

"How the University must Research and Work with Peruvian Industries to Achieve Maintenance Excellence"

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ABSTRACT: “ACHIEVING THE MAINTENANCE EXCELLENCE - A PERUVIAN CASE”.

In the “*Pontificia Universidad Católica del Perú*” – *PUCP* we know that the maintenance excellence is when a plant performs up to its design standards on a consistent basis with minimum downtime, reasonable capital investments are used to continuously improve the equipment, maintenance costs are well controlled, parts inventory are managed with high service levels and high turnover ratio. It takes a good balance of performance, risk, and cost to achieve an optimum performance.

So in the Science and Engineering Faculty of the *PUCP* we have been researching that in a Latin-American country to achieve maintenance excellence is more complicated than in most developed countries, because much of what happens in our industrial environment is unpredictable and often affected by political situations, economic uncertainty and poor disciplined managerial culture. This 2006 is an electoral year in Perú, so many things change and our industries don't invest because the political uncertainty. We know that the goal of maintenance is universal: "exceptional performance" that is generally achieved by using a systematic approach to Routine Work Management and a good Strategy for Improvements.

Presently, our priority in the *PUCP* is to develop in industries basic maintenance management capabilities that will facilitate the implementation and control of sound:

- Strategy, including vision of maintenance management.
- Tactics, including PM, PdM
- Routine Work Management, including Planning and Scheduling
- Continuous Improvement, including Root Cause Analysis (RCA)

The above are required to attain good maintenance practices. The *PUCP* in Perú wants to develop a MAINTENANCE EXCELLENCE FRAMEWORK TRAINING divided into: Maintenance Management Fundamentals; Managing Equipment Reliability; Optimizing Maintenance Decisions, and Achieving Maintenance Excellence.

Productivity can be defined as what you get out for what you put in. We should expect capacity in our industries managing the equipment availability, utilization, running at the desired speed, and producing the desired quality with low maintenance cost. The challenge of maintenance excellence for us is to develop tactics that would minimize breakdowns and maximize the rewards of planned, preventive and predictive work in Peruvian industries.

INTRODUCTION

In 2000 year the Science and Engineering Faculty of the **PUCP** began to research in Maintenance Management in the biggest Peruvian Industries. We invited them to participate in a survey to find benchmarks to prepare a project. We had a first meeting that was very anecdotic, some Plant Managers, Production Managers and Corporate Managers of Human Resources attended. In the interview we asked them about their experience in maintenance and what we could offer them to implement new maintenance philosophies, or methodologies that they required to achieve Maintenance Excellence. They answered us a couple of questions that were:

- *How is your Plant doing?* They very proud answered us that they were doing **WELL**, because they billed thousands of US \$ per year, they had workers which had received more than 60 hours of training in the last year and they had just certified their Plants in ISO 9000, they were also guided to certify in ISO 14000. We told them that they had not still answered us, *how is your Plant doing?* They were a little surprised and asked us in return, what more do we need to know? With a lot of tact we asked if they measured performance and they told us that they didn't have specific management measures. So we asked: *How can you tell us that you are doing **WELL** if you are not measuring?*
- We asked them another question: *How do you perform in Maintenance?* Those answers were not immediatly but almost all said **WELL**, because they have a Preventive Maintenance Schedule in the whole Plant, of which 80% is outsourced. They have just enough personnel to administer the maintenance in the Plant.
- We told them that they had not yet answered us. This time they responded what we needed to know. We asked them if they measured their maintenance results and they told us that they didn't have specific maintenance management indicators. And we asked again: *How can you tell us that you are doing **WELL** if you are not measuring?*

We made a conclusion and told them that if they want to answer that they were doing **WELL**, they should add the measure of the Overall Effectiveness Equipment (OEE) to know how their Plant is, and the equipment availability, the equipment reliability and maintenance costs / billing to assess how maintenance is in their Plant. After this some managers asked us to make a proposal for maintenance management research in their Plants. We answered that we were not able to present it at that moment because previously we needed to do a diagnosis of its current situation. Only then we could make a proposal. They accepted and immediately asked us to do an assessment of their plants.

DIAGNOSTIC:

We had many meetings with:

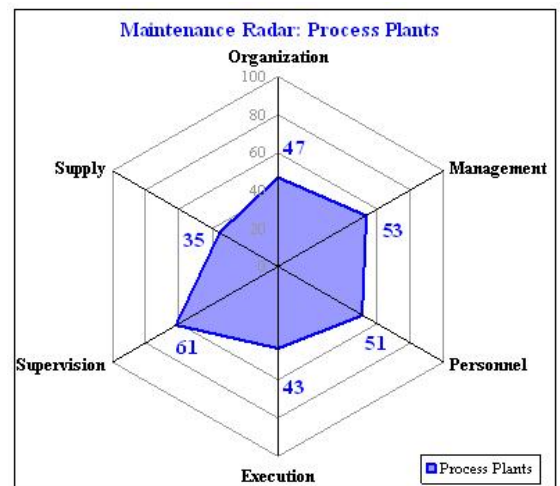
- Production and Maintenance Managers:
 - Production & Maintenance Organization of “Process Plants”.
 - Information of Maintenance Management.
 - Plants’ Safety System.
- Managers of Finance, Personnel Managers and Production & Maintenance Managers:
 - Scope and Objectives of the proposal.
 - Productive Management Improvement Project based on the Maintenance Management.
- Plants Managers
 - Organization of “Process Plants”

- ISO 9000 Quality Systems
- Training according to ISO 9000 Systems
- Positions Profile of staff and hourly workers.
- Accounting.
- Shift Engineers - Production Supervisors
 - Shift engineers' number, working Shifts, Productive shifts Support
 - Responsibilities, working shifts in operation and maintenance. Works with contractors.
- Mechanical Maintenance Managers
 - We visited Production Plants: Mining, Power Generation, Manufacturing, Process, Mill, Refineries, Packing and Industrial Services.
 - Mechanical maintenance planning and scheduling.
 - Coordination of maintenance works requested by shift engineer, input to CMMS or EAM systems.
 - Tools or resources that are needed to improve maintenance management, PM and Pdm?
- Electrical Maintenance Managers:
 - Electrical Maintenance Planning and Scheduling.
 - CMMS or EAM Systems: Materials Management. Charge the costs to each work order?
 - Time Control sheet of working teams. Clocks.

After these meetings a maintenance Audit was carried out in 20 Plants using the radar methodology. The following results were obtained: (figure # 1)

Area	Org.	Adm.	Pers.	Exec.	Super.	Supp.
%	47	53	51	43	61	35

Figure # 1: “Process Plants” Radar

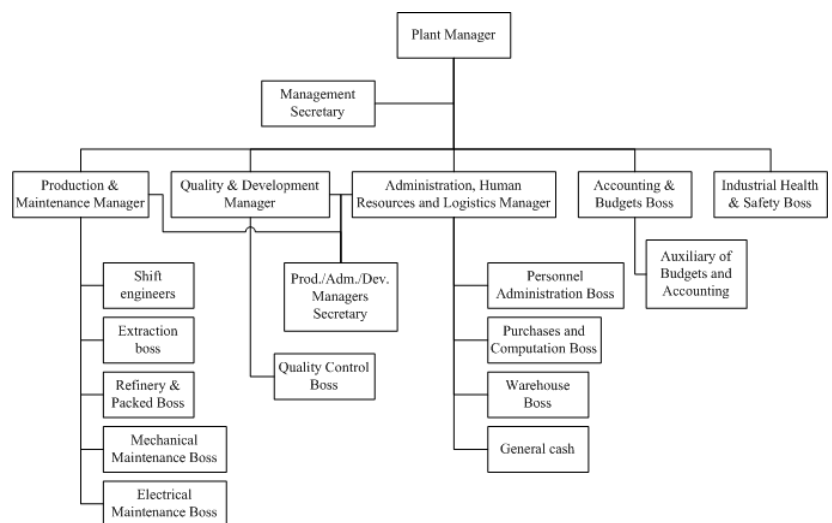


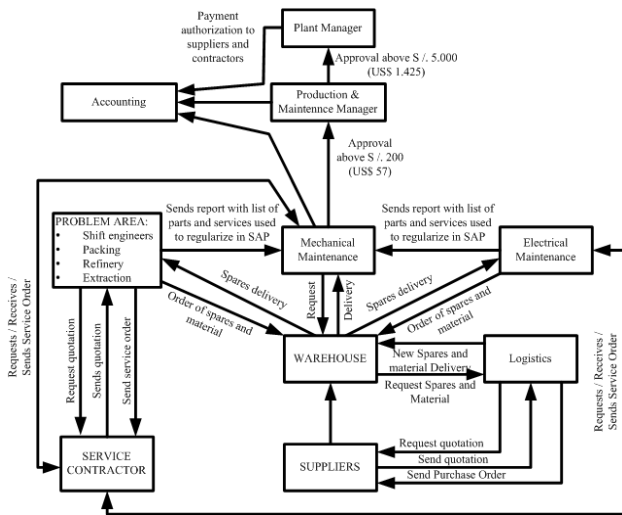
We can conclude the following, based on the current situation analysis results of the observations in the visit to the “Process Plants” and of the comments from the people interviews, on the execution of maintenance activities:

Central problem: Maintenance Organization IS NOT INTEGRATED. They did not measure and/or manage management indicators. This prevented them from knowing their current situation at the moment; neither they could compare with previous exercises. They don’t set goals. Outstanding facts:

- **Current Organization:** You can appreciate a typical flowchart (Figures # 1) that there is not a defined maintenance line in the Production and Maintenance Management,: there is not a visible head, there are two bosses and the responsibilities are rotated with the shift engineers, none of them plan, they only schedule day by day activities and historical activities without a defined job order.

Figure # 2: Flowchart “Process Plants”





• **Typical flow of the information when a machine failure occurs** (figure # 2), at the upper levels of management. As you can appreciate, the power decision of the mechanical maintenance and electrician maintenance bosses are practically restricted by the very small money quantity that they can prepare, all are decided by the Managers: This leaves maintenance people without freedom to make decisions

Figure # 3: Flow of the information “Process Plants”

Mechanical Maintenance Area Antecedents:

- **Organization:** Mechanical Maintenance Boss, Supervisors, technicians and shift mechanics.
- **Administration:** A mechanical workshop, good experienced mechanical technicians and a shift mechanic that know all the equipments; they carry out the global maintenance works or overhauls in different areas of the company. They look after the Industrial Services: steam, compressed air, soft water, cooling water systems and ammonia refrigeration systems. Contractors that are constantly in the factory, among welders, mechanics, insulators of pipes and cleaners. They carry out the orders of parts and spares. They have a clear idea of planned maintenance management and its benefits, but it is not carried out fully for lack of resources. There are not equipment technical sheets for the Plant. An equipment history of the whole Plant is not taken: maintenance indicators are not measured. This area generates all the Service orders for the whole Plant by the EAM / CMMS system, for the respective approval.
- **Personnel:** The boss knows the operation and maintenance thoroughly of each one of his machines. His wide experience in this industrial field gives him an advantage in front of the other professionals of the Plant. The mechanical technician and the shift mechanic know the maintenance thoroughly of each one of their machines.
- **Maintenance Execution:** They didn't have adequate Preventive Maintenance Systems. Every month maintenance activities are indicated to be carried out according to an annual historical maintenance program, but there didn't exist lubrication, cleaning or repair standard route sheets neither standard inspections checklist that mechanics should carry out each one. It is more difficult to make the tasks because of machinery age.
- **Electrical Maintenance Area Antecedents:**
 - **Organization:** Electrical Maintenance Boss, Supervisors, technicians and shift electricians.
 - **Administration:** An Electrical workshop with good experienced electrical technicians who know the machineries and carry out the global maintenance works or overhaul in the different areas of the Plants. Electrical contractors that are constantly in the factories. They carry out the orders of electric and of control spares. They don't have a clear idea of the planned maintenance management and its benefits, but it is not carried out to completion for lack of resources. In most of the plants there are not technical equipment sheets of the whole Plants. A record of the teams of the whole Plants are not taken. They don't measure electrical maintenance indicators.
- **Antecedents of different Operation & Maintenance areas of the Plants: Production, Elaboration, Manufacturing, Packing and General services.**
 - **Organization:** Engineers, supervisors, workers per shift.
 - **Administration:** They didn't have a planned maintenance system. Antiquity average of machines, many of them recovered of other Plants. The growth has been disordered as the necessities arose; and there was not technical history of the original equipment and modifications.

- *Personnel*: The shift Bosses didn't have the resources to make an effective maintenance program. The personnel was very qualified in operations. The Laboratory and Safety engineers support covering shift Engineers vacations.
- *Maintenance Execution*: The main problem is maintenance: there was not carried out adequate preventive planned maintenance activities. They didn't have equipment maintenance history neither a maintenance plan for each equipment, although they had critical equipments. Contractor personnel was used constantly in the plants, they made the corrective maintenance activities during the production with coordination with the Mechanical and Electrical Maintenance Areas. A well elaborated maintenance work order doesn't exist (WO). They did not find spares and parts resources in stock frequently.

RECOMMENDED SOLUTION TO ACHIEVE MAINTENANCE EXCELLENCE,

Initially they needed to develop basic capacities for the Maintenance Management that allow them to control the day by day maintenance, that was what governed the activities of maintenance.

Strategy, including a new vision of maintenance management, starting from the results of the maintenance situation analysis, intends the following:

- S1. They have to reorganize the maintenance area, to integrate the whole information of the carried out maintenance work and to carry out in a single database, with the purpose of being able to administer it establishing a new list of functions and responsibilities of each responsible one for Plant. Procedure to establish recommended solution for the reorganization of the Maintenance Area.
- S2. Necessary training for development to be able to follow the proposed plan:
 - S2.1. Administration of the Maintenance (8 hours)
 - S2.2. Working in Team (8 hours)
- S3. Audit of Maintenance area by area to identify the individual problems. They have to develop procedures to carry out an Audit of Maintenance in the different areas, to establish the reference indicators that will allow to evaluate the efficiency of the proposed program later.
- S4. Measurement of results using the index OEE (Overall Equipment Effectiveness). They have to develop the formats for the Measurement of the OEE in each process of the Plant by working in Teams.

Tactics, in this part should include the Preventive and Predictive maintenance, intends the following:

- T1. They have to establish an appropriate Preventive Maintenance System to all the productive areas of the Plant. To develop the appropriate preventive maintenance system it is suggested to work with troubleshooting teams.
- T2. Rising of Technical Information:
 - T2.1. Technical sheet for each equipment.
 - T2.2. Maintenance history for each equipment.
- T3. Training is necessary to develop the proposed. plan Initially the following training is needed to be able to follow the proposed plan:
 - T3.1. Maintenance Planning and Scheduling (8 hours)

Routine Work Management, in this part they should include Maintenance Planning & Scheduling, intends the following:

- R1. They have to develop a procedure to settle down, inside the annual strategic planning, the objectives of the maintenance area, to support the strategic objectives of their Companies and specific Objectives for their "Process Plants". An Annual Plan of Maintenance is the result.
- R2. They have to establish a procedure of an appropriate Maintenance Planning to fulfill the Annual Maintenance Plan for all the productive areas of the Plant. They have to develop a resource management system for the maintenance system, to assure the resources before they emitted the monthly Work Orders.

- R3.They have to establish a weekly procedure for an appropriate Maintenance Scheduling to fulfill the monthly planning. They have to develop a System for Supervision, Execution and Control the maintenance activities.
- R4.They have to establish to a weekly procedure of appropriate Activities Maintenance Report to fulfill with data to the productivity of the maintenance area. This report should allow to enhance the strengths to be able to sell own work and the weaknesses to be able to work immediately correcting with the purpose of improving.
- R5.Necessary training to develop the proposed plan. The following training initially is needed to be able to follow the proposed plan:
 - R5.1. TPM-Total Productive Maintenance (8 hours)

Continuous Improvement, in this part they should include the Root Cause of the failures analysis, for what intends to obtain the following:

- C1.They have to develop a procedure to settle down the equipment that fail frequently, fail more and those that require a higher maintenance cost inside the “Process Plants”.
- C2.They have to establish a procedure to select a failure mode of an equipment to apply its a RCFA.
- C3.They have to establish a procedure to search of troubleshooting locating Root Causes Failures.
- C4.They have to establish Continuous Improvement Plan of the Maintenance area, based in the feedback of the system for Supervision, Execution and Control of the maintenance activities.
- C5.Training is necessary to develop the proposed plan the following training. Initially the following training is needed to be able to follow the proposed plan:
 - C5.1. TPM-MA Installation (8 hours)

Development of the recommended Solution

Strategy, They must begin with the elaboration of a Maintenance Manual.

- M1. INTRODUCTION: The Maintenance System – in many of “The Process Plants” is supported in procedures and documented manuals, designed to assure the Policies' of Maintenance execution, which allow to guarantee the uniformity in the Maintenance of its equipments and the continuity of the processes, as well as the increment of the safe-deposit levels. Our commitment is to maintain the continuity in the production processes, besides prolonging the useful life of the teams.
- M2. OBJECTIVE: to communicate the Maintenance Policies and to define the list of each element of the Maintenance System.
- M3. SCOPE: The present Manual is applied to all the elements of the Maintenance System: it structures organizational, procedures and necessary resources for the execution of maintenance programs, and the correct evaluation of the suppliers of services.
- M4. REQUIREMENTS:
 - M4.1. MANAGEMENT RESPONSIBILITIES
 - M4.1.1. OBJECTIVE, to settle down and to diffuse the commitment and involvement of the Production and Maintenance Management with the maintenance administration and to integrate the Maintenance System of – “Process Plants” to its Policies and objectives.
 - M4.1.2. SCOPE, The responsibilities of the Production and Maintenance Management of “Process Plants” is applied in all the activities that impact in the maintenance administration and they are executed in the areas that conform the Structural Flowchart of the System.
 - M4.1.3. IMPLEMENTATION
 - 4.1.3.1. To define and to document the Maintenance Policies of “Process Plants” / Maintenance Policies – PCR / Production & Maintenance
 - 4.1.3.2. To define and to document the objectives of Maintenance and to carry out the corresponding stocks to reach them / Maintenance Objectives and Results Evaluation / Maintenance and Services Boss

- 4.1.3.3. To maintain and to upgrade the Structural Flowchart of the Maintenance System - “Process Plants”, described in the figure # 4. / Structural flowchart of the Maintenance System - “Process Plants” / Production & Maintenance Manager
- 4.1.3.4. To describe the responsibilities, the authority and the interrelations of the whole personnel whose work impact in Maintenance. / Functions Manuals: Production and Maintenance / Production & Maintenance Manager
- 4.1.3.5. To revise the execution of the budget for the implementation and maintenance of the Maintenance System. To identify and to provide the appropriate resources, including personnel qualified to administer, to execute and to verify the activities. / Presupposed of the Maintenance System of - “Process Plants” / Production & Maintenance Manager
- 4.1.3.6. To revise and to register the effectiveness of the Maintenance System - “Process Plants”, regarding the policies and objectives of Maintenance / Revision for the Direction and Report of Revision for the Direction. / Production & Maintenance Manager

A SUGGESTED MAINTENANCE POLICY

“In our Process Plants, we are resolved to implement a Maintenance System that allows to increase the levels of productivity, quality and safety in its. Through the adoption of the techniques and the most appropriate maintenance systems to our reality and our personnel's continuous training, we will guarantee the execution of our production schedules”.

General Manager

NEW SUGGESTED STRUCTURAL FLOWCHART OF THE MAINTENANCE SYSTEM FOR OUR “PROCESS PLANTS”

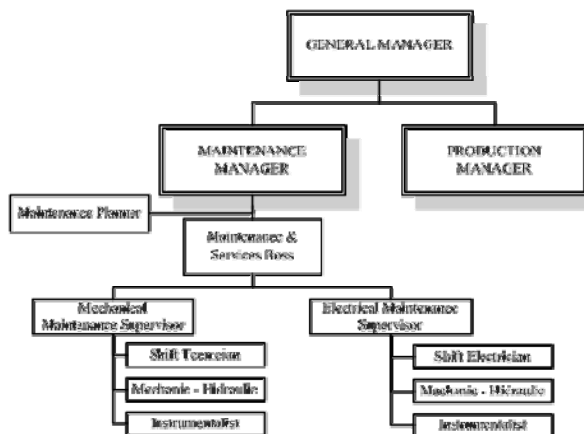


Figure #4: New suggested maintenance flowchart

M4.2. MAINTENANCE SYSTEM

M4.2.1. OBJECTIVE to provide “The Process Plants” with a Maintenance System that assures the reliable execution of the production schedules

M4.2.2. SCOPE The Maintenance System - “Process Plants” may cover the processes of: planning, scheduling, execution and control of routine work maintenance process plants.

M4.2.3. IMPLEMENTATION

4.2.3.1. To maintain and to upgrade the Maintenance Manual. / Maintenance Manual – Process Plants / Production & Maintenance Manager

4.2.3.2. To structure the documentation of the Maintenance System. / Control of Documents and Data / Production & Maintenance Manager

4.2.3.3. To maintain and to upgrade documented procedures. / The designated ones in each document.

4.2.3.4. Maintenance Planning. To define and to document the execution of the Maintenance requirements. / Documents of the Maintenance System - Maintenance Programs for Production Process / Maintenance and Services Boss - Maintenance Planning

Maintenance is considered today a strategic factor to increase the levels of productivity, quality and safety in the plant. For their optimization, a Preventive Maintenance System has been implemented which very organized, will allow to prevent failures, carrying out simple inspection routines, adjustment, lubrication or smaller change of pieces. They defined a new flow of preventive maintenance information based on the maintenance cycle of Jasper Coetzee in his book "Maintenance".

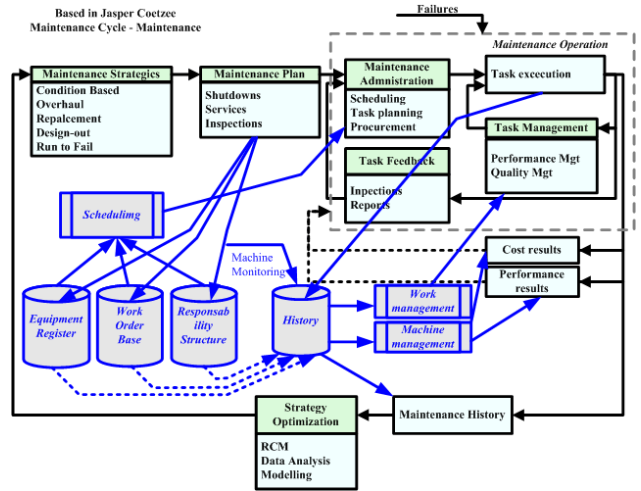


Figure # 5: New data flowchart

Tactics, in this part includes the Preventive and Predictive Maintenance. It was defined that the Preventive maintenance is formed by three stages:

- Technical information of the equipments that embraces: Technical Location, Registers Technique, Note of Maintenance.
- Maintenance Planning - Maintenance Programs.
- Execution of work orders that covers: Generation, Execution and Follow-up of work orders.

The following objectives were traced for a year period:

1. Elaboration of equipment techniques cards. It is the document that allows to identify in detail the plant equipment, according to a technical location that has already been defined.

The documentation of the equipment cards was carried out with two practitioners carrying out the following tasks: database elaboration, collection of information in plant, in time period of 2 months, they documented approximately 1000 pieces of equipments.

Process Plant - Ficha Técnica			
1. Descripción y Ubicación de la máquina			
COCIDO	BOG0001	7	
DESCRIPCIÓN	Boquilla de Storage de aceite (en semiconductores) con líneas		
FUNCIÓN QUE REALIZA	Control de aceite de la línea semiconductora.		
ÁREA	Parafina	MARCA	Cashers
SECCIÓN	Control de aceite	MÓDULO	BOG001
LOCALIZACIÓN (Ab. 300)	TIPO Controlador		
DIMENSIONES (Cm. alto x 15)	SERIAL 27A.11908		
FECHA DE FABRICACIÓN (d)	NÚMERO		
FABRICADO EN (País)	PROYECTOR (Módulo)		
OTROS DATOS (d)	TELEFONO (d) (Llamada)		
2. Datos Técnicos			
Dónde se instala: en armario (Armar. 3000)			
CATEGORÍA	3750 BOG001		
PRELUDIO	Regulador		
TEMPERATURA	TE. 30°C		
CARACTERÍSTICAS	Caudal: 1 litera por hora (Armar. 3000)		
CALIDAD/TERMINACIÓN/OTRAS	S		
3. Especificaciones			
REQUERIMIENTO No. 1	100V	ANILAJE (O BBO)	0
REQUERIMIENTO No. 2	50V	FILTRO	50V 10000
CELLO	J. CRANE (INFO 1)	ALUM.	0
EMPACOTADO/OTRAS	S		
4. Parte Móvil			
Accesorios/Bomba	Fornica	10 CV	Bomba No. 1 600Z
Accesorios/Fluido	Fornica	30000	Bomba No. 2 600Z
Motores	TE. 10	Aluminio	1451 35A
Módulo	TE. 1325	EPDM	330
Tubo	0	Acero	60 IN
Sensores	0796 A1707	0	Senza 1000
Sensores	0	Potencia	0
Sensores	0	Oper. Sen.	Oper. Sen. C. 11.15
5. DATOS DE CONDICIÓN			
DE EFECTIVIDAD ACTUAL	30%	IMPORTANCIA CRÍTICA	ESBORTABLE
ESTADO DE EXISTENCIA	Exista	RESPONSABILIDAD OPERATIVA	En Mantenimiento
6. DOCUMENTOS DISPONIBLES			
HISTORIA	0	PLANOS/Ab. Lev. Asistido	MANUALES/Ab. Lev. Asistido
7. Costos			
COSTO ORIGINAL (US\$)	COSTO DE REPOSICIÓN (US\$)		
COSTO ACTUAL (US\$)	COSTO DE MANTENIMIENTO		
CENTRO-COSTO	AÑO	COSTO	
8. COMPONENTES			
NOMBRE	Nº SERIE / MODELO	CARACTERÍSTICAS	
0			

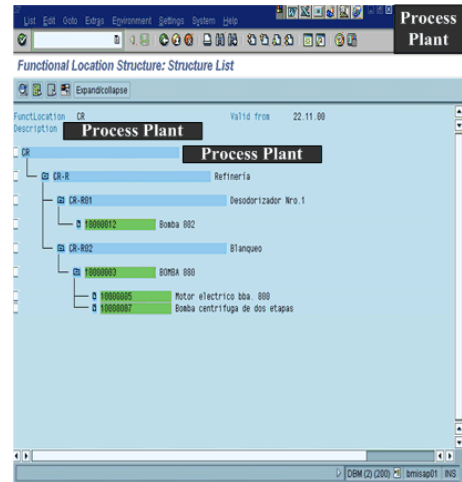
Figure # 6: Techniques cards

Figure # 7: Database

The technical location has been defined in the following way:

Area
 Process
 Line
 Equipment N°
 For example: mol_sil_11_009.

Figure # 8: technical location



2. Elaboration of preventive maintenance (PM) sheets for the equipment. PM sheets are documents that contain detailed information of the PM tasks . The elaboration of the PM tasks begins once the equipment cards are finished.

ROUTINE WORK MANAGEMENT, IN THIS PART YOU INCLUDES THE MAINTENANCE PLANNING & SCHEDULING, INTENDS THE FOLLOWING:

- 3. Design, development and implementation of a program of preventive maintenance tasks for equipment. The Maintenance Department in coordination with an University (UDEP) – High School Technological develop a Pursuit System of the maintenance works for the equipment of the plant. This system was developed in Visual Basic, allows to make a scheduling of the 12.000 foreseen maintenance tasks for this year, its pursuit and rescheduling in the face of eventualities that can arise. The time for its implementation was of sixty days.
- 4. Contractors' Selection and Evaluation. A user friendly database was elaborated that contains the suppliers information of the services.

Figure # 9: Suppliers Database

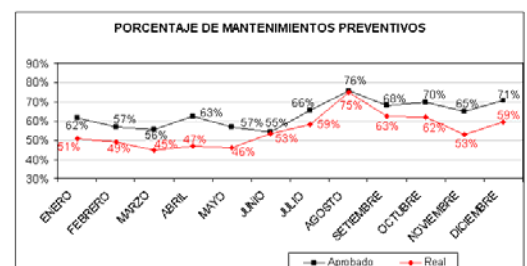
Process Plant	Cartilla de Proveedores
1. Datos de la Empresa	
R.U.C:	34387729
Razón Social:	DIN AUMATIZACIÓN S.A.C
Dirección:	Calle Rimsac pampa 385 - Huandoy 501, Lima 32
Teléfono:	(01) 451-1733 / 451-0686
Fax:	(01) 449-1095
Apartado Postal:	
Página Web:	
Servicio que brinda:	Control e instrumentación industrial
2. Datos del Contacto	
Nombre:	Ing. Marcos Garay Pimentel
Cargo:	Gerente General
Teléfono:	Cel: 947-7144
Email:	din_aut@terra.com.pe

Figure # 10: suppliers notes

They had documented suppliers notes. They could evaluate the suppliers with more agility and later on send to the CMMS.

5. Measurements and evaluation of maintenance plan results. It begins with the measurement of the level of executed preventive maintenance in relation to the total of maintenances (correctives and of improvement)

Figure #12: Preventive Maintenance Index Execution



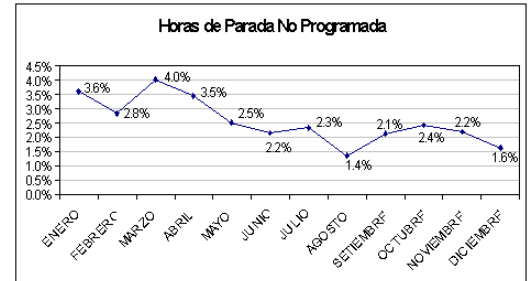
Número Centro Area PRD: 4				
Centro Area PRD	OEE	Disponibil	Tasa Rendi	Tasa Calid
Suna	75.87	97.54	77.83	99.94
Aceite Crudo	78.80	98.67	79.86	100.00
Refinería	84.14	96.02	87.63	100.00
Envasamiento	87.23	96.19	91.28	99.35
Servicios industri	56.37	100.00	56.37	100.00

It began to evaluate the OEE and equipment availability for the different areas and processes.

Figure # 13: OEE index

The control of the downtimes hours, failures in equipments.

Figure # 14: Equipment Downtimes index



Continuous Improvement, in this part they have included the Root Cause Failure Analysis.

Formats FMEA and Ishikawa were developed to look for the root cause of certain problems that had caused a loss of production of 30 minutes or more. And that the maintenance costs for TM rose above the monthly objectives. Figure 15 shows an example of an analysis of Problems.

Figure # 15: Failure Analysis

ANÁLISIS DE FALLAS REPRESENTATIVAS DE EQUIPO DEL MES DE SEPTIEMBRE 2003									
BOQUÍ O / LINEA	DEFECTOS O FALLAS DE LA MAQUINARIA (LÍNEAS)	REPLICACIÓN DE FALLAS	CAUSAS DE LA FALLA	ACCIONES DE MANTENIMIENTO	PLAN DE ACCIÓN	ESTADO DE EJECUCIÓN	REPLICACIÓN DE FALLAS (LÍNEAS)	DEFECTOS O FALLAS (LÍNEAS)	TIEMPO DE FALLA (HORAS)
Envasadora 2000	313	15	Falta de aceite de motor de motor.	Mantenimiento preventivo y reemplazamiento	Cambio de aceite por medio de un sistema de aceite de motor.	Completado con éxito	0	0.00%	0
Máquina 1000	122	4	Falta de PCB de controlador de planta de gas.	Detección de material anticorrosivo	Cambio de PCB por medio de un sistema de controlador.	Deposición de PCB en el sistema de controlador.	15	0.99%	15
3000	141	7	Falta de aceite de motor de motor.	Reemplazo de aceite de motor de motor de motor.	Reemplazo de aceite de motor de motor de motor.	Reemplazo de aceite de motor de motor de motor.	14	0.00%	0
Planta de gas	149	4	Falta de PCB de controlador de planta de gas.	Detección de material anticorrosivo	Cambio de PCB por medio de un sistema de controlador.	Deposición de PCB en el sistema de controlador.	9	0.00%	0

Starting from the improvement obtained in the previous year, the results of the present year were constantly improving:

As you it can be seen in the graphics of the figure 16 the unavailability index in the present year, it overcame the objective layout largely for that year (line of green color)

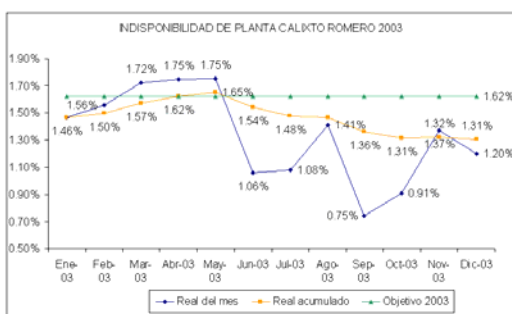


Figure # 16: Chart Non Availability

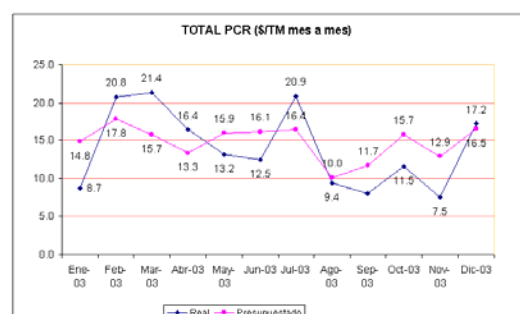


Figure # 17: Maintenance costs per metric ton produced

Lastly we can present a graph of maintenance costs per produced TM and we can analyze their tendency.

To conclude they have to present their objectives for the success of the next year, on the part of the Maintenance area of the "Process Plants".