Influence of Computers and Information Technology on Process Operations and Business Processes—A Case Study

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Abstract

Managing a company for longevity is different than managing for the stock price, the former requires flexibility, the latter requires a very short term (quarterly) focus. This paper describes some of the challenges to the management of industrial complexes brought about by the explosion of innovations in the informations system world. It focuses on a case study of a large, integrated mining company in Chile, Codelco, and describes how they have very successfully addressed this problem with largely packaged software and their own initiatives.

Keywords

Information systems, Mining, Optimization, Desktop, Infrastructure

Prices, products, and markets are changing more rapidly every year as information based management replaces the experience based management. Arie P. de Geus, in a short article called Strategy and Learning, observed that the average company survives only 40 years. This study was conducted long before the acceleration caused by the Internet Age so I suspect the number is lower now. He points out that no matter how well a company is managed (e.g. Sears, Penny's), epoch external changes can occur without warning and influence the business in sudden and unpredictable ways. The issue is one of human psychology—"You can not see what your mind has not experienced before, and you will not see that which calls forth unpleasant emotions." This especially applies to new Internet companies that have never experienced the old world values of profits, investment, competition, and growth from within. It also applies to old manufacturing companies that have not experienced new world values of e-Business, direct relations with customers, mind share and globalization.

To survive, companies must create what de Geus called "The Living Company." He also studied companies that had survived over 100 and up to 700 years looking for the secrets of longevity. In his conclusions he noted that "a more open company that involves everybody needed for execution in the planning and decision making process will be more successful in a world which it does not control." It is also clear that the strategy of managing for quarterly profits is quite different than managing for longevity. This changes the basic role of management in an information-based world. In the past, its main role was to allocate the available money generated from profits between the long term good of the company and the short-term demands of the shareholder. With the new demanding shareholder, that role has changed to taking the money left over after giving the shareholders enough to maintain the stock price and using it carefully to keep the company viable. With an Internet company unable to generate profits, the task is more difficult as management also needs to continuously borrow money at usurious rates.

A company is actually its intellectual property, not the mortar and bricks. Its future lies in its ability to create a collaborative environment of its people. It seems so simple—enable and motivate the people that work for the company. They already know how raw materials are acquired, the applicable environmental law, the processes, local conditions, even the limitations of the company and its people. Is it any surprise that they might know more than outside consultants on how to improve the company? If such an environment could be generated, then the 100's of smaller projects would net out large changes and sustained improvement. This is a dramatically different tact than betting the company on a giant software package, whether ERP, CRM, SCM, e-Business, or other "magic bullet." These large, vertically integrated packages do NOT increase the flexibility and enable people, they clamp down on procedures in the hope that in the automation of the business processes lies the efficiency needed to survive. The fatal flaw, as pointed out by de Geus is that it is not efficiency but flexibility that is needed to survive.

An alternative approach could be called IDEA (Infrastructure, Data Collection, Engineering, and Analysis (see `www.osisoft.com` white paper—Just an IDEA). It requires companies to have the methods, vision and faith to put in a system that enables the existing staff. People can then alter the direction of the company with many small moves within and outside their domain. When I wrote the article I had no idea that I would see IDEA in action at a large, state run mining operation in South America. They began this vision in 1997 and were well on their way to success. For all industries, it is worthwhile to analyze their experience.

The company is Codelco and they visualized an Industrial Desktop using Microsoft technology for integration. They combines Microsoft Office and OSI Software PI System to provide a very easy to use, real time development environment suitable for micro projects in the harshest conditions imaginable. Located in Chile, Codelco has five operating Divisions (Chuquicamata, Radomiro Tomic, El Salvador, Andina, El Teniente), each a full mining/metallurgical complex—e.g. mining, concentrators, smelting, refining, leaching, solvent extraction, electrowinning, utilities, and maintenance. In 1997, the group of representatives from each division went to management and made the case that building this people-enabling environment was a strategic move and should be installed without bids, project justification or other methods associated with capital projects. It would be like a PC or telephone, it was just needed—an amazing move for a conservative manufacturer owned by the government. It has been an outstanding success.

It is almost impossible to describe how unusual and dramatically different this is from business as usual. Mining facilities are very large and diverse; they have different instrumentation, different systems, different equipment, different infrastructure, different standards and are actually in different industries (e.g. mining vs. refining) at each site. These sites tend to be remote—one is in an area called Moon Valley because it looks like the surface of Moon, located in the Atacama Desert. The unique feature of this implementation was that it was not just a common environment, but also a common DEVELOPMENT environment that encouraged mini projects by the users with only minimal help from outside or systems people. This was unique in the world for heavy manufacturers. They bet the future of the company on their employees, not an outside consultant working in London. The only question was would it work.

To say that they have won is an understatement. Recently Microsoft unveiled Microsoft.NET—their new initiative. This is an environment, totally compatible with the desktop environment above, that extends the development environment to the Web. This is a remarkable advancement in its own right. Whereas the first generation of browser users were content to look through information easily (i.e. browse), the next generation user will want to perform actions with the same, universal, and easy to use interface. Microsoft.NET is not only the best, it is the ONLY development environment that will allow people to build this next generation system and incorporate their PC. Imagine that you are able to purchase, set up the shipping, track the arrival, receive the invoice, and pay the invoice for a raw material from one integrated browser screen from any location. The remarkable feature is that even though this vision was not even embryonic in 1997, everything that Codelco has done supports this new vision.

I had the privilege in May 2000 of attending one of our Technology Seminars in Santiago and, even speaking no Spanish I could see the creation of "The Living Company." Codelco was to provide a user paper, but instead they produced on quick order not one but several applications done by their own people. These applications drove to the heart of the problems that exist in mining operations located in the high desert—saving water, saving oxygen consumption, reducing environmental emissions, better coordination of resources, saving energy, increasing tonnage, reducing waste, improving quality. These successes were in no small part a result of the low incremental cost of projects, which were not burdened with the cost of the infrastructure.

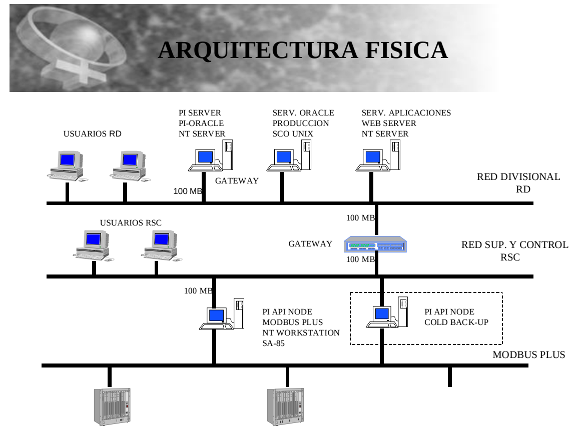

Figure 1: Radomiro Tomic architecture.

Figure 2: Teniente mine/concentrator plants architecture.

From a software perspective, the key was the openness and extensibility of the Microsoft DNA strategy. Not only did most of the people all ready know how to use Excel, Access, and Word, the PI System client (ProcessBook) is based on Microsoft COM/ActiveX technology and contains VBA from Microsoft. Codelco did not complain that they do not have the manpower to improve the operation. Although, like all other industries, they are minimizing manpower, using these Microsoft tools are as natural as writing a memo or building a spreadsheet.

This presentation was only part of the program—it is clear that there are hundreds more of these mini projects that will be envisioned and implemented by the people of Codelco. The first step was to build an infras-

Figure 3: El Teniente projects.

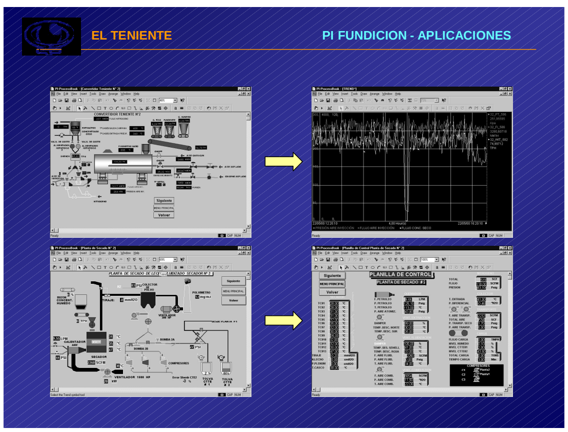

Figure 4: Same displays at El Teniente.

tructure. They have installed 15 PI Systems since 1997 and rolled Microsoft desktops everywhere. They are also cross-pollinating the implementations between Divisions because they have a common environment.

Figure 1 shows what the base infrastructure at Radomiro Tomic Division and Figure 2 shows the oldest systems at Teniente. They presented four separate papers from the different sites and head office with more than 10 separate applications—and a list of future applications.

In Figure 1 you can see the separation between the Control and Divisional Network—the basic data collection is done with a redundant system connected to their Modbus Plus network. There are workstations on the Control Network and the Divisional Network, but the servers that have the real time data (PI), Production data (Oracle) and Web Server are on the Divisional Network. In this way, there can be no interference to the control system or its consoles.

Figure 2 is a similar drawing for the Teniente Mine/Concentrator Plants—the first fully integrated site. The integration means from the crusher at the mine, transfer of ore from mine to crusher and concentrators, tailings management and concentrate filtering. The same basic structure is used except that there is not a separate Control Network. In some cases (e.g. Honeywell TDC3000) this network is incorporated into the control systems. A Modicon Modbus local control network is used at the tailings plant, an Allen Bradley local system is used at the filter plant. Of note here is that this system has continued to expand, e.g. extending the data collection to manual inputs, the railroad car transportation system and the mines, but these changes are incremental and do not require any modifications of the existing systems. For example, if Codelco were to add another DCS or an upgrade of an existing DCS, none of the information infrastructure would have to be changed.

The integration of the railroad car system (FFCC TTE-8) is simplifying the material handling into stockpiles and smoothing the major disturbances in these very large metallurgical complexes.

Figure 3 shows the projects at the El Teniente Division. The initial system was installed in late 1997 at the Smelter for $350K and through the end of 1999 they did various projects that took advantage of the real time data. The integration effort at the Teniente Smelter was large. They have more than 10 PI-API nodes collecting information and events from several areas (Drying, Smelting, Converters, Acid Plants, Anode Plants). The sum of all these projects was only $90K and this number included any additional software (e.g. ProcessBooks or DataLink for additional people), hardware (computers, routers, networks, analyzers), engineering (design of the project) and implementation. Clearly complex problems are being solved at such a low cost that there is almost no limit to the return. In parallel, they are implementing the MINCO System combined with PI for the Mine, Crushing, Concentrators (Sag Grinding, Conventional Grinding, Copper Flotation Plant, Retreatment Plant, Reagent Plant, and Molybdenite Flotation Plant) including the transportation system, tailings and concentrate filter plants.

In the next year, they have some larger projects that will involve adding more of the site plus smaller projects that are targeted at specific problems such as water conversation, air conservation, environmental monitoring, production reporting, integration with training system and others. These projects are all funded and managed locally. Codelco personnel do most of the work, but they also use local integrators (e.g. Contac Ingenieros) as needed.

Figure 4 shows some of the displays built for these projects. PI-ProcessBook from OSI Software was used as the development environment on these displays. Since this package contains VBA, any display can be upgraded to include interactive input and actions such as creating a hierarchy of displays or allow the user to "drill down." A key to the success of these projects is the ease of use of the Microsoft desktop. Very little training was needed since displays are built just like sketches on PowerPoint and macros can be built just like they are in Excel. It is coincidental that just the week after this presentation the US Government decided that this seamless integration by Microsoft has hurt consumers and must stop—to say that those users that are gaining competitive edge using US software were confused is an understatement.

Figure 4 shows the performance monitoring screens for the Teniente Converter. They have implemented their process models using Datalink and ProcessBook. They also show their preparation and fluidized bed drying of the concentrate to optimize the smelting process. They show all performance, quality control, and events for coordinated decision-making. All personnel have real-time information access at the plant floor, business office, maintenance and metallurgical engineering. Some of the unique features of the software is that all of these display are live—curves are updating, equipment changes color on state, and alarms are seen throughout the site, if desire, within seconds. Any of these displays can be seen on the company Intranet using an ActiveX Viewer called PI-ActiveView.

Figure 5 shows a schematic of the Secondary-Tertiary Crushing plant and all conveyors at Teniente. This overview gives an overall view of the performance of the bins inventories, secondary and tertiary crushers, feeders, conveyors and screens at any time. Special queries can position the performance indicators at any shift, day, and monthly aggregation of the information on request. Spreadsheets can be used to compare the performance indicators by ore type or shifts.

There is a large amount of information in this real time graphic. However, by using the Microsoft VBA in ProcessBook they have each object connected to the tags by areas and units for the trend to get activated. They can monitor the inventories of these large bins to stabilize the level, thus minimizing segregation of the ore, which can cause large disturbances in the crushers, screening and conveying systems. The conveying systems are very large and require special monitoring. Several simple applications have been developed like counting how many times a crusher has hit a high oil pressure and motor amps, similar for the conveyors and screen. These slow moving variables are the cause of long-term degradation of the equipment. They use the historical and event driven routines for real time asset management and implementing condition based monitoring.

These systems are much different than existing instrumentation such as SCADA, DCS and PLC's. These plant systems can "see" and support projects that span multiple areas and help make the enterprise much more flexible. The PI System is the bridge between the plants and the enterprise business systems.

Figure 6 shows the real time production reporting using ProcessBook while Figure 7 shows reporting using Excel and DataLink (the PI real time data Add-In). Figure 6 shows the transfer of ore between the mine and the concentrator. These reports have macro capability (e.g. click on a number and see a trend or execute an analysis program or export the data), but Excel has the same rich set of features, familiar to all. In addition, most third party software can use Excel as data input to run new and legacy analysis programs. This shows the flexibility of the integrated environment from Microsoft and all of its partners like OSI Software. The full integration of all tiers, common menu operations (e.g. to Send a display as an object or to Save As is done the same everywhere) overcomes the training issue—always a problem for remote, industrial sites.

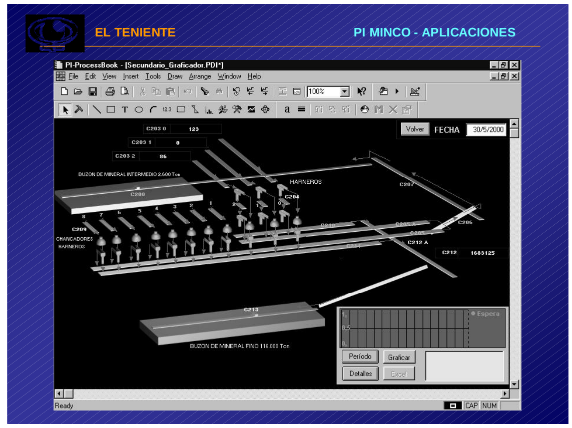

Figure 5: Secondary and tertiary crushing plant.

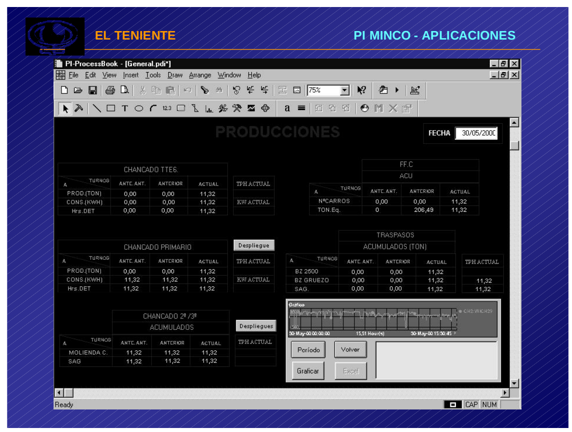

Figure 6: Real time production reporting.

Figure 8 is a ProcessBook display from the Plant Systems Operations computer at Radomiro Tomic. One advantage of having a common infrastructure is that everyone is familiar with the systems both across Divisions and sites. This had lead to a significant sharing of applications and knowledge that was never possible before due to the difference in the systems. Codelco presented a paper at the Latin American Mining Perpectives describing the strategic plan for automation and process management and work being done at Chuquicamata (Rojas

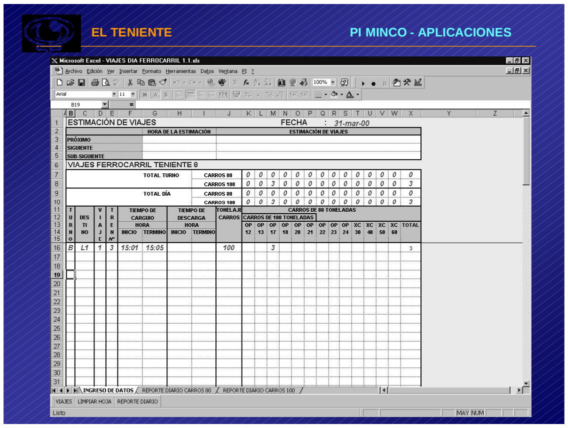

Figure 7: Excel and DataLink manual data entry tools.

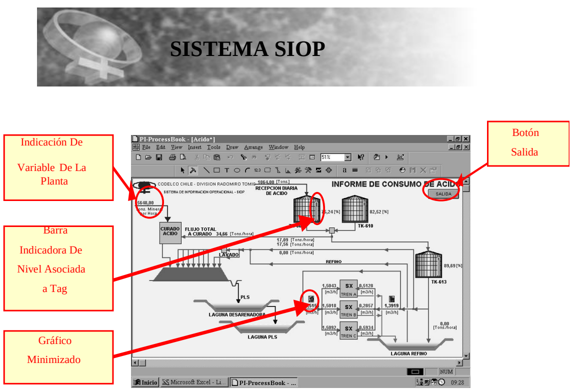

Figure 8: Sample display from plant operations system at Radomiro Tomic.

and Valenzuela, 1998). Montoya (1998) described the Radomiro Tomic hydrometallurgical complex. The integration of operational data and easy access are the key for improved leaching, improved equipment availability, minimized organic losses in the solvent extraction plants, and improved copper harvest cycle times at the electrowinning plant. Codelco personnel have developed many creative ways of transforming raw process data into highly valuable actionable information for fast operational decision-making. The real time operational information infrastructure is empowering operators, technologists, and managers to work in collaborative environment of continuous improvement.

It is collaboration of the employees which is making a change in paradigm on how we operate in these remote plants.

They have not stopped yet, in the next few years they will use their flexible infrastructure and the RLINK SAP gateway to support the real time applications in SAP's R/3—the corporate standard.

The decision in 1997 to use PI/Microsoft development environment to enable the employees was a masterstroke for Codelco.

It is with no little pride that I saw our highly complex software running flawlessly in this environment and delivering benefits unheard of in the mining industry. My only regret is that I do not see this more in other industrial sites. This is a very good example of how the integration of the desktop software from Microsoft has helped the manufacturing industry. By opening up their technology (e.g. ActiveX, COM, VBA) they have made it possible for smaller vendors to take advantage of the ease of use and built in training one gets with the Microsoft desktop. The technology used at Codelco is far more sophisticated than the most of the telco's and Internet companies that have been held back by their slow adoption of the Microsoft technology.

Conclusions

Many other companies are transforming themselves using Microsoft technology and all of those will be prepared for the next surge referred to earlier, Microsoft.NET. The missing element has been the willingness of companies to believe in their own people instead of the consultants. Web Enabled E-Business is a hoax of the same order as the Y2K hoax of last decade and Codelco is the proof.

Additional discussions about Arie de Geus methods and strategies on how to build an intelligent organization can be found in the book, Fifth Discipline Field Book by Peter Senge and collaborators (Senge et al., 1994).

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