



**Real Time Information — Currency of the New Decade**

Hilton San Francisco Union Square | San Francisco, CA

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# Development & Implementation of the PI System at Cuajone Concentrator – Southern Peru

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# AGENDA

- About Southern Peru – Southern Copper Corporation.
- About Cuajone Concentrator
- PI System Architecture
- Some Applications
- Use of PI System for Process Optimization
- Benefits

# ABOUT “Southern Peru – Southern Copper Corporation”



It is the largest copper company in the world based on amount of copper reserves.

## Four Open-Pit Mines:

- Cuajone & Toquepala, located in southern Peru.
- Cananea & Caridad, located in northern México.

## Metallurgical Complexes:

- Ilo (Peru)
- La Caridad & San Luís Potosí (México).
- Additionally, owns and operates 5 underground mines producing various metals as Cu, Zn, Mo, Ag, etc.

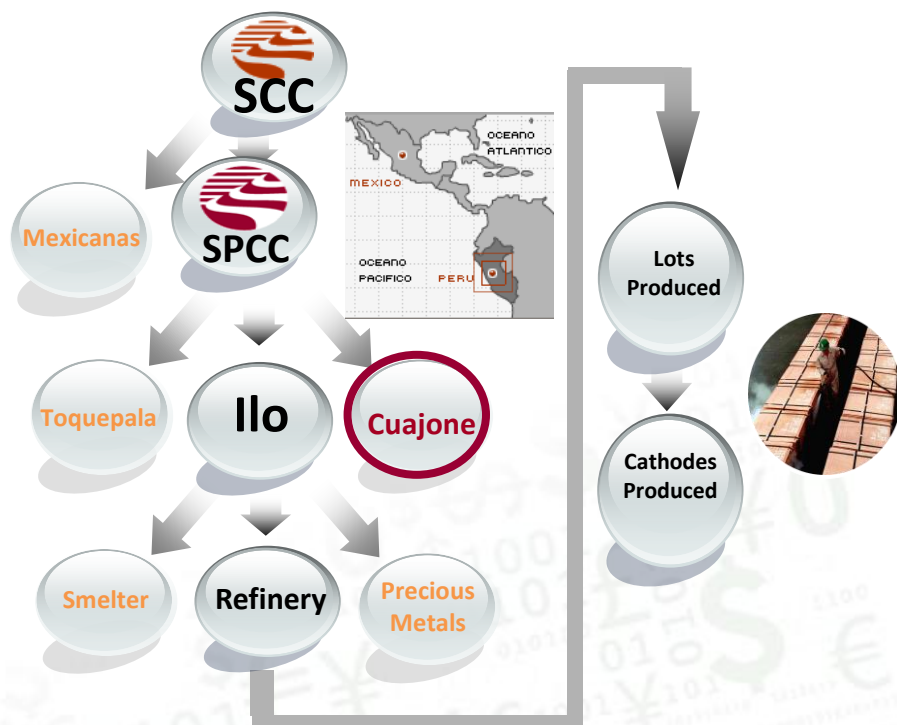
## Projects:

- Expansion of the Toquepala and Cuajone concentrators.
- Tía María project, located in Arequipa.
- Los Chancas project, located in Huancavelica.

## CORPORATION STRUCTURE



## MAIN ACTIVITY



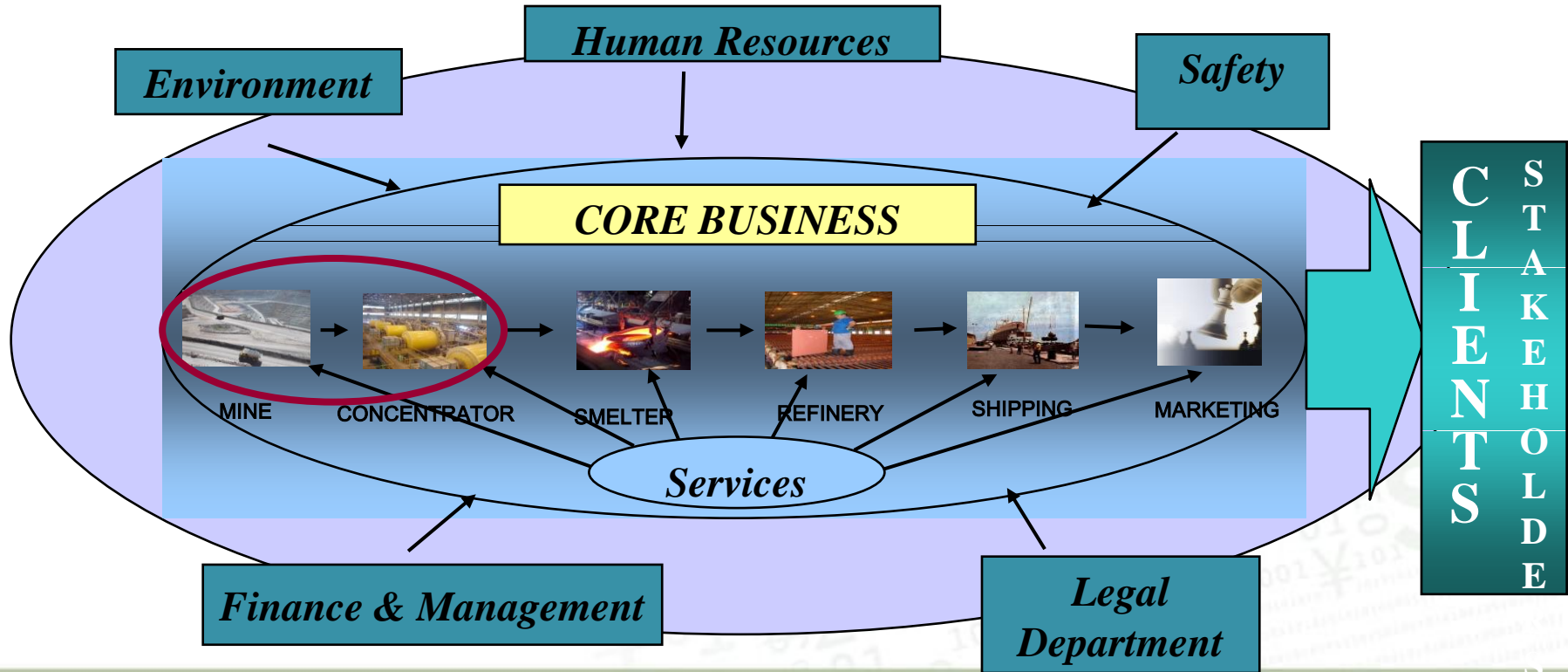
# Cuajone



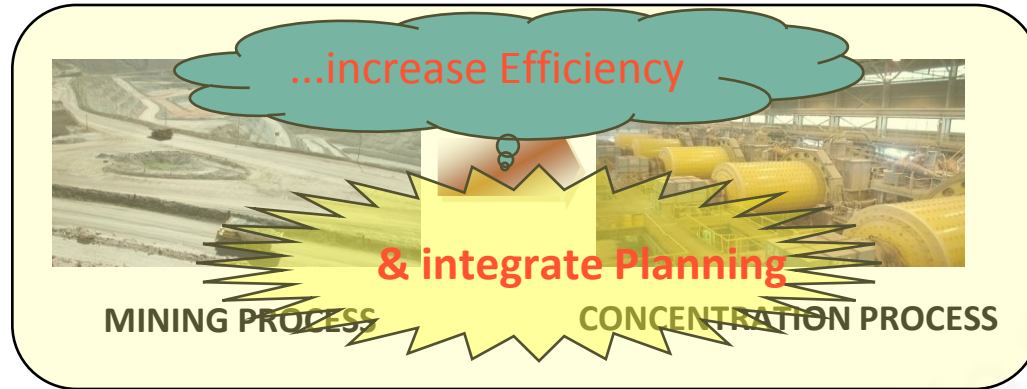
- The Cuajone facility operates an open-pit mine and a concentrator located in the southern part of Peru, 30 kilometers from the Moquegua city and 840 kilometers from Lima.
- The Cuajone Concentrator is one of the most important industrial plants in Peru, because of its production level and up-to-date technology applied on the many processes. It has a nominal capacity of 87,000 MT per day.
- Operations were commissioned in 1976.
- A conventional open-pit mining method is used to obtain a copper ore that is then processed in our concentrator plant.



# Actual Value Chain of the SPCC Production Process



**Within the SPCC value chain, efforts are made to:**



**How can technology help to place value on our production processes?**

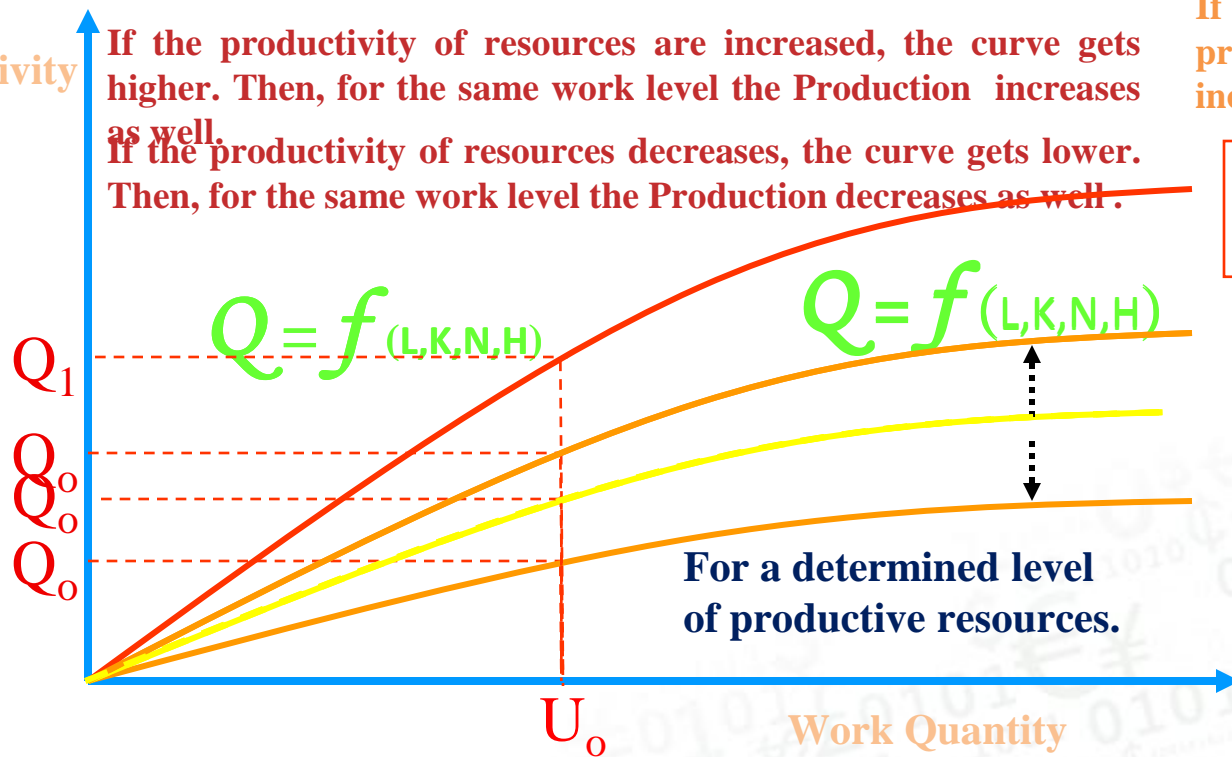


# ...the answer

Productivity

If the productivity of resources are increased, the curve gets higher. Then, for the same work level the Production increases as well.

If the productivity of resources decreases, the curve gets lower. Then, for the same work level the Production decreases as well.



If technology is included, the production curve is going to increase remarkably.

$$Q = f(L, K, N, H, T)$$

Becomes Asymptotic



Q = Productivity.

L = Work.

K = Capital.

N = Natural Resource.  
(Raw Material)

H = Human Resource..

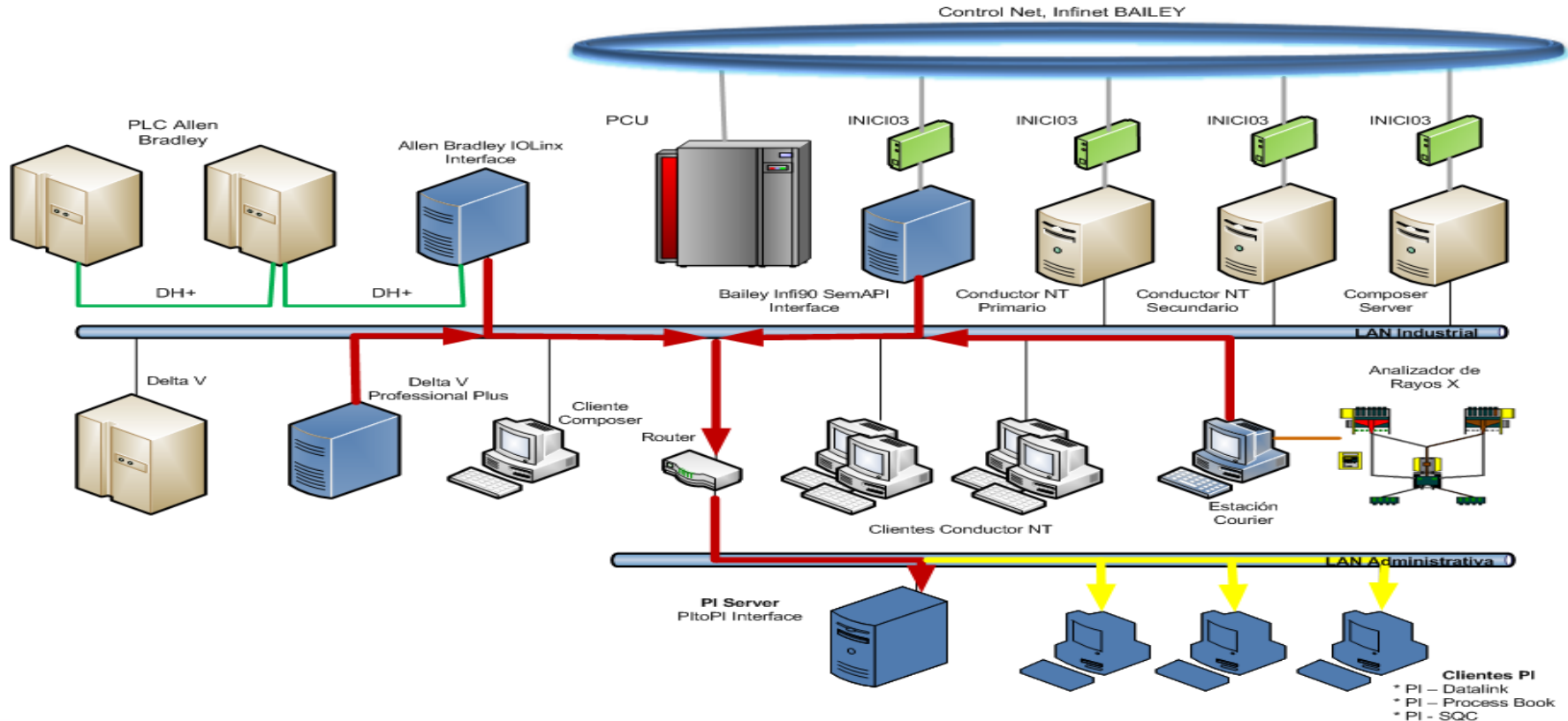
T = Technology.



# PI SYSTEM ARCHITECTURE



# Initial PI System Architecture



# Initial PI System Architecture

## **PI Server keeps history of plant information**

- Used from 1998.
- Gathers information from 3 different control systems.

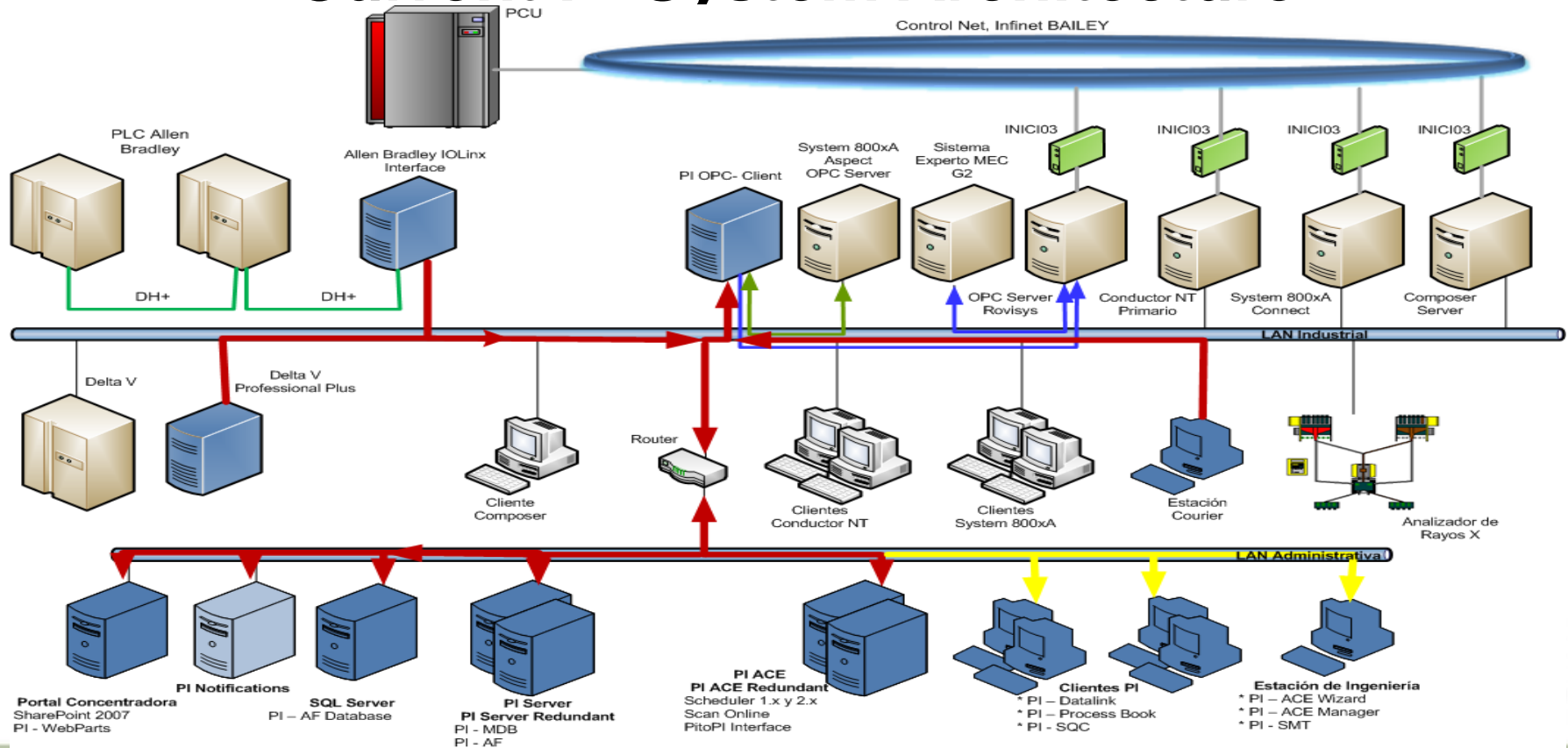
## **No System Redundancy**

- System had to be stopped for updates or maintenance of the server.

## **A Limited Analysis of Information**

- PI ProcessBook, PI DataLink and PI SQC.

# Current PI System Architecture



# Current PI System Architecture

## **Main system for performance management in real time**

- Unifies information from all control systems.
- Allows to interact with other advanced control systems such as MEC G2.

## **A system with redundancy**

- Maintenance and updates can be carried out without affecting the system availability.

## **Allows to do any type of information analysis**

- Production personnel are developing Metrics so that they can determine whether objectives are being achieved.
- PI ACE allows calculation of KPI's for both operations personnel and management.

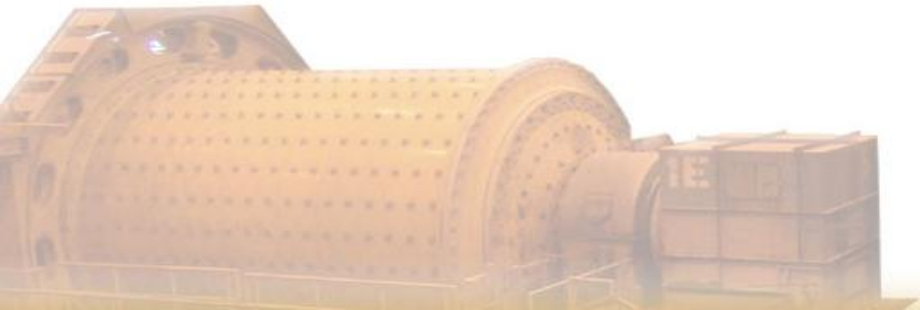
## **Allows to distribute information to any level**

- Information is forwarded through a browser like Internet Explorer.
- It is possible to access information from any site including from outside the Company.

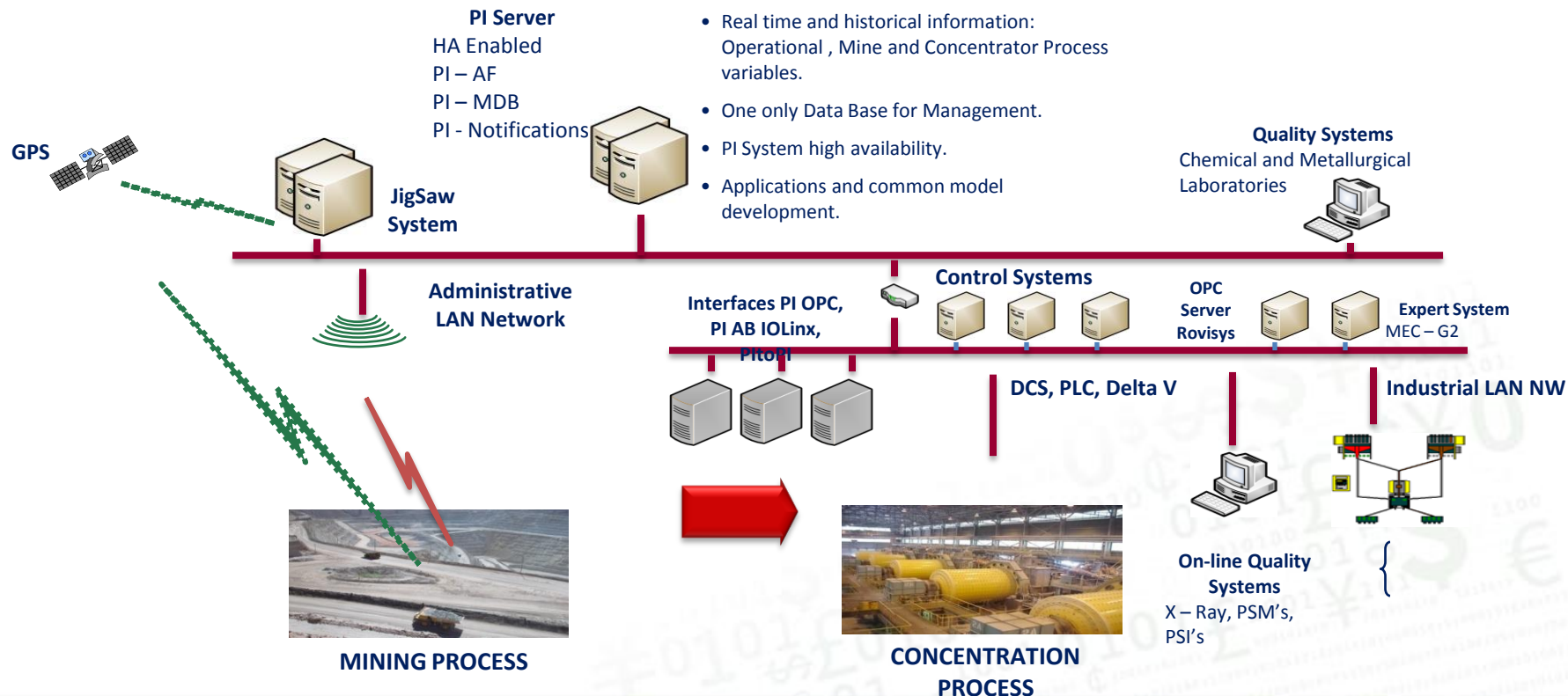


# Architecture of PI System

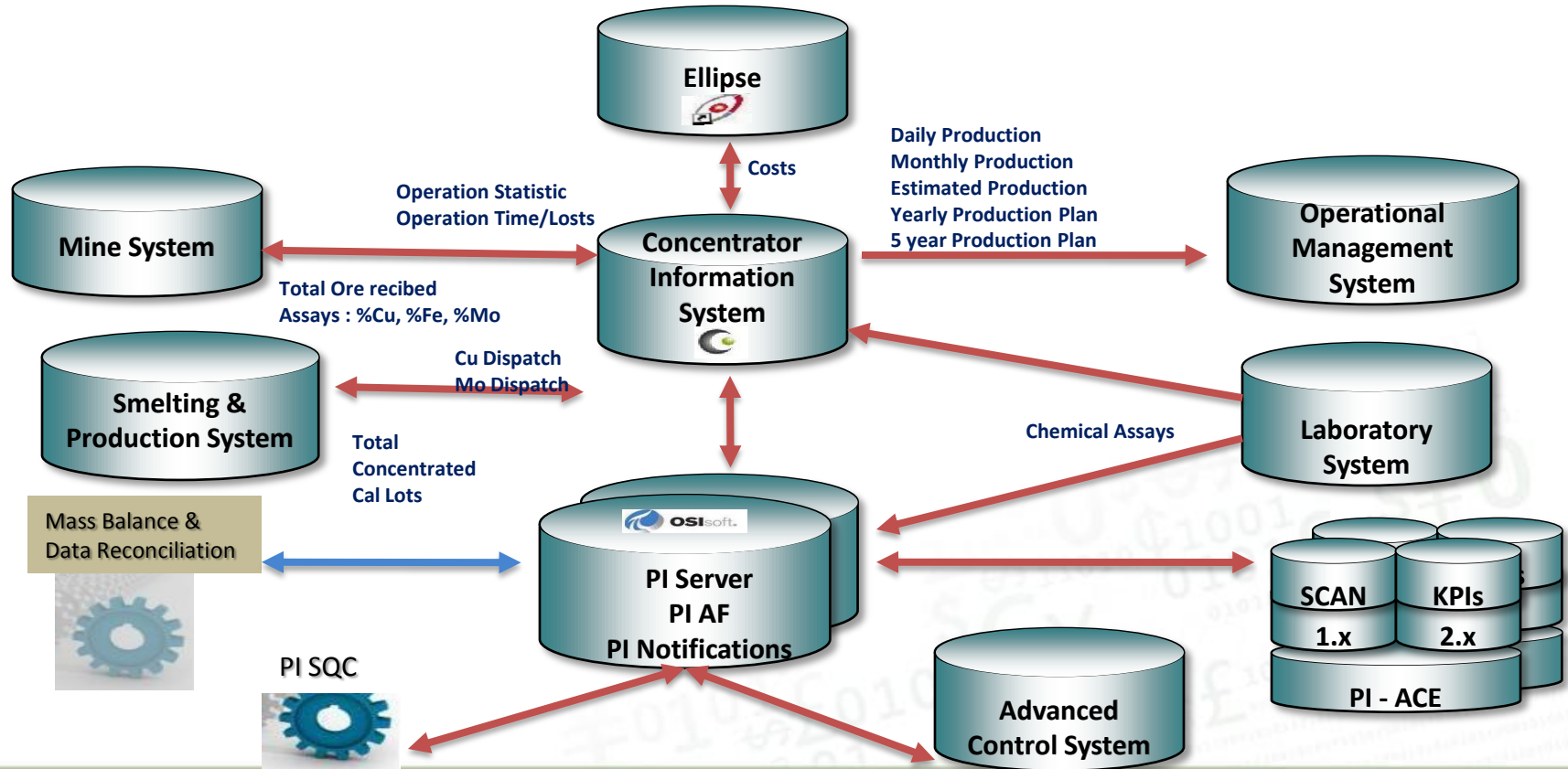
1. **Server Architecture.**
2. **Analysis & Optimization Architecture.**
3. **Visualization Architecture.**



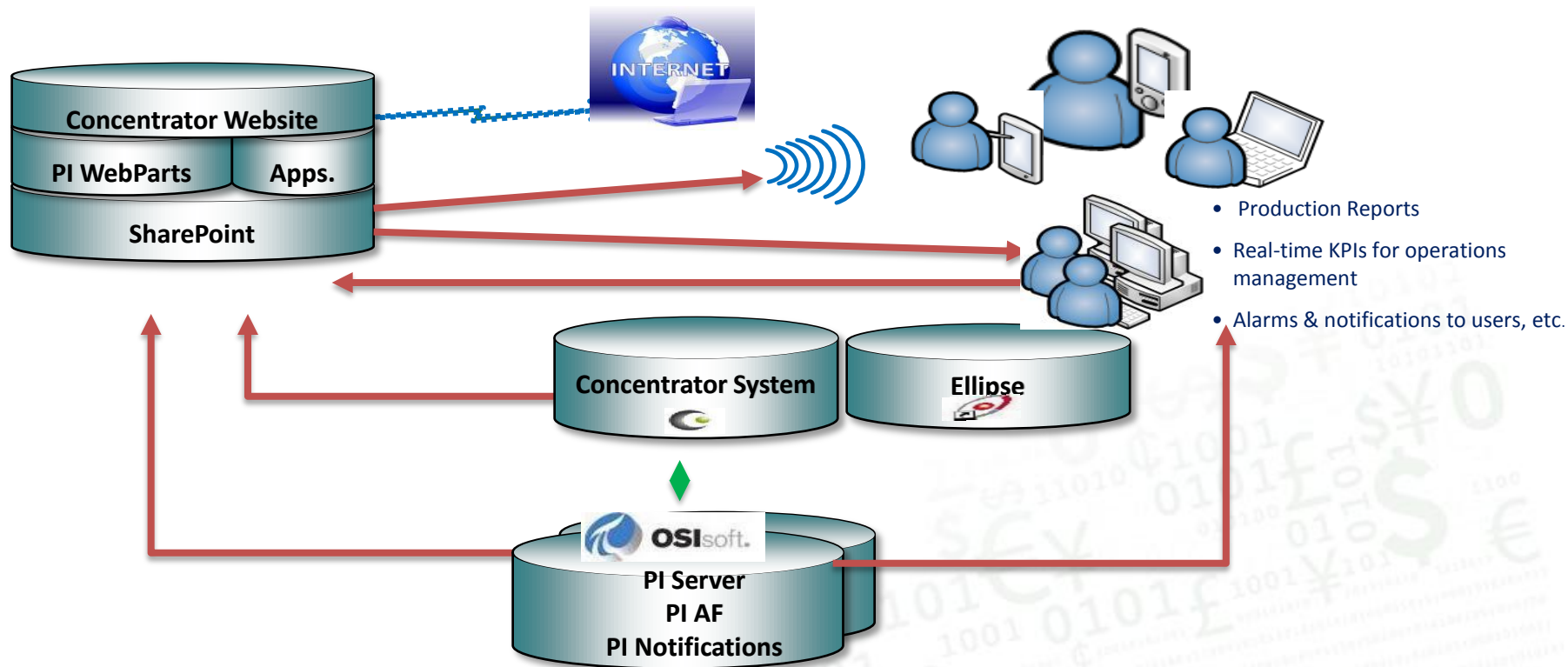
# Server Architecture



# Analysis & Optimization Architecture



# Visualization Architecture





# SOME APPLICATIONS



# Operational Management Support

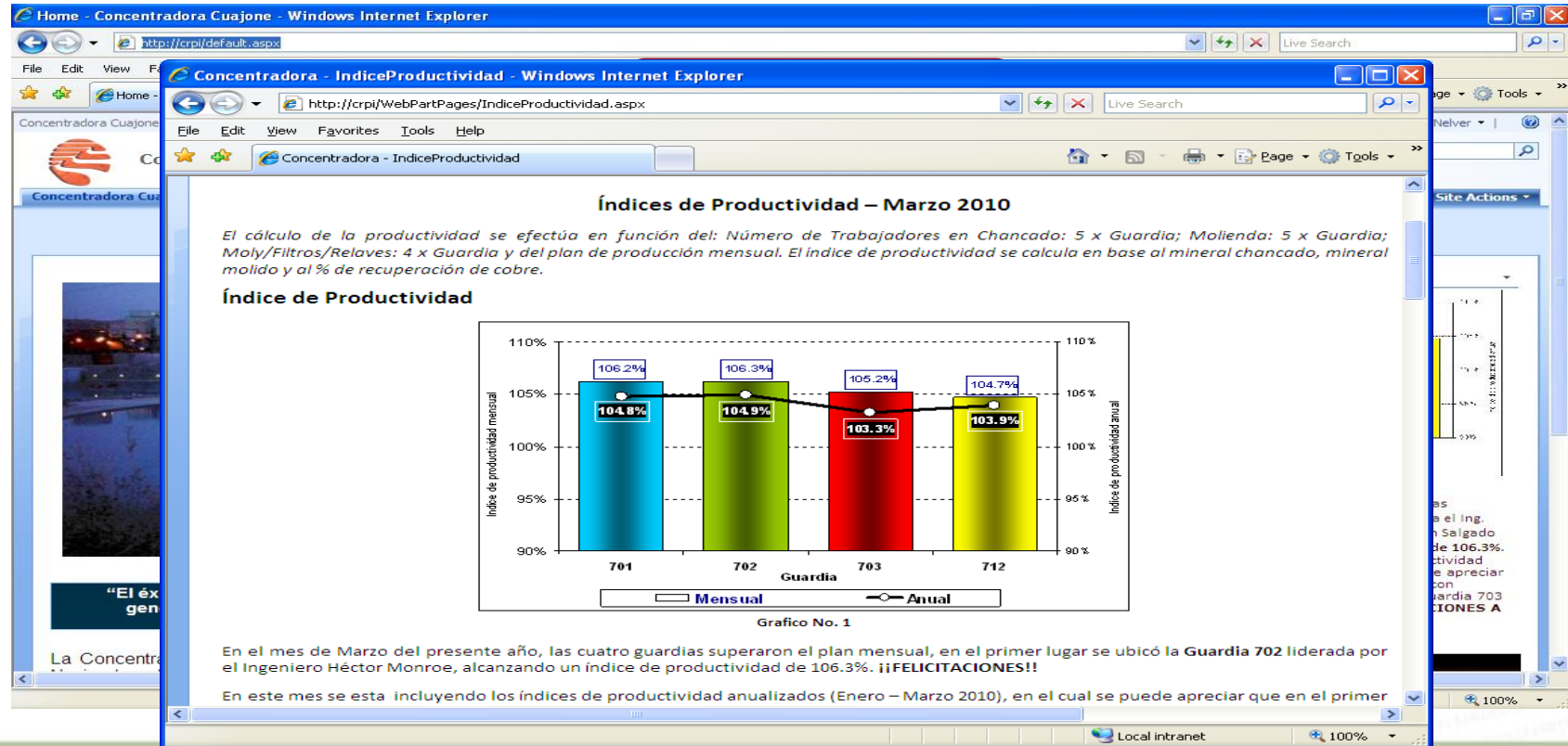
The screenshot displays a web-based Operational Management Support (OMS) interface for a flotation process. The main window, titled "Gestión del Proceso - Flotación Rougher Lamas", shows a detailed process flow diagram. The diagram includes various tanks and pumps, with labels such as "LAMAS A", "LAMAS B", "LAMAS C", "WOLLENDIA", "ROUGHER ARENAS", "RELAVES", "REMOLLENDIA", "BOMBA 1", and "BOMBA 2". The interface is titled "Gestión del Proceso - Flotación Rougher Lamas" and includes a navigation menu on the left. A secondary window, "PI Module Database Editor", is open, showing a tree view of modules and a table of properties for "Molino 1C".

The "PI Module Database Editor" window displays a table of properties for "Molino 1C". The table has columns for "Sub-Module", "PI Alias", "PI Properties", and "Datatype". The properties listed include:

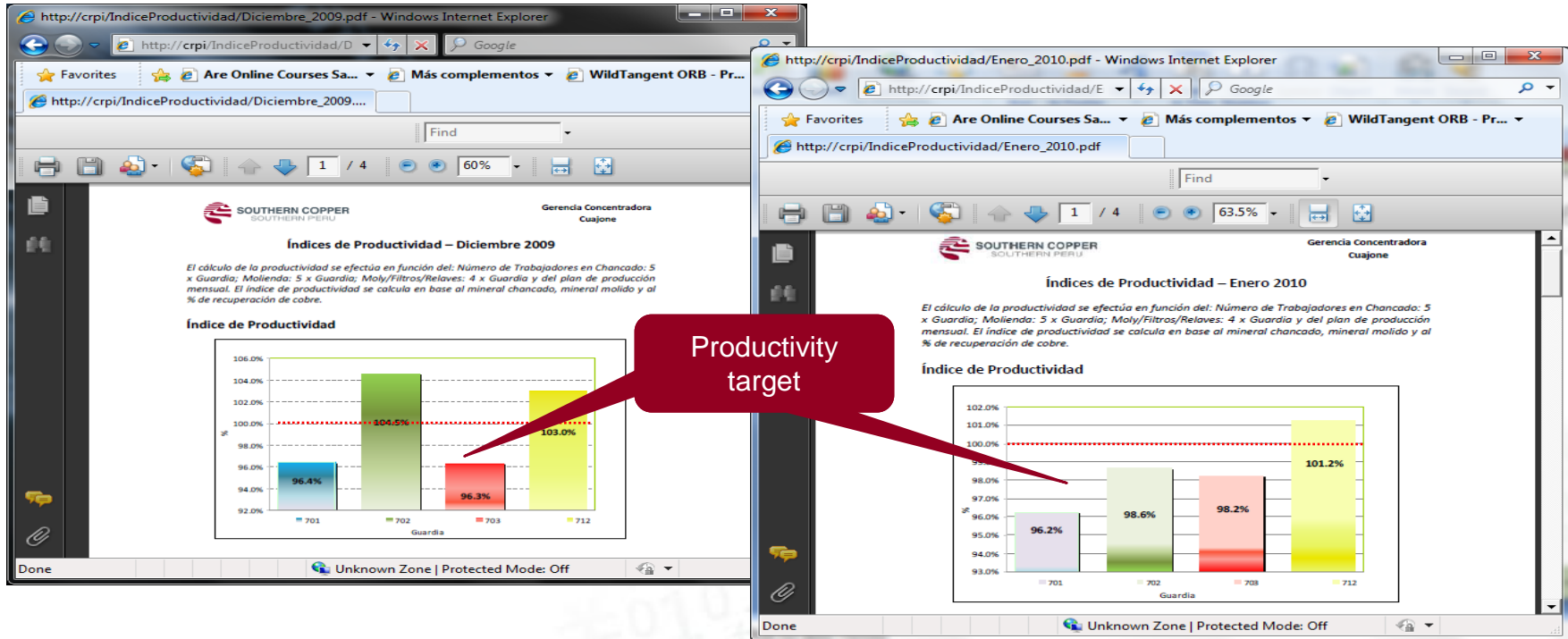
Sub-Module	PI Alias	PI Properties	Datatype
		DurationGuardia	12
		HorasInicioGuardia	7:30 AM
		PlantTPHTon	276
		_PorcCumplimTOper	37.7800925925926
		_PorcObjetivoTOper	37.775462962963
		_VariacionTOper	-4.42962962962963
		_PBTPHTon	273.11459470524
		_PorcCumplimPBTON	102.858609699414
		_PorcCumplimPlanTon	101.763268043478
		_PlantTurnoTon	2332
		_PorcCumplimPlanTon	37.3773399758454
		_PorcObjetivoTon	37.775462962963
		_PreyTurnoTon	3335.56553385417
		Nombre	Molino 1C



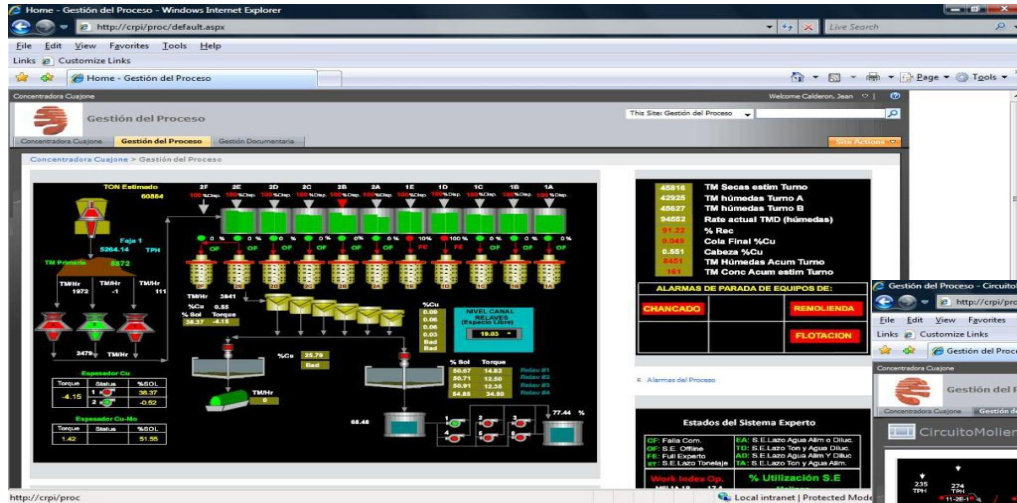
# Concentrator Portal Applications



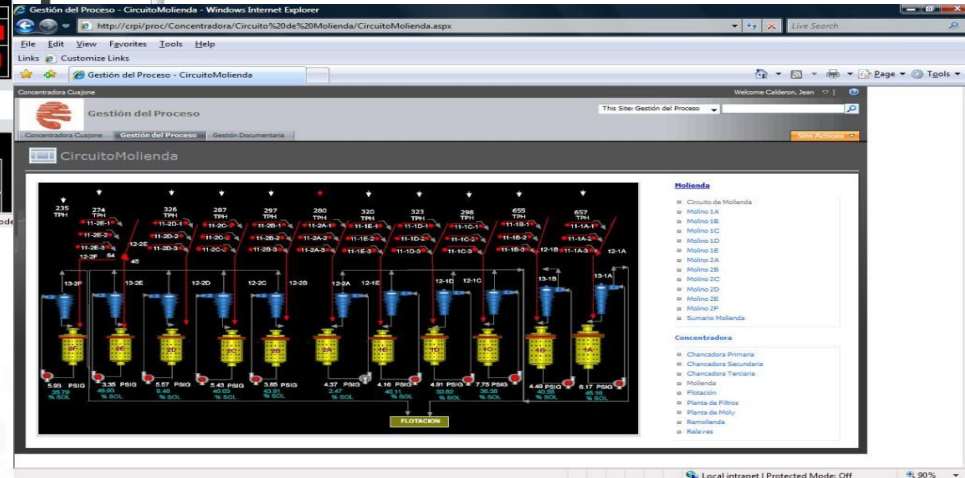
# Productivity KPIs: Allows us to meet Targets



# Applications PI WebParts



Process monitoring at an  
Intranet / Internet  
browser level



# Management KPI's



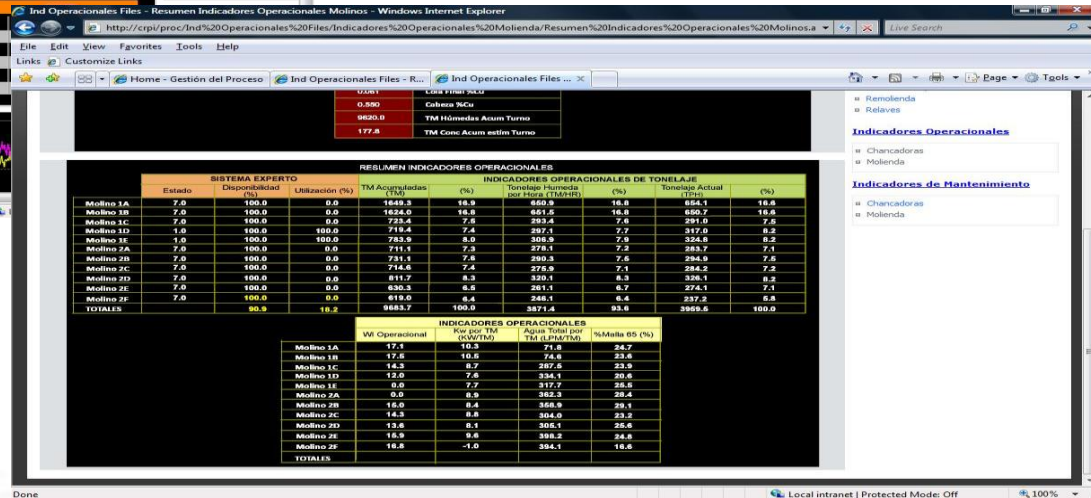
Alarm system and start/stop equipment, sub-standard conditions of processes and operations, etc. (PI – ACE)



PDA & Tablet PC's

# Applications PI WebParts

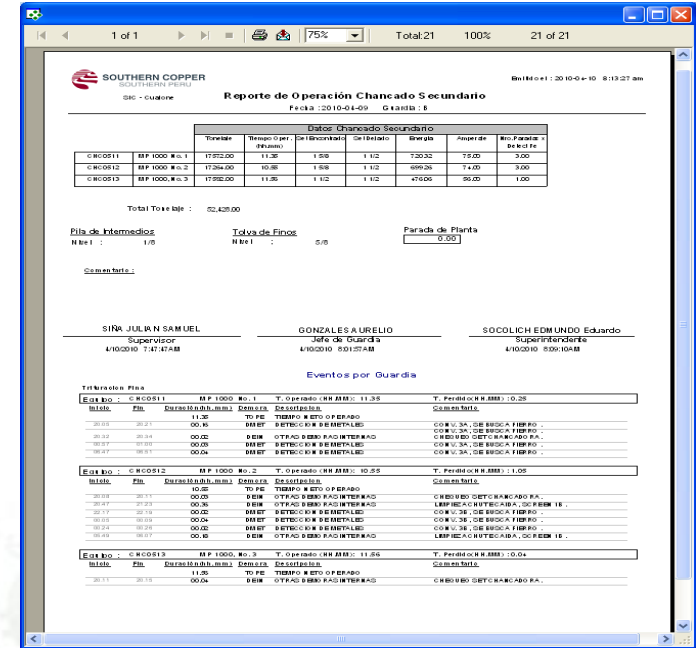
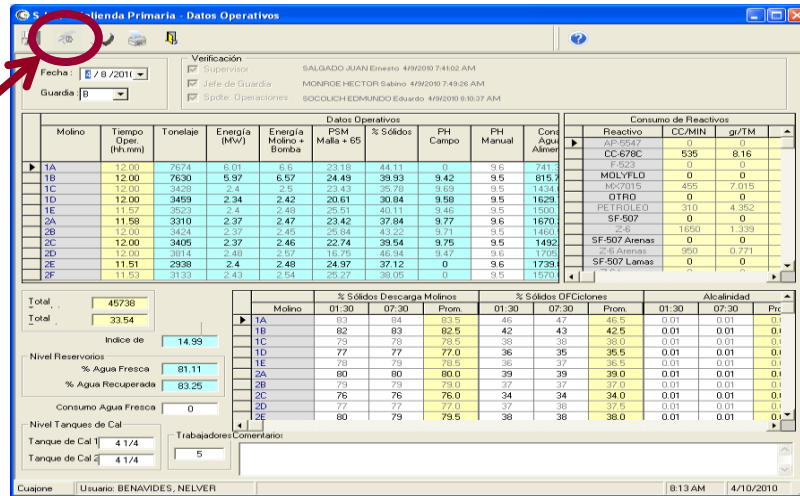
Monitoring of KPI's  
Intranet / Internet  
browser





# General Management Support

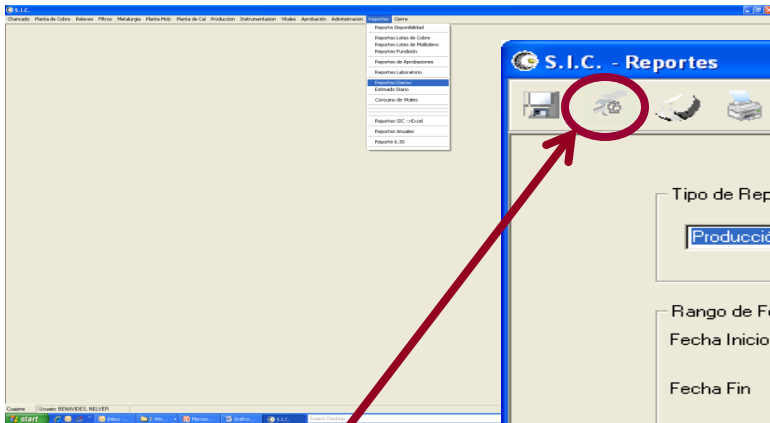
## Concentrator Information System (SIC)



The SIC obtains its information from the PI System (PI - ACE)



## Concentrator Information System (SIC)



## Information from the PI System

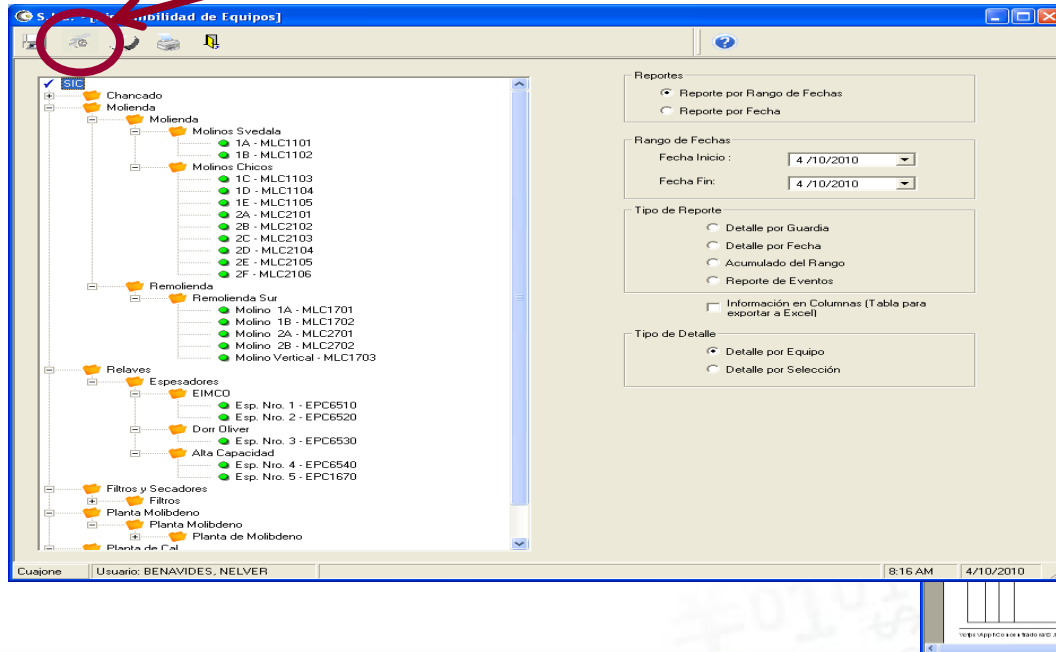
**Official Production  
Reports obtained from  
the SIC system**

[illegible]

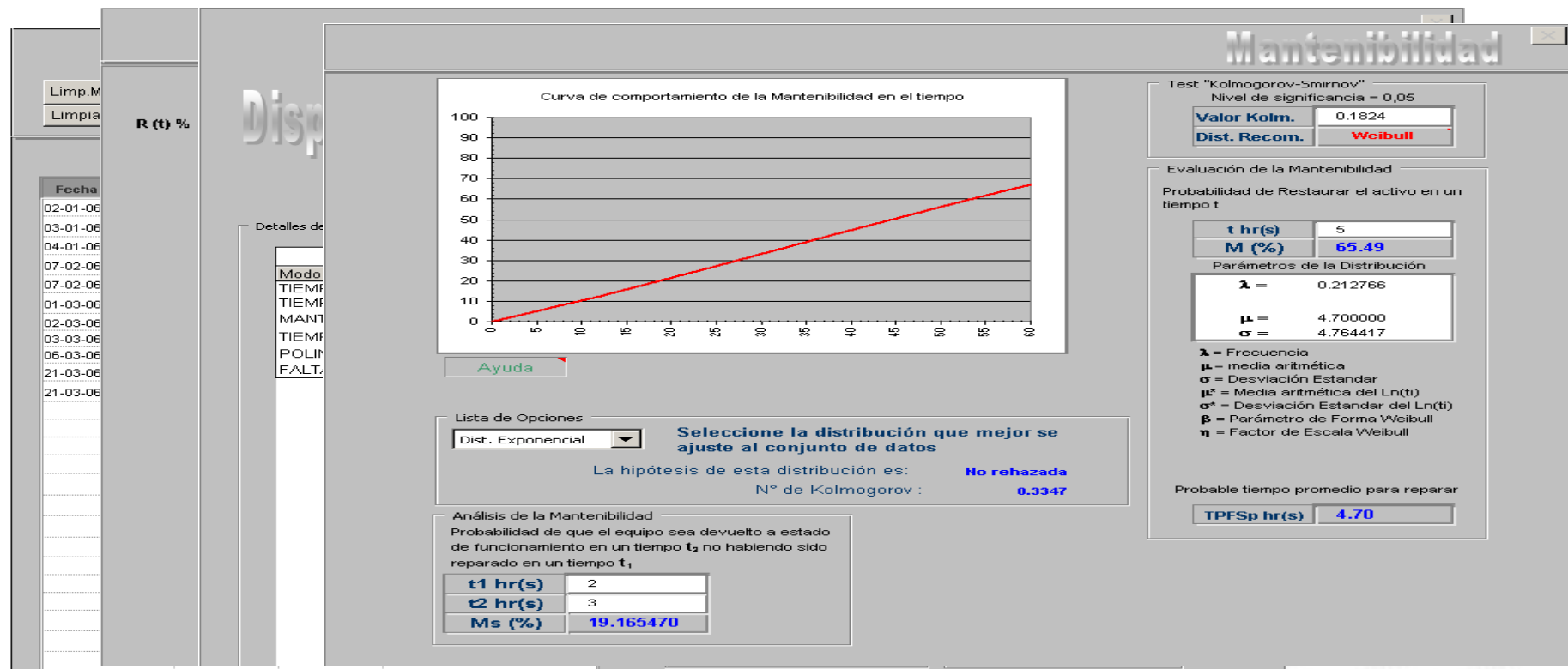
# Concentrator Information System (SIC)

## Information obtained from PI System

## Availability reports & information for maintenance management from the SIC system

[illegible]

# Management & Maintenance Planning: Reliability, Availability & Maintenance



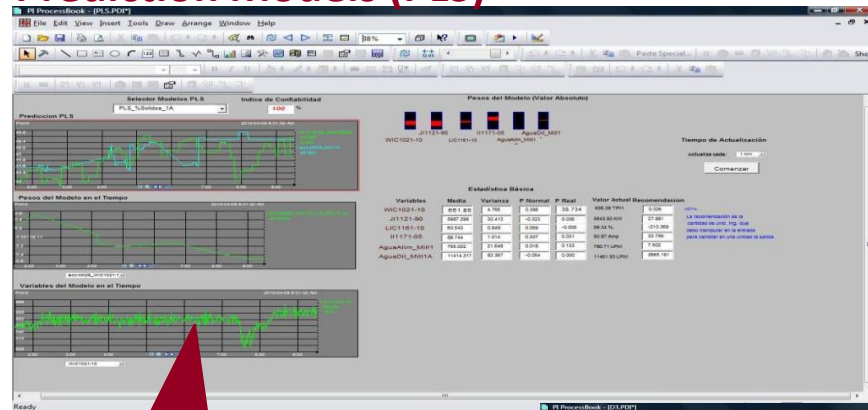
# PI System Support for Process Optimization



Development of Virtual/Soft Sensor as inputs to the Milling Advanced Control System, supported with PI System tools

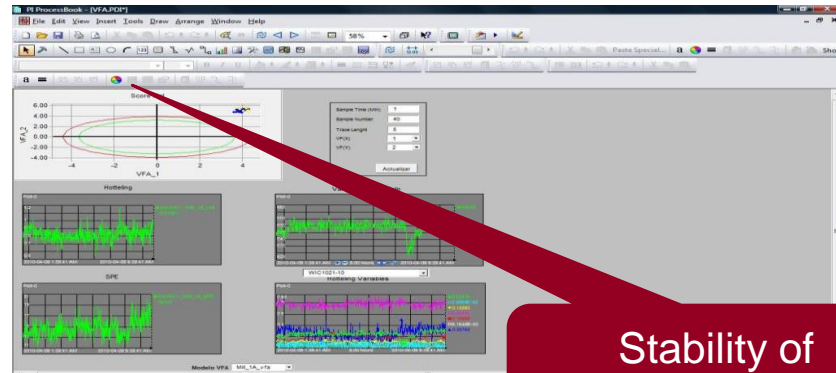
# Multivariable Statistical Analysis: SCAN

## Prediction Models (PLS)

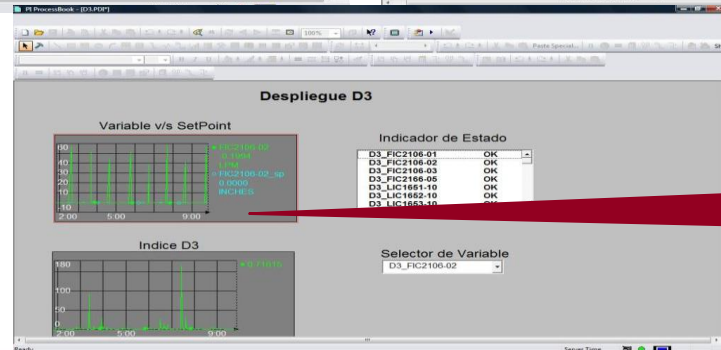


Virtual Sensors of % Solid and P80 Overflow Cyclones

## Statistical Variability Models (VFA)



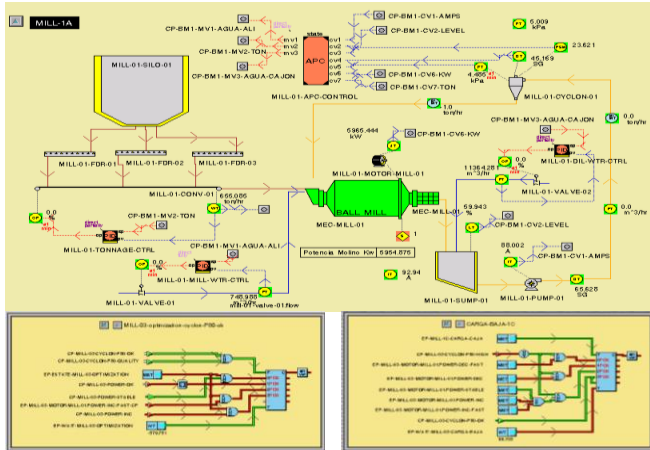
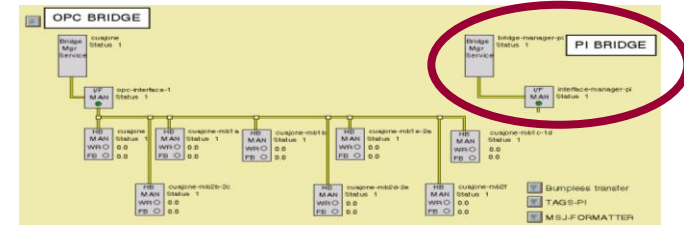
Stability of Operation



Performance of control loops

Evaluation Models for Tuning Control loops (D3)

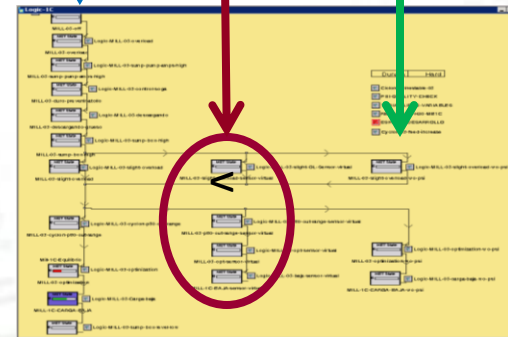
# Virtual Sensors & Optimization of Milling Process



PSI / P80

PI-ACE P80  
Virtual Sensor

No PSI



Advanced Control System

Logical Status

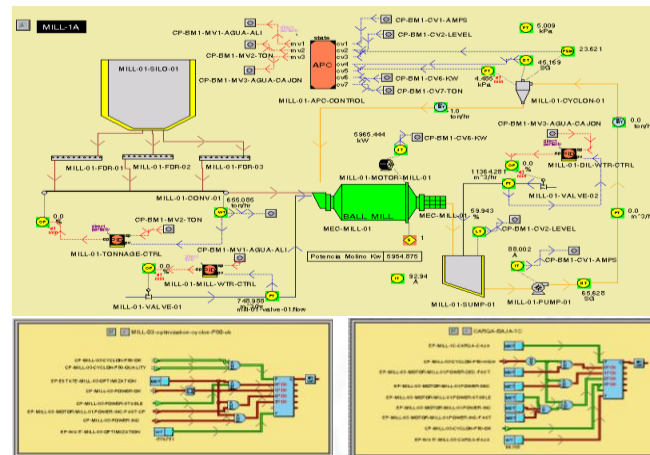
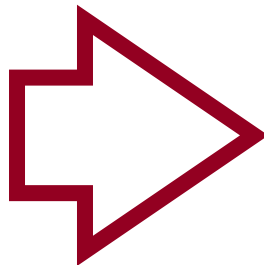


# Virtual Sensors & Optimization of Milling Process

+ 65 Mesh



% Solids



PSI Virtual Sensor Selection Logic

Advanced Control System

# Virtual Sensors and Optimization of the Milling Process

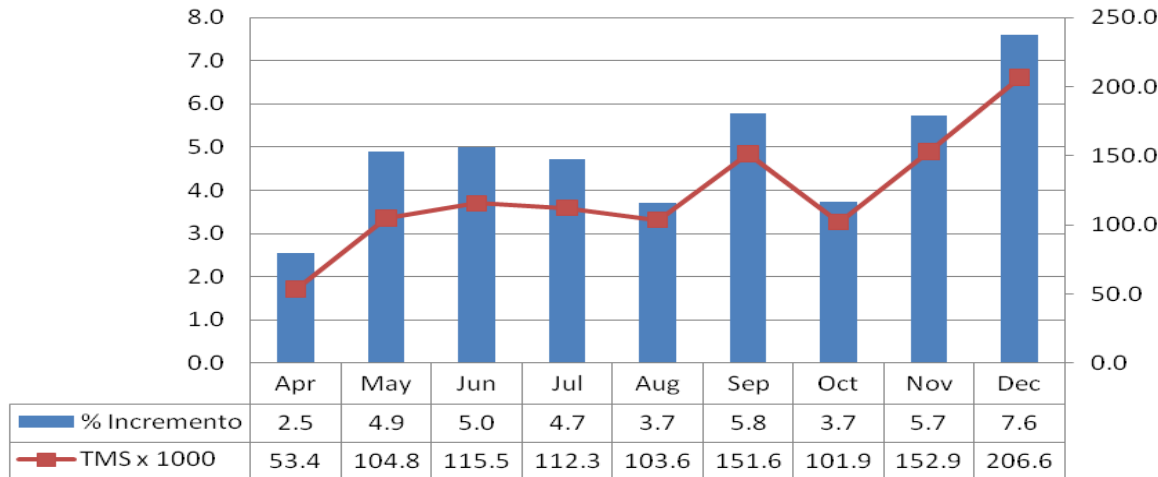
## Evaluación del Sistema Experto en los circuitos de molienda primaria

Periodo de evaluación: 4/4/2009 al 31/12/2009

INDICADORES
% Disponibilidad S.E.
% Utilización S.E.
<b>Total TMS molidas (x1000)</b>
Incremento TMS - S.E.
<b>% Mejora TMS molidas</b>
WI Operacional (kWhr/t)
WI operacional (kWhr/t)
% Cu en el mineral
% Recuperación Cu
Total Lb. Cu fino (x1000)
Increment. Lb. Cu fino - S.E.
<b>%Increment. Lb. Cu fino</b>



### Incremento mensual de tonelaje con el Sistema Experto de Molinos - Año 2009



2F	TOTAL
94.4	94.7
71.6	73.4
727.6	23926
71.4	1102.7
4.1	4.6
15.1	14.7
7830	198522
522	9920
6.66	5.00

# Benefits of the Milling Process Advanced Control System


## Production Benefits:

- Increase in production: 4.6%
- Decrease power consumption: 3.9%
- Decrease of fresh water consumption: 6.8%

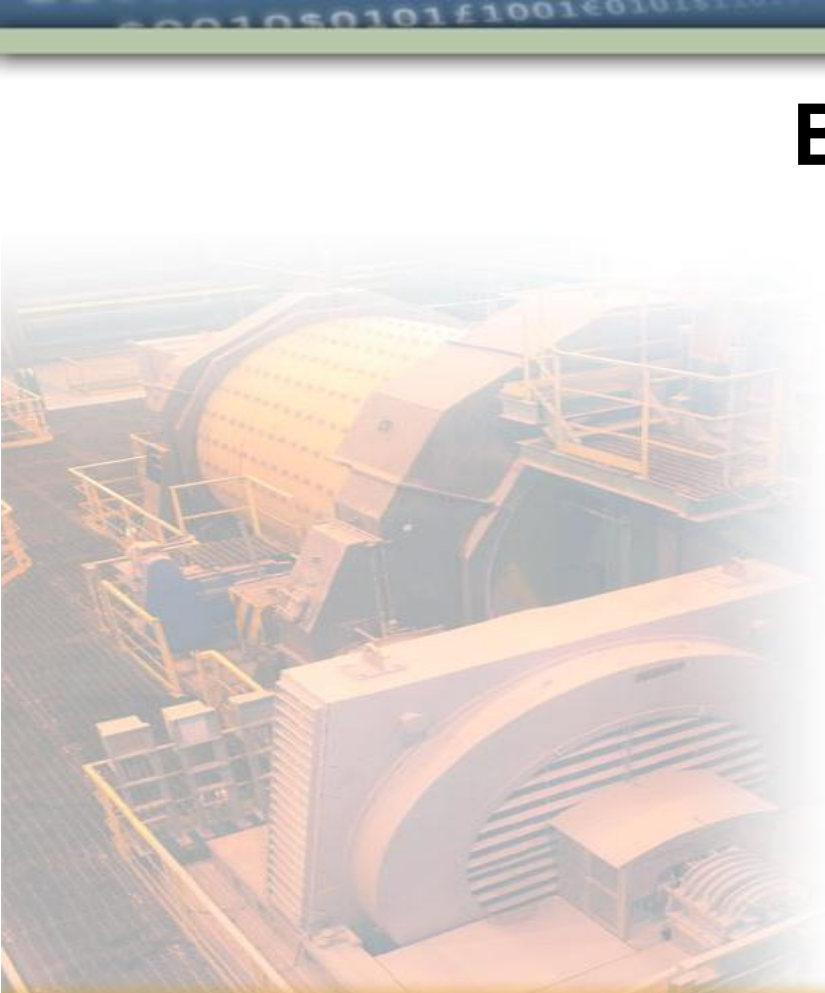
## Economic Benefits:

- Net profit: US\$ 31.8 million (period: 2009/04/04 to 2009/12/31)

# Requirements for Success

- 
- Requires resources that will efficiently and proactively manage the PI System and associated applications.
  - Assign as many human resources to develop and enhance specialized applications.
  - Invest in development and training of your staff.

# Benefits

- 
- A single database.
  - Unified view of information.
  - Increased availability of information.
  - Detailed insight into the process.
  - Easy integration with the rest of the systems.
  - Ability to analyze the process and identify new control strategies.
  - Improve the Predictive Maintenance.
  - Identify best practices for operations.
  - Real impact in decreasing operating costs.



# Final Conclusion

PI System provides a natural and flexible infrastructure that enables and supports continuous innovation and improvement.





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# Thank you

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