K. “The ERP maze: Enterprise resource planning and other production and inventory control software.” Industrial Engineer, Aug 1995, Vol.27, Iss.8, p.12-16.

LANGENWALTER, G. “Enterprise resources planning and beyond: integrating your entire organization.” Boca Raton, St. Lucie Press, the APICS series, 2000.

LAURINDO, F.J.B. “Tecnologia da Informação: eficácia nas organizações”. São Paulo, Futura, 2002.

LAURINDO, F.J.B.; MESQUITA, M.A. "Material Requirements Planning: 25 anos de história; uma revisão do passado e prospecção do futuro." Revista G&P: Gestão & Produção, Vol.7, n.3, p.320-337, São Carlos, Dezembro 2000.

LAURINDO, F.J.B.; PESSÔA, M.S.P. “Sistemas Integrados de Gestão” in Amato Neto, João, org. Manufatura classe mundial: conceitos, estratégias e aplicações. São Paulo, Atlas, 2001, p.114-130.

PORTER, M.E.; MILLAR, V. “How information gives you competitive advantage”. Harvard Business Review, p.149-160, Jul/Aug 1985.

POSTON, R.; GRABSKY, S. “The Impact of Enterprise Resource Planning Systems on Firm Performance.” 21st International Conference on Information Systems, p. 479-493, Australia, 2000.

PTAK, C.A.; SCHRAGENHEINM, E. “ERP: Tools, Techniques, and Applications for Integrating the Supply Chain.” Boca Raton, St. Lucie Press, the APICS series, 2000.

SOUZA, C.A. “Sistemas integrados de gestão empresarial: estudos de casos de implementação de sistemas ERP.” Dissertação de Mestrado. São Paulo, 2000. Faculdade de Economia, Administração e Contabilidade, Universidade de São Paulo.

YIN, R.K. “Case Study Research – Design and Methods.” 2<sup>nd</sup> Edition, London, Sage Publications, 1994.

ZWICKER, R.; SOUZA, C.A. “Sistemas ERP: Conceituação, Ciclo de Vida e Estudos de Caso Comparados” in Souza, C.A.; Saccol, A.Z., org. Sistemas ERP no Brasil: (Enterprise Resource Planning): teoria e casos. São Paulo, Atlas, 2003, p. 63-87.