

ADVANCED SYSTEMS SOLUTION FOR MAINTAINABILITY AND PRODUCTIVITY ¹

A. Grilli ²

Abstracts

With the traditional service approach, the plant Owner with a breakdown buy to Danieli parts, repairs, and technical services as the plant requires. The overall objective is a price focus in which lowest price bids are solicited for troubleshooting, training, repairs, and new replacements parts. This traditional relationship can be extended into a longer-term traditional arrangement by execution of a Agreement, which is typically a price discounted arrangement in exchange for a long term volume commitment. Sometime this Long Term Service Agreement (LTSA), however, suffers from the business goals being unaligned, because it is far more economically productive to have every one working to the same goal. The Production and Maintenance Services Agreements change the focus from minimum price to maximum value by alignment the risk/reward goal. In this relationship, Danieli assumes a range of pro-forma responsibilities for an identified maintenance LTSA price range, for a identified OEM (Original Equipment Manufacturer) price range and performance guarantees (Win Project – WWP). The main target of the Danieli LTSA is to maximize Customer benefits by minimize equipment breakdowns and maintenance costs while supporting and freeing the Customer from the critical issues related to equipment maintenance and operation including maintenance scheduling, spare parts inventory management, ordering and other activities of this nature. These type of Service Agreements may include contractual performance provisions, which provide guarantees for achieving the pro-forma profitability. Contractual performance is a key influence in driving high plant operating out capability, high personnel and efficiency in operation and maintenance, high plant reliability and availability. The Danieli WWPs can achieve this by using the latest technology replacement parts, implementation advanced repair and services technology to assure correct parts fit with minimum stoppages, using “state of the art” preventive and predictive maintenance systems and employing Danieli technical resources to quickly provide technical solutions. In addition, the WWP can make investments in new technology to further enhance the plant performance. To improve the Plant results in terms of equipment reliability and efficiency, while reducing overall running costs, Danieli has integrated its know-how in steel plants design and manufacturing with the expertise in process, equipment, maintenance practices and organization construction.

Key words: Remote support e trouble-shotting; Remote monitoring e diagnostic; Condition monitoring system

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² Executive Manager - Danieli Service Dept. - Udine, Italy

APPROACH

The Project will be conformed to the D.M.A.I.C.- Six Sigma approach as per the following description:

- DEFINE the main problems / constraints for each specific working team and site area;
- MEASURE the full extent of the lacks and characterize the Customer requirements;
- ANALYSE the reasons of the knowledge leakage in maintenance and operative procedures and further edit a problems solving plan;
- IMPROVE through the fulfillment of a defined training, supervision and troubleshooting plan involving specific personnel deployed all over the interesting areas on the site;
- CONTROL Plant facilities and organization through Back up Support aimed to monitor and if is necessary improve the skillfulness of plant personnel, technicians smoothing away the lacks and optimizing / develop the: SOP (standard operative procedures); WI (work instructions) and troubleshooting guides.

We principally identify three stages in the project:

Phase 1 - Assessment for the master plan of project

Phase 2 - On-site customized training

Phase 3 – Back-up support during production

REMOTE SUPPORT AND TROUBLESHOTTING

An innovative Inter@ctive Service of Danieli is named Remote Support & Troubleshooting - RS&T.

The main advantage of RS&T are:

- Immediate intervention of a specialist
- Reduce the specialist's traveling time and costs
- Increase the technical team knowledge
- Access to a virtually unlimited problem solving
- Identification of process malfunction in advance
- Remote resource process quality and costs.

This technology permits to evaluate process setup and identify any possible actions. Danieli Technical staff can assist plant maintenance staff by activating the following:

- Video/audio connections to discuss technical problems, perform diagnoses and supervise maintenance activities.
- Assistance for plant maintenance personnel and maintenance activities.
- Access to FAQ (Frequently Asked Questions) Guided paths for troubleshooting defined by past experiences in the field.
- Sharing of applications for viewing, and providing drawings and sketched to support technical description and accelerate problem solving

Danieli process engineers can support the customer from Danieli Headquarters in the following ways:

- On-call assistance. Starting from customer requests.
- Periodical monitoring; (without any disturbance to plant operations) and within Customer authorization.

The on-line connection to the remote assistance stations is carried out through a telephone line or via Internet, and allows the following activities:

- Troubleshooting of the mechanical and automation system.
- Setup tuning.
- Database maintenance.
- Exchanges of software backup.
- Personnel Training and Technical Assistance.

The inter@ctive approach assure a remote non-stop service and a reliable support 24/24 hours for a quick solution of unexpected malfunctions.

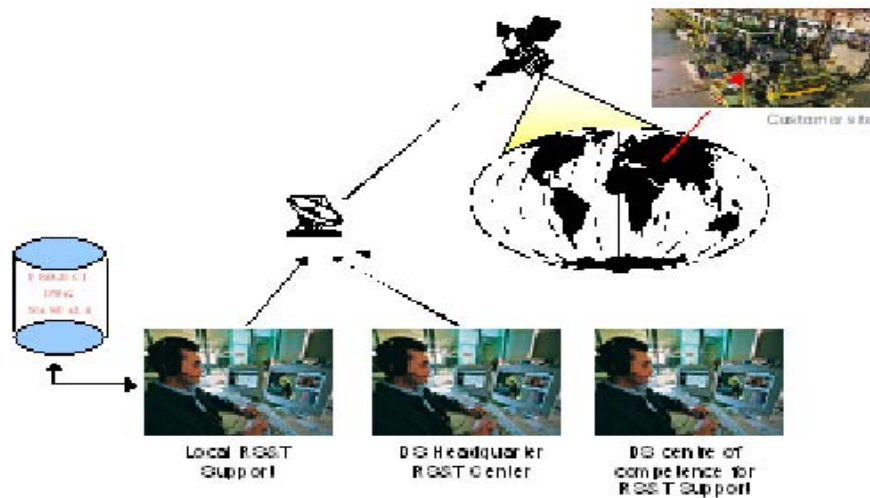


Figure 1.

DMMS (DANIELI MAINTENANCE MANAGEMENT SYSTEM)

The Danieli Maintenance Management System (DMMS) is designed for any level of user and successively customised by DANIELI's Advanced Maintenance Systems Dept. for handling all aspects of the maintenance activities in a steelmaking environment. That includes:

- Equipment & Facilities Management;
- Planning & Scheduling Preventive Maintenance Operation;
- Job Plan & Work Order Management;
- Resource Management;
- Inventory Management;
- Report & Analysis.
- It can store/find equipment/asset information, i.e. technical specifications, work outstanding, cost of ownership etc.
- It can build a comprehensive and detailed library of jobs for each planned and unplanned jobs/routines.
- It can run intelligent plans that will find the jobs that it needs to do for the forthcoming week, month, year, 10 years or however far into the future it wants.
- It can run multiple plans that will find the jobs that are due, it can extend that to plan if the man-time is available to do the work and also run a plan to see if the materials will be in stock. All of this can again be run as far into the future as it wants, with the exception of stock which is 20 days advance planning.

- It can quickly and easily look at the complete history of each equipment, even the depreciation.

The Danieli's Customer are acting in a field of iron metallurgy ranging from melting furnaces, casting plants to rolling mills, strip mills and galvanizing lines. Danieli's know-how has been successfully transferred to the several companies which at the end of the DMMS project, recognize the following benefits:

Information for decision making

- Improve information control
- Distribute information
- Communicate effectively
- Reduce paper work
- Reduce information lag time
- Effect better communications between departments
- Use multi media

Improve plant availability & reliability at minimum cost

- Increase plant availability and reliability with analytical tools
- Increase production up time
- Improve safety
- Increase productivity with pro-active information
- Improve quality of work by effective monitoring
- Target PM maintenance to needed assets
- Schedule resources and control labor more effectively
- Reduce waiting time
- Control statutory requirements
- Control major projects
- Analyze defects to engineer out recurring problems

Stock and procurement optimization

- Control stock at optimum levels
- Reduce capital holding
- Facilitate 'Just In Time' ordering
- Select most effective suppliers
- Reduce purchase administration costs
- Administer, and monitor usage and costs of stock

Analysis and cost optimization

- Control costs
- Control budgets
- Analyze statistical results
- Provide reporting facilities for all levels of personnel
- Benchmarking

Resource optimization

- Train and monitor effectively
- Co-ordinate staff
- Increase staff moral

RM&D (REMOTE MONITORING & DIAGNOSTIC) - CMS (CONDITION MONITORING SYSTEM)

The RM&D system is the key to move from preventive to proactive maintenance. It provides valuable information to assist in decision making, which allows the owner of the equipment to optimize the value of their assets.

Regarding the RM&D, the services are:

- Real-time condition monitoring and anomalies detection.
- Short and long term analysis.
- Diagnostic and troubleshooting.
- Advanced diagnostic and performance / life assessment.
- Periodic reporting.
- Archival database of plant operational history.
- Remote access by Danieli Service organization.

The Danieli RM&D is a flexible system that allows the customer to control and manage equipment in terms of machine troubleshooting and forecasting consumption of spare parts. By analysing a wide spectrum of parameters (vibration, thermography, tribology) a complete investigation of equipment status can be provided. This not only helps fault detection, but also keeps equipment in optimized running condition.

Particularly important is vibration analysis for rotating components, through which customers can easily ascertain the status of their equipment and, if necessary, alignment, balancing, bearing replacement or any other useful activities can be carried out by Danieli engineers. This provides an early analysis of fault symptoms and permits correct activity and spare parts planning, while reducing production stoppages due to unforeseen breakdowns.

The RM&D can be interfaced with the DMMS in order to semi-automatically fill the Based Maintenance module.

In Particular the "Condition Monitoring System" (CMS) is based on instrumental checks, on vibration monitoring. This system consists for example in monitoring the modules of the BGV and/or TMB during the operative condition and store, in a database the status of each rolling equipment component.

The condition monitoring in real time has the aim to keep under control the global vibration value generated by the equipments.

The vibration analysis of the database, established by periodic data stored, allow to:

- the identification of the damaged element
- the identification of the failure cause
- the evaluation of the residual life

These three arguments consent making appropriate decision, necessary for the scheduling of the maintenance activities. The aforesaid maintenance approach is named "Predictive Maintenance", with the following final aims:

- reducing the maintenance cost
- improving the overall equipment efficiency
- increasing the productivity
- increasing the safety of work

The vibration monitoring system proposes is illustrate in the following schema:

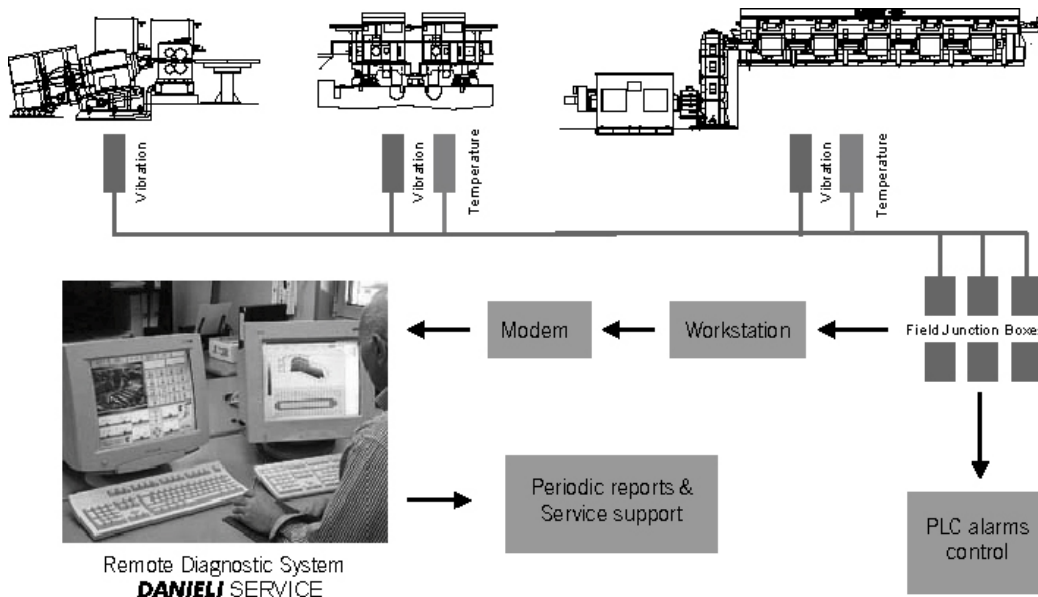


Figure 2. Vibration Monitoring System.

The signal collected by the sensors, fixed installed on the equipment modules, is a process with a predefined route of points set-up on a remote data unit, this is directly connect to the PLC mill control. Consequently when the vibration value exceeds the alarm limits, a defined action, on the mill control, will start, i.e.:

- Alarm visualisation or arrest immediate of the mill.

The output signal from the remote data unit is stored on the local workstation, which allows visualization of the vibration level in real time and the trend of data values.

The core of the system is the vibration analysis for:

- Detailed
- Trend values,

If necessary for the identification of the damage element and the relative cause.

Danieli Service Specialist performs the vibration analysis & reports with the support of the own technicians, the historical database and the experience in vibration analysis of it's own equipment.

The reports are of two different typologies:

- Detailed vibration analysis: conditions and amplitude must be analysed for all frequencies generated by the kinematics of every machine.

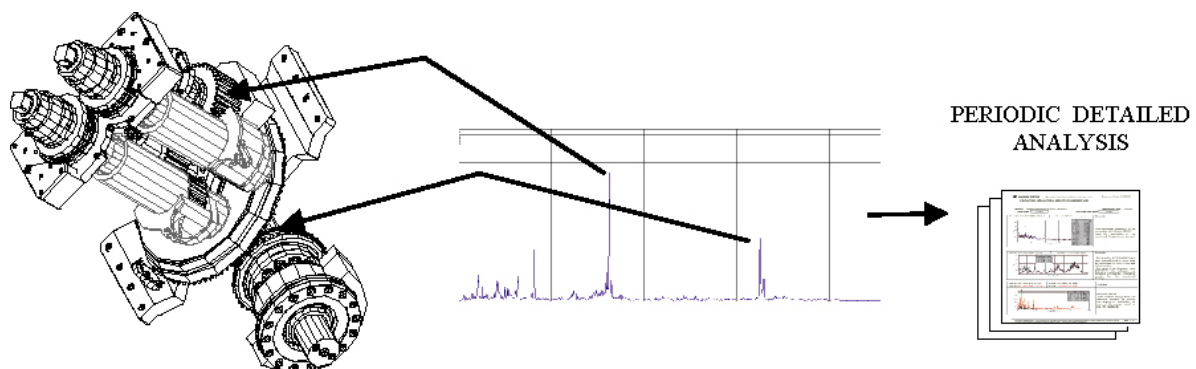


Figure 3. Periodic Detailed Analysis

- Trend analysis report: the periodic acquisitions performed in the same working conditions compose a trend of values. This report analyses the trend's evolution and when the values reach the alarm threshold.

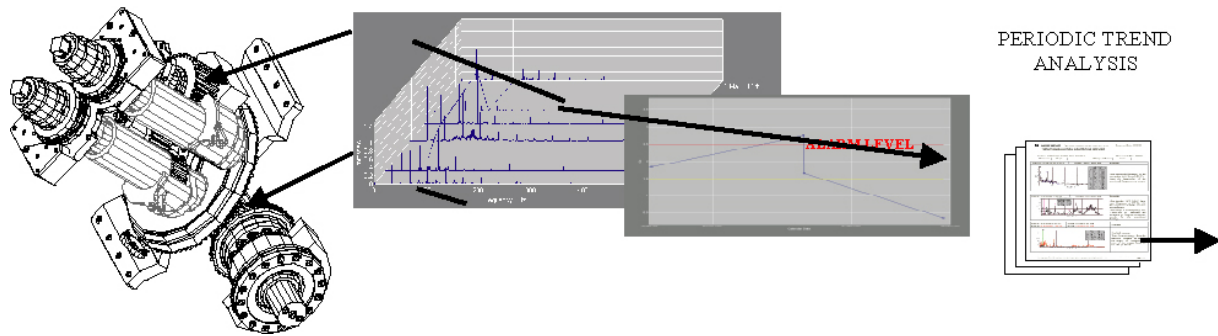


Figure 4. Periodic Trend Analysis

The activities necessary for install, set and tune the Condition Monitoring System are structured in accordance with the following issues:

- Engineering of the system necessary to collect, organise and set the CMS;
- Installation of the Hardware & software (remote unit, workstation...);
- Start-up of the system;
- Training to the Site specialist for the workstation (PC, software...);
- Data acquisition and storing data;
- Tuning set-set;
- Transfer data to Danieli Service
- Vibration analysis reports.

CASE HISTORY – FINANCIAL ANALYSIS OF THE GEARBOX OVERHAULING

A program of predictive maintenance is based on the instrumental checks, indispensable for the anomalies identification. Afterward is it organised the overhauling about the gearbox, which will be carried out by the maintenance people. Moreover to give a technical information, this type of maintenance should provide a further step, a value added for financial analysis evaluation giving a financial justification.

Case analyzed

The intent of this document is to highlight the cost and the benefit of a service, in this case referred to a gearbox overhauling of a bar mill stand

During the periodic vibration monitoring it was identified an anomaly on the input shaft bearing of the gearbox as result of increasing of the amplitude level reaching the alarm limit. In that case was organised the gearbox overhauling during a planed shutdown. In the bearing outer ring was find the damage, some little incisions caused by the passage of electrical current starting from the motor going through the coupling, caused by the no good electrical insulation.

Financial analysis

The financial study of the case aforementioned and described, is based on the real maintenance cost and on the assessment of the benefits. These benefits are based on the assumption of a progressive worsening of the components condition.

Actually for the calculation of the benefit is necessary consider two area of analysis:

- Lost production avoidable;
- Maintenance cost avoided: spare parts and machining;

The amount of these costs are provided by the customer.

To simplify the analysis process, we define three levels of damaging.

The first effect is the interruption of the mill for an unscheduled downtime, with lost of production and increasing of man power involved.

- LOWER: include the cost of the replacement of the damage components, the time of mill downtime for organise the gearbox inspection.
- MODERATE: include the cost of the replacement of the damage elements, the unscheduled downtime for the inspection and a more critically damage level as a pinion machining.
- HEAVY include all the cost specify in the previous points and a damage level more critically as a gearbox body damage and bushing if necessary.

The result of the total cost is the soma of loss production and the maintenance cost at the three levels of damage:

- LOWER: €156.435,00
- MODERATE: €158.264,00
- HEAVY: €160.710,00

These three hypothesis of damage doesn't have the same probability of occur, in percentage we can consider the HEAVY and the MODERATE with a lower probability (10% each) while the LOWER case with a higher probability (80%), consequently the following results:

- LOWER: €117.234,40
- MODERATE: €14.837,20
- HEAVY: €15.081,80

The result of total benefit is the sum of these three hypothesis and is equal at €147.153,40, practically this is consider the hypothetical savings, the following table summarise all.

Table 1. Cost/Benefit.

Machine: Gearbox of stand#8 for bar mill
Damage: Bearing in the input shaft

Table COST/BENEFIT

		DAMAGE SUPPOSE			(d) REGISTERED STOP
		(a) HEAVY UNSCHEDULED DOWNTIME	(b) MODERATE UNSCHEDULED DOWNTIME	(c) LOWER UNSCHEDULED DOWNTIME	
DESCRIPTION OF THE DAMAGE SUPPOSE	PRODUCTION DELAYED		PRODUCTION DELAYED	PRODUCTION DELAYED	BEARING DAMAGE REPLACEMENT
	GEARBOX INSPECTION		GEARBOX INSPECTION	GEARBOX INSPECTION	
	BEARING DAMAGE REPLACEMENT		BEARING DAMAGE REPLACEMENT	BEARING DAMAGE REPLACEMENT	
	PINION DAMAGE REPAIRING		PINION DAMAGE REPAIRING		
	BEARING HOUSING REPAIRING				
A	Production cost				
	Down Time Totale (hours)	5	5	5	0
	Cost average for hours downtime (€/hour)	€30.000,00	€30.000,00	€30.000,00	€30.000,00
	Total cost of production lost	€150.000,00	€150.000,00	€150.000,00	€0,00
B	Maintenance cost				
	Elements replaced (€)	€450,00	€450,00	€450,00	€450,00
	Work hour/man	400	350	285	282
	Cost work hours/man (€/hour)	€21,00	€21,00	€21,00	€21,00
	Work hours/machine	31	8	0	0
	Work cost hours/machine (€/hour)	€ 60	€ 58	€ 0	€ 0
	Works total cost (€)	€10.260,00	€7.814,00	€5.985,00	€5.922,00
	Maintenance total cost	€10.710,00	€8.264,00	€6.435,00	€6.372,00
A+B	Total cost				
1	Total cost of production lost and maintenance	€160.710,00	€158.264,00	€156.435,00	€6.372,00
2	Overhauling cost registered (d) (€)	€6.372,00	€6.372,00	€6.372,00	
1 - 2	Cost/Benefit (subtraction) (€)	€154.338,00	€151.892,00	€150.063,00	
	Probability of damage (%)	10%	10%	80%	
%*(1-2)	Weigh cost for class of damage	€15.433,80	€15.189,20	€120.050,40	
	BENEFIT of damage suppose (a+b+c)	€150.673,40			