PROMIS® maintenance

PROMISmaintenance
Engineering Maintenance Management Process

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In today's world, Reliability and Maintenance have a high impact on the three main market competition factors: quality, costs and useful life. The necessity of controlling the number of failures, the related damages and the times of repair of the productive systems, of the products and services provided, has grown together with the automation investments growth, with the increase of transformation speed and with the versatility and flexibility of use.

Productive equipments and systems, when assisted by effective maintenance process, keep at their prescribed level their quality and safety requirements, reduce scraps and re-works, improve products both from a technical (e.g. shape, size, finishing, etc.), and a qualitative point of view (e.g. performances, energetic consumption reduction, ease of use, simplicity, comfort, etc.). Hence, Maintenance is a technical discipline that is strictly related to production and design (both of systems and products).

A proper methodological approach to Maintenance Management can then lead to competitive improvements. The objective of the PROMIS® Engineering Maintenance Management Pyramid is therefore to provide for a structured methodology and some basic tools that can support SMEs and/or consultants in developing and implementing their own specific Maintenance process.

The three sides of the pyramid contain methods (Process), process templates and presentations/training material (Contents), reference standards, relevant bibliography and related articles (Services).

The advantages of using the PROMIS® resources which can be downloaded, populated and edited by the subscriber include the fact that the methods are used by many companies, are proven in use, and where relevant, seen as good practice by regulators. Further help is available from the authors registered in the PROMIS® organisation.

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The PROMIS® Engineering Maintenance Management solution has been developed by considering the maintenance process composed of 7 key steps as depicted in Picture 1.

Picture 1: the Engineering Maintenance Process

In particular, the PROMIS® Maintenance Pyramid is structured as follows:

1 – "Processes" Side: it illustrates the methodology to manage the Engineering Maintenance Management process steps indicated in Picture 1:

A) Base Maintenance & Inspection Plan:

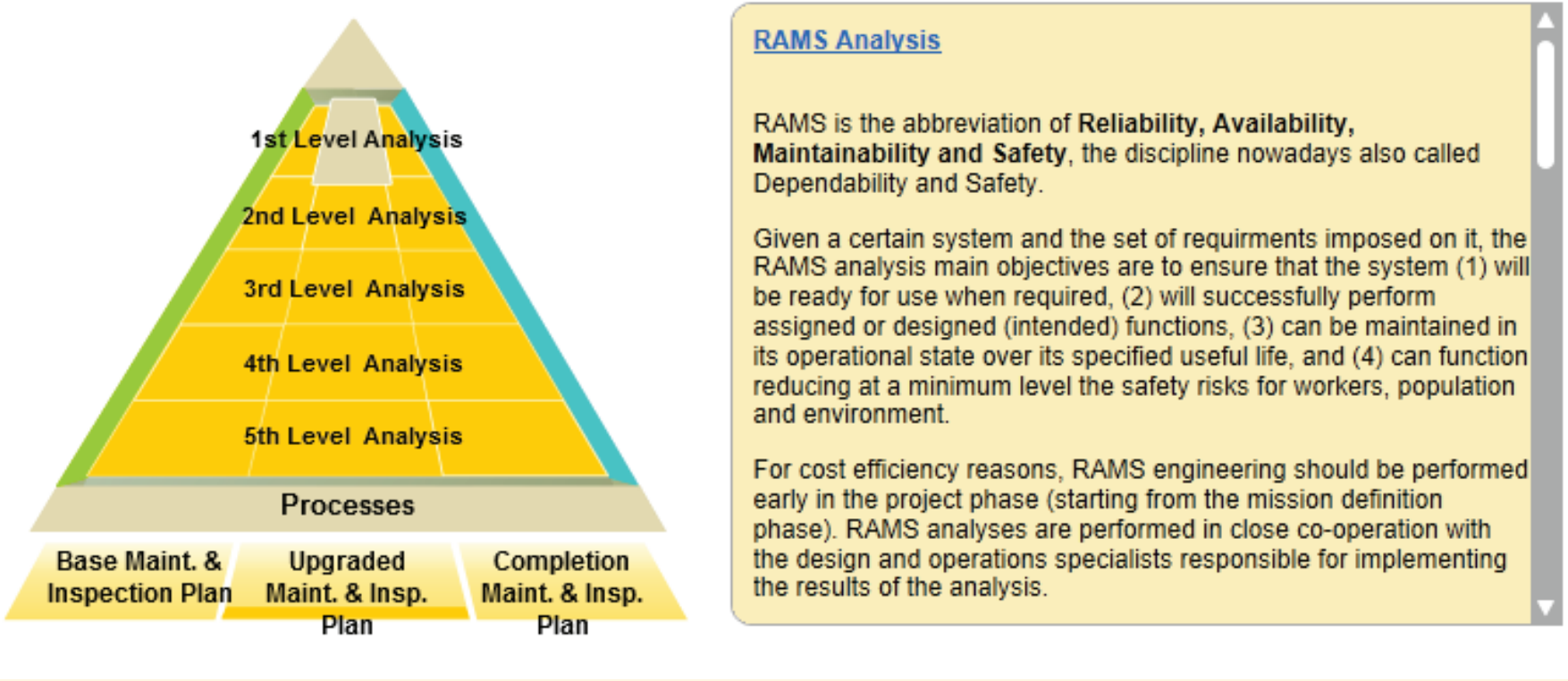
- 1st Level: Maintenance Process Self-Assessment
- 2nd Level: Plant Asset Register Definition
- 3rd Level: Requirements Identification (Technical, HSEQ, Rules & Regulations)
- 4th Level: Safety Integrity Level (SIL) & Risk Based Inspection (RBI) Analysis
- 5th Level: Base Maintenance & Inspection Plan Creation

B) Upgraded Maintenance & Inspection Plan:

- 1st Level: Reliability Availability Maintainability & Safety (RAMS) Analysis
- 2nd Level: Reliability Centered Maintenance (RCM) Analysis (FMEA)
- 3rd Level: Maintenance Benchmarking Analysis
- 4th Level: Life Cycle Cost (LCC) Analysis
- 5th Level: Quantitative Risk Analysis (QRA)

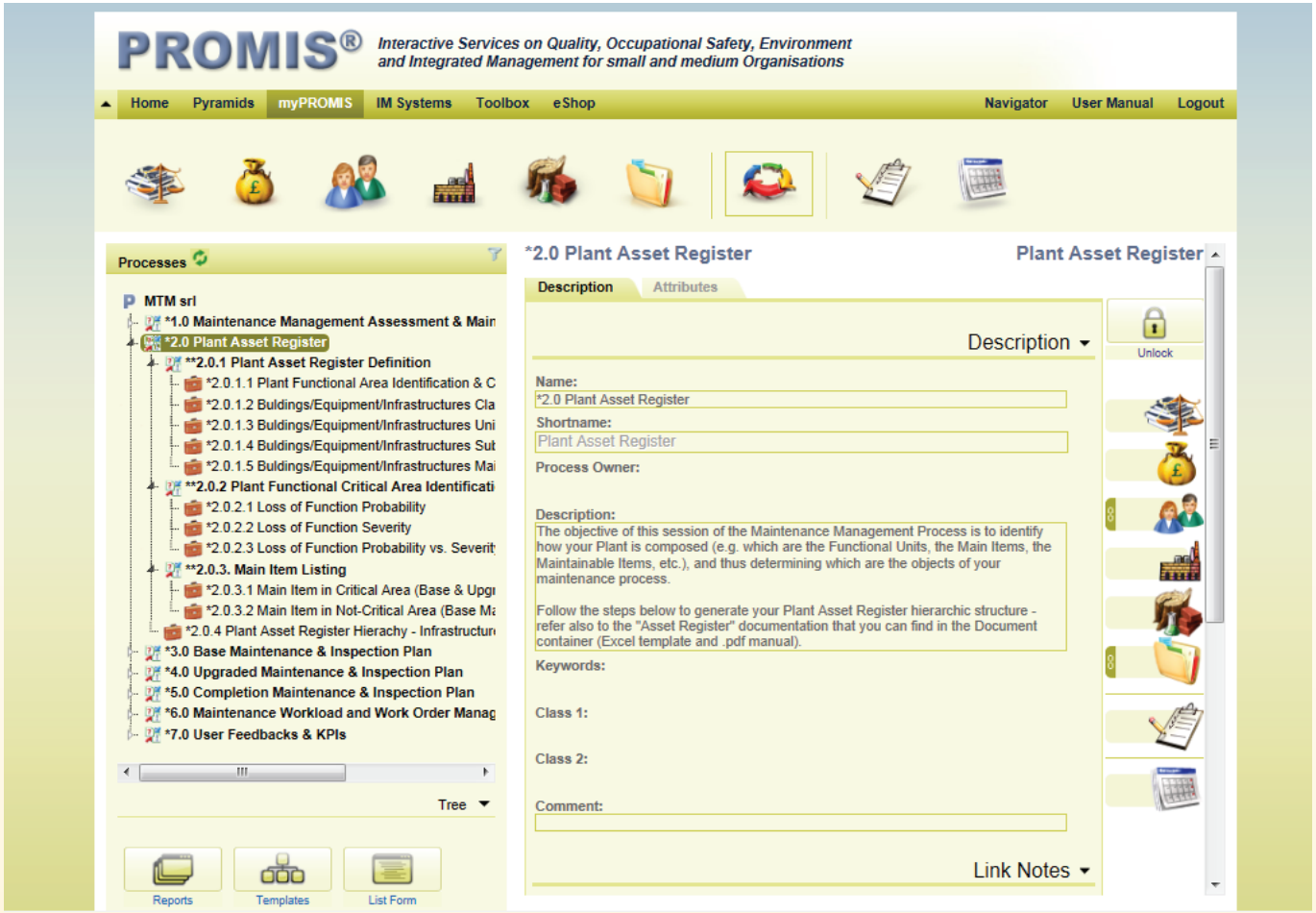
C) Completion Maintenance & Inspection Plan:

- 1st Level: Spare Parts Analysis (Interchangeability)
- 2nd Level: Special Tools Analysis
- 3rd Level: Consumables & Support Services Analysis
- 4th Level: Preventive Maintenance Management - Work Orders
- 5th Level: Maintenance Events log, Key Performance Indicators (KPIs) & Plans Review



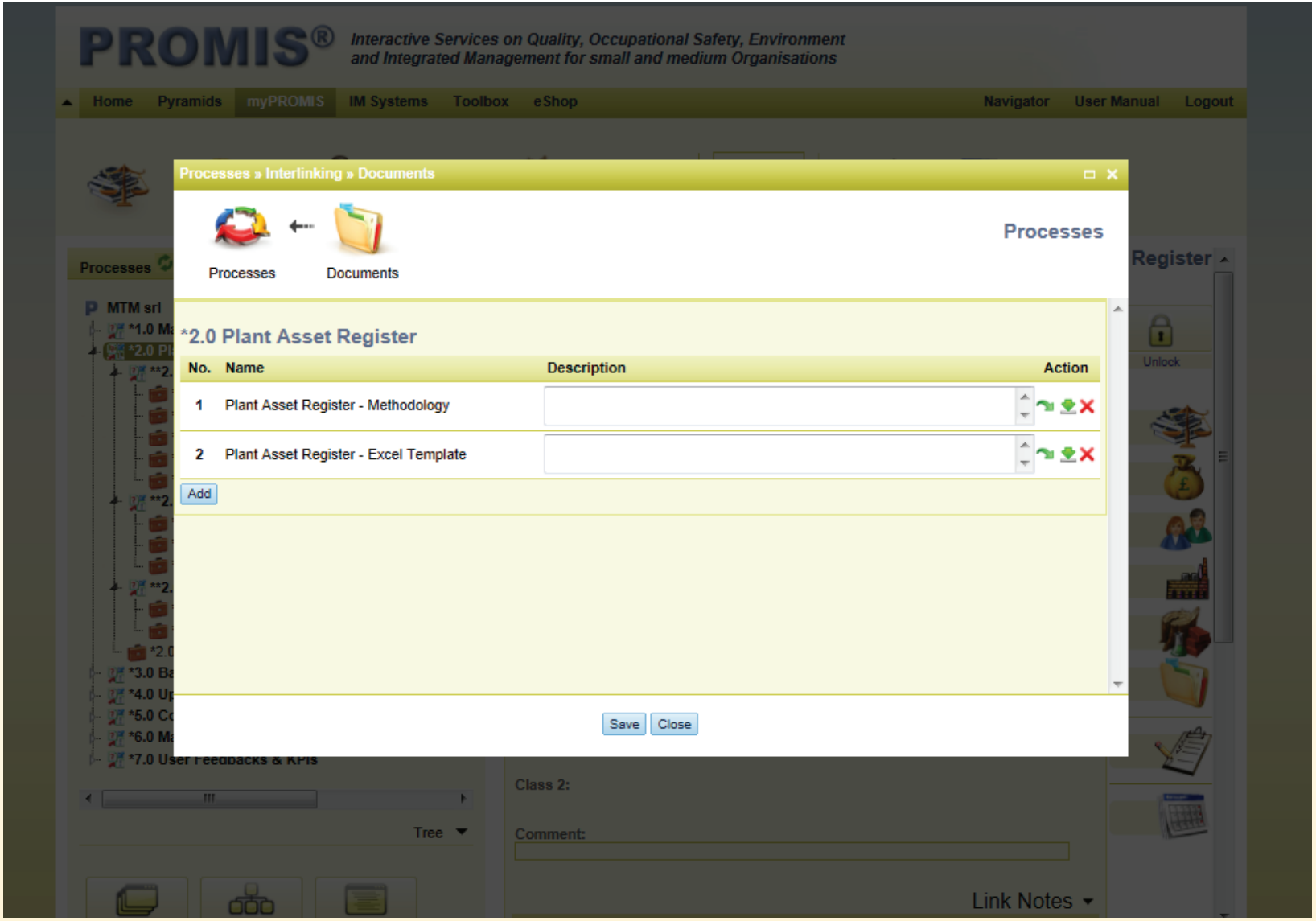
Picture 2: the PROMIS® Pyramid –"Processes" side

From each cell the PROMIS® user can easily access to the myPROMIS® "Processes" Container, where the step of the Maintenance Process are explained and linked to other myPROMIS® Containers (see pictures below).



Picture 3: the myPROMIS® "Processes" Container for Maintenance

As an example, from the "Plant Asset Register" step, the related manual and template (contained in the "Documents" Container"), are accessible from the user, who then can perform the plant breakdown analysis efficiently and effectively. The outcome of such analysis can then be stored in myPROMIS® through the use of the available containers (e.g. "Infrastructure", "Documents", etc.)



Picture 4: example of relation between the "Processes" and the "Documents" Container for Maintenance

Plant Asset Register - Methodology.pdf - Adobe Reader

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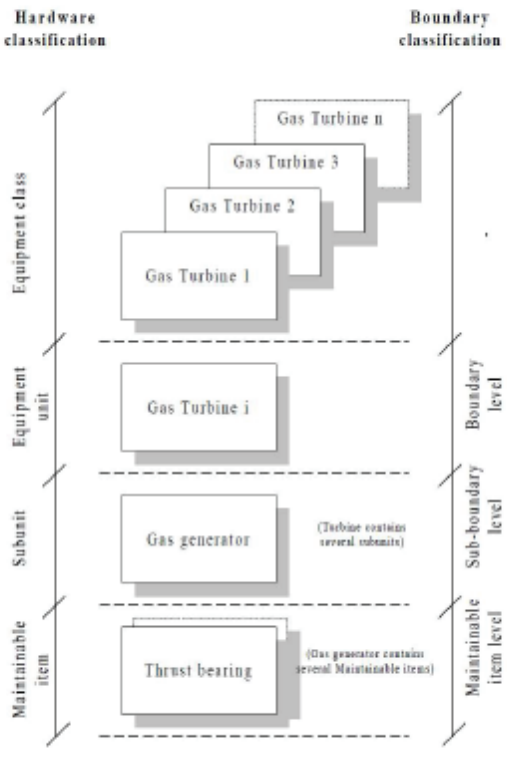
The following picture shows an example of a FFU definition (in the example, the Gas Separation Unit), together with the description of its functions, main components, and physical interfaces with the other Plant Functional Areas (FFUs).

Unit	Subject	Functions	Main Components	Physical Interfaces with Other FFU
GAS HYDROCARBON PROCESS				
300	GAS SEPARATION	a) Heating : heat the natural gas coming from the primary separation, through the production manifolds, to allow the regular working of secondary treatment units in critical environmental conditions. b) Gas separation : separate the reservoir water and eventual glycol injection into the natural gas coming from wellhead. Convey the gas in the production manifold to the treatment units. c) Test and measure (separation test and measure of flow rate and gas characteristics.	Gas separators, test separators, thermal safety valves, liquid discharge automatic valves, flow rate control manual choke valves, measure flanges, pipes, line accessories, manual valves, instrumentation primaries and transmitters, instrumentation and control electric cables, electric feeding cables.	100 Wellhead (Production) 190 Launching / receiving traps 230 Flare, vent and blowdown 240 Swing out burner 390 Glycol for hydrate inhibition 420 Fuel gas 460 Compressed air 540 Open drains system 550 Closed drains system 560 Oily water treatment 580 Piping tracing water 920 Main electric power distribution ≤ 1000 970 Control System

Picture 2

Once identified the Plant Functional Areas, it is necessary to proceed in breaking them down according to the following process/structure (see picture 3):



Picture 3

Picture 5: Plant Breakdown Process Management methodology manual

EQUIPMENT UNIT (MAIN ITEM) BREAK DOWN TEMPLATE

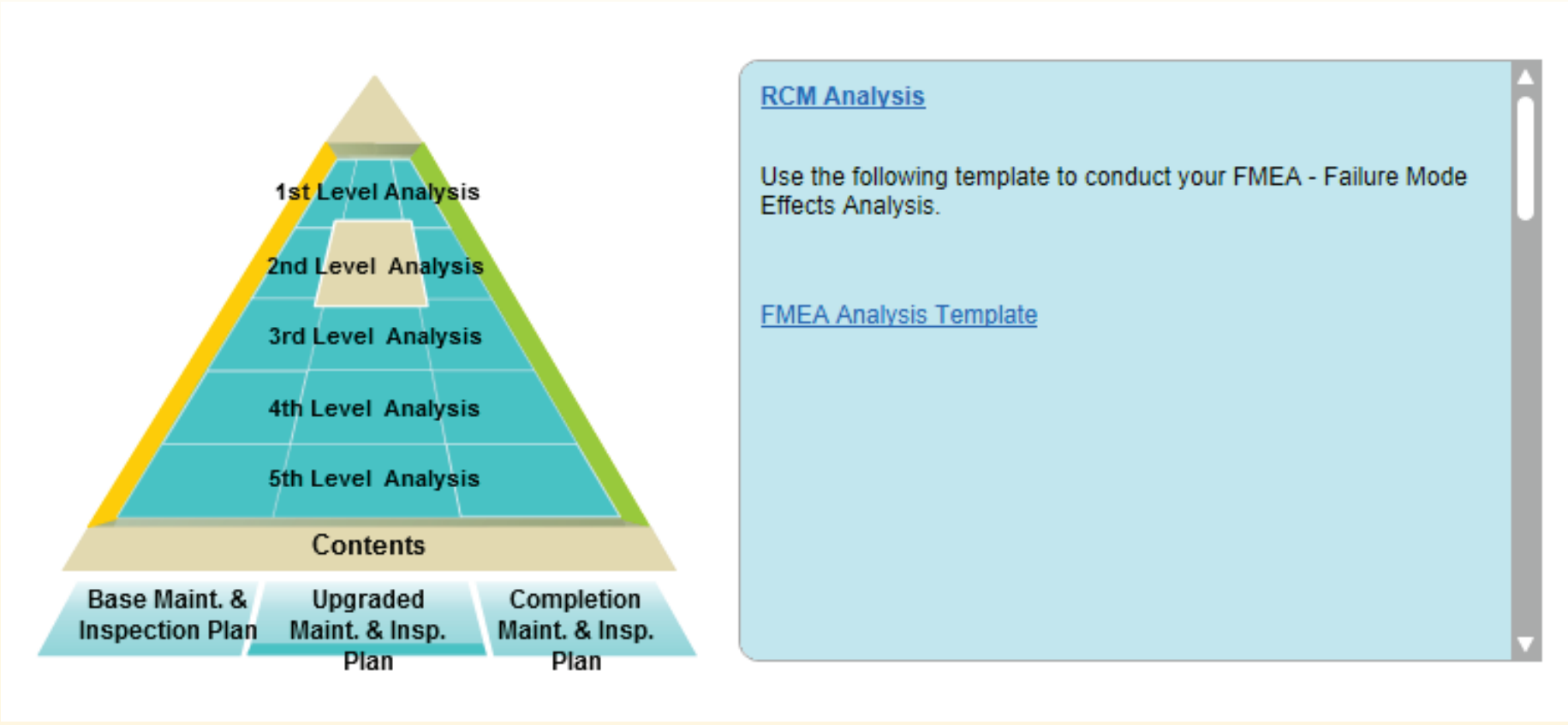
Plant:	Power Plant			*Workshifts/Year:*	
Functional Area:	Gas Separator			*Working days/Year:*	
Equipment Class:	Turbine			*Working weeks/Year:*	
				Working months/Year:	

Cod.	*1st Level (Equipment Unit)*	*Cod.*	*2nd Level (Sub-Unit)*	*Cod.*	*3rd Level (Maintainable Item)*	*Qty.*
10001	**Gas Turbine 1**	**10001-001**	**Gas Generator**	10001-001-001	Thrust Bearing	2
				10001-001-002	Electric Motor	1
				10001-001-003	Vessel	1
10002	**Gas Turbine 2**	**10002-001**	**Gas Generator**	10002-001-001	Thrust Bearing	2
				10002-001-002	Electric Motor	1
				10002-001-003	Vessel	2
				10002-001-004	PSV Valve	1

Picture 6: Equipment Unit Breakdown Template

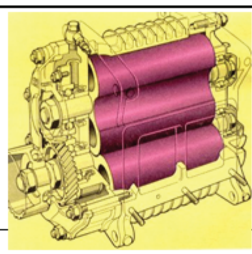
2 – "Contents" Side: structured in the same way as the "Processes" side, it contains relevant templates and training materials to perform the maintenance processes depicted above. In particular:

- Plant Breakdown Process Management - Manual
- Asset Register definition - Template
- Requirements Identification - EU Product Directives & Maintenance Standards
- RBI analysis
- Maintenance & Inspection Plan definition - Template
- RAM analysis
- FMEA Analysis - Template
- Benchmark Analysis - reference articles
- LCC Analysis
- Spare Parts Interchangeability Analysis - Template
- Corrective Maintenance Event Recording - Template
- Preventive Maintenance Event Recording - Template



Picture 7: the PROMIS® Pyramid – "Contents" side

By clicking on the related link, it is possible to easily access to the available contents such as process templates (see Picture 8).



FMEA CARD (ANALYSIS OF THE EFFECTS AND FAILURE MODES)

OPERATION/MAIN ITEM:	Compressor Unit
COD.:	
MAINTAINABLE ITEM:	Lobe Compressor
COD.:	

IV LEVEL	Rotating shaft bearings	Rotating shaft bearings	Rotors	Gearing	Fixing Systems (screws/bolts)
FAILURE TYPE	wear	rupture	wear	wear	looseness
FAILURE CAUSES	operative cycles	dirty lubricant	corrosive fluids	operative cycles	operative cycles
PREMONITORY SYMPTOMS	Vibrations/ Increased Temperature	Vibrations/ Increased Temperature	Vibrations/ Noise	Vibrations/ Increased Temperature	Vibrations
INDUCED FAILURES	Shaft/rotors deformation	Shaft/rotors deformation	None	None	None
PARTS TO BE SUBSITUTED/ ADJUSTED/ CHECKED OUT	Bearings	Bearings	Rotors	Pump substitution	Tighten screws and bolts
INFORMATION FOR THE DIAGNOSIS	Increased Temperature / Ouput Pressure Level	None	Ouput Pressure Level	Noise Level	None
EFFECTS ON THE PRODUCTIVE FLOW	1 TOTAL FLOW FAILURE **2 FLOW SLOWDOWN** 3 FLOW PRESERVED 4 NO EFFECTS ON THE FLOW residual flow rate	**1 TOTAL FLOW FAILURE** 2 FLOW SLOWDOWN 3 FLOW PRESERVED 4 NO EFFECTS ON THE FLOW residual flow rate	1 TOTAL FLOW FAILURE **2 FLOW SLOWDOWN** 3 FLOW PRESERVED 4 NO EFFECTS ON THE FLOW residual flow rate	**1 TOTAL FLOW FAILURE** 2 FLOW SLOWDOWN 3 FLOW PRESERVED 4 NO EFFECTS ON THE FLOW residual flow rate	1 TOTAL FLOW FAILURE 2 FLOW SLOWDOWN 3 FLOW PRESERVED **4 NO EFFECTS ON THE FLOW** residual flow rate
INTERVENTION BUFFER	none	none	none	none	none
EFFECTS ON THE OUTPUT	1 UNACCEPTABLE QUALITY **2 QUALITATIVE FLAWS** 3 NO EFFECTS ON QUALITY	**1 UNACCEPTABLE QUALITY** 2 QUALITATIVE FLAWS 3 NO EFFECTS ON QUALITY	1 UNACCEPTABLE QUALITY **2 QUALITATIVE FLAWS** 3 NO EFFECTS ON QUALITY	**1 UNACCEPTABLE QUALITY** 2 QUALITATIVE FLAWS 3 NO EFFECTS ON QUALITY	1 UNACCEPTABLE QUALITY 2 QUALITATIVE FLAWS **3 NO EFFECTS ON QUALITY**
MAINTENANCE TEAM	1 Mechanical Technician No. People	1 Mechanical Technician No. People	1 Mechanical Technician No. People	1 Mechanical Technician No. People	1 Mechanical Technician No. People
TOOLS / SPECIAL MAINT. EQUIPMENT REQUIRED					
STOP DURATION (MTTR)	0,5 Hours	1 Hours	0,5 Hours	1 Hours	0,5 Hours
INTERVENTION DURATION	1 man hours	1 man hours	1 man hours	1 man hours	1 man hours
INTERVENTION FREQUENCY (MTBF)	0,5 years	1 years	1,5 years	1 years	0,5 years
MAINTAINABILITY INDEX	hours/year	hours/year	hours/year	hours/year	hours/year
CRITICALITY INDEX					
MODIFICATIONS					
NOTES:					

Picture 8: An example of the FMEA Analysis Template

Through the use of "ready to use" templates and the related examples provided, the PROMIS® user can rapidly and effectively perform the maintenance management steps described in the "Processes" side of the Pyramid and in the PROMIS® Process Container. The following pictures illustrate an example of how easily a Maintenance & Inspection Plan can be structured.

Main Item	Main Item Code	Main Item Description	Maintenance Plan	Maintenance Plan Code	Maintenance Plan Description
	B4-470-XY-006	Gas Generator Lubricating Oil System		MP_PCKG006	Lube Oil (Synthetic) System (Aeroderivative Turbine Package)

Maintenance Strategy	☒ Running Hours	☐ Frequency	Class	Driving Equipment
Plant Functional Area	Power Generation			
Note	Pumps (and relevant Electrical Motors) and Tank have to be covered by another Maintenance Plan			

Job Plan Summary

No.	Job Plan Code and Title	Job Plan Type	Frequency/Running Hours	Main Item Shut Down
1	ZZ0001 Solenoid Valve Check	Functional Test	8 kh	☒ Y ☐ N
2	IPSTS0001 Temperature Switch Setting Check	Functional Test	8 kh	☐ Y ☒ N
3	IPSZZ0101 Transmitter Functional Test	Functional Test	32 kh	☒ Y ☐ N
4	IVACV0101 Control Valve Minor Inspection	Minor Inspection	8 kh	☐ Y ☒ N
5	IVACV0102 Control Valve Overhaul	Overhaul	24 kh	☒ Y ☐ N
6	MFIAC0001 Filter Cleaning	Minor Inspection	8 kh	☒ Y ☐ N
7	SVASF0104 On/Off Valve Overhaul	Overhaul	24 kh	☒ Y ☐ N

Job Plans Maintainable Items List

Job Plan Title/Code	Maintainable Item Code/Description	Maintainable Item Manufacturer/Supplier - Model/Part Number - Reference Document
ZZ0001 Solenoid Valve Check	RC004 Valve Check	
IPSTS0001 Temperature Switch Setting Check	S002 Temperature Switch	
IPSZZ0101 Transmitter Functional Test	T004 Transmitter	
IVACV0101 Control Valve Minor Inspection	CV001 Control Valve	
IVACV0102 Control Valve Overhaul	CV001 Control Valve	
MFIAC0001 Filter Cleaning	ZL006 Filter	
SVASF0104 On/Off Valve Overhaul	XV102 On/Off Valve	

Picture 9:An Example of the Maintenance & Inspection Plan Template

Job Plan details

Job Plan Title/Code	Job Plan Type	Frequency/Running Hours	Main Item Shut Down	Maintainable Item	Plant Functional Area
IVACV0102 Control Valve Overhaul	Overhaul	Running Hours	[X] Y [ ] N	CV001 Control Valve	Power Generation

No.	Maintenance Task Type	Maintenance Task Description	Maintenance Discipline/ Work Center				Overall Maintenance WorkLoad
			Work Center	Quantity	Hours	WorkTime	
1	TOST	Electrical Isolation	ET	1	0,2	0,2	0,4
2	TOST	Instrumental Item Removal	IT	1	0,2	0,2	
3	Main Maintenance Task	Remove actuator from valve body	IT	1	4	4	4
4	Main Maintenance Task	Check general status of equipment and clean					
5	Main Maintenance Task	Replace stem packing kit					
6	Main Maintenance Task	Replace threaded seat rings kit					
7	Main Maintenance Task	Replace body gasket kit					
8	Main Maintenance Task	Replace instrument air filter					
9	Main Maintenance Task	Check pneumatic system leakages/pressure					
10	Main Maintenance Task	Check positioner					
11	Main Maintenance Task	Check membrane					
12	Main Maintenance Task	Lubricate moving parts					
13	Main Maintenance Task	Reinstall actuator on valve body					
14	Main Maintenance Task	Functional Test of the valve					
15	BIST	Instrumental Item Reinstalling	IT	1	0,2	0,2	0,4
16	BIST	Electrical Reinstalling	IT	1	0,2	0,2	

Operations to be carried out in workshop

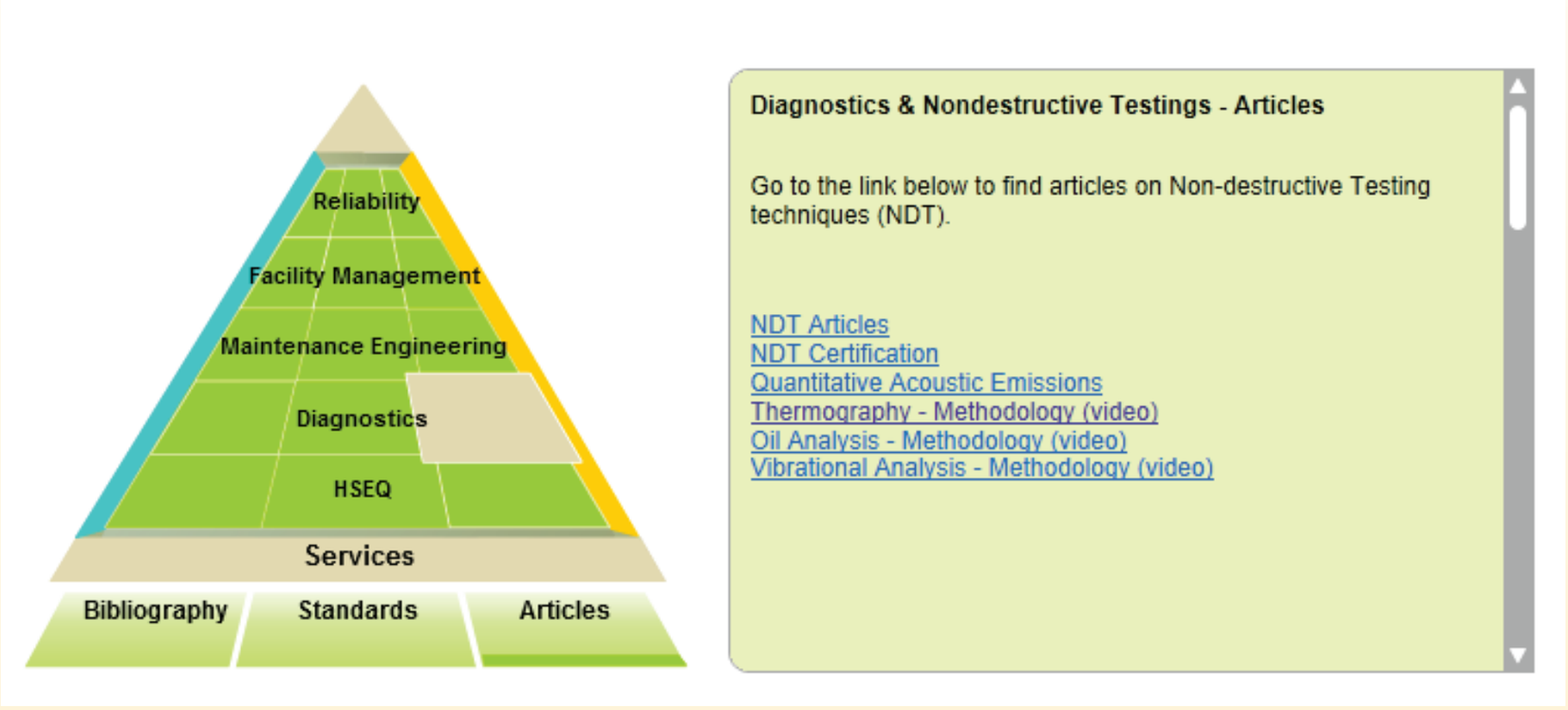
Maintenance Discipline/ Work Center Code & Description

ET	Electrical Technician	NDT	Non Destructive Control Technician	MAT	Machinery Technician
IT	Instrument Technician	VIB	Vibration Control Technician	MET	Metrology Technician
MT	Mechanical Technician	THER	Thermography Control Technician	PIT	Piping Technician
CT	Civil Technician	SAF	Safety Control Technician	INT	Inspection Technicians
PROP	Production Operator	SST	Support Services Technicians	OTH	Others

Picture 10: Example of the Maintenance & Inspection Plan – Job Plan Template

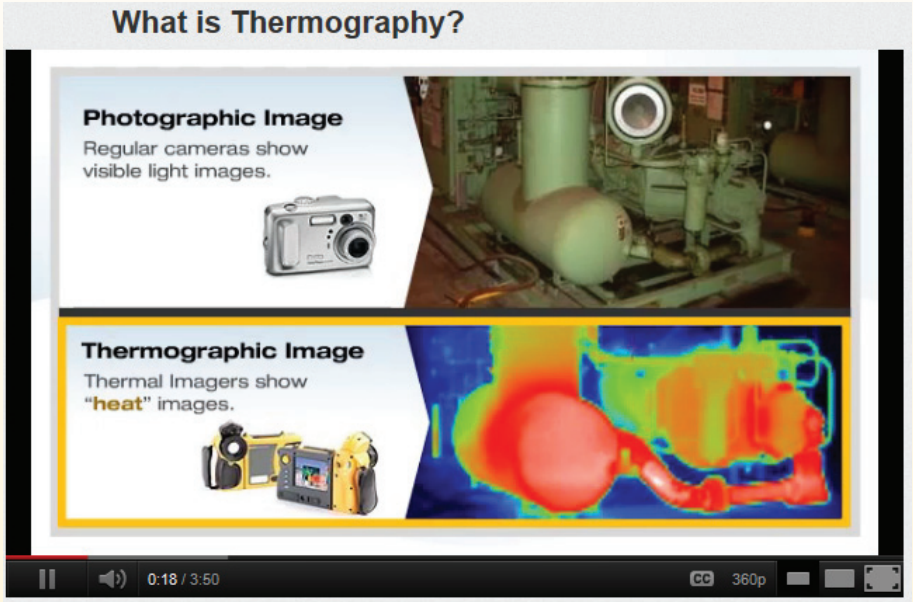
3 – "Services" Side: structured as depicted in Picture 11, it contains reference standards and/or associations, relevant bibliography and articles related to the following specific Maintenance topics:

- Reliability
- Facility Management
- Maintenance Engineering
- Diagnostics
- Health, Safety, Environment & Quality

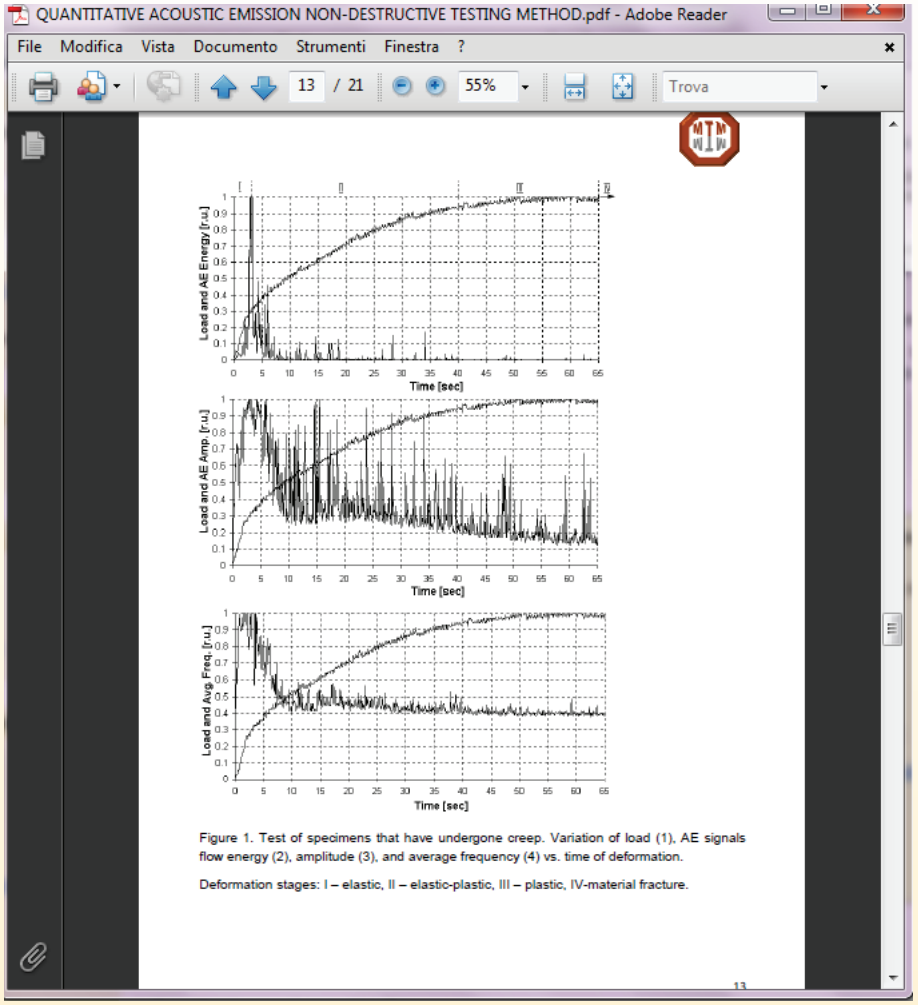


Picture 11: the PROMIS® Pyramid –"Services" side

The following Pictures illustrate how easily PROMIS® User can be empowered by accessing relevant information such as training videos (Picture 12), and Maintenance Experts articles (Picture 13).



Picture 12: Thermography video tutorial



Picture 13: Acoustic Emissions article

Author

Andrea Maciga

Andrea Maciga is the founder and owner of MTM srl, a Maintenance Engineering consulting company, which has been operating for more than 20 years in the Operations & Maintenance and Asset Management area. MTM srl is one of the most competent and active realities in Italy in managing the maintenance issues, that concern both the industrial sector (oil & gas, process industry and manufacturing industry), and the infrastructure sector (e.g. roads, dams, railways, bridges, etc.). In his position of MTM srl owner and CEO, Andrea is responsible for maintaining his Company in the leader level of the Italian maintenance market.

During his career (both at MTM and during his previous experiences in other Engineering Maintenance consulting companies), he has matured strong competencies in the following fields:

- Total Productive Maintenance (TPM)
- Inspection and Direct Assessment of Plant and Pipeline in Oil & Gas Field
- RBI Analysis for Petrochemical Plants, Refineries and Pipeline
- Maintenance Engineering
- Contracts Management and Supplies Evaluation in the Maintenance Global Services Logic
- Failure Modes, Effects and Criticality Analysis (FMECA) of Plants and Machines
- Diagnostics
- Quality Assessments & Performance Improvement
- Spare Parts and Material Management
- Personnel Training

His main Customers/references are:
ABB, AGIP, ALCOA, BASF, SIEMENS, ENEL, ENICHEM, FIAT, FOSTER WHEELER, HARTFORD STEAM BOILER, HYDROALLUMINIO, NUOVO PIGNONE, RFI, SAIPEM, SNAM, SNAMPROGETTI, SOLVAY, TECNIMONT, TECNOMARE.

Andrea is the co-author of "The Maintenance Manual of the Industrial Plants and Services"(1998 - Franco Angeli Editore, Milan), and author of many articles related to maintenance, published in the main technical Italian and international magazines.

He is currently coordinator and teacher of the Master in "Maintenance Management" organized by the Polytechnic of Milan and University of Bergamo (Italy).
Education & Qualification:

- Doctorate in Nuclear Engineering University of Bologna - Italy, 1974
- Level 3 in Not Destructive Testing, according to EN 473 and SNT-TC-1A
- Member of the International WG (TTS-SNAM-ROSEN-RTD-ENEA) for Feasibility Study relevant to pipeline tools for ultrasonic inspection
- Quality Assurance Lead Assessor according to BS EN ISO 9000 and BS 7229
- Lecturer at the University of Maintenance of Guangzhou (China)
- Member of BoD of AIMAN (Italian Association of Maintenance)
- Member of BoD of EFNMS (European Federation of National Maintenance Societies)