MAESTRI

Total Resource and Energy Efficiency
Management System for Process Industries

Deliverable 6.9

Training modules for Total Efficiency Framework Implementation

Date: 19/03/2018

WP6 Pilots implementation and validation

T6.3 Implementation&Training

Dissemination Level: Public

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SPIRE Sustainable Process Industry through Resource and Energy Efficiency

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1 Introduction

1.1 The MAESTRI project

Process industries represent the foremost part of the manufacturing base, around 20% of the total European manufacturing industry, which include more than 450,000 individual enterprises (EU27), an employment of around 6.8 million citizens that generate more than 1,600 billion € turnover. On the other hand, process industries are largely dependent on resource imports from international markets that are hampering the industry's access to globally traded raw materials, due to the increased political instability in many regions of the globe, which is perfectly visible from a sharp increase in raw material prices during recent years.

Moreover, European industry has also accounted for more than a quarter of total energy consumption in 2010 in Europe with a significant portion of that used within the process industry.

The imperative for a reduction in carbon footprint has emerged, hence the urge to increase the energy efficiency of production systems, while fostering also their competitiveness by "doing more with less".

To this intent the MAESTRI project aims at providing a management system in the form of a flexible and scalable platform to promote and simplify the implementation of an innovative approach: the Total Efficiency Framework. Based on a holistic approach which combines different assessment methods and tools, the overall purpose of the Framework is to generate improvement on a continuous basis and increase the eco-competitiveness by fostering sustainability in routine operations.

MAESTRI developed an innovative and integrated platform combining holistic efficiency assessment tools, IoT technologies, a novel management system and an innovative approach for industrial symbioses implementation.

MAESTRI is offering to process industries a decision making support tool, regarding resources and energy efficiency, able to guide them in identifying potential re-usages of wastes as resource, incorporating the sustainability aspects in company strategy and objectives, targeting resources consumption for efficiency, gaining the needed knowledge, technology and organizational patterns to produce in a greener and more competitive way.

MAESTRI foreseen the testing and validation of the Framework through 4 pilot implementations in real industrial setting. These pilots will identify, analyse and assess the platform efficiency, both from environmental and economic perspectives.

All process stages and elementary glows, both inputs (energy, materials, consumables, equipment, labour, etc.) and outputs (products, by-products, residues, emissions, …), will be properly identified and quantified taking into account a life cycle perspective.

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As the pilot results will be extremely important for the optimization of the whole MAESTRI Total Efficiency Framework, they will also offer the chance to test the specific training modules that will be delivered.

In fact, ad hoc training will be provided to the staff of the pilot industries, in order to allow them to better use the platform and implement the framework optimally.

The current document (Deliverable 6.9) will present the training, finalised to the development of monitoring procedures, that will be delivered to the staff of the industries which will be implementing the 4 Total Efficiency Framework pilots. Training materials developed in this WP will provide the basis for the general training of WP 8.

2 The training

2.1 Scope of the training

The overall scope of MAESTRI training for pilots is providing the industrial partners, who will be implementing the project pilots, with the skills needed for the implementation of the MAESTRI Total Efficiency Framework.

Implementing the MAESTRI Total Efficiency Framework means implementing all its four pillars:

- Management System:

MAESTRI provides the industries with a management system that encompass LEAN strategies related to sustainable continuous improvements, promoted also by the parallel implementing of the efficiency assessment tools. The MAESTRI MS will define the relevant KPIs, monitoring them in order to identify improvement potential and support the entrepreneur in decision making. Moreover, it will take into account every possible synergy with already existing management instruments (e.g. ISO standards).

- Efficiency Assessment:

The efficiency assessment method proposed by MAESTRI integrate two innovative methodologies: Multi-layer Stream Mapping (MSM®) and Eco-Efficiency Integrated Methodology for Production Systems (ecoPROSYS©), enabling the overall assessment both from environment, including energy efficiency, and value and cost perspectives. Aiming to production cost-saving optimization, the decision support model will provide scenarios simulations, the identification of consumption patterns and related optimization models.

- Industrial Symbiosis:

The implementation of the Industrial Symbiosis concept enables companies to reduce consumptions (of energy and raw material) and waste disposal costs, by promoting the sharing of resources within the different processes of a single company or between

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multiple companies. The entrepreneurs will benefit of a broad database of Industrial Symbiosis success stories and examples of wastes conversion into resources.

- IoT Platform:

MAESTRI provides the industries with an innovative IoT platform to assess consumptions and the overall resources efficiency. The platform will monitor process data, most of it in continuum, for parameters hardly taken into account for plant engineering. As shown, every pillar of the Framework carries its amount of complexity, hence the need for the piloting staff to be trained in order to take advantage of every benefit offered by the MAESTRI Total Efficiency Framework implementation.

2.2 The methodology

The training course dedicated to staff of pilot companies will adopt methodologies that will allow participants to learn about the MAESTRI Total Efficiency Framework and apply its principles and tools with a view of continuous improvement towards sustainability.

A blended and strongly interactive learning approach will be adopted to offer trainees a training opportunity that is custom-designed for them and the learning environment that is the company they work for. The reason of this choice is that blended learning saves time and money since this training process is an efficient use of resources to help employees develop sufficient levels of knowledge retention.

The course will adopt a mix of the following training methodologies:

1. **Self-learning:** Individual learning through training material in digital format provided to employees in order to deepen the main topics from a theoretical point of view; in this way, employees can study the material individually, without the necessity to participate to class lessons. Self-learning is flexible because trainees can learn at their own pace and at a time that is convenient for them. This method is one of the most popular lecture methods and can be combined with handouts and other interactive methods.

2. **Interactive Methods:** Case studies analysis and practical applications to the company environment to talk over during group discussions. Interactive sessions keep trainees engaged in the training, which makes them more receptive to the new information. They provide ways for external experts (pilot's trainers) and veteran employees to pass on knowledge and experience to less experienced employees. They can provide in-session feedback to trainers on how well trainees are learning. Different interactive methods can be adopted during the group discussions:

    - **Small group discussions**. Break the participants down into small groups and give them case studies or work situations to discuss or solve.
    - **Case studies**. By analysing real job-related situations, employees can learn how to handle similar situations. They can also see how various elements of a job work together to create problems as well as solutions.

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- **Active summaries**. Create small groups and have them choose a leader. Ask them to summarize the lecture's major points and have each team leader present the summaries to the class. Read aloud a prewritten summary and compare this with participants' impressions.
- **Q&A sessions**. Informal question-and-answer sessions are most effective with small groups and for updating skills rather than teaching new skills. For example, some changes in departmental procedure might easily be handled by a short explanation by the supervisor, followed by a question-and-answer period and a discussion period.
- **Role-playing**. By assuming roles and acting out situations that might occur in the workplace, employees learn how to handle various situations before they face them on the job.
- **Demonstrations.** Whenever possible, teachers bring tools or equipment that are part of the training topic and demonstrate the steps being taught or the processes being adopted.
- **Other activities**: Brainstorm, thinking time, sharing experiences, exercises and simulations.

3. **Learning on the job:** These methods are effective for training in new procedures and new equipment. They are immediately applicable to trainees' jobs. They allow trainers to immediately determine whether a trainee has learned the new skill or procedure. Learning on the job, or experiential training, offers several effective techniques for teaching employees, including:

- **Cross-training**. This method allows employees to experience other jobs, which not only enhances employee skills but also gives companies the benefit of having employees who can perform more than one job. Cross-training also gives employees a better appreciation of what co-workers do and how their own jobs fit in with the work of others to achieve company goals.
- **Demonstrations**. Demonstrations are attention-grabbers. They are an excellent way to teach employees to use new equipment or to teach the steps in a new process. They are also effective in teaching safety skills. Combined with the opportunity for questions and answers, this is a powerful, engaging form of training.
- **Coaching**. The goal of job coaching is to improve an employee's performance. Coaching focuses on the individual needs of an employee and is generally less formal than other kinds of training. There are usually no set training sessions. A manager, supervisor, or veteran employee serves as the coach.
- **Drills**. Drilling is a good way for employees to practice skills. Evacuation drills are effective when training emergency preparedness, for example.

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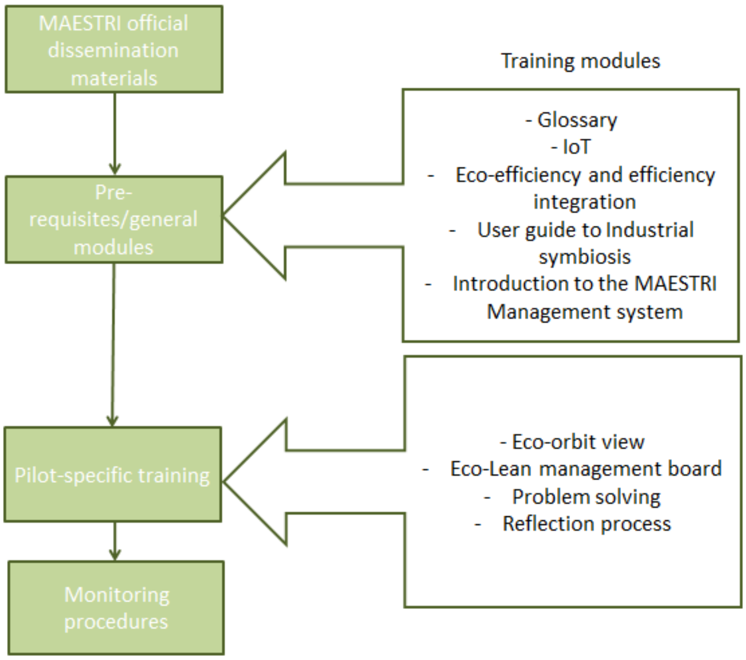
3 The training materials

3.1 Training materials concept

The purpose of this deliverable is to provide a training scheme as well as learning materials to pilot companies. This will ensure that all involved staff is able to learn information at the base of MAESTRI implementation, ensuring that the system is correctly and efficiently adopted within the involved companies. Additionally, general modules will be used for general training as foreseen in WP 8.

The scheme below explains the logic underlying the training schemes and the connection between the different modules. Companies are free to follow the whole scheme or select materials according to their training needs.



The final aim of the deliverable is to present pilot-specific monitoring procedures and the background skills and knowledges that the company operators need to efficiently use them.

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3.2 Glossary and generic training tools

A **glossary** will be developed in order to make available for employees a list of technical terms or abbreviations that may be unfamiliar or need to be explained in the field of new technologies and approaches in the Manufacturing Industries.

The glossary will be an appendix to the self-learning materials provided in form of **technical manuals** focusing on the 4 pillars of the "Total Efficiency Framework" concept:

Efficiency Assessment	Management System	Industrial Symbiosis	IoT
• Efficiency Framework concept description • Methods for Efficiency Framework for resource and energy efficiency description • Simulation and decision support approach for sustainable manufacturing • Efficiency framework testing results	• Internal challenges and barriers for energy and resource management • Management system framework for Continuous Improvements in process industries	• Report on challenges and key success factors and gap analysis for industrial symbiosis • Prototype library of case studies linked to a waste database • Toolkit for industrial symbiosis • User guide for getting started with industrial symbiosis (report on user guide implementation) • User Guide to engage in industrial symbiosis through the T4IS	• Industrial and manufacturing applications of IoT • Applications to the development of DSSs • Technology state-of-the-art

3.3 Pilot-specific materials regarding the implementation of MAESTRI in the 4 industrial pilots

Effective Management System developed within Maestri project includes four training modules that can be used separately in accordance with needs and expectations of the organization.

- Eco Orbit View (detail description in the attachment …)
- Eco Lean Management Board (detail description in the attachment …)
- Problem Solving (detail description in the attachment …)
- Reflection Process (detail description in the attachment …)

Content, scope, purpose and details of each workshop module were described in above-listed attachments.

The project assumes that each training module will be tested in at least two manufacturing companies. For this reason, each industrial partner has its own implementation plan:

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- MCG - is covered by Eco Orbit View, Eco Lean Management Board, Problem Solving and Reflection Process
- GLN - is covered by Eco Orbit View, Problem Solving and Reflection Process
- Worlee - is covered by Eco Orbit View and Eco Lean Management Board
- JWO - is not covered by Maestri Effective Management System due to implementation of their own management system

			Company Name			
	Process	Tool	MCG	GLN	Worlee	JWO
Effective Management System	Planning	Eco Orbit View	X	X	X	NA
	Monitoring	Eco Lean Management Board	X		X	NA
	Problem solving	• Retrospective Analysis • Focused Gemba Walk	X	X		NA
	Reflection	• Hansei • Kaizen	X	X		NA

Each module of Effective Management System is performed in a workshop (training) formula. While the training modules are scheduled – a lot of following technical and organizational aspects have to be agreed with industrial partners:

- scope and purpose of the training module
- time frame and training process
- list of participants adapted to the purpose of the training and the company needs
- guidelines on how to prepare for the training by company's employees - gather relevant information and data, make a reflection on the current situation

The communication process takes a few weeks. The better it is done, the better training modules are adapted to company's expectations. All agreed information is described in Training Module description and send to the company before the workshop.

Purpose of the workshop is to teach company's employees how to use in practice developed methods, which should boost their management system and make it more effective. Workshop events are carried out by Lean experienced trainers in line with the agreed program and companies expectations. Training methodologies are adapted to the purpose of the workshop and present mix of interactive and learning on the job methods (see chapter 2.3).

In order to check workshop effectiveness a "Follow up" visit is scheduled a few weeks later. The purpose of this visit is to check how companies used acquired skills, support them in the implementation process and issues. "Follow up" visit should help companies to see strengths and weaknesses of implemented solutions. Based on this, companies have to define next actions to improve the processes.

In order to execute the implementation plan, it is necessary to monitor the processes and results of the Management System. This is accomplished by determining success factors and monitoring procedures specific to the company, scope and purpose of the workshop modules.

Monitoring procedure describes what, how and how often will be tracked and what results are expected at the end of the project. Details you can find in attachments "How to design a performance monitoring procedure".

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As it was mentioned - Effective Management System consists of four modules implemented in selected industrial partners. Scope and progress of implementation depend on companies needs and it is presented below (see table 1, 2 and 3):

Table 1. Implementation status in MCG

Training module	Success factor	Status	Remarks
Eco Orbit View	Eco Orbit View Map	Done	
	Success Equation	Done	
	List of low-cost improvements	Done	Most of improvements from the list are already implemented by MCG
Eco Lean Management Board	ELMB workshop	Done	Mock-up prepared during the workshop
	ELMB implemented	Done	MCG is using board in Cutting Area
Problem Solving	Problem solving workshop	Done	
	Problem solving process established	Planned	
	2 problems solved	Planned	
Reflection Process	Reflection process established	Planned	
	List of improvements for management processes	Planned	

Table 2. Implementation status in GLN

Training module	Success factor	Status	Remarks
Eco Orbit View	Eco Orbit View Map	Done	
	Success Equation	Done	
	ELMB mock-up	Done	
Problem Solving	Problem solving	Done	

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	workshop		
	Problem solving process established	Planned	
	2 problems solved	Planned	
Reflection Process	Reflection process established	Planned	
	List of improvements for management processes	Planned	

Table 3. Implementation status in Worlee

Training module	Success factor	Status	Remarks
Eco Orbit View	Eco Orbit View Map	Done	
	List of potential improvement projects	Done	
Eco Lean Management Board	ELMB workshop	Done	mock-up prepared during the workshop

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3.4 List of training materials

Annex 1: Glossary

Annex 2: IoT

Annex 3: Eco-Efficiency and Efficiency integration

Annex 4: User guide to industrial symbiosis

Annex 5: Introduction to the MAESTRI Management System

Annex 6: Eco Orbit View

Annex 7: Eco Lean Management Board

Annex 8: Problem Solving

Annex 9: Reflection process

Annex 10: Monitoring procedure

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Total Resource and Energy Efficiency Management System for Process Industries

Glossary

Date: 28/02/2018

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A

Advanced Analytics

The autonomous or semi-autonomous examination of data using sophisticated quantitative methods (ie: optimization) to produce deeper insights, make intelligent predictions, and drive real-time actions.

API (Application Programming Interface)

One way for an application to present itself to other, typically remote, applications so that they can interact with it (for example, to read or write data to it). Often now used as another term for a Web Service.

Application software

…are programs which enable specific, end user applications. This means that the software uses the given potential provided by computers to form an application. Examples include Microsoft Word (text editing), Adobe Photoshop (image editing) and many other programs.

Architectural reference model in IoT

The IoT-A architectural reference model follows the definition of the IoT reference model and combines it with the related IoT reference architecture. It also describes the methodology with which the reference model and the reference architecture are derived, including the use of internal and external stakeholder requirements.

Architecture

The fundamental organization of a system embodied in its components, their relationships to each other and to the environment, and the principles guiding its design and evolution.

Analysis of material and energy flows (AMEF)

The analysis of material and energy flows consists of performing an overview of material and energy flows through a given system (territory, business, process, etc.) over a determined period of time. An AMEF can be materialised by a graphical and quantitative representation:

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the “industrial metabolism” or “territorial metabolism”, which also takes into account material and energy stocks. The aim of AMEF and industrial metabolisms is to identify potential eco-industrial synergies between the economic stakeholders within the system examined. The search for synergies per se requires the in-depth study of flow sharing or recovery opportunities according to flow characteristics.

Assumption

There may be external circumstances or events that must occur for the project to be successful (or that should happen to increase your chances of success). If you believe that the probability of the event occurring is acceptable, you could list it as an assumption. An assumption has a probability between 0 and 100%. That is, it is not impossible that the event will occur (0%) and it is not a fact (100%). It is somewhere in between. Assumptions are important because they set the context in which the entire remainder of the project is defined. If an assumption doesn't come through, the estimate and the rest of the project definition may no longer be valid.

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B

Big data

Big Data describes the always-growing sums of data, as well as the problems that come with processing this massive flood of information.

BIG DATA ANALYTICS

Systems and processes that analyze vast amounts of information to provide insight into industry patterns, areas of risk and growth, and to streamline the supply chain. The material world is processed virtually and patterns are detected autonomously.

BLE (Bluetooth Low Energy)

BLE (Bluetooth 4.0) is a lower-energy-consumption version of the Bluetooth wireless communications standard, which runs constantly, announcing a device's presence to local sensors and optimizing battery life for the device in question. In the IoT, BLE allows for precise location and feature tracking without reduced battery life

Bottleneck

The place in the value stream that negatively affects throughput; as a resource capacity limitation, a bottleneck will not allow a system to meet the demand of the customer.

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C

Cloud

Highly scalable compute, storage and memory capabilities located in a data centre that enables flexible and rapid scale-up and scaledown of application resources

Cloud communication

Communication services being provided by third parties which can be accessed and used through the internet. The program Skype is the best-known cloud communication software.

Cloud orchestration

The automated management of a cloud. This includes all services and systems that are part of the cloud as well as the flow of information

Controller

Anything that has the capability to affect a physical entity, like changing its state or moving it.

Credential

A record that contains the authentication information (credentials) required to connect to a resource. Most credentials contain a user name and password.

Carbon footprint

A carbon footprint is a measure of the amount of greenhouse gas (GHG) emissions that are released within the boundaries of study. A carbon footprint is often measured in the units of kg or tonnes of CO2e. A true carbon footprint starts at the cradle and measures the release of GHG emissions throughout a supply chain or life-cycle.

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Carbon sequestration

Carbon sequestration is normally discussed when assessing naturally grown materials, such as timber. When a tree grows it absorbs carbon dioxide (CO2) from the atmosphere (through photosynthesis) and stores the carbon (C) within the make up of the tree. Wood is roughly 50% carbon by dry weight. This could be claimed as biogenic carbon storage in an embodied carbon assessment, which is in essence a carbon benefit to the results. However, it is important to appreciate that at the end of life of such materials the stored carbon may be released back into the atmosphere, for example through incineration or through decaying in a landfill. If including carbon sequestration in a study, then it's important to take care in modelling the results and to appreciate the end of life scenario.

Cradle

The cradle is defined as the earth. It is used as the start of the boundary for embodied carbon, carbon footprint and LCA assessments, i.e. the extraction of materials from the ground.

Cradle to cradle

'Cradle to cradle' goes beyond 'cradle to grave' and conforms more to the model of the circular economy. In a cradle to cradle model products would be designed in a way so that at the end of their initial life they can be readily reused, or recycled, and therefore avoid landfill altogether.

Cradle to gate

Cradle to gate is a boundary condition associated with embodied carbon, carbon footprint and LCA studies. A study to these boundaries considers all activities starting with the extraction of materials from the earth (the cradle), their transportation, refining, processing and fabrication activities until the material or product is ready to leave the factory gate.

Cradle to site

Cradle to site is a boundary condition associated with embodied carbon, carbon footprint and LCA studies. A study to these boundaries includes the cradle to gate results and the transportation of the material or product to its site of use.

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Cradle to grave

Cradle to site is a boundary condition associated with embodied carbon, carbon footprint and LCA studies. A study to these boundaries includes the cradle to site results but also includes the GHG emissions associated with the in use of the material or product (maintenance) and the end of life (disposal, reuse, recycling).

Cause and Effect Diagram

A problem-solving tool used to establish relationships between effects and multiple causes.

Changeover

As used in manufacturing, the time from when the last "good" piece comes off of a machine until the first "good" piece of the next product is made on that machine. Includes warm up, first piece inspection and adjustments.

Counter Measures

Immediate actions to bring performance that is tracking below expectations back into the proper trend. Requires root cause analysis

Client / Customers

The person or group that is the direct beneficiary of a project or service is the client / customer. These are the people for whom the project is being undertaken (indirect beneficiaries are stakeholders). In many organizations, internal beneficiaries are called "clients" and external beneficiaries are called "customers," but this is not a hard and fast rule.

Constraints

Constraints are limitations that are outside the control of the project team and need to be managed around. They are not necessarily problems. However, the project manager should be aware of constraints because they represent limitations that the project must execute within. Date constraints, for instance, imply that certain events (perhaps the end of the project) must occur by certain dates. Resources are almost always a constraint, since they are not available in an unlimited supply.

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Critical path

The critical path is the sequence of activities that must be completed on schedule for the entire project to be completed on schedule. It is the longest duration path through the workplan. If an activity on the critical path is delayed by one day, the entire project will be delayed by one day (unless another activity on the critical path can be accelerated by one day).

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D

Data centre

A data centre is a location where most of the computer systems and the computing power of companies, or other large entities, are bundled.

Device

Technical physical component (hardware) with communication capabilities to other IT systems. A device can be either attached to or embedded inside a physical entity, or monitor a physical entity in its vicinity

Domotics

Domotics indicates the confluences of ‘domestic’ and ‘robotics’ and forms the basis of many IoT innovations. These include home automation systems, autonomous service robots like the Roomba vacuum, and networked security systems. In the IoT, these devices often have machine-to-machine communication capabilities.

Dematerialisation

The objective of the dematerialisation strategy, assuming the service provided is the same, is to reduce the amount of resources required to provide this service. Different strategies can be used: functionality economy, eco-design, development of eco-technologies, industrial ecology (via the networking of material and energy flows, in particular by replacing the use of natural resources with by-products).

Data mining

Generally, data mining […] is the process of analyzing data from different perspectives and summarizing it into useful information […]. Technically, data mining is the process of finding correlations or patterns among dozens of fields in large relational databases. (Palace, 1996)

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Decisional approach

System modelling approach in which activities in a product system are linked to anticipated future suppliers with which one may establish financial and contractual relations even if the said suppliers are constrained.

Deliverable

A deliverable is any tangible outcome that is produced by the project. All projects create deliverables. These can be documents, plans, computer systems, buildings, aircraft, etc. Internal deliverables are produced as a consequence of executing the project and are usually needed only by the project team. External deliverables are those that are created for clients and stakeholders. Your project may create one or many deliverables.

Decision support system (DSS)

A decision support system (DSS) is an information system that supports business or organizational decision-making activities. DSSs serve the management, operations and planning levels of an organization (usually mid and higher management) and help people make decisions about problems that may be rapidly changing and not easily specified in advance—i.e. unstructured and semi-structured decision problems. Decision support systems can be either fully computerized or human-powered, or a combination of both.

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E

Evaluation

Evaluation is the systematic and objective assessment of an ongoing or completed project, including its design, implementation, and results. The aim is to determine the relevance and fulfillment of objectives, development efficiency, effectiveness, impact, and sustainability. An evaluation should provide information that is credible and useful, enabling the incorporation of lessons learned into the company's decision making process.

EAN (European Article Number)

…stands for and is used to mark and identify products. Since 2009 it is called GTIN (Global Trade Item Number). The number is usually found beneath barcodes and consists of up to 13 digits (EAN 13 barcode).

Embedded computing / systems

A term for computing that is dedicated to a single purpose, as opposed to general-purpose computing. Embedded computer systems are special-purpose and contain only the software and hardware needed to achieve those ends. In the IoT, many systems are developed for specific purposes and made to work in concert with other systems.

Energy-harvesting technologies

This (also known as power harvesting or energy scavenging) is the process by which energy is derived from external sources (e.g., solar power, thermal energy, wind energy, salinity gradients, and kinetic energy), captured, and stored. Frequently, this term is applied when speaking about small, wireless autonomous devices, like those used in wearable electronics and wireless sensor networks. Traditionally, electrical power has been generated in large, centralized plants powered by fossil fuels, nuclear fission or flowing water. Large-scale ambient energy, such as sun, wind and tides, is widely available but technologies do not exist to capture it with great efficiency. Energy harvesters currently do not produce sufficient energy to perform mechanical work, but instead provide very small amount of power for powering low-energy electronics. While the input fuel to large scale generation costs money (oil, coal, etc.), the 'fuel' for energy harvesters is naturally present and is therefore considered free. For example, temperature gradients exist from the operation of a combustion engine and in urban areas, there is also a large amount of electromagnetic energy in the environment because of radio and television broadcasting.

E-learning

any forms of electronically supported learning and teaching.

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Embodied carbon

Embodied carbon may be defined as the carbon footprint of a material. It considers the amount of greenhouse gas emissions (GHGs) that are released throughout a production supply chain to produce a material or product. It is often measured with the boundaries of cradle to gate, cradle to site, or cradle to grave. It considers all extraction, transport, processing and fabrication activities of a material or product. Embodied carbon differers from a carbon footprint in that embodied carbon can only be associated with materials or products, whereas a carbon footprint could also measure the GHG emissions in the operation of a building, for example.

Elementary Flow

Material or energy entering the system being studied that has been drawn from the environment without previous human transformation, or material or energy leaving the system being studied that is released into the environment without subsequent human transformation (ISO 14040, 2006).

Environmental product declaration (EPD)

An EPD is a standardized (ISO 14025/TR) and LCA based tool to communicate the environmental performance of a product or system, and is applicable worldwide for all interested companies and organizations. http://www.environdec.com)

Environmentally extended input-output data (environmentally extended input-output / environmentally extended input-output tables)

The data presented by national statistical agencies as supply-use tables (also known as "make-use tables") and direct requirements tables. The environmental extension is an inventory of the elementary flows for each unit process in these tables.

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F

Flow

The progressive achievement of tasks and/or information as it proceeds along the value stream, flow challenges us to reorganize the Value Stream to be continuous… "one by one, non-stop".

Flow Cell

A logical, efficient, and usually physically self contained arrangement of supplies, equipment, and personnel to complete a service sequence; a flow cell enables visual management, simple flow, standard work, transparency, and tight connections.

FIFO (First In First Out)

A type of material flow with a defined upper limit and a FIFO principle used for Pull systems. Opposite of the much less common LIFO. See also my posts on FIFO.

Flexible Manufacturing System (FMS)

A flexible manufacturing system aims to produce different products on the same system. See also Agile, Reconfigurable, Robust, Adaptable, and Holonic manufacturing systems. See also my post Facing Change in Modern Manufacturing Systems.

Fordism

Type of Mass Production established by Henry Ford, in particular for his Model T. Focus is on relentless optimization for Mass Production of one good (e.g. the Ford Model T). Its weakness is its inflexibility.

Functional manager

The functional manager is the person you report to within your functional organization. Typically, this is the person who does your performance review. The project manager may also be a functional manager, but he or she does not have to be. If your project manager is

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different from your functional manager, your organization is probably utilizing matrix management.

G

Gateway

A network device or software run on a computer in the network that can communicate with other networks, even if these use a different protocol. This way they can share information with each other.

GIS (Geographic Information System)

Such systems capture, manage, analyse, and present geographic data via hardware and software. In the IoT, GIS often forms the basis for location-enabled services and related apps.

Geotagging

The process of tagging a photo, video or other types of media with coordinates, thus marking it with a location.

Gantt Chart

Bar chart to visualize a project schedule.

Gemba Walk

Gemba walk is a Quality management technique that denotes the action of going to see the actual process, understand the work, ask questions, and learn. It is also known as one fundamental part of Lean management philosophy.

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H

Horizon2020

The Framework Programmes for Research and Technological Development, also called Framework Programmes or abbreviated FP1 to FP7 with "FP8" being named "Horizon 2020", are funding programmes created by the European Union/European Commission to support and foster research in the European Research Area (ERA). The specific objectives and actions vary between funding periods. In FP6 and FP7 focus was still in technological research, in Horizon 2020 the focus is in innovation, delivering economic growth faster and delivering solutions to end users that are often governmental agencies.

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I

INTERNET OF THINGS

The connectivity of everyday objects with ability to send and receive data. IoT embeds sensors and machines in our lives to understand and gather data, creating endless opportunities that have far greater impacts than previous industrial revolutions.

A development of the Internet in which everyday objects have network connectivity, allowing them to send and receive data. A state in which physical objects (things) having embedded technology to sense and communicate, being connected via an identifier such as a micro-chip/SIM. This will serve the communication among those things, closing the gap between the real and the virtual world and creating smarter processes and structures that can support us without needing our attention. It can be compared with the digital connection on the internet.

Industrial Automation

The innovation and application of control systems and information technologies to monitor and control processes and machines to deliver products and services.

Identity

Identity consists of recognizable properties that are linked to an object, a person, etc. Those attributes expose the entity and allow for clear identification. If two things have the exact same attributes, they usually have the same identity as they can't be distinguished from each other.

Industrial Internet

A term introduced by General Electric (GE) and stands for the convergence of machinery and smart data. It allows for constant and real time adjustments.

Information model

An information model is a representation of concepts, relationships, constraints, rules, and operations to specify data semantics for a chosen domain of discourse. The advantage of using an information model is that it can provide sharable, stable, and organized structure of

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information requirements for the domain context. The information model is an abstract representation of entities which can be real objects such as devices in a network or logical such as the entities used in a billing system. Typically, the information model provides formalism to the description of a specific domain without constraining how that description is mapped to an actual implementation., Different mappings can thus be derived from the same information model. Such mappings are called data models.

Interface

How a software application or system, or physical device or component appears to other software or hardware so that it can be interacted with.

Internet

The Internet is a global system of interconnected computer networks that use the standard Internet protocol suite (TCP/IP) to serve billions of users worldwide. It is a network of networks that consists of millions of private, public, academic, business, and government networks of local to global scope that are linked by a broad array of electronic and optical networking technologies. The Internet carries a vast array of information resources and services, most notably the inter-linked hypertext documents of the World Wide Web (WWW) and the infrastructure to support electronic mail.

Interoperability

The term describes a system’s ability to share information and services with another system ideally based upon common standards. Much of the success of the IoT relies on the ability of connected devices to operate seamlessly and effectively together

IoT service

Software component enabling interaction with resources through a well-defined interface. Can be orchestrated together with non-IoT services (e.g. enterprise services). Interaction with the service is done via the network.

IP (Internet Protocol)

One of the most fundamental protocols used for data communication on the Internet.

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IPv6 (Internet Protocol version 6)

Ipv6 is a new version of IP, where the addresses are made up of 128 bits and the number of addresses possible is huge.

Industrial ecosystem

Natural ecosystems in the biosphere are largely interdependent, as are the species within these ecosystems. For example, "plants synthesise substances which feed herbivores, who are eaten by carnivores, whose waste and carcasses are used as food by other organisms". This combination of interdependences is one of the cornerstones of the balance and stability of natural ecosystems. Consequently, the strategy proposed by industrial ecology is to reshape the organisation of industrial systems in accordance with these principles, i.e. aim for an eco-systemic organisation in order to strive for a mode of development which is compatible with the ecological balance. On a local scale, industrial symbioses or eco-industrial parks therefore refer to the notion of industrial ecosystem.

Industrial (or territorial) metabolism

Industrial metabolism consists of establishing mass balances by estimating the material and energy flows and stocks of a given company or industrial system, with a view to obtaining a global view of its functioning via a graphical and quantitative representation. Territorial metabolism applies to a broader geographical scale in accordance with the same principles.

Industrial symbiosis

As an analogy of natural ecosystems, an industrial symbiosis refers to inter-business relations based on sustainable and mutually beneficial partnerships. It is defined as "belonging to the emerging field of industrial ecology and requiring special focus on material and energy flows within local and regional economies. Industrial symbiosis involves [...] physical exchanges of material, energy, water and/or by-products. The keys to industrial symbiosis lie in the collaboration and synergy opportunities inherent in geographical proximity".

Source: Chertow M., Industrial Symbiosis: Literature and Taxonomy, Annual Review of Energy and the Environment.

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Impact category

Impact Categories are logical groupings of Life Cycle Assessment results of interest to stakeholders and decision makers. (UNEP/SETAC, 2009)

Inventory dataset

A set of input and output data of a process. All of them are related to the same reference of this process. Usually, an inventory dataset also contains metadata describing, for example, geography, time reference, and ownership of the dataset. The process can be a unit process or an aggregated process.

Industry 4.0

Set of European governments programs to promote new developments related to computers in industry.

Issue

An issue is a major problem that will impede the progress of the project and that can't be resolved by the project manager and project team without outside help. Project managers should proactively deal with issues through a defined issues management process.

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J

Just-in-Time (JIT)

A system of managing production processes that result in line-balancing, one-piece flow, and little or no excess material inventory on hand. A strategy that concentrates on making quality products, in the quantity needed, when needed

Just in Sequence (JIS)

Delivery of products in the exact sequence they are needed.

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K

Key enabling technologies (KETs)

KETs are a group of six technologies: micro and nanoelectronics, nanotechnology, industrial biotechnology, advanced materials, photonics, and advanced manufacturing technologies.

Kaizen

A Japanese term meaning “change for the better”. Applied to business organizations, it implies continuing improvement involving everyone

Kanban

A card or sheet used to authorize production or movement of an item; when fully implemented, kanban (the plural is the same as the singular) operate according to the following rules: 1. All production and movement of parts and material takes place only as required by a downstream operation 2. The specific tool which authorizes production or movement is called a kanban. The word literally means card or sign, but it can legitimately refer to a container or other authorizing device. 3. The quantity authorized per kanban is minimal, ideally one. The number of available kanban for an item is determined by the demand rate for the item and the time required to replenish.

Key Performance Indicators (K.P.I.)

A method of tracking or monitoring the progress of existing daily management systems.

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L

Local storage

Special type of celectronic data storage that contains information about one or only a few entities in the vicinity of a device.

Location technologies

All location technologies like Global Positioning Systems (GPS) work to establish and communicate the location of a device to sensors around it. In the IoT, this capability serves to position a device or user within a system.

Life Cycle Assessment (LCA)

Life cycle assessment, also known as life cycle analysis, considers a full basket of environmental impact categories, beyond just carbon. For example it can produce results for toxicity, eutrophication, acidification, water depletion, resource depletion...etc. LCA can be a powerful decision support tool, but requires a higher level of expertise than an embodied carbon assessment or carbon footprint.

Life cycle costing (LCC)

Life cycle costing, or LCC, is a compilation and assessment of all costs related to a product, over its entire life cycle, from production to use, maintenance and disposal. (UNEP/SETAC, 2009).

Life cycle inventory database

A system intended to organize, store, and retrieve large amounts of digital LCI datasets easily. It consists of an organized collection of LCI datasets that completely or partially conforms to a common set of criteria, including methodology, format, review, and nomenclature, and that allows for interconnection of individual datasets that can be specified for use with identified impact assessment methods in application of life cycle assessments and life cycle impact assessments.

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Life cycle management (LCM)

Life cycle management is a product management system aiming to minimize environmental and socio- economic burdens associated with an organization's product or product portfolio during its entire life cycle and across its value chain. LCM is not a single tool or methodology, but a management system collecting, structuring and disseminating product- related information from various programs, concepts, and tools.

Life cycle sustainability assessment (LCSA)

Life cycle sustainability assessment (LCSA) refers to the evaluation of all environmental, social and economic negative impacts and benefits in decision making processes towards more sustainable products throughout their life cycle. (UNEP/SETAC, 2011).

Life cycle thinking

Life Cycle Thinking is a mostly qualitative discussion to identify stages of the life cycle and/or the potential environmental impacts of greatest significance e.g. for use in a design brief or in an introductory discussion of policy measures. The greatest benefit is that it helps focus consideration of the full life cycle of the product or system; data are typically qualitative (statements) or very general and available-by-heart quantitative data. (Christiansen et al., 1997).

Lead Time

The total time it takes for a process to convert a raw material to a finished quality part.

Line Balancing

Equalizing cycle times (productive capacity, assuming 100% capacity utilization) for relatively small units of the manufacturing process, through proper assignment of workers and machines; ensures smooth production flow

Lean

More general term than Lean Manufacturing, which originates in the Toyota Production System. Also applies outside of manufacturing, e.g. lean banking, lean office, lean government, lean military, lean service, lean accounting, lean logistics, lean management,

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lean product development, lean startup, lean maritime, or anything other type of industry or sector that you can think of with the word "Lean" added.

Lean 2.0

Part of the general trend to rejuvenate a buzzword (in this case Lean) by simply adding another "version" number to it (Internet 2.0, industry 4.0, web 2.0, …). While lean has been around for decades, it is still in my view the best approach to organize and improve manufacturing and related systems. Lean 2.0 also has no real changes except for a vague promise to fix everything that is wrong in lean (See for example Lean Religion), or simply promise to be better without going into detail on how it actually will be better. In my view this term is not needed, and luckily seems to be little used by real practitioners.

Lean consumption

Opposite of Lean Manufacturing or lean production. Sort of Leanfor retailing or service providers. Tries to provide the customer exactly what he wants, when he wants it, where he wants it, in good quality, and without wasting the resources of the customer.

Lean Enterprise

Attempt at a re-branding of lean with the goal to provide lean not only in manufacturing, but for the entire enterprise.

Lean Manufacturing

Both generic term for and based on the Toyota Production System (TPS). Usually used synonymous with Lean Production, although lean manufacturing is more common. Term coined by John Krafcik. Versions of Lean manufacturing outside of Toyota often flawed (see Lean Religion). Sometimes also called lean production, and also often abbreviated to Lean.

Lean Production

Same as Lean Manufacturing, which is more common.

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LIFO (Last in, First Out)

Opposite of FIFO. Also type of material flow with a defined upper limit. The sequence, however, is last in first out, i.e. the last part that arrived is the first one that is removed. This approach is rarely used, since it has a high risk of parts staying in the system for a long time. Usually only used if storage conditions force this system. I.e. if parts are stacked, the last part stacked on the top is also the first part removed, since it would be difficult to remove the part at the bottom of the stack. Another example: A pile or material (coal, stones, etc.) is both filled and emptied from the top. Hence the material at the very bottom was the first to be added, but will be the last to be removed.

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M

Monitoring

Monitoring is a continuous function that uses the systematic collection of data on specified indicators to provide management and the main stakeholders of an ongoing development intervention with indications of the extent of progress and achievement of objectives and progress in the use of allocated funds.

M2M (Machine to Machine)

A typically closed network of devices in which they can communicate with one another and/or other control systems located on the same network.

Microcontroller

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on-chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, and toys. By reducing the size and cost compared with a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to control digitally even more devices and processes. Mixed signal microcontrollers are common, integrating analogue components needed to control non-digital electronic systems

Machine Cycle Time

The time it takes for an individual piece of equipment to complete its functions to produce a quality part independent of the operator's unloading and loading time

Make to Order (MTO)

General term of products that are produced only for a specific customer order. Often for High Mix Low Volume production. Often produced in a Job Shop, but Flow

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Shop production is also sometimes possible. Opposite of Make to Stock. Since you do not have finished goods stock, you cannot decouple fluctuation through finished goods stock, hence the customer usually has to wait until the product is completed, hence decoupling through time.

Make to Stock (MTS)

General term of products that are produced for an inventory rather than a customer order, and the customer satisfies his demand by taking a part out of the inventory. Possible only for products where a customer demand for this product can be expected, mostly Low Mix High Volume production. Usually produced in a Flow Shop. Opposite of Make to Order. The Advantage of MTS products is that you can decouple fluctuations through your inventory (your stock).

Material Flow

Flow of the material through the Value Stream. One of the key points to optimize in Lean Manufacturing, for example to achieve the goal of One Piece Flow. Often combined with Information Flow.

Matrix Diagram

Matrix that shows the relationship between items. Not to be confused with the Prioritization Matrix. One of the 7 Management and Planning Toolsby JUSE.

Milestone

A milestone is a scheduling event that signifies the completion of a major deliverable or a set of related deliverables. A milestone, by definition, has duration of zero and no effort. There is no work associated with a milestone. It is a flag in the workplan to signify that some other work has completed. Usually, a milestone is used as a project checkpoint to validate how the project is progressing. In many cases there is a decision, such as validating that the project is ready to proceed further, that needs to be made at a milestone.

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N

Node

A connection point, a redistribution point or a communication endpoint. The definition depends on the network and the protocol layer referred to. A network node is an active electronic device that is attached to a network and is capable of creating, receiving or transmitting information over a communications channel.

Non Value Added (NVA)

Those process steps in a Value Stream that take time, resources or space, but do not transform or shape the product or service to meet the needs of the customer

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O

Open source

Open Source software makes its source code freely available for anyone to modify and redistribute. This stands in contrast to a proprietary system. Readily available Open Source software is fuelling a great deal of advancement in the IoT, as developers from all walks of life try their hand at innovation.

Operator

The operator owns administration rights on the services it provides and/or on the entities it owns, is able to negotiate partnerships with equivalent counterparts and define policies specifying how a service may be accessed by users.

Operator Cycle Time

The total time it takes an operator to complete one cycle of all the standard work elements in his job.

On-the-job training (OTJ or OJT, both abbreviations are in use)

Training of new workers directly on the job, i.e. learning while doing. On its own often not optimal, should be enhanced with off the job training. But both are needed to train an employee.

Objective

An objective is a concrete statement that describes what the project is trying to achieve. The objective should be written at a low level, so that it can be evaluated at the conclusion of a project to see whether it was achieved. Project success is determined based on whether the project objectives were achieved. A technique for writing an objective is to make sure it is Specific, Measurable, Attainable/Achievable, Realistic, and Timebound (SMART).

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P

Pervasive computing

Pervasive computing (also called ubiquitous computing) is the growing trend towards embedding microprocessors in everyday objects so they can communicate information. Such computing devices are completely connected and constantly available.

Power over WiFi (PoWiFi)

A technology that can convert signals sent by wireless routers into direct current. A continuous stream of low power signals can be harvested from inactive WiFi hotspots.

Primary data

Data determined by direct measurement, estimation or calculation from the original source. (Weidema et al. 2003)

Product life cycle

Product life cycle is a term that has different meanings for different functional groups. It can refer to the purchase, use and disposal of the product from the owner/ user perspective. The marketing product life cycle refers to the distinct stages every product goes through: introduction, growth in sales revenue, maturity, and finally, decline and withdrawal. The environmental product life cycle consists of all the direct and supporting processes (see product system) required to build, distribute, use, maintain, and retire a product, from extraction of raw materials to their final disposal or recycle, i.e. cradle to grave.

Product system

ISO defines product system as a collection of materially and energetically connected unit processes, which perform one or more defined functions. The term "product" used alone includes not only product systems but can also include service systems.

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P.D.C.A. Cycle

Plan-Do-Check-Act. An iterative four-step problemsolving process typically used in quality control. It is also known as the Deming Cycle, Shewhart Cycle, Deming Wheel, or Plan-Do-Study-Act.

Paradigm

A fundamental idea about reality, frequently unquestioned and difficult to change, that conditions all our thinking about and even our physical perceptions of the world or some aspect of experience

Perfection

A never ending pursuit of the complete elimination of non-value adding waste so that all activities along a value stream create value; perfection challenges us to also create compelling quality ("defect free") while also reducing cost ("lowest cost").

Point of use

The condition in which all supplies are within arms reach and positioned in the sequence in which they are used to prevent extra reaching, lifting, straining, turning, and twisting

Pareto Analysis

Named after Italian economist Vilfredo Pareto (1848-1923). Ordering of data by a quantity. For example, part numbers are ordered by quantity or value sold, errors are ordered by number of occurrences. Frequently, the Pareto Principle holds true for the resulting graph.

Pareto Principle

Named after Italian economist Vilfredo Pareto (1848-1923). General rule of thumb that many data sets can be split in 20%/80% groups. E. g. 20% of your products make 80% of your revenue; or 20% of your products will be 80% of the work, 20% of your customers will give you 80% of your orders, 20% of the land is owned by 80% of the people, etc. This holds true surprisingly often. Also known as the 80/20 rule.

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PERT (Program evaluation and review technique)

Sometimes also *Project*evaluation and review technique. Also known as Activity Network Diagram. Project management tool developed by the US Navy based upon and very similar to the Gantt Chart.

Prioritization Matrix

Useful management tool to prioritize possible actions or projects on a two-axis diagram. These two axes are often but not always cost and benefit. Not to be confused with the Matrix Diagram. One of the 7 Management and Planning Tools by JUSE.

Problem Solving

Fundamental part of every lean operation: You have problems, you solve them. Sometimes abbreviated as PSP. Common sense dictates to start with the most urgent problem first, and to make sure the solution addresses the problem, not only the symptoms (see Root Cause Analysis). Numerous tools have been developed for this, most importantly PDCA or one of its variants, the A3, 4 M, 5 Why, 5W1H, and FMEA to name just a few. Toyota also uses a Toyota Six Step Problem Solving method.

Program

A program is the umbrella structure established to manage a series of related projects. The program does not produce any project deliverables. The project teams produce them all. The purpose of the program is to provide overall direction and guidance, to make sure the related projects are communicating effectively, to provide a central point of contact and focus for the client and the project teams, and to determine how individual projects should be defined to ensure that all the work gets completed successfully.

Program manager

A program manager is the person with the authority to manage a program. (Note that this is a role. The program manager may also be responsible for one or more of the projects within the program.) The program manager leads the overall planning and management of the program. All project managers within the program report to the program manager.

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Project

A project is a temporary structure to organize and manage work and ultimately to build a specific defined deliverable or set of deliverables. By definition, all projects are unique, which is one reason it is difficult to compare different projects to one another.

Project definition (charter)

Before you start a project, it is important to know the overall objectives of the project, as well as the scope, deliverables, risks, assumptions, project organization chart, etc. The project definition (or charter) is the document that holds this relevant information. The project manager is responsible for creating the project definition. The document should be approved by the sponsor to signify that the project manager and the sponsor are in agreement on these important aspects of the project.

Project manager

The project manager is the person with the authority to manage a project. The project manager is 100 percent responsible for the processes used to manage the project. He or she also has people management responsibilities for team members, although this is shared with the team member's functional manager. The processes used to manage the project include defining the work, building the workplan and budget, managing the workplan and budget, scope management, issues management, risk management, etc.

Project phase

A phase is a major logical grouping of work on a project. It also represents the completion of a major deliverable or set of related deliverables. On an IT development project, logical phases might be planning, analysis, design, construct (including testing), and implementation.

Project team

The project team consists of the full-time and part-time resources assigned to work on the deliverables of the project. They are responsible for understanding the work to be completed; completing assigned work within the budget, timeline, and quality expectations; informing the project manager of issues, scope changes, and risk and quality concerns; and proactively communicating status and managing expectations.

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Q

Quality Assurance Matrix (QA Matrix)

Structured approach to identify causes of quality issues and prevent their occurrence.

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R

Reference model

A reference model is an abstract framework for understanding significant relationships among the entities of some environment. It enables the development of specific reference or concrete architectures using consistent standards or specifications supporting that environment. A reference model consists of a minimal set of unifying concepts, axioms and relationships within a particular problem domain, and is independent of specific standards, technologies, implementations, or other concrete details. A reference model may be used as a basis for education and explaining standards to nonspecialists.

Remote monitoring and control

Remote monitoring and control describes the more and more automated monitoring and control of devices, technologies or processes. Wireless devices which send information gathered directly to control centres are often used to achieve this.

RFID (Radio Frequency Identification)

The use of electromagnetic or inductive coupling in the radio frequency portion of the spectrum to communicate to or from a tag through a variety of modulation and encoding schemes uniquely to read the identity of an RFQ Tag. A method to identify objects (including humans) through electromagnetic waves without actual physical contact. This way, data can be gathered more easily. An object or creature is equipped with a transponder which transmits data to an electronic reader. Other than, for example, barcodes, the information can be read without a line of sight and in some cases operating distance can be over a kilometre.

Raw data

Data used in unit process inventory modelling to deliver inventory data at the end, which are extracted from various data sources, such as bookkeeping of a plant, national statistics, or journal literature.

Reference flow

Measure of the outputs from processes in a given product system required to fulfil the function expressed by the functional unit. (ISO 2006).

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Reference product

Product of an activity for which a change in demand will affect the production volume of the activity (also known as the determining products in consequential modelling). (Weidema et al. 2011).

Root Cause

The ultimate reason for an event or condition

Requirements

Requirements are descriptions of how a product or service should act, appear, or perform. Requirements generally refer to the features and functions of the deliverables you are building on your project. Requirements are considered to be a part of project scope. High-level scope is defined in your project definition (charter). The requirements form the detailed scope. After your requirements are approved, they can be changed through the scope change management process.

Risk

There may be potential external events that will have a negative impact on your project if they occur. Risk refers to the combination of the probability the event will occur and the impact on the project if the event occurs. If the combination of the probability of the occurrence and the impact to the project is too high, you should identify the potential event as a risk and put a proactive plan in place to manage the risk.

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S

SMART PRODUCTION

An Industry 4.0 factory will be self-aware and can predict component faults, inecient material usage, and condition monitoring. Since the production process is smarter, management will have more transparency into the supply chain.

Smart Factory

Creates the framework for efficient production. The smart factory is based on cyber-physical systems which enable machines, resources and humans to intercommunicate over the Internet of Things. The information is exchanged via the cloud, the intranet or directly via RFID chips.

Security (Information)

The correct term is 'information security' and typically information security comprises three component parts: Confidentiality: assurance that information is shared only among authorised persons or organisations. Breaches of confidentiality can occur when data is not handled in a manner appropriate to safeguard the confidentiality of the information concerned. Such disclosure can take place by word of mouth, by printing, copying, emailing or creating documents and other data, etc.; Integrity: assurance that the information is authentic and complete. Ensuring that information can be relied upon to be sufficiently accurate for its purpose. The term 'integrity' is used frequently when considering information security as it represents one of the primary indicators of information security (or lack of it). The integrity of data is not only whether the data is 'correct', but whether it can be trusted and relied upon.; Availability: assurance that the systems responsible for delivering, storing and processing information are accessible when needed, by those who need them.

Sensor

A sensor is used to determine certain physical or chemical characteristics and transform them into an electrical signal to make them digitally processable. Sensors form the backbone of the IoT, helping to bridge the gap between digital and physical.

Sensor hub

A technology which connects sensor data and processes it. This way the hub does part of a processor's data-processing job.

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Smart buildings

Buildings which are designed and equipped to try to minimize costs and environmental impact. This is achieved by connected systems and efficient use of energy through new, automated technology that intelligently responds to certain circumstances (available solar energy, temperature inside the building, etc.).

Smart cities

A concept that tries to create a more intelligent city infrastructure by using modern information and communication technologies. Smart cities are about a more flexible adaptation to certain circumstances, more efficient use of resources, improved quality of life, fluent transportation and more. This will be achieved through networking and integrated information exchange between humans and things

Smart grids

Grids which coordinate energy use and distribution. This enhances efficiency and becomes more and more important because of renewable energies which are not always as reliable as other forms of energy.

Smart meters

Electronic devices which measure and display resource consumption (of water, gas, electricity, etc.) and communicate this information to third parties (mainly control systems). This allows for a more efficient distribution, usage and control of these resources.

Stakeholder (also referred to as system stakeholder)

An individual, team, or organisation (or classes thereof) with interests in, or concerns relative to, a system.

Supply chain

A supply chain is a system of organizations, people, technology, activities, information and resources involved in moving a product or service from supplier to customer. Supply chain activities transform natural resources, raw materials and components into a finished product that is delivered to the end customer.

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Sustainability

Sustainability is the capacity to endure. In ecology, the word describes how biological systems remain diverse and productive over time. For humans, sustainability is the potential for long-term maintenance of well- being, which has environmental, economic, and social dimensions.

Sustainable consumption and production

The UN Commission on Sustainable Development (UNCSD) defined sustainable consumption and production as the use of goods and services that respond to basic needs and bring a better quality of life, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardize the needs of future generations. It is increasingly recognized that efficiency gains and technological advances in products and their associated production processes alone will not be sufficient to bring global impacts to a sustainable level; changes will also be required to consumer lifestyles, including the ways in which consumers choose and use products and services.

Substitution

Solving multi-functionality of processes by expanding the system boundaries and substituting the non-reference products with an alternative way of providing them, i.e., the processes or products that the non-reference product supersedes. Effectively the non-reference products are moved from being outputs of the multi-functional process to be negative inputs of this process, so that the life cycle inventory of the superseded processes or products is subtracted from the system, i.e., it is "credited." Substitution is a special (subtractive) case of applying the system expansion principle. (Definition prepared by merging the definitions from ISO 14040ff and the European Commission – Joint Research Centre – Institute for Environment and Sustainability 2010)

Sustainable development

The Brundtland Commission (Our Common Future, 1987) defined sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The concept was a compromise between rich economies pushing for stronger environmental protection and developing economies focused on poverty alleviation. Sustainable development attempts to achieve equitable development within the current generation, while also protecting the rights of future generations.

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Set-up Time

Work required to change over a machine or process from one item or operation to the next item or operation; can be divided into two types: 1. Internal: set-up work that can be done only when the machine is not actively engaged in production OR 2. External: set-up work that can be done concurrently with the machine or process performing production duties

Six Sigma

A statistical term used to refer to a process that generates a maximum defect probability of 3.4 parts per million (PPM) when the amount of process shifts and drifts are controlled over the long term to less than +1.5 standard deviations from the centered mean.

Standard Work

An agreed upon set of work procedures that effectively combines people, materials, and machines to maintain quality, efficiency, safety, and predictability; establishes a routine for repetitive tasks, provides a basis for improvement by defining the normal and highlighting the abnormal, and it prohibits backsliding

Standard Work in Progress

The minimum amount of material or a given product, which must be in process at any time to insure proper flow of the operation

Total Productive Maintenance (TPM)

Aims at maximizing equipment effectiveness throughout the entire life of the equipment. It involves such basic elements as a routine maintenance system, education in basic housekeeping, problem-solving skills, and activities to achieve zero breakdowns

Scrum

Framework for project management, often part of the Agile philosophy. The name comes from the Scrum formation in Rugby, which got its name from the English word "scrum" for a tightly packed crowd. Used often but not only in software development. Is based on five activities (Plan a step (called "Sprint"); Daily Scrum meeting; End of Sprint Review; End of Project Review; Backlog refinement) , three artifacts (Product Backlog, Sprint Backlog; List of

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completed Sprints) , and three roles (Owner; Developer; Scrum master). Not part of the original Lean tool set.

Standardized Work

Idea that the work is described in precise detail so that the worker merely follows the instructions to create good parts. In my view, you have to find a trade-off between framework of the standard and worker flexibility. Workers can follow high quality standards, but following low quality or not regularly updated standards to the letter is usually a mess. Unfortunately, many western standards are low quality and not regularly updated. Also called “Standard Work” or “Work Standard”. There is a finer grading called Standard Work Type 1-3, distinguishing three types of work standards based on the repeatability of the work.

Suggestion System

System that collects improvement ideas from the employees. The ideas are not (only) from the employee that are usually in charge of improvement changes, but also from others that “only” work with the system, i.e. the operators. Good suggestion systems also encourage idea generation. Excellent suggestion systems are also fast in implementation. The latter two are usually lacking in the western world, where often ideas are treated more as a nuisance and are implemented slowly or not-at-all. Toyota has about one idea per employee and week, whereas western companies struggle to get one idea per employee and year, let alone getting them implemented. Toyota got the idea for its suggestion system from Ford.

Scope

Scope is the way you describe the boundaries of the project. It defines what the project will deliver and what it will not deliver. High-level scope is set in your project definition (charter) and includes all of your deliverables and the boundaries of your project. The detailed scope is identified through your business requirements. Any changes to your project deliverables, boundaries, or requirements would require approval through scope change management.

Scope change management

The purpose of scope change management is to manage change that occurs to previously approved scope statements and requirements. Scope is defined and approved in the scope section of the project definition (charter) and the more detailed business requirements. If the scope or the business requirements change during the project (and usually this means that the client wants additional items), the estimates for cost, effort, and duration may no longer be valid. If the sponsor agrees to include the new work in the project scope, the project manager has the right to expect that the current budget and deadline will be modified

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(usually increased) to reflect this additional work. This new estimated cost, effort, and duration now become the approved target.

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T

Tag

A label or other physical object used to identify the physical entity to which it is attached.

Thing

In the phrase 'IoT', the word 'thing' denotes a physical entity (in contrast to the digital and network connection shared between these systems). This could be household appliances, wearable technology, security systems, or other connected/connectable devices.

Thread

An organisation attempting to specify how to assemble and configure a range of standards into a complete software stack to create an IPbased, secure, reliable, interoperable mesh network.

Taylorism

Also called Scientific Management. A theory to analyze and manage work processes developed by Frederick Winslow Taylor. The concept is controversial as it was often used to put more pressure on the worker, even though it was not intended that way. See also my post on Frederick Winslow Taylor.

TQC (Total Quality Control)

Name for a quality control (QC) approach. Other names for very similar and overlapping approaches are SQC (Statistical quality control), SPC (Statistical process control), TQM (Total Quality Management), TPM (Total Preventive/Productive Maintenance) and 6 σ. While a highly relevant topic, it seems to me some of these terms were primarily invented as new buzzwords to sell the same methods in a new and fancier package. In terms of industry attention the topic seems to have peaked around the year 2000, and is now slowly becoming less prominent.

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Traceability

The idea to trace the production history of every single product sold. Of interest are process parameters, testing results, and especially the production history of every individual component that goes in the product, and its subcomponents. The idea is to improve quality by understanding what type of process parameters can cause failures, and also to know exactly which products to recall in the case of a recall.

Turnover

Also known as inventory turns. Measures how often in a year in average you sell your entire inventory and replace it with new material. Usually, this is calculated by value. i.e. by dividing the annual sales or the value of the material consumed by the average value of the material. The turnover is the inverse of the inventory reach in years.

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U

Uncertainty

Quantitative definition: Measurement that characterizes the dispersion of values that could reasonably be attributed to a parameter. (adapted from ISO 1995)

Qualitative definition: A general and imprecise term which refers to the lack of certainty in data and methodology choices, such as the application of non- representative factors or methods, incomplete data on sources and sinks, lack of transparency, etc. (WRI and WBCSD 2010)

Utilization

Percentage of the total time a machine or process is planned to work. Sometimes also called the "operating rate". The similar "Operational availability" measures the percentage of the time a machine is running properly. This differs from the more commonly used OEE, as the OEE sometimes excludes scheduled maintenance or scheduled downtime from the total time, and defects (quality loss) and slow work (speed loss) from the output side.

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V

Viewpoint

A definition of the perspective from which a view is taken. It is a specification of the conventions for constructing and using a view(often by means of an appropriate schema or template). A view is what you see; a viewpoint is where you are looking from - the vantage point or perspective that determines what you see.

Virtual entity

Computational or data element representing a physical entity. Virtual entities can be either active or passive digital entities.

Virtual power plant

In a virtual power plant, different, decentralized power generating plants are connected and are monitored and controlled from a single control centre. This way, virtual power plants can integrate smaller energy providers – for example solar or wind parks – into the energy infrastructure. VPPs are also able to react flexibly to changes in demand.

Virtual sensors

Virtual sensors use data from sensors to gather information that would not be measurable by a single device. This way they can attain information that cannot be measured directly.

Value chain

A value chain is a high- level model describing the activities that a firm operating in a specific industry conducts to receive raw materials as input, add value to the raw materials through various processes, and deliver finished products to customers. Michael Porter popularized the concept in his 1985 best seller, Competitive Advantage: Creating and Sustaining Superior Performance. He suggested that the activities of a business could be grouped under two headings: (1) Primary Activities – those that are directly concerned with creating and delivering a product; and (2) Support Activities – those not directly involved in production, but may increase effectiveness or efficiency (e.g. human resource management).

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Value

When a product or service has been perceived or appraised to fulfill a need or desire--as defined by the customer--the product or service may be said to have value or worth. Components of value may include quality, utility, functionality, capacity, aesthetics, timeliness or availability, price, etc.

Value Stream

All the activities (both value-added and non-value added) required within an organization to deliver a specific service; "everything that goes into" creating and delivering the "value" to the end-customer.

Value Stream Analysis

The identification of all the specific activities occurring along the value stream, represented pictorially in a value stream map; see waste, unevenness, and overburden, size the opportunity, share a vision, communicate visually, permission to change, predict results.

Visual Management

The presentation of a wide variety of information in the workplace. Such information may pertain to jobs themselves, to the business as a whole, to how work teams are progressing on a project. Kanban cards are examples of Visual Management, as are storage bins with sample parts displayed, tool shadow boards, story boards, etc…

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W

Wearable technology

Technologies or computers that, integrated into articles of clothing or accessories, can be worn. The most prominent example would be Apple Watch. Wearable technology, like the Jawbone Up and Fitbit activity trackers, is one of the main focus areas of the IoT at the moment. Devices like these often work by gamifying real-life tasks, bringing people into the device's ecosystem and generating data that can be analysed to improve products and lifestyles.

Wireless communication technologies

Wireless communication is the transfer of information over a distance without the use of enhanced electrical conductors or 'wires'. The distances involved may be short (a few meters as in television remote control) or long (thousands or millions of kilometres for radio communications). When the context is clear, the term is often shortened to 'wireless'. Wireless communication is generally considered to be a branch of telecommunications.

Wireless sensors and actuators network (WSAN)

WSAN are networks of nodes that sense and, potentially, control their environment. They communicate the information through wireless links enabling interaction between people or computers and the surrounding environment.

Waste / Muda

any operation or activity that takes time and resources but does not add value to the product or service sold to the customer

Workplan (schedule)

The project workplan tells you how you will complete the project. It describes the activities required, the sequence of the work, who is assigned to the work, an estimate of how much effort is required, when the work is due, and other information of interest to the project manager. The workplan allows the project manager to identify the work required to complete the project and also allows the project manager to monitor the work to determine whether the project is on schedule.

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X

XML (Extensible Markup Language)

XML is universally used to describe content on websites or other information that can be read by machines.

X Matrix

Matrix showing instructions, objectives, measures & targets, and action programs for policy deployment (Hoshin Kanri). Hence also known as Hoshin Planning Matrix. For my taste too complex, also sounds like a buzzword, although I have not yet used it.

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Y

Yokoten

Japanese for "across everywhere". Knowledge is shared and plant related activities and countermeasures may be communicated plant wide and with other branches of the company and its affiliates.

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Z

ZD (Zero Defects)

Management program with the highly unrealistic goal to reduce defects to zero. Popular in America in the 70’s. Still pops up every now and then in manufacturing.

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Total Resource and Energy Efficiency Management System for Process Industries

Internet of Things

Date: 26/02/2018

Sustainable Process Industry through Resource and Energy Efficiency

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1. The IoT in industrial ecosystems

The evolution of technologies used in the industrial ecosystems has usually followed the advancements of Information and Communication Technology (ICT) systems. Many aspects of ICTs are involved in this evolution, like environmental sensing, data communication technologies, data mining, data storage, and so on. In recent years, specific fields like application logic and decision-making are features where modern ICTs support and maintain the progress of manufacturing systems. Furthermore, the computing technology ecosystem is today facing with the Internet of Things (IoT) innovation, driven by both technological and methodological changes, which include communications paradigms among devices as well as instruments to enable the creation of value added services on top of them. As consequence, the accelerating growth of miniaturized embedded systems and the constantly increasing interest within ubiquitous computing is showing the direction for the next-generation industry, since it already leverages on modern microelectronics and wireless data communication.

Thanks to the growth of such technology services, today's production environment is living a new era of innovations and changes that have the potential to bring higher efficiency, flexibility and interoperability among industries, even if belonging to different production ecosystems. The IoT introduction into the industrial applications enables to enrich the value of the information traversing specific application, thereby supporting the development of actual intelligent environments, even in industrial and energy intensive ecosystems where this has been never considered. Furthermore, an elevated level of flexibility is needed into these environments, and today this is achievable thanks to the IoT framework available combined with high level of pervasiveness and ubiquitous computing. Integrated with intelligence, pervasiveness and flexibility, industrial applications can enjoy improved service quality, achieve better efficiency and accelerate the business innovation (UCKELMANN, D, 2014). A vast number of IoT development already exist in the industry fields, namely for oil and gas level monitoring, automated stock calculation, explosive and hazardous gases detection, machine auto-diagnosis and assets control, etc. The main characteristic of these developments is that are vertically designed, since mainly leveraging on specific technologies to handle specific problems. In addition, other systems, SCADA, MES, ERP and EAI, provide limited vision on the status and performance of the production systems from both the economic and environmental perspective.

2. The IoT and process optimisations

The Internet of things, the natural extension of the Internet, added the key concept of connecting things, sensors, actuators, and many other smart technologies apart the sole computers: the vision of having an immediate access to information about physical objects is now fully related with the possibility to provide innovative services with high efficiency and productivity. Indeed, the fact that the industrial scenario can take several advantages from the introduction of the IoT paradigm has been widely ruled by a number of publications. For example, BI, Z. (2014) states that IoT has is crucial technology that will definitely affect the industry and will have a great impact on the economy. BI, Z. (2014) also underline that an IoT system is well aligned with the architecture of an industry, since an enterprise can be modelled as a set of components and a set of interactions among them. From those premises is it possible to underline that the IoT match the industry on two main side: in one side, the IoT represents all the new technologies and communication protocols that enable the flexible, efficient and effective sensing and data acquisition in the production environment. On the other side, the IoT meet the industry in the orchestration, aggregation and federation of logical component, systems and subsystems. Furthermore, modern

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industries face a challenge raised from the increasingly complexity and dynamicity of the production environments. The IoT and the pervasive computing has enabled companies continuously adapting to these changes. Within (EU COMMISSION, 2016) is evident how European research strategy today specifically addresses this need while stating that future shop floors have to endorse flexibility and define networks in which a tight collaboration between humans, machines and robots is key for performance e.g. maintenance operations and changes in product set-up. These will be reality enabling machinery and robots to collaborate and adapt their behaviour in order to give a response to unforeseen changes, situations or problem. Finally, modern industry also faces with the worker's well-being under working conditions, as a crucial part of manufacturing element. Human factors indeed need to be considered in order to achieve sustainable and efficient organizational. For example, the advances in the area of wearable sensors, useful for sensing human parameters, make it possible to enable a wide range of user-factory' value added services. As stated by NEUBAUER, M. (2015), sensing human conditions, such as the level of comfort or stress, allows for continuous adaptation of the manufacturing process behaviour on the top of randomly changing human needs.

3. The MAESTRI's IoT vision

Within the business environment, vertical and horizontal integration is the key condition for seamless information flows from different business units as well as between business partners. Unfortunately, there is still a huge gap to achieve this integration: the MAESTRI project propose a vision for filling this gap. Specifically, The integration of IoT topic is not of course centred in development of ICT specific components, but rather to get the best capabilities and functionalities of this powerful technology in order that processing industries are aligned and benefited with these high-level technologies application and usefulness. The proposed approach advantages on the deeper integration, in the production environment, of the Internet of Things paradigm, envisioning a seamless interconnection of heterogeneous devices, systems and subsystems in order to achieve higher degree of interactions between the shop floor, the legacy management systems and the end users, supporting end-to-end business optimizations addressed by MAESTRI. The full integration of the Internet of Things allows managing assets, optimizing performance, and developing new business models, paving the way to the hyper-connected factory, which improve energy efficiency and optimize resource management and savings.

4. More information

To know more about the monitoring of performances and efficiency, the MAESTRI project made available the following materials:

>> MAESTRI D1.2 Technology Watch

>> MAESTRI D5.3 Final MAESTRI Platform Architecture Design & Specification

All reports related to the development of the IoT platform and its validation ara available here: https://maestri-spire.eu/downloads/technical-materials/

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5. Acknowledgements

Chapter 1-3 comes from MAESTRI D1.2 Technology Watch. To download the full documents, click the following link:

https://maestri-spire.eu/wp-content/uploads/2016/09/D1.2-MAESTRI-_-Technology-Watch-Report.pdf

Sustainable Process Industry through Resource and Energy Efficiency

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Total Resource and Energy Efficiency Management System for Process Industries

Eco-Efficiency and Efficiency integration

Date: 26/02/2018

Sustainable Process Industry through Resource and Energy Efficiency

Total Resource and Energy Efficiency Management System for Process Industries

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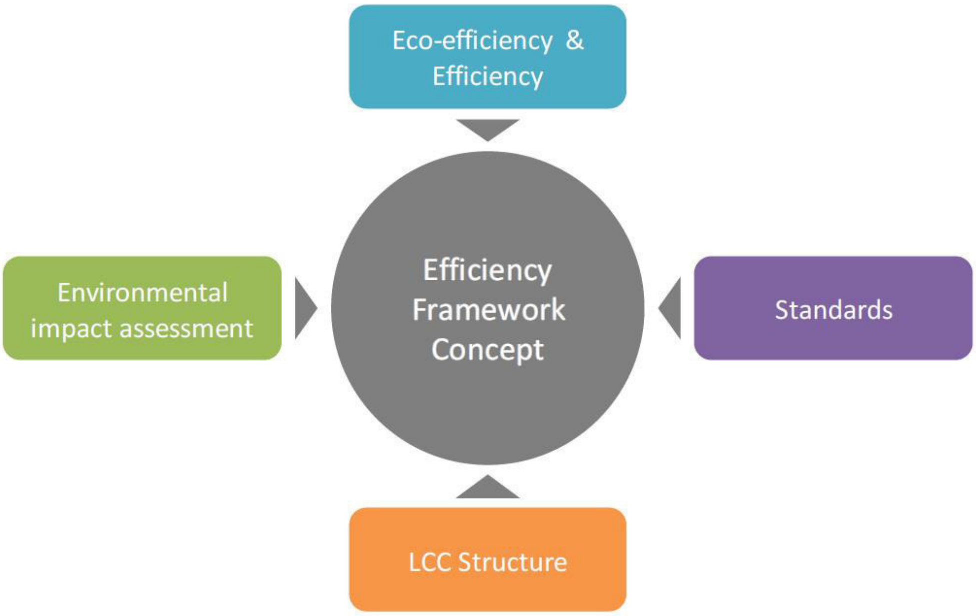
1. *Definition of efficiency framework concept*

The conceptual **MAESTRI's efficiency assessment framework**, consists of four modules, depicted in the figure below, and their integration.



This integration enables an overall efficiency performance assessment from environmental (including resource and energy efficiency), value and cost perspectives. Such integration encompasses Environmental Performance Evaluation with Environmental Influence and Cost/Value assessment models through a life cycle perspective. The aim is to optimize all process elementary flows by clearly assessing resource and energy usage (valuable / wasteful), and each flow efficiency. Decision support via value-adding optimization is foreseen among the integration of the modules.
The modules of the efficiency framework will be outlined in order to ensure a scalable and flexible integration. The main goal of each module is stated as the following:

a) Eco-efficiency & Efficiency
Aiming the integration of two innovative methodologies, namely the Multi-layer Stream Mapping (MSM©) – to assess overall efficiency performance, and Eco-Efficiency Integrated Methodology for Production Systems (ecoPROSYS©) - to assess and evaluate eco-efficiency performance.

b) Standards
To identify the standards / methodologies, currently available, which can support and enhance the efficiency framework.

c) LCC Structure
To define the structure for the LCC analysis, and integrate the LCC structure within the efficiency framework, taking into account Cost and Value modelling, as well as accounting approaches.

d) Environmental Impact Assessment

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Define and incorporate a structure to be used to assess and evaluate the environmental influence of production systems, as part of the efficiency framework.

2. *Eco-efficiency assessment methods and application - ecoPROSYS©*

The Eco-Efficiency Integrated Methodology for Production Systems (ecoPROSYS©) approach relies on the use of a systematized and organized set of indicators easy to understand/analyse, aiming to promote continuous improvement and a more efficient use of resources and energy. The goal is to assess eco-efficiency performance in order to support decision-making and enable the maximization of product / processes value creation and minimization of environmental burdens.
Eco-efficiency, the base concept of ecoPROSYS©, measures the relationship between environmental and economic development of activities as sustainability aspects that evidence more value from lower inputs of material and energy and with reduced emissions. Eco-efficiency is commonly expressed by the ratio between value and environmental influence.

$$Eco - Efficiency = \frac{Production\ or\ Service\ Value}{Environmental\ Influence}$$

According to the WBCSD (Michelsen, et al., 2006) the two most common goals of eco-efficiency assessments are: (i) measuring progress and (ii) internal and external communication of economic and environmental performance. In order to improve overall performance, the WBCSD established seven principles (Lehni, et al., 2000):

- Reduce material intensity;
- Reduce energy intensity;
- Reduce dispersion of toxic substances;
- Enhance recyclability;
- Maximize use of renewable resources;
- Extend product durability;
- Increase service intensity.

From a conceptual point of view, in ecoPROSYS© methodology the indicators are generated by a combination of three components: (1) Environmental performance evaluation (2) Life Cycle Assessment, and (3) Cost and Value Assessment.

3. *Efficiency assessment methods and application: Multi-Layer Stream Mapping - MSM©*

The MSM© - Multi-layer Stream Mapping was developed between 2012 and 2013 at INEGI in order to create a method / tool able to achieve an overall efficiency assessment of production systems. It takes into account the base design elements from the VSM (value streams), in order to identify and quantify all "value adding" and "non-value adding" actions, as well as, all types of waste and inefficiencies along the production system (as in - Arbulu et al. , 2003, Kuhlang et al. , 2011). Therefore, the great similarity to the VSM tool consists in the identification and quantification, at each stage of the process system, of "what adds value"

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and "what does not add value" to a product or service. The basic principle of the MSM© relates to Lean Principles (i.e. clear definition of waste and value dichotomy).

The MSM© - Multi-Layer Stream Mapping approach aims to assess the overall performance of a production system, while evaluating the productivity and efficiency of resource utilization (e.g. energy, raw materials, various consumables, etc.) as well as evaluate the costs related to missuses and inefficiencies and other process and domains variables (e.g. quality aspects, specification metrics, bottlenecks, etc.). Despite the MSM© containing an intrinsic link with the lean tool VSM, this new approach introduces disruptive innovations related with its applicability and wide assessment solutions for complex systems analysis.
The MSM© is intended to be used, not only for analytical evaluation, but also to support the decision making process, namely for greenfield design or online systems monitoring, related with:

• The identification of the most critical resource or process parameters;

• The identification and quantification of inefficiencies of a given production system and unit process;

• The quantification of resource and operational efficiency, and overall production system performance and costs;

• The implementation of improvement actions and optimization actions;

• The evaluation of efficiency progress and to incite for continuous improvement sustainability within organizations.

The MSM© approach is intended to encourage the pursuit of maximum efficiency, (i.e. 100%) and continuous improvement mind-set along teams and workforce.

4. Integration of the ecoPROSYS© and MSM© approaches

The outline of the integration of ecoPROSYS© and MSM© concerns the exchange of information between efficiency and eco-efficiency assessments.

The approach followed to integrate ecoPROSYS© and MSM© is primarily through the combination of the eco-efficiency and efficiency results as opposed to a fusion of results. Such approach enables to obtain efficiency and eco-efficiency stand-alone results to support decisions, in addition to the new integrated results, namely the:

- *Total Efficiency Index*: It is a new metric of MAESTRI which is obtained by integrating results from ecoPROSYS© and MSM©, i.e. combine eco-efficiency KPIs with MSM© efficiency metrics and architecture;
- Environmental and value performance: These results are based on real and target figures;
- Normalized eco-efficiency: combining results from real and target eco-efficiency ratios for each process step of a production system;
- *Effectiveness of accomplishment for each eco-efficiency principle*: It is obtained by the interaction between ecoPROSYS© and MSM©'s efficiency assessment method;
- Environmental influence and costs of the VA and NVA activities: These are obtained by integrating results from ecoPROSYS© and MSM©.

Sustainable Process Industry through Resource and Energy Efficiency

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

5. More information

To know more about the monitoring of performances and efficiency, the MAESTRI project made available the following materials:

>> MAESTRI D2.1 Efficiency Framework concept description

>> MAESTRI D2.2 Methods for Efficiency Framework for resource and energy efficiency description

All reports related to the development of the efficiency framework methodology and its validation ara available here: https://maestri-spire.eu/downloads/technical-materials/

6. Acknowledgements

The current training material represent a reduction of D2.1 and D2.2. Full documents are available here:

D2.1 https://maestri-spire.eu/wp-content/uploads/2016/09/D2.1-MAESTRI-Efficiency-Framework-concept-description.pdf

D2.2 https://maestri-spire.eu/wp-content/uploads/2016/09/D2.2-MAESTRI-Methods-for-Efficiency-Framework_v1.0.pdf

Authors are listed in the respective documents.

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Practical Guide

Developed by Dr Maria Holgado, University of Cambridge

Audience: production managers, environmental managers, waste managers, R&D managers.

Keywords: circular economy, manufacturing, industrial symbiosis, industrial sustainability, resource productivity

User Guide to engage in industrial symbiosis through the T4IS

In this User Guide you will

1 **Learn about the concept of industrial symbiosis**

2 **Understand how to develop an industrial symbiosis project**

3 **Understand how to increase the likelihood of success**

Industrial symbiosis means, in practical terms, the recovery or reuse of secondary outputs from production processes as alternative inputs to other production processes. This happens at the level of production process, thus, the entities involved in the exchanges can be processes within the same factory, processes from different factories belonging to one company or processes from factories belonging to different companies.

One of the main challenges for its wide application is the high degree of contextualisation of the potential symbiotic solutions. In this regard, the appropriateness of the solutions to a certain context is strongly influenced by a set of factors, such as the type of production processes of companies involved in the symbiotic exchange, the geographical landscape and industrialization approach of the region and specific sectorial and / or national regulations and policy.

Within the MAESTRI project, a stepwise process has been developed to support the identification and analysis of potential symbiotic solutions, the Toolkit for Industrial Symbiosis (T4IS). The T4IS constitute a self-guided process to engage in industrial symbiosis and develop symbiotic exchanges. It supports the identification of possible alternative uses for exploitable wastes and their value creation strategies, independently of the business context. Thus, it is framed in a very flexible way, in order to provide support in multiple cases and contexts.

The T4IS seeks to change how companies look at their waste, by considering that everything has potential to have or create value. Thus, the entire T4IS uses the term "waste resource" as an initial attempt to change companies' perception of waste and support the mind-set shift towards seeing waste as a new type of resource for companies. The T4IS guides companies along four steps framed as "How to" questions. A brief overview of these steps is provided herein.

The T4IS - a self-guided process to engage in industrial symbiosis and develop symbiotic exchanges.

How to see waste. A systematic analysis of value captured, destroyed and missed in production processes lays the foundation to identify waste resources. This step results in a comprehensive list of resources within production processes and facilities that can be potentially subject to industrial symbiosis, such as waste streams, secondary outputs and input resources.

How to characterise waste. The previously listed resources, specifically waste streams and secondary outputs, are categorised following a method based on widely known classifications at European level (i.e. EWC, CPA and CAS Registry Number®). This is complemented with operational data to fully understand their nature and remaining properties, such as their chemical and physical characteristics, their substitutability or replacement potential, their hazardous behaviour and the needed mitigation and neutralisation actions.

How to value waste. The valorisation of waste resources (i.e. waste streams and secondary outputs) follows different strategies. This allows further flexibility to understand knowledge gaps related to possible symbiosis opportunities for each waste resource independently. An analysis is proposed based on different information sources in order to figure out: the potential market value of the resource or its separated components; the existence of implemented symbiotic exchanges involving the resource; the possibility to find solutions in the closest company network.

How to exploit waste. Actions to better exploit the valorised resources in the previous step are defined here. This involves identifying and understanding the exchange partner as well as configuring and developing the value creation and delivery system to make the best use out of the waste resources.

The T4IS addresses the need for tools and methods to support self-organised industrial symbiosis. Companies looking at innovating their operations can initiate the process by selecting a production area for analysis. The T4IS supports the definition of opportunities and the analysis of ideas to obtain higher value from the resources within that area. The use of the T4IS is envisaged to need initially some expert facilitation and training from T4IS developers and afterwards companies will be able to use it themselves and integrate the steps in their own innovation processes.

Actions to successfully use the T4IS

Schedule several on-site visits to plant, production areas and shop floor to ensure that all processes are taken into account and details do not get missed.
Dedicate time to select carefully the classification standard to be used for waste and secondary outputs.
Create a multidisciplinary team to work on the T4IS, bringing together expertise on energy and resources efficiency practices, production operations, purchasing and sales operations, business and innovation practices.
Consider the search for symbiotic opportunities as part of the innovation strategy of the company and integrate T4IS activities within company operations for new products / business areas development.

>> More information
MAESTRI Deliverable 4.3 "Toolkit for Industrial Symbiosis", available at: https://maestri-spire.eu/downloads/technical-materials/

>> Website
www.maestri-spire.eu

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Total Resource and Energy Efficiency Management System for Process Industries

Introduction to the MAESTRI Management System

Date: 26/02/2018

Sustainable Process Industry through Resource and Energy Efficiency

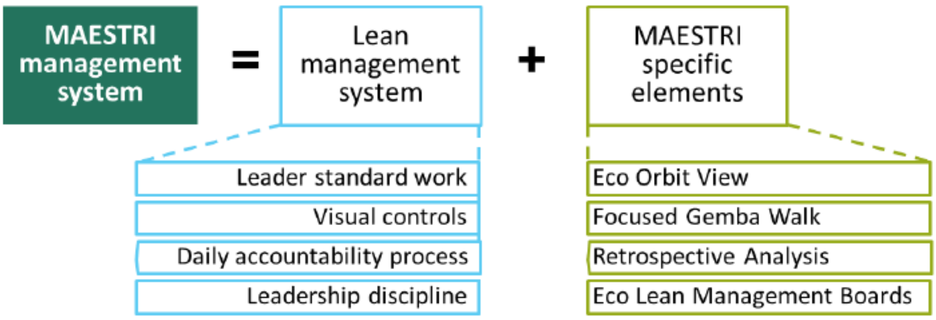
Total Resource and Energy Efficiency Management System for Process Industries

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

1. MAESTRI Management System elements

The MAESTRI project aims to advance the sustainability of European manufacturing and process industries. That will be achieved thanks to developing the MAESTRI Total Efficiency Framework (MTEF), which is a MAESTRI management system in the form of a flexible and scalable platform and methodology.
The MTEF is based on four pillars (Ferrera et al. n.d.):
a) an effective management system targeted at process and continuous improvement;
b) Efficiency assessment tools to support improvements, optimisation strategies and decision support;
c) Industrial Symbiosis paradigm to gain value from waste and energy exchange;
d) an Internet-of-Things infrastructure to support easy integration and data exchange among shop-floor, business systems and tools.

The MAESTRI management system, which is described in this chapter as a one of the pillars supporting MTEF, combines two groups of elements (Figure 1):
a) conventional Lean Management System;
b) MAESTRI specific elements – to meet the requirements caused by specific conditions of process industry, a set of methods and tools has been proposed: Eco Orbit View, Focused Gemba Walk, Retrospective Analysis, Eco Lean Management Boards.



2. MAESTRI specific elements of the management system

There are two main types of production process in manufacturing industry: continuous process (process industry) and discrete process (mechanical manufacturing). Continuous process is a process with continuity of introducing raw material to the environment of transformation and withdrawing completed product. Industry sectors that can be classified as continuous processes are: chemicals, synthetic fibres, oil refining, pulp, paper, natural gas processing, continuous casting of steel, synthetic fibres etc. Processes with individual or separate unit production like automobiles, furniture or toys are called discrete processes. These type of processes characterize by individual or separate unit production.

The main difference between process industry and mechanical manufacturing is the way of raw material transformation. In process industry raw material experiences a transformational change as it becomes a product, opposed to a reconfiguration change in mechanical manufacturing. Another significant difference between process industry and mechanical manufacturing is the manner in which the process of transformation occurs. In discreet manufacturing the changes that occur in the raw material so that it becomes a finished

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product are achieved by applying a direct touch either personally by operators (like in assembly) or by some tools or devices (e.g. cutting tool). On the contrary, in the process industries the raw material changes itself by applying the proper environment conditions.

The differences mentioned above cause that both types of manufacturing processes require different approaches to process improvement as well as Lean Manufacturing implementation and face different types of difficulties as well.

Generally continuous processes are more capital-intensive. That results from the higher dependence on machinery and equipment both in terms of the production process organisation and of implementing improvements. Improving availability of finished goods, flexibility and product quality can be achieved rather by mitigating machine problems than by improving operators' work by implementing such Lean Management techniques like e.g. 5S and workstation organisation.
Discrete processes are more labour intensive due to the fact that operators generate most added value to the process. Effective improvements focus on standardization of operators' work for example by 5S which makes better results and has a wider range of application than in the continuous processes.

To provide relevant solutions to the specific conditions of process industries, the following methods and tools have been proposed:

1) Eco Orbit View

Eco Orbit View (EOV) is a simple method intended to indicate areas in the production process where the company should focus the improvement activities in order to get simultaneous improvement of business and environmental performance.

The Eco Orbit View analysis is performed in 5 steps:

1. Identification of production process steps (for a selected product family)
2. Identification of Key Performance Indicators (KPIs) relevant for each process step
3. Identification of Key Environmental Performance Indicators (KEPIs) or Environmental Aspects relevant for each process step
4. Identification links and synergies between KPIs and KEPIs
5. Prioritisation of improvement ideas, selection of the potential improvement areas

In summary, the Eco Orbit View shows KPIs (reflecting company needs) and KEPIs or environmental aspects (reflecting environmental needs) side by side for chosen process steps. The analysis results in the indication of potential improvement areas, reflecting the needs of the company to improve both the economic and environmental performance. Thus, the areas where the eco-efficiency of the company may be improved can be identified.

2) Focused Gemba Walk

Focused Gemba Walk is a method for a very quick analysis focused on a potential improvement area identified during an Eco Orbit View analysis. The result of this analysis should be low-cost organisational (process) improvement ideas, which could be implemented within a few following weeks.

Focused Gemba Walk is based on the Go-See-Act approach.

1. Go - go to the place where the problem occurs.
2. See - observe the process from 6 perspectives: Method; Man; Machine; Material; Measurement; Environment

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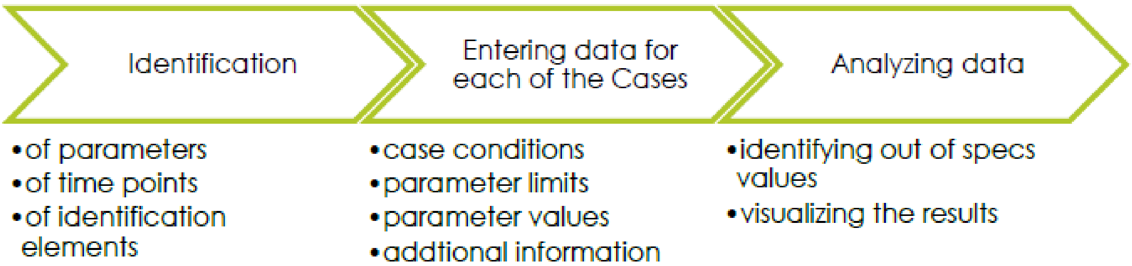
3. Act - based on step 2 find the root cause of the problem (usually related to one or few of the 6 analysed perspectives) and identify low cost organisational (process) improvements to implement.
The result of Focused Gemba Walk is a list of low cost improvement ideas that could be implemented.

3) Retrospective Analysis

The main aim of the Retrospective Analysis is to find root causes of a problem quickly, without the need for an extensive data collection over a long period (like in statistic-based methods).

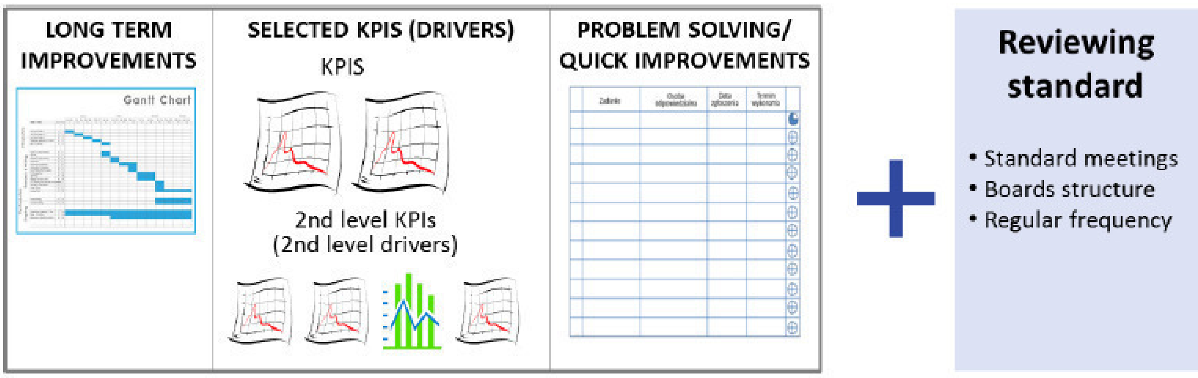
The Retrospective Analysis consists of three steps:



The outputs of Retrospective Analysis are identified root causes of a problem. After root causes being identified, an organization may undertake actions to eliminate those root causes and in that way eliminate or at least mitigate the problem.

4) Eco Lean Management Boards

Eco Lean Management Board is one of the practical means for implementing the visual control element of a Lean Management system.
In order to get the best benefits from managements boards the routines of regular reviews should be established. Review routine is a clear standards of structured regular meeting defining who, when, how often and in which way should review the indicators presented on the management board. From that meetings the list of actions should origin, which then in turn are reviewed during the next regular meeting. In that way a daily accountability process is built in the company, which is one of Lean management system elements.



The aim of introducing Eco Lean Management Boards to the company is to:

- Link daily operation with the most important improvement projects resulting from the company strategy

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- Provide enough resources for improvement activities on every level of the organisation
- Embed eco performance into improvement activities
- Build a culture of continuous improvement and leadership discipline.

3. More information

To know more about the monitoring of performances and efficiency, the MAESTRI project made available the following materials:

>> MAESTRI D3.2 Management System Framework for Continuous Improvement in Process Industries

All reports related to the development of the efficiency framework methodology and its validation ara available here: https://maestri-spire.eu/downloads/technical-materials/

4. Acknowledgements

The current training material represent a reduction of D3.2. Full documents is available here:

D3.2 https://maestri-spire.eu/wp-content/uploads/2016/09/D3.2_MAESTRI_Mngt-System-Framework-for-CI-in-Process-Industries_v1.0.pdf

Authors are listed in the linked document.

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Total Resource and Energy Efficiency
Management System for Process Industries

Training modules

Eco Orbit View

Date: 07/02/2018

Sustainable Process Industry through
Resource and Energy Efficiency

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

Eco Orbit View Workshop

1. Workshop purpose

Eco Orbit View is a method of quick analysis of production process in order to understand the current status of main challenges in the organization - both those perceived as typical business and those ecological one. During the workshop, participants identify the link between these elements and indicate how they are eliminated or reduced. What is important - the method assumes loss reduction through low-cost improvements and the fact that they are easy and quick to implement, while giving visible benefits to management and employees. Workshop participants choose the stage of the process or an area in the company where an improvements implementation will bring the best benefits both from environmental and business perspective. The method is being developed in the scope of MAESTRI project founded by European Commission.

2. What are the benefits of the workshop

- Increase awareness about issues and problems in the production process
- Analyse production process in order to establish business and environmental challenges and indicators as well
- Get knowledge of synergy between environmental and business aspects
- Identify potential improvement projects
- Increase company performance through implementation of selected projects

3. What will happen during workshop

The analysis is performed in 5 steps:

1. Identification of product family
2. Identification of process steps (simplified process map)
3. Defining Key Performance Indicators (KPIs) and Key Business Challenges for each process step
4. Defining Eco Indicators or Environmental Aspects of each process step
5. Set the priorities of defined aspects through selection matrix
6. Identify links between KPIs and Key Environmental Performance Indicators
7. Selection of areas for improvement

4. How to prepare for the workshop?

What we need is an initial **REFLECTION** of all participants about the current state of the actual process.

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All participants are kindly asked to think about following questions and prepare information needed:

1. Do you use KPIs and/or Key Environmental Performance Indicators in your company and it is possible to extract it easily during the workshop?
2. Do you have ISO 14001 standard completely implemented in your company?
3. Do you have Key Environmental Performance Indicators that stem from ISO 14001 standard?
4. How often do you verify the indicators?
5. Is it possible to have an insight into environmental indicators results from last six months?
6. Which family or families of products are the most significant from production volumes point of view? (Product family is a group of products passing through similar processing steps and common equipment just prior to shipment to the customer).
7. Which Performance Indicators are used by production managers in the areas of Delivery, Cost, Productivity, Quality, Safety? Which are the most important?

5. *Required participants*

For EOV workshop a selected group of company representatives is required. Because in different companies, names of positions have different meanings, we have defined roles that should be represented during the workshop:

- manager/leader responsible directly for the selected pilot area (an expert in the manufacturing process and KPI's related to that process)
- managers/leaders from the supporting processes - maintenance, internal logistics, etc. (in order to provide information about their KPI's related to the observed process)
- high-mid level manager responsible for a broader area than the pilot area – plant manager for example (to help to understand the strategic challenges and evaluate the business metrics and their significance)
- person responsible for the implementation of ISO14000 standard (especially for the elaboration of environmental aspects
- person responsible for improvement initiatives (e.g. continuous improvement coordinator)

6. *What are the next actions after workshop*

1. Eco A3 reports, resource consumption study
2. Implementation of selected lean tools and methods
3. Improvements implementation.

Implementation of selected lean tools is carried out with the support of LEIP. Supporting methods are adapted to the company needs.

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Total Resource and Energy Efficiency Management System for Process Industries

Training modules

Eco Lean Management Board

Date: 07/02/2018

SPIRE Sustainable Process Industry through Resource and Energy Efficiency

MAESTRI Total Resource and Energy Efficiency Management System for Process Industries

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

Eco Lean Management Board Workshop

1. Workshop purpose

Eco Lean Management Boards are tools (boards) to track and monitor factory/area performance. They are used by factory teams during regular operational meetings (short standardized reviews).

In order to design the board Key Performance Indicators (KPIs) have to be defined in the cascading process called Hoshin Kanri. KPIs have to be adopted to the current situation of the factory to reflect its problems and challenges. Through the KPIs monitoring the factory needs to take corrective and preventive actions, which should impact the KPIs. Eco Lean Management Boards underline the importance of boosting eco-efficiency.

The workshop consists of two main parts. The first one is dedicated Hoshin Kanri to define the right KPIs for selected area. The second part will be focused on Eco Lean Management Boards – how to design and use them.

2. What are the benefits from the workshop

- Suitable KPIs which reflect factory/area problems and challenges
- Visualization of current situation in the pilot area
- Alignment between different levels of organization and different functions for selected area
- Prototype of management board to monitor KPIs
- New management process to track the pilot area performance – operational meetings

3. What will happend during workshop

1. Verification and update of the Eco Orbit View Map
2. Defining organization level covered by management board
3. Cascading KPIs coming from Eco Orbit View Map
4. Defining KPIs tracked on selected level
5. Setting yearly and monthly targets for selected area
6. Identification of key elements of management board
7. Preparing visualization of KPIs for selected measures
8. Building a prototype of Eco Lean Management Board
9. Setting the rules of operational meetings
10. Perform operational meeting based on movies and factory data and facts

4. How to prepare for the workshop?

We need initial **REFLECTION** of all participants about the current state of the process:

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a. Do KPIs drive effective actions?
b. How your daily activities influence KPIs?
c. How communication flows looks like just now? What are you doing with information gathered during the whole day?

Before workshop we ask you to **PREPARE** following **DATA** and **INFORMATION**:

d. Define the pilot area
e. Define main challenges in the pilot area
f. What is the frequency of KPIs monitoring (if relevant)?
g. Yearly and monthly (if relevant) targets of main KPI
h. What kind of daily tasks have direct impact on the main indicators - especially in the pilot area?
i. What information/ topics/ KPIs would you need to exchange between shifts or days?

Data, facts and information from last day before workshop about production process in the pilot area – productivity, quality, safety, problems, key information?

5. *Required participants*

For Eco Lean Management Board workshop a selected group of company representatives is required.

IMPORTANT! Selection of the desired group depends on the organizational level which will be covered by management board. Because in different companies, names of positions have different meanings, we have defined roles that should be represented during the workshop:

- employees direct responsible for using the management boards – ex operators, mechanics, programmers, warehouse operators, etc.
- leader/manager responsible directly for the selected process (an expert in manufacturing process and KPI's related to that process),
- leaders of supporting processes – for example: maintenance, internal logistics, technologist, process engineer, etc. (in order to provide information about their KPI's related to the observed process)
- a person responsible for improvement initiatives (e.g. continuous improvement coordinator),

6. *What are the next actions after workshop*

- Refine the final version of Eco Lean Management Board
- Start using the management board
- Perform 1day follow up – how to use management board in the efficient way, how verify correlation between indicators on different level, etc.
- Assess quality and effectiveness of operational meeting

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Total Resource and Energy Efficiency
Management System for Process Industries

Training modules

Problem solving

Date: 09/02/2018

Sustainable Process Industry through
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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

Problem Solving Workshop

1. Workshop purpose

Problem solving approach is a key method which allows the company to achieve better results through the focusing on the particular problems and solving them effectively. The purpose of the workshop is to teach an employee how to solve problems in a methodological way. In order to do it – employees need to know what type of problems they have in a production process and what kind of tools they might use in a most efficient manner.

2. What are the benefits of the workshop

- Increase awareness of what type of waste occurs in the organization and the ability to recognize them
- Build knowledge how to adopt relevant problem solving tools to different scope and range of problems
- Develop skills of problem solving by using in practice: Pareto diagram, Ishikawa diagram, 5 Why method, etc.
- Reduce "firefighting" approach
- Improve stability of the production processes
- Improve production processes performance and factory results

3. What will happen during workshop

1. Wastes and problems definition and examples
2. "Firefighting" vs problem solving approach
3. Role of management in the problem solving approach
4. Presentation of problem solving process – steps, structure, important elements
5. Presentation problem solving tools: Pareto diagram, Ishikawa diagram, 5 Why method
6. Presentation A3 form to problem solving – structure and examples
7. Discussion how to spread and sustain knowledge coming from the problem solving methodology
8. Work in group to solve company real problems by using problem solving tools
9. Presentation of the problem solving analyses and proposals of action plans

4. How to prepare for the workshop?

We need initial **REFLECTION** of all participants about the current state of the process:

a. How do you identify problems?
b. How do you solve the problems?
c. How do you know that the problems were eliminated or limited effectively? Is it visible in the factory results?

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d. What is the role of employees and management team in the problem solving approach?

Before workshop we ask you to **PREPARE** following **DATA** and **INFORMATION**:

e. Select two or three factory problems. Please note, that selected problems have to be dependent on the factory. Additionally those problems have to be important for company but not to complicated. The purpose of the workshop is to learn the problem solving methodology. Too much complex problem cause that workshop team will not be able complete the analyses till the end of workshop.
f. Prepare a list of indicators that are monitored in the area where the problems will be solved.
g. Take into account that actions defined in the problem solving analyses may require additional resources (time and money). Please, have in mind those resources to ensure effectiveness of problem solving.

5. Required participants

For Problem solving workshop a selected group of company representatives is required. Because in different companies, names of positions have different meanings, we have defined roles that should be represented during the workshop:

- a production leader and team leader responsible directly for the selected process
- operators from the selected process
- leaders or engineers/specialists from supporting processes – for example: maintenance, quality, internal logistics, technologist, process engineer, etc.
- a person responsible for improvement initiatives (e.g. continuous improvement coordinator),

others e.g: programmers, designers etc. – according to company needs

6. What are the next actions after workshop

1. Implementation of action plans defined during workshop
2. Use problem solving method to solve three company problems
3. Assess effectiveness of the solutions based on the monitoring of selected indicators

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Total Resource and Energy Efficiency
Management System for Process Industries

Training modules

Reflection Process Workshop

Date: 28/02/2018

Sustainable Process Industry through Resource and Energy Efficiency

Total Resource and Energy Efficiency Management System for Process Industries

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

Reflection Process Workshop

1. Workshop purpose

The purpose of the workshop is to make reflection by industrial partners about the implementation of Effective Management System elements. Reflection mechanism should help the organization to improve their Management System and show what and how should be done differently.

2. What are the benefits of the workshop

- Increase awareness about continuous improvement of Management System
- Increase awareness about the limitation of the processes.
- Establish actions regarding the improvement of the Management System processes.

3. What will happen during the workshop

1. Presentation of Reflection Process mechanism.
2. Analyse of the chosen Management System processes.
3. Definition of the advantages and improvement opportunities.
4. Setting of improvement action plan.

4. How to prepare for the workshop?

<u>We need initial **REFLECTION** of all participants about the current state of the process:</u>

a. What do you think about the implementation and realization of Management System processes?
b. Which elements of the Management System are working well, which need to be improved and why?
c. What is your vision regarding Management System?

5. Required participants

For Reflection Process workshop a selected group of company representatives is required. Because in different companies, names of positions have different meanings, we have defined roles that should be represented during the workshop:

- A factory manager or his representative
- Leaders responsible for implementation selected Management System processes

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- Employees involved in the implementation and working on Management System processes.
- The person responsible for company Management system (if relevant)
- Others interested parties according to company needs

6. What are the next actions after the workshop

1. Implementation of action plans defined during the workshop
2. Make reflection mechanism in a defined time period as a constant process of the Management System

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Total Resource and Energy Efficiency
Management System for Process Industries

Monitoring procedure

Date: 26/02/2018

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Definition of efficiency framework concept Monitoring process of Effective Management System

Purpose of the monitoring process

Lean methods implemented inside companies are one of the way to improve company performance. To find out whether the situation inside the company has improved or not, it is necessary to implement monitoring system. The assumption of the system is to define success factors that show whether the project brings the expected results or not. In practice, the results of chosen factors are compared at the beginning and at the end of the project. Additionally, the project is monitoring across throughout the duration, in order to track current state and to be able to take corrective actions.

Selection of the success factors

Selection of the success factors for Management System is a complex process. Making a choice, several factors have to be taken into account:

- Success factors should to be defined based on Eco Orbit View Map where the current state (baseline) for Management System of the company is established.
- The method of calculating the results for selected success factors should be determined at the beginning and unchangeable during the project because only then the results can be comparable. the same at the beginning and at the end of the project. This method should be adapted to the factory calculation system.
- Success factors have to be in line with the project's goals and reflect the main benefits of the project.
- Success factors have to be measurable. It is necessary to define the baseline and the target level. If success factors are qualitative – it is recommended to estimate quantitative equivalent.
- Success factors must be able to be monitored throughout the whole of the project.

Taking into the account above aspects, the exemplary success factors were selected:

a) Implement 1 Eco Lean Management Board + operational meeting
b) Improve quality of the operational meeting
c) Number of implemented actions in order to improve performance in selected area
d) Improve Continuous Improvement Culture
e) Improve selected indicators
f) Implement new Problem Solving procedure

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Monitoring procedure

Monitoring procedure is a set of rules that help you track changes and follow a proper direction of improvements implementation. Methods and frequency of monitoring have to be adapted to the following criteria:

1. The type of success factor. Stretch-target success factors should be monitored more often.
2. The ability to observe the impact of actions taken to improve the results in the particular time horizon. If the actions are able to improve results in one week – the success factors should be monitored weekly. If the actions taken require more time to execute better results – the success factors should be monitored less frequently
3. Communication channels between industrial and research partners. It is necessary to take into account ability to visit industrial partners, contacts by e-mails and phone.

Considering the above, the following monitoring procedure for MCG was set:

Table 1. Example of monitoring procedure

Success factors	Baseline	Target	Status	How MCG monitor the progress?	How LEI monitor the progress?	Frequency
Implement 1 Eco Lean Management Board + Reviews	Confidential	Confidential	o	Observation of operational meeting and assessment How many operational meetings were performed according to schedule?	Teleconference	Weekly
					Visit	Quarterly
Quality of the operational meeting	Confidential	Confidential	o	Based on the checklist	Teleconference	Weekly
					Visit and assessment done by checklist	Monthly/quarterly
Improve indicators	Confidential	Confidential	o	Based on internal software	Discussion by teleconference documented in Excel file	Weekly
	Confidential	Confidential	o	Based on internal software		Weekly
Number of implemented actions in	Confidential	Confidential	o	Based on the improveme	Teleconference	Monthly

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order to improve performance in selected area				nt list		
Improve Continuous Improvement Culture	Confidential	Confidential	o	Based on the survey performed across operators	Teleconference and visit	Quarterly
Implement Problem Solving	Confidential	Confidential	o	Based on the number of resolved problems	Teleconference and visit	Weekly

Execution of the procedure should ensure that the project will be performed in a proper way, according to the schedule and will give a high probability of achieving the set goals.

Monitoring methods

Eco Lean **Management Board**

Completed Eco Lean Management Board it is the board located in a selected area, it contains relevant indicators and information. It is used by operators in a defined frequency (shiftly or daily). The indicators are selected based on Eco Orbit View Map and company needs. There is an action plan on the board and this is used to cover troubles and challenges presented at the operational meeting.

Quality of the operational meeting.

Quality of the operational meeting is assessed by selected and trained person based on assessment form. Those form (see figure 2) consist of 18 questions regarding rules and routines of the operational meeting. Each question is assessed according to the range:

0 – the rule was not met
1 – the rule was met partially
2 – the rule was met completely

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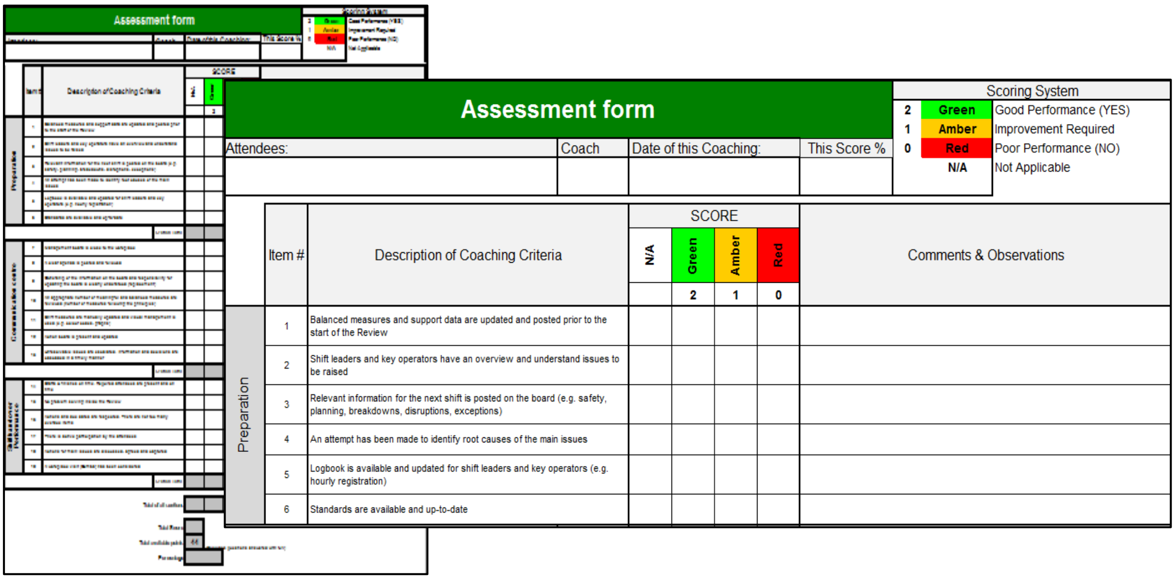

Assessment form

Attendees:	Coach	Date of this Coaching:	This Score %

Scoring System

2	Green	Good Performance (YES)
1	Amber	Improvement Required
0	Red	Poor Performance (NO)
	N/A	Not Applicable

	Item #	Description of Coaching Criteria	N/A	Green 2	Amber 1	Red 0	Comments & Observations
Preparation	1	Balanced measures and support data are updated and posted prior to the start of the Review					
	2	Shift leaders and key operators have an overview and understand issues to be raised					
	3	Relevant information for the next shift is posted on the board (e.g. safety, planning, breakdowns, disruptions, exceptions)					
	4	An attempt has been made to identify root causes of the main issues					
	5	Logbook is available and updated for shift leaders and key operators (e.g. hourly registration)					
	6	Standards are available and up-to-date					

The total result is expressed by percentages value as a compliance with assessment form. It is assumed that a 70% is a targeted result.

A number of actions implemented in order to improve area performance.

Several actions are defined during the realization of each workshop and follow up visit. They lead to low cost improvement of the company performance. Monitoring of these actions is telling how many effort was taken by the company to achieve assumed result. The list of actions and the status is monitored weekly through the teleconference.

Continuous Improvement Culture

Assessment and measuring of the Continuous Improvement Culture is performed by survey among the operators. The survey consists of 24 questions (Figure 2) related to the management board's design, the operational meeting's rules and routines, operator's behaviours and habits.

Each question is assessed according to the range:

0 – the rule was not met
1 – the rule was met partially
2 – the rule was met completely

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SURVEY OF CONTINUOUS IMPROVEMENT CULTURE		
Questions	**Answers**	**Score**
How the operation meeting run – what do you feel		
What was the best and the worst element		
How do you know about priorities for this day		
How do you know about the most important information?		
What is the sequence of the operational meeting?		
What do you think about your measures?		
How the measures was improved? How do you track it?		
If you have problem – what do you do?		
What was the starting point for your management board? (strategy)		
Which indicators are environmental.		
Which indicators are the most important for you		
Who is the owner of the management board?		
Who is responsible for the management board? Who can change the content of management board?		
How do you reflect reality in a board? Do you have standards?		
How the communication flow looks like?		
How do you communicate important information to the management		
How do you train the rest people about operational meeting		
What changed since the operational meetings were introduced?		
Who and how often support you. What was the last recommendation?		
What is the purpose of the operational meeting		
What advantage do you expect?		
How are you going to achieve the advantages What the problems with operational meeting did you have		
What the success of operational meeting do you have		
If somebody ask you about tips – how to implement OM effectively – what do you can say?		
If you could change anythink on your board – what it would be?		
What happened if your indicators will be still above the target?		
What was changed since the first operational meeting board was created.		
How often do you have your operational meetings?		
What happened if you have technical problem during operational meeting? (stop the meeting, phone etc.		
What do you do if somebody is delay or missing?		
What do you do if somebody is not prepared		
What do you do if somebody did not his action plan		
How do you split responsibilities for the actions		

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