| |
|---|
| Programme |
| Factory of the Future PPP |
| Strategic Objective |
| Objective ICT-2010-10 Smart Factories: ICT for agile and environmentally friendly manufacturing |
| Support Action / Project Title |
| **European Forum for ICT in Factories of the Future** |
| Acronym |
| **ActionPlanT** |
| Project No |
| 258617 |
| Industrial Learning – Developing Competence and Competitiveness |
| WP4 |

# Deliverable D4.2: Training Material for Selected Topics of the Curriculum

Leading Partner: IPK

Contributing partners: EPFL, POLIMI

Security Classification: PUBLIC

28 February 2011
Version 1.02

## Versioning and contribution history

| Version | Description | Comments |
|---|---|---|
| 0.3 | First Version | Thomas Knothe |
| 0.5 | Improvement according to D4.1 and D6.3 and Evaluation Criteria | Thomas Knothe |
| 0.6 | Integrate Step 6 | Thomas Knothe |
| 0.9 | Integration of Step 3 and 4, integration of curricula | Dimitris Kiritsis, Thomas Knothe |
| 0.91 | Integration of Content for Chapter 3 | Dimitris Mavrikios |
| 0.92 | Improvement of Table2 | Ahmed Bufardi |
| 0.93 | Improvement according to review. | Chris Decubber, Anirban Majumdar, Sonja Goceva |
| 1.01 | Take into account reviewer's comments. Improvement of learning topics by integration of ILPE courses "InTime" and "PLM Advantages" in chapter 6.2.11,/12 as well as rationalizing topics in 4.4 and 4.5 | Jacopo Cassina, Thomas Knothe |
| 1.02 | Improvement according to feedback from Anirban Majumar and Dimitris Mavrikios, especially regarding questionnaire | Dimitris Mavrikios, Anirban Majumdar, Thomas Knothe |

## Table of contents

# 1 Preamble – Introduction

This Deliverable describes the intended structure of modules, the content of training material and the target audiences for industrial learning pilots. These pilots will be validated along the road-mapping workshops in 2011 and 2012.

The module structure instantiates the methodology for industrial learning as defined in deliverable D4.1. A set of pilots will be defined according to a typology of possible learning configurations based on the key aspects: “Processes”, “Target audience”, FoF Types and Industrial Learning Types. Finally the planned courses to be executed in Industrial Learning Pilot Events (ILPE) along the ActionPlanT workshops will be described in a curriculum and factors of validation will be assigned.

## 2 Management Summary

The dynamics of the production environment driven from customer's requirements, technological enhancements, and production re-organization foster the continuous learning processes and education Factories of the Future. Furthermore, the demographic changes and other social and organizational changes are fostering the need for and learning process for radical improvements of the industrial learning contexts and methods. The ActionPlanT Project has identified this need and has the objective to implement an innovative Industrial Learning (IL) in order to:

1. Make aware the achievements of recent ICT and the potential of actual and future research in ICT for the FoF.
2. Validate new learning schemes according to the future needs for knowledge and skills
3. Identify needs for future research regarding industrial learning.

During the ActionPlanT Project, the IL implementation will be executed through Industrial Learning Piloting Events (ILPE) as instances of the comprehensive industrial learning model, proposed in deliverable D4.1. The major goals for the ILPE are: faster competence improvement, focussing on knowledge and skills and increase in attitude.

The entire Industrial Learning model will be validated using eleven selected pilots. This will be performed according to the following procedure:

- Identification of target groups
- Definition of Learning needs and target groups
- Analysis and classification of learning needs
- Identification of learning content
- Identification of ILPE and delivery mechanisms

The valuation of the Industrial Learning model will be applied to pre-selected target groups. The target groups are representing eight typical roles of industrial knowledge workers executing thirteen major activities along the entire product life cycle. Twelve learning topics, from embedded information devices to semantic technologies, are derived from the core components of the FoF paradigm (smart, digital and virtual). ILPE's will be conducted in connection with the ActionPlanT workshops and through a summer school in 2012 (see schedule in deliverable 6.3).

Finally, the curricula of all learning modules are described as well as all aspects of the learning instruments to be used. This document is the basis for the detailed operational planning of each learning module. The complete ILPE will be finalized in WP4.3 and WP4.4.

# 3 Objectives for Industrial Learning

## 3.1 Challenges for industrial learning in Europe

Nowadays, manufacturing education addresses some of the major challenges concerning the industrial learning and training aspects.

New skills are required by the future generations of "knowledge workers". To that direction, an adaptation of the educational content and its delivery mechanisms to the new requirements of knowledge-based manufacturing is required. Manufacturing education should care about the provision of integrated engineering competencies and strong multi-disciplinary background. Manufacturing strategy with focus on digital business, extended production and virtual enterprises should be greatly considered. On the other hand, there is a growing need for expanding the technological aspect of education, with an extension to the 'soft skills'. On top of that, within a global environment, there is a need that key manufacturing oriented actors, such as human resources and knowledge / information, become more international.

Engineers and blue-collar workers need new life-long learning schemes to assist them in keeping up with the pace of change. The rapid advancements in manufacturing technology and ICT necessitate a continuous update of the knowledge content and delivery schemes for manufacturing education. The comprehension of the technical essence and of the business potential of new knowledge / technology is essential for its smooth adaptation and integration into the industrial working practice.

European manufacturing has been generally addressing significant challenges with respect to innovation, *suffering from a weak innovation activity*. The EU does not suffer from a lack of new ideas, but is not so good at transforming these into new products and processes. European enterprises consider the lack of qualified personnel and the lack of information on technology as being the major knowledge related factors hampering innovation today [1]. Thus, modern concepts of training, novel industrial learning and knowledge transfer schemes can have a significant impact on the ICT related innovation performance of the European Factories of the Future.

The development of educational curricula has not kept pace with the growing complexity of industry, technology and economy. Moreover, research outcomes of educational institutions are typically presented to the scientific community without having been directly accessible to industry. Within this context, it is difficult for industry to comprehend and to adapt to the technological advances in a direct way. Thus, promoting a novel integrated approach of education, research and technology transfer emerges as a key challenge.

## 3.2 ActionPlanT objective

The ActionPlanT objective for Industrial Learning is to create awareness and transfer state-of-the-art knowledge and perspectives about the benefits of ICT as an enabler for the efficient and sustainable Factories of the Future and the development of required new sustainable business models.

ActionPlanT will implement Industrial Learning on ICT for FoF along the following two dimensions:

- Inform, make aware & disseminate to selected industrial sectors about (i) the achievements of recent ICT for the FoF and (ii) the potential of actual and future research in ICT.
- Inform & make aware selected societal stakeholders about the importance of ICT applications in Industry for sustainability and quality of life.

The steps of implementing the ActionPlanT concept of Industrial Learning on ICT for FoF are as follows:

- Create a community of partners (relevant FP7 & FP6 projects, FP7 clusters, IMS projects, ETPs, Industries, Industrial Associations, Societal Stakeholders)
- Collect good practices, cases & innovative solutions from industry, prototypes, demonstrators & scenarios from research projects and academia

- Define categories of Audience and associated learning objectives
- Specify learning concept with respect to content, material & methodology for webinars, seminars, and workshops.
- Validate these methodologies

As already described in D-4.1, the project will aim at applying an industrial learning model / methodology focusing on four major building blocks of the learning process:

- *Attitude*. The aim is to raise awareness on new ICTs, attract the interest of the engineers and workers to the respective research advances, and eliminate their possible concerns and/or negative view to "change".
- *Knowledge*. The aim is to depict new ICT knowledge created by R&D projects, organize and classify the knowledge in a way being close to industrial practices and way of thinking, provide access to this knowledge,
- *Skills*. The aim is to support the comprehension and use of new ICT knowledge through training. Training for skills development will include "realistic" conditions, trial & error approaches and hands-on practice
- *Competence*. The aim is to address training needs for a systematic, but also visionary, use and exploitation of knowledge and skills for innovating industrial products and processes, e.g. understanding of opportunities, combining different pieces of new knowledge and developed skills to solve problems etc.

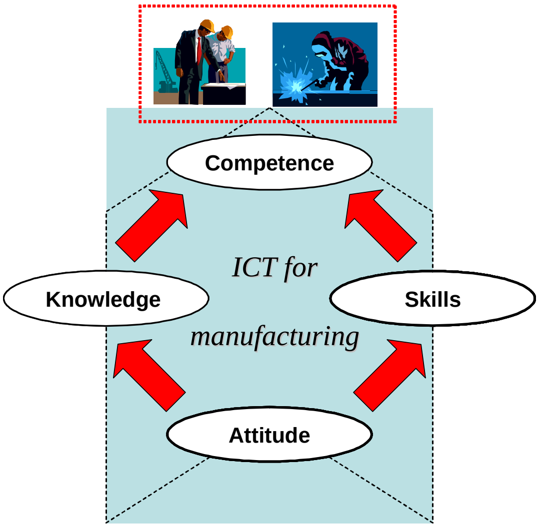



**Figure 1 Building blocks of the learning process to be addressed by the ActionPlanT industrial learning model / methodology**

The industrial learning model / methodology of ActionPlanT will be based on the Teaching Factory concept. It will:

- help define in easily perceived ways the business potential of the new knowledge developed in research projects (i.e. focus on *attitude*)
- facilitate the comprehension of the technical essence of new knowledge developed in research projects (i.e. focus on *knowledge* and *skills*)
- identify practical approaches for the integration of new knowledge developed in research projects into the industrial working practices and products (i.e. focus on *competence*)

The application / validation of the industrial learning model / methodology will be carried out in the context of a series of Industrial Learning Pilot Events (ILPEs). ILPEs will address a number of indicative, but also representative, knowledge topics on ICT for manufacturing, addressing appropriately all four major building blocks of the learning process. Indicative means to be employed in the context of the ILPTEs in order to address these building blocks would include

- *Attitude:* demonstration of case studies / success stories, analysing the impact of the new knowledge, e.g. economic impact / business potential, societal impact / work conditions, environmental impact, etc.
- *Knowledge transfer:* seminar-based theme presentations, access to ontologies and digital libraries and use of semantic-based search capabilities, etc.
- *Skills development:* use of Computer Based Training (CBT) tools, interactive VR-based simulation environments, single & multiple user (collaborative) web-based platforms, simulation engines, etc.
- *Competence development:* study of best practices, “manufacturing games” sessions, game-based collaboration and group decision-making scenarios, training on learning factories, demonstrations on existing living labs, etc.

# 4 ActionPlanT ILPE Definition model implementation

In deliverable D4.1, an industrial learning model was defined. In this document, major steps for the instantiation of this learning model in piloting events will be carried out in an adapted way (see yellow bars in Figure 2). The adaptation is related to Step 4, Step 5 and Step 6. In this document, in Step 4, the learning content will only be identified and the full definition will be performed in work package 4.3. Potential trainers are already identified. Therefore the Step 5 "Identification of trainers" is not required for the pilots. In Step 6, the ILPE will be identified according to the already scheduled ActionPlanT workshops.

Step 1 Identification of target groups
Step 2 Definition of learning needs of target groups
Step 3 Analysis and classification of learning needs
Step 4 Definition of learning content
Step 5 Identification of trainers
Step 6 Definition of IL action type and delivery mechanisms
Step 7 Development of delivery material
Step 8 Follow up and evaluation

**Figure 2 Relevant steps of the generic ILPE model**

The other Step 7, "Development of Training Material" will be executed in the work package 4.3.

## 4.1 Step 1: identification of target groups

The aim of this step is to identify who will benefit from the training program on ICT in manufacturing to be developed in ActionPlanT. The criteria are adapted from the generic model defined in D4.1.

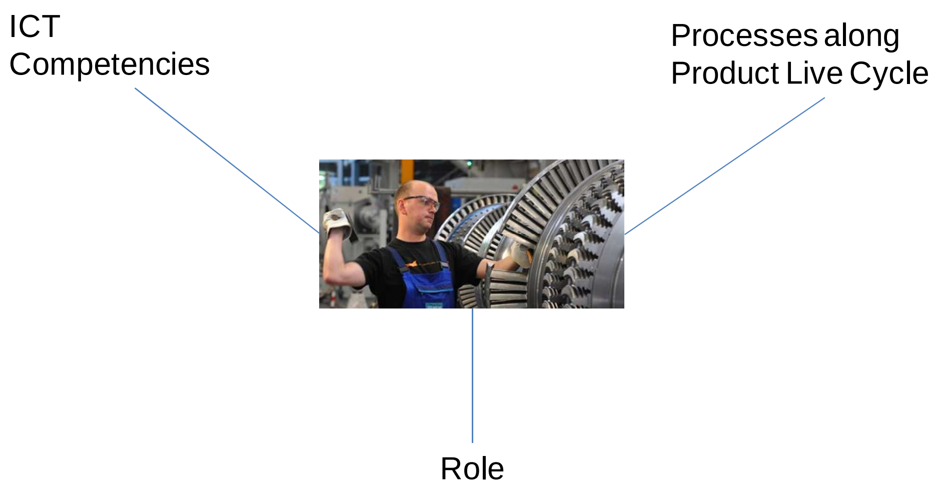



**Figure 3 Criteria or identification of target groups**

### *4.1.1 Role*

ICT in manufacturing is a cross-over activity and affects nowadays almost all roles in manufacturing companies. The most important roles are listed hereafter:

- o *Knowledge Worker* performs production steps, through job enrichment increase of responsibility

- *Product Designer* defines functional, parametric, quality, geometry and material properties of a product.
- *Factory Planner* develops the configuration of product facilities, logistics and machinery layouts as well as the infrastructure and utilities
- *Technology Planner* identifies and combines manufacturing technologies and their parameters (e.g. drilling with eight indexable inserts )
- *ICT Developer* designs, installs and tests SW/HW-Systems related to manufacturing
- *Production Controller* plans, observes and optimises production programs, defines rules for production scheduling and control manufacturing execution
- *Production Engineer* is responsible for the availability and performance of production equipment in order to enable the right production output in the requested quality
- *ICT Manager* is responsible for the availability and productivity of all ICT equipment related to the product lifecycle.

The roles are not completely separated from each other. The role "*Student*" cannot be connected specifically to this roles, but student training is also important in the frame of ICT for FoF. Therefore students related to manufacturing engineering, as well as to computer science, are selected as a target group, too.
The Product Designer, Factory Planner, Technology Planner, Production Controller and the Production Engineer are deeply involved into the daily business in the factory. Therefore a specific industrial learning course should not extend to more than a week. Optimal duration would be one to two days courses. The ICT Manager normally does spend more than a day for training. Students can apply from short courses (some hours) to mid and long term trainings.

| Role | Time Frame | Main Focus |
|---|---|---|
| Knowledge Worker | Frequently on a daily basis | Competency |
| Product Designer | Max. 1 Week<br>Optimal: 1- 2 Day | Attitude & Competency |
| Factory Planner | | |
| Technology Planer | | |
| Production Controller (incl. Supply Chain Manager) | | |
| Production Engineer | | |
| ICT Developer | | |
| ICT Manager | Optimal 1 Day | Attitude |
| Student | Mid and long term | Knowledge & Skills |

**Figure 4 Roles and their main focus on ILPE**

#### *4.1.2 ICT Competency*

The application of each learning course requires a generic set of ICT competencies. Related to the specification in D4.1 three types are relevant:

- High: The audience is familiar with the architecture of ICT systems, the development of system components as well has experiences in implementation and installation of ICT systems in manufacturing
- Medium: The audience is using ICT systems for carrying out the technical oriented tasks along manufacturing

- Low: The audience has basic knowledge in applying ICT for usual communication and information sharing

A further refinement is necessary for specific courses only.

#### *4.1.3 Process*

The processes are oriented along reference processes for product development and deployment. The steps are influenced by specifications coming from systems engineering domain, NASA [1] and ISO 15288 [2] and ISYPROM [3].

- *Product Planning* covers the product portfolio planning and feasibility studies from a long term perspective including the product conceptualisation and the definition of systems requirements (e.g. design and product constraints)
- *Design* includes:
  - Early design phases of a product, where decisional parameters of a product will be defined and refined and the Logical Decomposition has to be fixed
  - Technical Solution development, fixing the geometry, calculations, the production technologies
- *Testing / Assessment* are tasks to validate technical requirements, define and implement measurement equipment and procedures, perform measurement and validation
- *Strategic Factory Planning* has the objective to develop a roadmap for the entire factory based on different external parameters and link required projects to implement the roadmap. The frequent controlling regarding the influence of external and internal factors (e.g. new production technology) is included too.
- *Ramp-Up* is the period between the existence of first complete physical product prototypes until Start of Production (SOP), usually several disciplines have to interact close to each other
- *Production Planning* deals with the midterm to short term capacity planning based on forecasts down the machinery group level.
- *Quality Planning* is the definition of quality objectives for products and services, the planning of related quality processes (e.g. inspections) as well the required resources to achieve the quality objectives
- *Production contains* all value added processes to manipulate the product from raw material to the final product
- *Production Control* has to execute the following tasks: Schedule production orders to manufacturing resources, Receive and analyse feedback from production processes and provision of measures in order to reschedule manufacturing orders.
- Supply Chain Management is the planning and management of all tasks for supplier selection, sourcing and external logistics. This includes as well the supplier control (supplier satisfactory analysis).
- Quality Control contains all steps to validate products and processes against specifications.
- Distribution is the logistical process step to move products to the customer and perform if required installation and ramp-up
- Maintenance includes all tasks to reduce degeneration e.g. inspection, repair and overhaul.

Due to the fact of convergence the process phases cannot be separated from each other completely.

### 4.2 Step 2: Definition of learning needs for target groups

This step deals with the definition of the training needs on ICT in manufacturing of the target groups identified in the previous step. A usual technique that is commonly used to address this problem is the "skills matrix" as introduced in D4.1. Because of the individuality of needs in ICT competencies, a general matrix is not possible to be defined. The needs are defined according to existing learning content and the topics of the FoF paradigm. Semantic technologies are place-holder for all technologies affecting all FoF topics.

Existing learning content will be assigned as examples to the major aspects of the FoF paradigm.

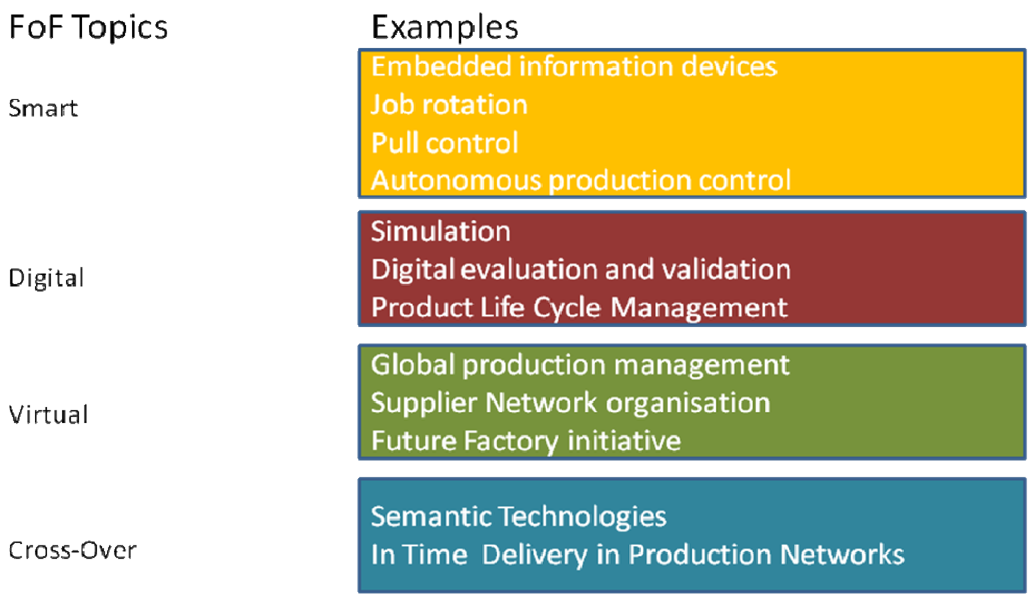



**Figure 5 Learning Content along to the FoF paradigms**

The learning content is coming from all partners involved into WP4 of ActionPlanT.

## 4.3 Step 3: Analysis and classification of learning needs

Step 3 aims at analysing the training needs of the different target groups and determining homogeneous classes of training requirements.
In the previous step, learning needs were identified for the different target groups. They aim to fill the gap between what the target groups possess in terms of attitude, knowledge, skills and competency with regard to ICT issues in manufacturing and what they can acquire through attending the training activity in the ActionPlanT project. In the case where an organisation decides to train its employees to achieve specific objectives then the aim will be filing the gap between what the employees possess and what is required from them in order to meet their organisation's objectives.
The analysis consists of identifying the common and specific learning needs of the different target groups. The different needs from these two groups are then portioned into homogeneous classes of training requirements regardless the groups from which they are obtained. The classes of training requirements can be defined through different levels using different classification criteria as shown in Table1.

| FoF Paradigm | Example ILPE actions | Focus on | | | |
|---|---|---|---|---|---|
| | | Attitute | Knowledge | Skills | Competency |
| Smart | Embedded information devices | Knowledge Worker, Factory Planner, Production Controller, ICT Manager | Knowledge Worker, Factory Planner, Technology Planner, ICT Developer, Production Controller | Factory Planner, Technology Planner, ICT Developer | Production Engineer |
| | Job rotation | Knowledge Worker, Production Controller | Production Controller | Production Controller | Production Controller |
| | Pull Control | Factory Planner, technology Planner | Factory Planner, technology Planner, Production Controller | Factory Planner, technology Planner, Production Controller | Factory Planner, technology Planner, Production Controller |
| | Autonomous production control | Knowledge Worker, Production Controller | Production Controller | Production Controller | Production Controller |
| Digital | Simulation | Knowledge Worker | | | Production Controller |
| | Digital evaluation and validation | Production Engineer | Production Engineer | Production Engineer | Production Engineer |
| | Product Life Cycle Management | ICT Manager, Strategic Factory Planner | Product Designer, Product Planner, Strategic Factory Planner | Product Designer, Product Planner, | Product Designer, Product Planner, |
| Virtual | Global production management | Production Engineer, Production Controller | Production Engineer, Production Controller | Production Engineer, Production Controller | Production Engineer, Production Controller |
| | Future Factory | Factory Planner, Technology Planner | ICT Developer | ICT Developer | ICT Manager |
| | Supplier Network organisation | Production Controller | Production Controller | Production Controller | Production Controller |
| Cross-Over | Semantic Technologies | ICT Developer, ICT Manager, Production Engineer | ICT Developer, Production Engineer | ICT Developer | ICT Developer |
| | In time delivery in manufacturing | Production Controller, Production Engineer | Production Controller, Production Engineer | Production Controller, Production Engineer | Production Controller, Production Engineer |

**Table 1 ILPE actions and their focus**

-

Table 1 shows for each learning topic not only which target groups are concerned but also which aspects among attitude, knowledge, skills and competency are aimed for the target groups concerned by the learning topic.

## 4.4 Step 4: Identification of learning content

Step 4 is concerned with the identification of learning content for the training activity in the ActionPlanT project.

From the previous step, homogeneous classes of training requirements are obtained. The learning content which allows fulfilling the requirements of the different target groups is developed in the current step. To achieve that, key themes about ICT issues in manufacturing are associated to the classes of training requirements. These themes should be covered by the training activity in the ActionPlanT project. They allow determining the training modules to consider.

Firstly, the FoF paradigms (smart, digital, virtual, cross-over) are considered and within these paradigms, the following list of potential training themes is identified:

- Future Factory Initiative
- Semantic Technologies for Manufacturing
- Product Embedded Information Devices
- Petri Nets for Manufacturing Modelling & Simulation
- Supply Chain Simulation
- In-Time delivery in non hierarchical networks
- Ergonomics Digital Evaluation
- Job Rotation Scheduling
- Global Production Management
- Autonomous Production Control
- Advantages of PLM

- Muscle Car Challenge

This list covers advanced ICT issues in manufacturing.

The training modules are structured around a number of aspects which are described in Table 2.

| **Aspect** | **description** | **Instantiations** |
|---|---|---|
| Title | Title of the training module | N.A. |
| Acronym | Acronym of the of the training module | N.A. |
| Major field | Major field that is related to the training module | Management, Finance, Marketing / Sales, Information technology, Production / Manufacturing, Design / Engineering, Logistic, Maintenance, etc. |
| Business domain | Business domain related to the training module | Automotive, Aeronautic, Machine-tools, Electrical and electronic equipment (EEE), Railways, Watch-making, etc. |
| Introduction | It allows having an idea about the training module but without too many details. This can be sufficient for a first appreciation and showing interest | N.A. |
| Content description | Brief description of content of the module in terms of its main training units | N.A. |
| Role | Role of the trainee within his/her organization | Knowledge Worker, Product Designer, Factory Planner, Technology Planner, ICT Developer, Production Controller, Production Engineer, ICT Manager, Student, etc. |
| ICT competency | Level of ICT competency of the trainee | High, Medium, Low |
| Process | Process of the organization that is impacted by the training module | Product Planning, Design, Testing / Assessment, Strategic Factory Planning, Ramp-Up, Production Planning, Quality Planning, Production, Production Control, Supply Chain Management, Quality Control, Distribution, Maintenance, etc. |
| Objective | What is aimed to improve for the candidate through the training module | Attitude, Knowledge, Skills, Competency |
| FoF type | FoF aspect related to the training module | Smart Factory, Digital Factory, Virtual Factory, Cross-over |
| Industrial Learning Type | Type of delivery of training module | Onsite: Seminar / Workshop / Conference, synchronized/non-synchronized virtual classroom, Internet-based training, Webinar, Serious Games, Mid and long term course, Workshops at Future Factory, etc. |

Table 2 Aspects of structure of training modules

The explanation of industrial learning types is given in deliverable D4.1 and can be seen in Annex 7.2. The training modules are described according to the above-mentioned structure in subsections 6.2.1-6.2.11. Each training module provides content from recent achievements in ICT for the FoF, as well as an outlook about the future research and its impact for the community.

To facilitate the elaboration of the contents for training modules, the usual approach consists in dividing the modules into topics, the topics in sub-topics until obtaining elementary topics: the training units. The modules will be described at the level of the units composing each module only. The units themselves will not be detailed.

## 4.5 Step 6 Identification of ILPE and delivery mechanisms

The learning actions are timely organized along to the major ActionPlanT workshops where external attendees will be invited to. In order to reduce complexity for planning, execution and validation, each ILPE will apply a minimum of different IL instruments, e.g. the second workshop will use “Serious Games” for both modules (Autonomous Production Control and Muscle Car Challenge).
In order to identify current challenges and future opportunities in industrial learning, four main objectives have been taken into account for selecting the ILPE themes:

- Foresee topics from the entire product life cycle – means from product development to service
- Application of almost all identified learning instruments and knowledge delivery mechanisms (from serious games to class lectures)
- Address a wide spread set of potential roles affected to ICT in factories
- Take into account all aspects of ActionPlanT: Smart, Digital, Virtual Factory

The entire schedule for the learning activities can be seen in Figure 6.

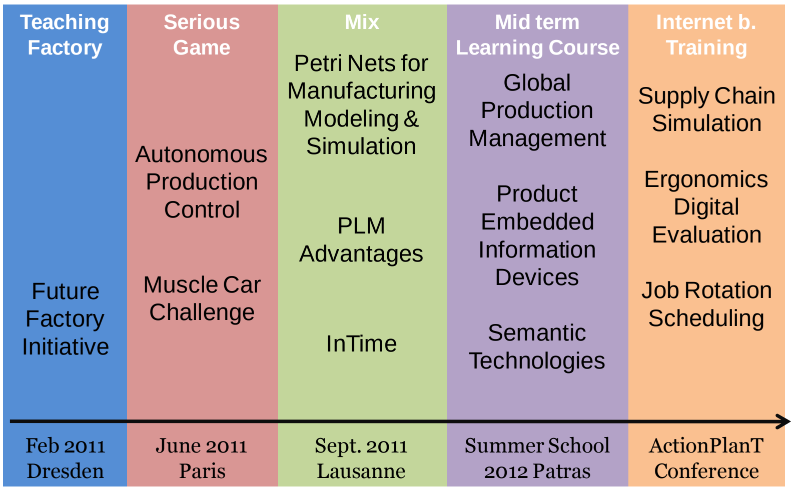



Figure 6 Delivery Plan – Schedule

The “InTime” and the “Supply Chain Simulation” courses are complementary, while they are developed with different background. Here the ActionPlanT partners will evaluate how complementary courses, but coming from different sources with partially overlapping topics, can be combined seamlessly.

In the September workshop and in the summer school event a mix of instruments will be applied. In the Midterm Learning Course different instruments will be applied for one module (e.g. the seminar based trainings will be performed during the summer school event as part of global production engineering). During the ActionPlanT conference only internet based instruments of the assigned trainings will be explained in order to show the ability of such instruments.

## 4.6 Template for describing IL Modules

In the following table the template for an industrial Learning module is given.

<table>
<tr><td colspan="3">Module Title:<br>Global Production Management</td><td colspan="3">Acronym:<br>GPM</td><td colspan="2">Major field:<br>Manufacturing</td></tr>
<tr><td colspan="8">Module Description</td></tr>
<tr><td colspan="8">Introduction</td></tr>
<tr><td colspan="8">Successful enterprises do not only produce competitive products, they also obtain long-term decisive competitive advantages by using process innovations. Process innovations are related to the production process of products and services as well as to the planning, controlling and supporting processes in an enterprise.</td></tr>
<tr><td>FoF Type</td><td colspan="2">Smart Factory</td><td colspan="2">Digital Factory</td><td>Virtual Factory</td><td colspan="2">Cross-over</td></tr>
<tr><td colspan="8">Key Audience</td></tr>
<tr><td>Role</td><td>Student</td><td>Product Designer</td><td colspan="2">Factory Planner<br>Technology Planner</td><td colspan="2">ICT Developer<br>Production Controller<br>Production Engineer</td><td>(ICT )Manager</td></tr>
<tr><td>ICT Competency</td><td colspan="2">Strong</td><td colspan="2">Medium</td><td colspan="3">Weak</td></tr>
<tr><td>Process</td><td colspan="2">Product Planning<br>Design<br>Testing<br>Strategic Factory Planning</td><td colspan="2">Production Planning<br>Ramp-Up<br>Quality Planning</td><td colspan="2">Production<br>Production Control<br>Supply Chain Management<br>Quality Control</td><td>Distribution ,<br>Maintenance</td></tr>
<tr><td colspan="8">Objectives (note: not all aspects have be taken into account)</td></tr>
<tr><td colspan="8">Attitude:<br>Global Production Management deals with methods and tools for a distributed and computer based realisation of a synchronous enterprise. Students will learn how concepts for an effective, efficient and human centred design of performance related processes in an enterprise looks like.<br>Transfer of Knowledge:<br>Integrated manufacturing management tasks like planning, scheduling and evaluation of manufacturing processes and facilities.<br>Development of Skills:<br>Complexity management is learnt by analysis and design applying modelling methods. Students become familiar with enterprise models, reference models and simulation that include products, logistics, human resources and qualification.<br>Development of Competences:<br>Students shall be enabled for a systematic manufacturing management, the management of production, logistics and supply chain projects, considering relevant decision criteria in the framework of global conditions.</td></tr>
</table>

<table>
<tr><td colspan="7">2. Contents</td></tr>
<tr><td colspan="7">Short description:<br>The teaching module deals with world trade institutions and organisations, for instance the European Union and the needs for globalization. The thematic contents of this course are:<ul><li>trade barriers and enterprise types,</li><li>global business and culture and global manufacturing strategy,</li><li>procurement, global logistics; logistics control and supply chain management,</li><li>just - in - time production and production control,</li><li>lean management and reengineering,</li><li>planning, benchmarking and simulation of enterprises.</li></ul></td></tr>
<tr><td colspan="7">Industrial Learning Types</td></tr>
<tr><td>OnSite: Seminar / Workshop / Conference</td><td>synchronized/non-synchronized virtual classroom</td><td>Internet-based training</td><td>Webinar</td><td>Serious Games</td><td>Mid and long term course</td><td>Workshops at Teaching Factory</td></tr>
</table>

All industrial learning modules are primarily described using that template. It contains all aspects to cluster the learning activities and ensure that all key aspects of ICT for FoF are covered.

# 5 Indicated Criteria for evaluation of ILPE

The detailed definition of evaluation criteria will be defined in deliverable D4.4. In order to prepare the validation for executed courses initial criteria will be provided already in this chapter. The objectives for evaluation are to find best practices of instruments and the validation of the industrial learning model. In theory the learning content is planned to be used only as example. The Learning content and the delivery mode are very much connected. A separate evaluation of content and delivery mode is not applicable. There will be three types of criteria: administrative, criteria evaluated through participants and evaluated through external observer to identify needs for course improvement as well as for future research in definition and delivery of industrial learning.

## 5.1 Administrative Criteria

Administrative criteria have to be fulfilled to start execution of training actions. Rather than to evaluate the effectiveness of learning modules the following criteria will be used as a check list.

- Availability of training materials
- Adaptability to the context of manufacturing industry
- Availability of documentation
- Use of ICT learning platform
- Existence of application experience

## 5.2 Criteria to be evaluated through ILPE participants

The feedback from ILPE participants will be collected through a questionnaire. In Annex 7.3 the questionnaire of the first ILPE in Dresden is included. The feedback from training audience will be analyzed.

## 5.3 Criteria to be evaluated through external observers

External observers, specialists in providing industrial learning will evaluate the ILPEs through the following criteria:

- Adequacy of delivery methods
- Adequacy of grouping approaches and participants
- Identification of challenges regarding learning content and delivery methods to be taken into account for future research

# 6 Learning Content

## 6.1 Overview and Major Focus on ILPE Objectives

In the following table an overview about the learning topics is given. Most are using seminar as instrument but always in combination with modern teaching methodologies.

| Topics | Instruments | | | | | | |
|---|---|---|---|---|---|---|---|
| | Seminar | Virt. Class-room | Webinar | Internet-based training | Serious Game | Mid and long term course | Workshops at Teaching Factory |
| Future Factory Initiative | x | | | | | | x |
| Semantic Technologies for Manufacturing | x | | | | | x | |
| Product Embedded Information Devices | | | | | | x | x |
| Petri Nets for Manufacturing Modelling & Simulation | x | x | x | | | | |
| Supply Chain Simulation | x | | | x | | | |
| Ergonomics Digital Evaluation | x | | | x | | | |
| Job Rotation Scheduling | x | | | x | | | |
| Global Production Management | x | | | | x | x | x |
| Autonomous Production Control | | | | | | | x |
| Muscle Car Challenge | | | | | x | | |
| InTime | | | | | x | | |
| Advantages of PLM | X | | | | | | |

Table 3 Overview of piloting industrial learning events and their used instruments

## 6.2 Curricula of Industrial Learning Pilot Events

### *6.2.1* Future Factory Initiative

| | | | | | | |
|---|---|---|---|---|---|---|
| **Module Title:**<br>Future Factory Initiative | | | **Acronym:**<br>FFI | | | Major field:<br>ICT for Manufacturing |
| Module Description | | | | | | |
| Introduction | | | | | | |
| This initiative demonstrates the role of the Future Factory living lab in the innovation lifecycle of SAP AG – it showcases some of the most advanced ICT for manufacturing middleware, their integration, business analytics and touches on the topics of sustainability, energy efficiency, and planning. | | | | | | |
| FoF Type | Smart Factory | | Digital Factory | Virtual Factory | Cross-over | |
| Key Audience | | | | | | |
| Role | Student | Product Designer | Factory Planner<br>Technology Planner | ICT Developer<br>Production Controller<br>Production Engineer | (ICT )Manager | |
| ICT Competency | Strong | | Medium | Weak | | |
| Process | Product Planning<br>Design<br>Testing<br>Strategic Factory Planning | | Production Planning<br>Ramp-Up<br>Quality Planning | Production<br>Production Control<br>Supply Chain Management<br>Quality Control | Distribution , Maintenance | |
| Objectives (note: not all aspects have be taken into account) | | | | | | |
| **Attitude:**<br>The Future Factory is a state of the art living lab where SAP customers and partners (including HP, Intel, Mitsubishi, Festo, …) demonstrate how their products integrate and work with SAP's solution chain. The EU PSP project APOLLON is in the process of promoting the Future Factory in to the European Network of Living Labs (EnoLL).<br>**Transfer of Knowledge:**<br>Integrated manufacturing management tasks like planning, scheduling and evaluation of manufacturing processes and facilities (ERP, Business-By-Design, MES) and sustainability solutions.<br>**Development of Skills:**<br>Participants will learn about new manufacturing solutions in the pipeline and how old and new solutions work hand in hand for solving complex planning and sustainability issues.<br>**Development of Competences:**<br>Participants will get an opportunity to develop competencies in ERP systems as well as MES (MII, ME). Furthermore they will learn about business analytics, energy monitoring, and shop-floor integration through the SAP Research Middleware for Device Integration (MDI) prototype. | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2. Contents | | | | | | |
| **Short description:**<br>The thematic contents of the workshop are:<br>• Basis ERP systems and on-demand solutions such as Business-By-Design<br>• Introduction to RFID technology and its usage in supply chain<br>• Shop floor device integration through SAP Research's MDI prototype.<br>• Remote service management (RSM) through Endress & Hauser prototype.<br>• 3D visualization through ICONICS and usage of SCADA systems.<br>• Localization and tracking through Agilion sensors.<br>• Information management and business analytics through XCelsius and Business Objects. | | | | | | |
| Industrial Learning Types | | | | | | |
| OnSite: Seminar / Workshop / Conference | synchronized/non-synchronized virtual classroom | Internet-based training | Webinar | Serious Games | Mid and long term course | Workshops at Teaching Factory |

### *6.2.2* Semantic Technologies for Manufacturing

<table>
<tr><td colspan="3">Module Title:<br>Semantic Technologies for Manufacturing</td><td colspan="3">Acronym:<br>s-MAN</td><td colspan="2">Major field:<br>ICT</td></tr>
<tr><td colspan="8">Module Description</td></tr>
<tr><td colspan="8">Introduction</td></tr>
<tr><td colspan="8">Technologies to develop and implement semantics in various domains are developed quickly in the last years. Ontology based technologies are starting implemented in the domains of engineering and manufacturing with applications in data, knowledge management and decision making.</td></tr>
<tr><td>FoF Type</td><td colspan="2">Smart Factory</td><td colspan="2">Digital Factory</td><td colspan="2">Virtual Factory</td><td>Cross-over</td></tr>
<tr><td colspan="8">Key Audience</td></tr>
<tr><td>Role</td><td>Student</td><td>Product Designer</td><td colspan="2">Factory Planner<br>Technology Planner</td><td colspan="2">ICT Developer<br>Production Controller<br>Production Engineer</td><td>(ICT )Manager</td></tr>
<tr><td>ICT Competency</td><td colspan="2">Strong</td><td colspan="2">Medium</td><td colspan="3">Weak</td></tr>
<tr><td>Process</td><td colspan="2">Product Planning<br>Design<br>Testing<br>Strategic Factory Planning</td><td colspan="2">Production Planning<br>Ramp-Up<br>Quality Planning</td><td colspan="2">Production<br>Production Control<br>Supply Chain Management<br>Quality Control</td><td>Distribution ,<br>Maintenance</td></tr>
<tr><td colspan="8">Objectives (note: not all aspects have be taken into account)</td></tr>
<tr><td colspan="8">Attitude:<br>Students will learn how semantic technologies may change the point of view of developing information systems for sustainable manufacturing.<br>Transfer of Knowledge:<br>Semantic technologies for manufacturing.<br>Development of Skills:<br>Development of ontology models for manufacturing; perform queries and reasoning with ontology based systems.<br>Development of Competences:<br>Students shall be enabled for a better and deeper understanding of manufacturing systems with abilities for performing everyday knowledge based control of manufacturing operations.</td></tr>
</table>

<table>
<tr><td colspan="7">2. Contents</td></tr>
<tr><td colspan="7">Short description:<br>The thematic contents of this course are:<ul><li>Notions of concept, semantics, ontology in the domains of engineering and manufacturing,</li><li>Ontology based semantics technologies,</li><li>Ontology based tools,</li><li>Ontology based case studies in manufacturing.</li></ul></td></tr>
<tr><td colspan="7">Industrial Learning Types</td></tr>
<tr><td>OnSite: Seminar / Workshop / Conference</td><td>synchronized/non-synchronized virtual classroom</td><td>Internet-based training</td><td>Webinar</td><td>Serious Games</td><td>Mid and long term course</td><td>Workshops at Teaching Factory</td></tr>
</table>

### *6.2.3* Product Embedded Information Devices

| | | |
|---|---|---|
| **Module Title:**<br>Product Embedded Information Devices | **Acronym:**<br>PEID | Major field:<br>ICT for Manufacturing |
| Module Description | | |
| Introduction | | |
| With the emerging technologies of auto-id and IoT, Product Embedded Information Devices such as RFID, sensors etc. are used more and more in modern control systems of various manufacturing configurations allowing the development of new services around them. This module introduces the concept and uses of PEIDs in manufacturing. | | |

| | | | | |
|---|---|---|---|---|
| FoF Type | Smart Factory | Digital Factory | Virtual Factory | Cross-over |
| Key Audience | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Role | Student | Product Designer | Factory Planner<br>Technology Planner | ICT Developer<br>Production Controller<br>Production Engineer | (ICT )Manager |

| | | | |
|---|---|---|---|
| ICT Competency | Strong | Medium | Weak |

| | | | | |
|---|---|---|---|---|
| Process | Product Planning<br>Design<br>Testing<br>Strategic Factory Planning | Production Planning<br>Ramp-Up<br>Quality Planning | Production<br>Production Control<br>Supply Chain Management<br>Quality Control | Distribution ,<br>Maintenance |

| |
|---|
| Objectives (note: not all aspects have be taken into account) |
| **Attitude:**<br>Audience will develop an opinion of the potential of this type of technologies in manufacturing and in a more general scale as well.<br>**Transfer of Knowledge:**<br>Enabling technologies for knowledge based sustainable manufacturing.<br>**Development of Skills:**<br>Use of auto-id technologies. Real-time field data and information based decision support systems.<br>**Development of Competences:**<br>Ability to design real-time information based manufacturing control systems. |

2. Contents

**Short description:**

The thematic contents of this course are:

- Auto-id technologies,
- Sensors and sensor networks,
- Intelligent products and processes,
- Tracking and tracing of information,
- Data/Information transformations,
- Real-time field data based decision making.

Industrial Learning Types

| | | | | | | |
|---|---|---|---|---|---|---|
| OnSite: Seminar / Workshop / Conference | synchronized/non-synchronized virtual classroom | Internet-based training | Webinar | Serious Games | Mid and long term course | Workshops at Teaching Factory |

### *6.2.4* Petri Nets for Manufacturing Modelling & Simulation

| | | | | | | |
|---|---|---|---|---|---|---|
| **Module Title:** Petri Nets for Manufacturing Modeling & Simulation | | | **Acronym:** PN-MAN | | Major field: ICT for Manufacturing | |
| Module Description | | | | | | |
| Introduction | | | | | | |
| Successful enterprises do not only produce competitive products, they also obtain long-term decisive competitive advantages by using process innovations. Process innovations are related to the production process of products and services as well as to the planning, controlling and supporting processes in an enterprise. | | | | | | |
| FoF Type | Smart Factory | | Digital Factory | Virtual Factory | Cross-over | |
| Key Audience | | | | | | |
| Role | Student | Product Designer | Factory Planner Technology Planner | ICT Developer Production Controller Production Engineer | (ICT )Manager | |
| ICT Competency | Strong | | Medium | Weak | | |
| Process | Product Planning Design Testing Strategic Factory Planning | | Production Planning Ramp-Up Quality Planning | Production Production Control Supply Chain Management Quality Control | Distribution , Maintenance | |
| Objectives (note: not all aspects have be taken into account) | | | | | | |
| **Attitude:** Students will learn how visual and rather streamline modelling tools may allow easy and fast visualisation and simulation of manufacturing processes. **Transfer of Knowledge:** Integrated manufacturing management tasks like planning, scheduling and evaluation of manufacturing processes and facilities. **Development of Skills:** Modelling, simulation, model execution and model based evaluation of manufacturing systems. **Development of Competences:** Students shall be enabled for a systematic modelling, simulation and evaluation of manufacturing systems, the management of production, logistics and supply chain projects, considering relevant decision criteria. | | | | | | |

2. Contents

**Short description:**
The thematic contents of this course are:

- Visual modelling of manufacturing systems with Petri nets,
- Simulation,
- Model execution,
- Model based evaluation of manufacturing systems.

Industrial Learning Types

| | | | | | | |
|---|---|---|---|---|---|---|
| OnSite: Seminar / Workshop / Conference | synchronized/non-synchronized virtual classroom | Internet-based training | Webinar | Serious Games | Mid and long term course | Workshops at Teaching Factory |

### *6.2.5* Supply Chain Simulation

| | | | | | | |
|---|---|---|---|---|---|---|
| **Module Title:**<br>Supply Chain Simulation | | | **Acronym:**<br>SCS | | | Major field:<br>ICT for Manufacturing |
| Module Description | | | | | | |
| Introduction | | | | | | |
| This training module focuses on Supply Chain Simulation as a means for modelling the supply chain and dynamically querying the supply chain partners to provide real time or near real time information, regarding the availability of parts, required for the production of a highly customizable products.<br>The module is based on research outputs of the Integrated Project "Flexible Assembly Processes for the car of the third millennium (MyCar)" | | | | | | |
| FoF Type | Smart Factory | | Digital Factory | Virtual Factory | Cross-over | |
| Key Audience | | | | | | |
| Role | Student | Product Designer | Factory Planner<br>Technology Planner | ICT Developer<br>Production Controller<br>Production Engineer | (ICT )Manager | |
| ICT Competency | Strong | | Medium | Weak | | |
| Process | Product Planning<br>Design<br>Testing<br>Strategic Factory Planning | | Production Planning<br>Ramp-Up<br>Quality Planning | Production<br>Production Control<br>Supply Chain Management<br>Quality Control | Distribution , Maintenance | |
| Objectives (note: not all aspects have be taken into account) | | | | | | |
| **Attitude:** Demonstrate the industrial relevance of the technology through the presentation of industrial case studies from the MyCar IP.<br>**Transfer of Knowledge:** Present basic knowledge about supply chain management approaches for the production of highly customizable products / Application in the automotive industry. Access to relevant knowledge through the use of the MyCar Electronic Handbook<br>**Development of Skills:** Hands-on practice with running & testing some real life – like scenarios using two custom-made software tools "Supply Chain Simulator" together with the "Buyer Behaviour Modelling Tool", developed in the context of the MyCar IP.<br>**Development of Competences:** Game-based collaboration & group decision-making exercise on the basis of a specially designed supply chain management scenario. | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2. Contents | | | | | | |
| The teaching module deals with supply chain management approaches for the production of highly customizable products. It will provide a theoretical methodological insight and hands-on practice on relevant topics, such as:<br>• assessing the impact of production changes on suppliers.<br>• calculating the logistics lead time and the costs associated with the production change.<br>• considering the supplier inventory, production capability and capacity constraints, supplier's ability to support the plan<br>• enhancing web based flow of information from OEM to supplier and vice versa<br>• matching of pre-ordered and/or pre-configured ordered products with the actual customer requirements<br>• building model for quantifying the likelihood of a customer to purchase a highly customized vehicle with respect to a set of the vehicle build date, the parts acquisition costs and the expected revenue for the OEM | | | | | | |
| Industrial Learning Types | | | | | | |
| OnSite: Seminar / Workshop / Conference | synchronized/non-synchronized virtual classroom | Internet-based training | Webinar | Serious Games | Mid and long term course | Workshops at Teaching Factory |

### *6.2.6* Ergonomics Digital Evaluation

| **Module Title:**<br>Ergonomics Digital Evaluation | **Acronym:**<br>EDE | Major field:<br>Manufacturing |
|---|---|---|
| Module Description | | |
| Introduction | | |
| This training module focuses on *Ergonomics Digital Evaluation* as a means for simultaneous recording and analysis of different ergonomics factors, as well as the efficient and easily-repeatable ergonomics analysis of tasks involving different variants of the same product.<br>The module is based on research outputs of the Integrated Project "Flexible Assembly Processes for the car of the third millennium (MyCar)" | | |

| FoF Type | Smart Factory | Digital Factory | Virtual Factory | Cross-over |
|---|---|---|---|---|

Key Audience

| Role | Student | Product Designer | Factory Planner<br>Technology Planner | ICT Developer<br>Production Controller<br>Production Engineer | (ICT )Manager |
|---|---|---|---|---|---|

| ICT Competency | Strong | Medium | Weak |
|---|---|---|---|

| Process | Product Planning<br>Design<br>Testing<br>Strategic Factory Planning | Production Planning<br>Ramp-Up<br>Quality Planning | Production<br>Production Control<br>Supply Chain Management<br>Quality Control | Distribution ,<br>Maintenance |
|---|---|---|---|---|

Objectives (note: not all aspects have be taken into account)

**Attitude:**
Demonstrate the industrial relevance and the societal aspect of ergonomics assessment through the presentation of industrial case studies from the MyCar IP.
**Transfer of Knowledge:**
Present basic knowledge about digital human simulation, process ergonomics analysis, workplace design, human process design and redesign / Application in the automotive industry. Access to relevant knowledge through the use of the MyCar Electronic Handbook
**Development of Skills:**
Hands-on practice with running & testing some real life–like scenarios using a commercial digital human simulation platform and a custom-made software package called "ErgoToolkit", which has been developed in the context of the MyCar IP.
**Development of Competences:**
Best practices, game-based collaboration & group decision-making exercise on the basis of a specially designed ergonomics assessment scenario

2. Contents

**Short description:**
The training module deals with ergonomics assessment in digital mock-up environments, especially addressing assembly process issues relevant to the automotive industry. It will provide a theoretical methodological insight and hands-on practice on relevant topics, such as:

- Invalid Postures Recognition
- Ergonomic Volumes Recognition
- Dynamic simulation
- Assembly worksheet screening procedure

Industrial Learning Types

| OnSite: Seminar / Workshop / Conference | synchronized/non-synchronized virtual classroom | Internet-based training | Webinar | Serious Games | Mid and long term course | Workshops at Teaching Factory |
|---|---|---|---|---|---|---|

### *6.2.7* Job Rotation Scheduling

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Module Title:** Job Rotation Scheduling | | | **Acronym:** JRS | | | Major field: Manufacturing | |
| Module Description | | | | | | | |
| Introduction | | | | | | | |
| This training module focuses on dynamic *Job Rotation Scheduling* as a means for the optimization of the shift scheduling and the production scheduling in human-based assembly systems. According to the orders and market demands, the shop-floor workforce is adapted, re-scheduled and allocated to the new circumstances accordingly. The module is based on research outputs of the Integrated Project "Flexible Assembly Processes for the car of the third millennium (MyCar)" | | | | | | | |
| FoF Type | Smart Factory | | Digital Factory | | Virtual Factory | Cross-over | |
| Key Audience | | | | | | | |
| Role | Student | Product Designer | Factory Planner<br>Technology Planner | ICT Developer<br>Production Controller<br>Production Engineer | | (ICT )Manager | |
| ICT Competency | Strong | | Medium | Weak | | | |
| Process | Product Planning<br>Design<br>Testing<br>Strategic Factory Planning | | Production Planning<br>Ramp-Up<br>Quality Planning | Production<br>Production Control<br>Supply Chain Management<br>Quality Control | | Distribution , Maintenance | |
| Objectives (note: not all aspects have be taken into account) | | | | | | | |
| **Attitude:**<br>Demonstrate the industrial relevance and the societal aspect of job rotation through the presentation of industrial case studies from the MyCar IP.<br>**Transfer of Knowledge:**<br>Present basic knowledge about job rotation concepts, dynamic scheduling, tree search algorithms and multiple-criteria decision making / Application in the automotive industry. Access to relevant knowledge through the use of the MyCar Electronic Handbook<br>**Development of Skills:**<br>Hands-on practice with running & testing some real life – like scenarios using the custom-made software tool "Dynamic Job Rotation Tool", which has been developed in the context of the MyCar IP.<br>**Development of Competences:**<br>Game-based collaboration & group decision-making exercise on the basis of a specially designed scenario for the generation and assessment of alternative job rotation schedules | | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2. Contents | | | | | | |
| **Short description:**<br>The training module deals with dynamic job rotation scheduling approaches in human-based assembly systems. It will provide a theoretical methodological insight and hands-on practice on relevant topics, such as:<br>• introducing job rotation and dynamic scheduling concepts<br>• representing an assembly line on a hierarchical structure,<br>• defining the tasks to be carried out for the assembly of each product and the characteristics of the available operators<br>• using intelligent tree search algorithms, controlled by multiple factors, to generate alternatives to the scheduling problem.<br>• using multiple criteria decision making algorithms for the evaluation of the alternatives according to a set of user defined criteria. | | | | | | |
| Industrial Learning Types | | | | | | |
| OnSite: Seminar / Workshop / Conference | synchronized/non-synchronized virtual classroom | Internet-based training | Webinar | Serious Games | Mid and long term course | Workshops at Teaching Factory |

### *6.2.8* Global Production Management

| **Module Title:**<br>Global Production Management | | | **Acronym:**<br>GPM | | Major field:<br>Manufacturing |
|---|---|---|---|---|---|
| Module Description | | | | | |
| Introduction | | | | | |
| Successful enterprises do not only produce competitive products, they also obtain long-term decisive competitive advantages by using process innovations. Process innovations are related to the production process of products and services as well as to the planning, controlling and supporting processes in an enterprise. | | | | | |
| FoF Type | Smart Factory | | Digital Factory | Virtual Factory | Cross-over |
| Key Audience | | | | | |
| Role | Student | Product Designer | Factory Planner<br>Technology Planner | ICT Developer<br>Production Controller<br>Production Engineer | (ICT )Manager |
| ICT Competency | Strong | | Medium | Weak | |
| Process | Product Planning<br>Design<br>Testing<br>Strategic Factory Planning | | Production Planning<br>Ramp-Up<br>Quality Planning | Production<br>Production Control<br>Supply Chain Management<br>Quality Control | Distribution ,<br>Maintenance |
| Objectives (note: not all aspects have be taken into account) | | | | | |

**Attitude:**
Global Production Management deals with methods and tools for a distributed and computer based realisation of a synchronous enterprise. Students will learn how concepts for an effective, efficient and human centred design of performance related processes in an enterprise looks like.
**Transfer of Knowledge:**
Integrated manufacturing management tasks like planning, scheduling and evaluation of manufacturing processes and facilities.
**Development of Skills:**
Complexity management is learnt by analysis and design applying modelling methods. Students become familiar with enterprise models, reference models and simulation that include products, logistics, human resources and qualification.
**Development of Competences:**
Students shall be enabled for a systematic manufacturing management, the management of production, logistics and supply chain projects, considering relevant decision criteria in the framework of global conditions.

2. Contents

**Short description:**
The teaching module deals with world trade institutions and organisations, for instance the European Union and the needs for globalization. The thematic contents of this course are:

- trade barriers and enterprise types,
- global business and culture and global manufacturing strategy,
- procurement, global logistics; logistics control and supply chain management,
- just - in - time production and production control,
- lean management and reengineering,
- planning, benchmarking and simulation of enterprises.

Industrial Learning Types

| | | | | | | |
|---|---|---|---|---|---|---|
| OnSite: Seminar / Workshop / Conference | synchronized/non-synchronized virtual classroom | Internet-based training | Webinar | Serious Games | Mid and long term course | Workshops at Teaching Factory |

### *6.2.9* Autonomous Production Control

| | | | | | | |
|---|---|---|---|---|---|---|
| **Module Title:**<br>Autonomous Production Control | | | **Acronym:**<br>GPM | | Major field:<br>Manufacturing | |
| Module Description | | | | | | |
| Introduction | | | | | | |
| "The best control is when you don't need one". Under this statement a one day workshop provides both, the theoretical background of autonomous production control principles as well as the lively demonstration and experiments with the usage of eGrain controlled production. | | | | | | |
| FoF Type | Smart Factory | | Digital Factory | Virtual Factory | Cross-over | |
| Key Audience | | | | | | |
| Role | Student | Product Designer | Factory Planner<br>Technology Planner | ICT Developer<br>Production Controller<br>Production Engineer | (ICT )Manager | |
| ICT Competency | Strong | | Medium | Weak | | |
| Process | Product Planning<br>Design<br>Testing<br>Strategic Factory Planning | | Production Planning<br>Ramp-Up<br>Quality Planning | Production<br>Production Control<br>Supply Chain Management<br>Quality Control | Distribution , Maintenance | |
| Objectives (note: not all aspects have be taken into account) | | | | | | |
| **Attitude:**<br>New methods of production control<br>**Transfer of Knowledge:**<br>New scheduling methods, eGrain functions | | | | | | |

2. Contents

**Short description:**

The teaching module deals with concepts of decentralized and more and approaches for autonomous production control. The following aspects will be lectured

- Principles of autonomous production control
- Introduction into eGrains for production control: An eGrain is a very small computer-chip integrated into machines, tools and the products, communicating with others. So products "know" their status, their next steps to be more completed and their delivery date. Based on that knowledge the products can negotiate with machines according to time and costs for manufacturing.
- Experiments with an eGrain live demonstrator in the teaching factory.
- The entire concept will be explained and pros and cons discussed with the audience.

Industrial Learning Types

| | | | | | | |
|---|---|---|---|---|---|---|
| OnSite: Seminar / Workshop / Conference | synchronized/non-synchronized virtual classroom | Internet-based training | Webinar | Serious Games | Mid and long term course | Workshops at Teaching Factory |

### *6.2.10* Muscle Car Challenge

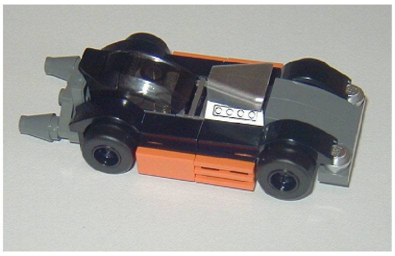
| **Module Title:** Muscle Car Challenge | **Acronym:** MCC | Major field: Manufacturing |
|---|---|---|
| Module Description | | |
| Introduction | | |

Classic organization of shopfloor is based on 'push mode' where new parts are produced at a certain fixed rate, then assembled, then stored. This organization creates a lot of buffers for intermediate and final storage and usually implies high costs for storage of intermediate goods.

Novel organizations based on lean principle implement 'pull mode' where parts are produced on demand. This organization reduces buffers to their strict minimum, and reduces costs.

One enabler of lean management is the ability to visually manage the production line to constantly know what is needed downstream. For small work centers this can be implemented simply by a good physical organization of work. For larger organizations it requires a computerized systems (MES) that can track and display in real-time the status of orders and the status of work in progress.

This Industrial Learning Module proposes a challenge that demonstrates the difference in efficiency between a classical and a novel organization, helped by an MES system.



Model #1
The Fire Stang
Impressive Stats Here

Model #2
The Blue Cuda
Impressive Stats Here

| FoF Type | Smart Factory | Digital Factory | Virtual Factory | Cross-over |
|---|---|---|---|---|
| Key Audience | | | | |

| Role | Student | Product Designer | Factory Planner<br>Technology Planner | ICT Developer<br>Production Controller<br>Production Engineer | (ICT )Manager |
|---|---|---|---|---|---|
| ICT Competency | Strong | | Medium | Weak | |
| Process | Product Planning<br>Design<br>Testing<br>Strategic Factory Planning | | Production Planning<br>Ramp-Up<br>Quality Planning | Production<br>Production Control<br>Supply Chain Management<br>Quality Control | Distribution ,<br>Maintenance |
| Objectives | | | | | |

**Attitude:**
Sensibilize audience to the values of lean manufacturing and visual management
**Transfer of Knowledge:**
Construction game (Lego) challenge.
**Development of *(hard)* Skills:**
Understanding of lean principles, added value of MES real-time visibility on information
**Development of Competences:**
Collaboration
Limited requirement for synchronization with team mates
Challenge spirit

2. Contents

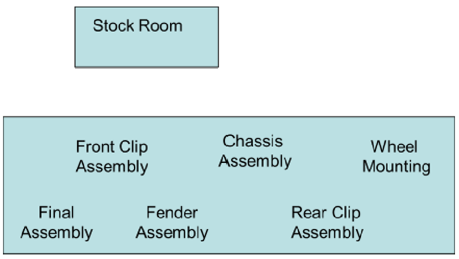
**Short description:**
The game simulates two distinct production organizations: one based on sub-assembly orders, vs. a second one based on Lean principles. Both are supported by an MES that brings real-time visibility on shopfloor status, and allows watchers to follow the game.

You are all working for the Velocity Muscle Car Company. You will have 4 simulated weeks to build as many cars as you can. 1 week is 10 minutes. The factory builds two models: The Fire Stang & The Blue Cuda

**Part 1 : Classic organization**

First part of exercise will be a factory that operates in the tradition method. You have 4 weeks to build as many cars as you can. Car sub assemblies are built on work orders issued by ERP. Final assembly orders are issued by ERP to assemble the sub assemblies based on customer demand.

Convention Factory



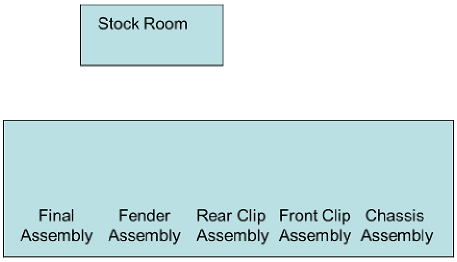

For Sub Assemblies:
- Orders must be processed in the order they are numbered.
- Orders are first picked by the stock room and kitted.
- Orders are then delivered to the proper assembly station by expediters.
- Assembly worker first must count and make sure they have all the parts, If not they must send kit back.
- Assembly worker must build all the assemblies. When all are finished they can call for inspection.
- After assemblies are inspected they can be returned to stock by calling the expediter.

In Final Assembly:
- Final assembly kits cannot be picked until all parts are present.
- Cars must be built in the order listed.
- All cars must be inspected before being delivered to customer.

**Part 2 : Classic organization**

Second part of exercise will implement lean concepts. You have 4 weeks to build as many cars as you can. No Kitting is performed and no sub-assembly or final assembly orders are used. **Cars are built in a lean pull line**

## Lean Flow Factory




Rules for Building:

- You must keep your buffer to your left full of partially built cars.
- No building assemblies ahead of time. If the buffer to your left is full **don't** build anything.
- When you do need to build something first take the required input assembly from your right and pull it into your work center. Build the assembly you are responsible for building and add it to the partially built car. When finished place the partially built car in the output buffer on your left.
- When you have an empty parts bin place it on the table in front of you and start using parts out of the second bin for that part.
- All cars must be inspected before delivery to customer

Rules for Stock Room and Expediter:

- Expediter passes by line and grabs all empty bins.
- Stock room fills the bins with the correct part and correct number of parts.
- Expediter returns the bins to the work center noted on the bin. Placing the bin under the bin of the same part is recommended.

Industrial Learning Types

| | | | | | | |
|---|---|---|---|---|---|---|
| OnSite: Seminar / Workshop / Conference | synchronized/non-synchronized virtual classroom | Internet-based training | Webinar | Serious Games | Mid and long term course | Workshops at Future Factory |

### *6.2.11* InTime

| | | | | | | |
|---|---|---|---|---|---|---|
| **Module Title:**<br>In time delivery in non-hierarchical manufacturing networks for the machinery and equipment industry | | | **Acronym:**<br>InTime | | Major field:<br>Manufacturing | |
| Module Description | | | | | | |
| Introduction | | | | | | |
| According to the inTime work plan, a serious game had to be developed for training and dissemination purposes. The game will be used to create awareness on the problems tackled by inTime and to understand the main logics behind the inTime project, in an engaging and entertaining way. | | | | | | |
| FoF Type | Smart Factory | | Digital Factory | Virtual Factory | Cross-over | |
| Key Audience | | | | | | |
| Role | Student | Product Designer | Factory Planner<br>Technology Planner | ICT Developer<br>Production Controller<br>Production Engineer | (ICT )Manager | |
| ICT Competency | Strong | | Medium | Weak | | |
| Process | Product Planning<br>Design<br>Testing<br>Strategic Factory Planning | | Production Planning<br>Ramp-Up<br>Quality Planning | Production<br>Production Control<br>Supply Chain Management<br>Quality Control | Distribution ,<br>Maintenance | |
| Objectives (note: not all aspects have be taken into account) | | | | | | |
| **Transfer of Knowledge:** developing awareness on the issues afflicting the machinery and equipment industry sector analyzed by the inTime project. Understanding the consequences on late deliveries and hence on the overall efficiency of the network, of a non-transparent communication between suppliers and manufacturers and of opportunistic behaviours.<br>**Development of Skills:** acquiring a more cooperative attitude, building trust. Understanding the point of view of members of the network that have a different role.<br>**Development of Competences:** learning the main concepts of the solutions adopted from inTime, in particular the value of the use of incentives related to punctuality | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2. Contents | | | | | | |
| **Short description:**<br>The game simulates a simple manufacturing network composed of two suppliers and three manufacturers. The players (one or two for each role) have to maximize their profits by satisfying the demand of products and are free to manage their relationship with the other players. The demand is pulled by the master and planned to generate stress on the network.<br>• The game-set is composed of both physical components (board-game like) and of a PC-interface to register the orders and deliveries<br>• N° of players 5-10 plus at least one master to lead the game<br>• The game is divided in rounds, the total time needed to play is about 2 hours | | | | | | |
| Industrial Learning Types | | | | | | |
| OnSite: Seminar / Workshop / Conference | synchronized/non-synchronized virtual classroom | Internet-based training | Webinar | Serious Games | Mid and long term course | Workshops at Teaching Factory |

#### *6.2.12* Advantages of PLM

| **Module Title:** Advantages of Item level Product Lifecycle Management | **Acronym:** PLM | Major field: Product Manufacturing, Use and End of Life |
|---|---|---|

Module Description

Introduction

This module aims at providing the audience with the basis to understand the potentials and the benefits of a system able to manage the whole lifecycle of product at item level. This module will also show use business cases from pilots. This module is defined from an European Project called PROMISE (Product Lifecycle Management and Information Tracking using Smart Embedded Systems - contract number 507100).

| FoF Type | Smart Factory | Digital Factory | Virtual Factory | Cross-over |
|---|---|---|---|---|

Key Audience

| Role | Student | Product Designer | Factory Planner<br>Technology Planner | ICT Developer<br>Production Controller<br>Production Engineer | (ICT )Manager |
|---|---|---|---|---|---|
| ICT Competency | Strong | | Medium | Weak | |
| Process | Product Planning<br>Design<br>Testing<br>Strategic Factory Planning | | Production Planning<br>Ramp-Up<br>Quality Planning | Production<br>Production Control<br>Supply Chain Management<br>Quality Control | Distribution , Maintenance |

Objectives (note: not all aspects have be taken into account)

**Attitude:**
Product Lifecycle Management deals with the different problematic and possibilities offered following and tracking the products during all their lifecycle. Students will learn about the possibilities and challenges offered by PLM, understanding the roots and conception of PLM and the concepts and peculiarities of item level data management.
**Transfer of Knowledge:** develop an understanding on the potentials of item level product lifecycle management, its possibilities and challenges. Presentation of best practices, potentials, examples of successful pilots.
**Development of Skills:** overview and understanding of practical and business implications of item level product lifecycle management.
**Development of Competences:**
Development of competencies on:

- Capturing Product Lifecycle data throughout all phases of product life;
- bringing together fragmented data held in disparate systems whilst people needing the data are themselves distributed;
- Processing data and converting to knowledge and decision support;
- Integrating people, processes and information beyond traditional and organizational boundaries;
- Dynamics of extended enterprise;
- Cost, complexity and infrastructure platforms of PLM.

2. Contents

**Short description:**
The module will present the results of the PROMISE project, showing the results, the potential benefits and developed pilots. The presentations will focus on:

- The business aspects of the product lifecycle management;
- Possibilities and opportunities offered within:
    - The Beginning of Life phase;
    - The Middle of Life phase;
    - The End of Life Phase.

Industrial Learning Types

| OnSite: Seminar / Workshop / Conference | synchronized/non-synchronized virtual classroom | Internet-based training | Webinar | Serious Games | Mid and long term course | Workshops at Teaching Factory |
|---|---|---|---|---|---|---|

# 7 Annex

## 7.1 References

1. Eurostat: Science, Technology & Innovation in Europe, 2008. http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-EM-08-001/EN/KS-EM-08-001-EN.PDF
2. International Council on Systems Engineering (INCOSE): INCOSE Systems Engineering Handbook v2, 2000.
3. National Aeronautics and Space Administration, NASA Headquarters: NASA/SP-2007-6105 Rev1, NASA Systems Engineering Handbook, 2007, http://education.ksc.nasa.gov/esmdspacegrant/ Documents/NASA%20SP-2007-6105%20Rev%201%20Final%2031Dec2007.pdf.
4. IEEE Computer Society: ISO/IEC 15288:2008(E), Systems and Software Engineering – System life cycle processes, Institute of Electrical and Electronics Engineers, 2008, ISBN 0-7381-5666-3
5. D. O'Sullivan , A. Rolstadås and E. Filos, 2009, "Global education in manufacturing strategy", Journal of Intelligent Manufacturing, DOI 10.1007/s10845-009-0326-2
6. PC Magazine Encyclopedia. http://www.pcmag.com/encyclopedia_term/0,2542,t=Webinar&i=54380,00.asp. Retrieved 2010-12-04

## 7.2 Industrial Learning Type definition (from D4.1)

### *7.2.1* Serious Games

Serious games are digital games that are driven by learning objectives. In fact, serious games can be deployed as testbeds for experience management that are highly motivating and emotionally engaging causing high and long knowledge retention [4]. The games could be configured to allow multiplayer use, i.e. virtual suppliers looking for virtual customers and so on. They could also be configured to incorporate real time information into the game for the user. A Serious Games approach is a powerful simulation technique. A virtual business environment is established to facilitate playing with different solutions to identify those who will work under different conditions. Moreover, the use of a serious games technique will stimulate learning and reflection.

### *7.2.2* The Teaching Factory

The objective of the Teaching Factory would be to seamlessly integrate research, innovation and education activities within a single initiative, so as to promote the future perspectives of a knowledge-based, competitive and sustainable manufacturing industry.
Co-operative research activities would be in the form of industrial projects or others, and could be addressing either technology application problems or technologically novel ideas. The research output developed within the industrial projects could be concurrently fed back to industry and academia.
The innovation activities would employ knowledge transfer schemes to keep industry, at the technological forefront, by supporting the continuous comprehension of the technical essence and the business potential of new knowledge and technology. These activities would also support their smooth adaptation to and integration into the working practices as well as their fast "transformation" into innovation for the extended products of the companies.

The education activities would employ teaching / training schemes to communicate new knowledge, business-like working methods, real – life industrial practice and an entrepreneurial spirit to the young people.

### *7.2.3* Webinar

A webinar is a neologism to describe a specific type of web conference. A webinar is usually collaborative and include polling and question & answer sessions to allow full participation between the audience and the presenter. In some cases, the presenter may speak over a standard telephone line, while pointing out information being presented onscreen, and the audience can respond over their own telephones, speaker phones allowing the greatest comfort and convenience. There are web conferencing technologies on the market that have incorporated the use of VoIP audio technology, to allow for a completely web-based communication. Depending upon the provider, webinars may provide hidden or anonymous participant functionality, making participants unaware of other participants in the same meeting [5].

#### *7.2.4* Onsite Seminar

Is a traditional seminar setting where both the instructor and the learners are located in the same room and are communicating face to face.

### Synchronized/ non-synchronized virtual classroom

#### *7.2.5* Internet Based Training

Internet-based training: the learners choose both the time and space for study and all communication is over the Internet

#### *7.2.6* Mid and long term course

Mid and long-term courses combine different instruments of industrial learning in order to execute a comprehensive knowledge transfer for complex and huge learning content. These courses can be performed in a compact way like a summer school in 2 to 3 weeks or in a frequently manner e.g. on monthly base for a year or more.

### 7.3 Questionnaire applied in the first ILPE in Dresden

# 1st Industrial Learning Pilot Event
# Dresden, 3rd February 2011

## Questionnaire

### *Introduction*

The objective of this questionnaire is to help assess the effectiveness of the learning model / methodology and the knowledge delivery mechanisms, which are suggested and applied by the *ActionPlanT* project. Your feedback will help us to further improve the suggested learning model / methodology and identify best practices in the use of knowledge delivery mechanisms for industrial learning.
In this Industrial Learning Pilot Event (ILPE), the questionnaire focuses on the assessment of the "Teaching Factory" paradigm as a knowledge delivery mechanism for industrial learning. In terms of content, the questionnaire is structured around the four major building blocks of the learning process, which are addressed by the *ActionPlanT* industrial learning model / methodology, i.e. attitude, knowledge, skills, competencies. These learning building blocks, together with the respective goals of this ILPE, are defined in the table hereafter.

| | **Definition** | **ILPE goals** |
| --- | --- | --- |
| ***Attitude*** | "Attitude" is a hypothetical construct that represents an individual's degree of like or dislike for an item. Attitudes are generally positive or negative views of a person, place, thing, or event. | Create awareness, attract interest, increase motivation to learn & apply |
| ***Knowledge*** | "Knowledge" means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study. | Create a basic technology understanding (basics of relevant theory & SW) oriented to industrial practice, and acquaint with relevant ICT tools to search for further information |
| ***Skills*** | "Skills" means the ability to apply knowledge and use know-how to complete well defined tasks. Skills may be cognitive or practical | Acquaint with the use of dedicated software tools, complete a well defined task involving processing of data with the given tools |
| ***Competencies*** | "Competence" means the proven ability to use knowledge, skills and personal, social and/or methodological abilities. Competences may be considered as the interface between the learning and the innovation processes. | Build-up basic ability to combine different pieces of knowledge, developed skills and own understanding, to make decisions and address real life-like use cases |

Two additional question groups aim to capture your overall impression of this ILPE and possible relevant experiences you may have in industrial learning.

## *1. Participant Background*

B1. Indicate your education discipline

- ☐ ICT
- ☐ Manufacturing / Engineering
- ☐ Management
- ☐ Economics
- ☐ Other

If "Other", please specify: ……………………………………………

B2. Indicate the profile of your company / organization

- ☐ Information Technology Vendor
- ☐ Manufacturing Company
- ☐ University
- ☐ Research Institute
- ☐ Other

If "Other", please specify: ……………………………………………

B3. Business position in the organization

- ☐ CEO / Director / General Manager
- ☐ R&D Manager
- ☐ Project Manager
- ☐ Professor
- ☐ Researcher
- ☐ Other

If "Other", please specify: ……………………………………………

B4. Years of industrial experience on ICT for manufacturing

- ☐ 1-5
- ☐ 6-10
- ☐ >10
- ☐ Not applicable

## *2. Attitude*

This is a set of questions to assess the impact of the ILPE on your personal attitude, namely the interest, the perceived impact / potential etc., against the introduced technology(ies).

A1 – Indicate your interest in the introduced technology(ies) before and after this ILPE.

Before the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high

After the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high

A2 – How would you rate the business potential of the introduced technology(ies) before and after this ILPE ?

Before the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high

After the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high

A3 – How would you rate the environmental impact of the introduced technology(ies) before and after this ILPE ?

Before the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high

After the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high

A4 – How would you rate the societal impact of the introduced technology(ies) before and after this ILPE ?

Before the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high

After the ILPE: very low ☐ ☐ ☐ ☐ ☐ very high

A5 – Indicate the potential (as you perceive that after the ILPE) of applying / integrating the introduced technology(ies) in the working practices of your company/institute

☐ Low potential

☐ Good potential but still immature for real-life practices

☐ High potential & mature technology / Motivated in pursuing application in real work.

☐ Already applied

☐ Not applicable / irrelevant

### *3. Knowledge*

This is a set of questions to assess the transfer of "theoretical" knowledge during the ILPE, which is provided as a technology background.

K1 – Indicate your understanding of the introduced technology(ies) before and after this ILPE.

Before the ILPE: poor ☐ ☐ ☐ ☐ ☐ good

After the ILPE: poor ☐ ☐ ☐ ☐ ☐ good

K2 – How would you rate the maturity of the ICT knowledge you got ?

State-of-the-art ☐ ☐ ☐ ☐ ☐ Highly innovative

K3 – How would you rate the applicability of the ICT knowledge you got ?

Theoretical / industrially immature ☐ ☐ ☐ ☐ ☐ Close to industrial practice / industrial way of thinking

K4 - How would you rate the knowledge "delivery mechanism" used in the ILPE ?

Inefficient / inappropriate ☐ ☐ ☐ ☐ ☐ Efficient / appropriate

State-of-the-art ☐ ☐ ☐ ☐ ☐ Highly innovative

K5 – Do you feel confident that you can easily access, if you wish, more information / knowledge on the introduced technology(ies) after this ILPE ?

Not confident at all ☐ ☐ ☐ ☐ ☐ Very confident

## *4. Skills*

This is a set of questions to assess the impact of the ILPE on the development of technical skills, oriented around the use of dedicated software tools.

S1 – How would you rate your cognitive skills (e.g. data manipulation, logical thinking, understanding of task work flows etc.) with respect to the introduced technology(ies) before and after this ILPE ?

Before the ILPE: poor ☐ ☐ ☐ ☐ ☐ good

After the ILPE: poor ☐ ☐ ☐ ☐ ☐ good

S2 – How would you rate your practical skills (e.g. good command of data input/output procedures, SW basic functions etc.) with respect to the introduced technology(ies) before and after this ILPE ?

Before the ILPE: poor ☐ ☐ ☐ ☐ ☐ good

After the ILPE: poor ☐ ☐ ☐ ☐ ☐ good

S3 - To what extent have you been able to complete well defined tasks (e.g. typical data processing et.) using the given software & hardware tools ?

Failed ☐ ☐ ☐ ☐ ☐ Succeeded

S4 – To what extent do you consider the offered hands-on practice useful for a better comprehension of the delivered knowledge ?

Irrelevant ☐ ☐ ☐ ☐ ☐ Very useful

S5 - To what extent has collaboration and team work helped you in reaching a good level of skills in using the software tools ?

Minor contribution ☐ ☐ ☐ ☐ ☐ Major contribution

S6 - How would you rate the skills “delivery mechanism” used in the ILPE ?

Inefficient / inappropriate ☐ ☐ ☐ ☐ ☐ Efficient / appropriate
State-of-the-art ☐ ☐ ☐ ☐ ☐ Highly innovative

## *5. Competence*

This is a set of questions to assess the impact of the ILPE on the development of competences related to the introduced technology(ies), including addressing real-life like use cases, decision making, practicing teamwork etc.

C1 – To what extent have you been able to apply the acquired knowledge and skills on the real life-like use case / exercise ?

Failed to apply ☐ ☐ ☐ ☐ ☐ Successfully applied

C2 - To what extent has the acquired knowledge and skills helped you in making correct decisions and reaching a solution to the real life-like use case / exercise ?

Minor contribution ☐ ☐ ☐ ☐ ☐ Major contribution

C3 - To what extent has collaboration and team work helped in making correct decisions and reaching a solution to the real life-like use case / exercise ?

Minor contribution ☐ ☐ ☐ ☐ ☐ Major contribution

C4 – To what extent do you think that competence development using such training paradigms could help bridging the gap between new ICT knowledge and product / process innovation ?

No impact ☐ ☐ ☐ ☐ ☐ Critical impact

C5 - How would you rate the “Teaching Factory” used in the ILPE as a “mechanism” for competence development ?

Inefficient / inappropriate ☐ ☐ ☐ ☐ ☐ Efficient / appropriate

State-of-the-art ☐ ☐ ☐ ☐ ☐ Highly innovative

## *5. Overall ILPE*

O1 - How would you rate the following aspects of this ILPE ?

| | | | |
|---|---|---|---|
| Overall organization | 0 | ☐ ☐ ☐ ☐ ☐ | 10 |
| Structure | 0 | ☐ ☐ ☐ ☐ ☐ | 10 |
| Supporting documentation | 0 | ☐ ☐ ☐ ☐ ☐ | 10 |
| Knowledge content | 0 | ☐ ☐ ☐ ☐ ☐ | 10 |
| Training aids, delivery mechanisms | 0 | ☐ ☐ ☐ ☐ ☐ | 10 |

O2 - What has been the *strong* point of this ILPE, e.g. with respect to the knowledge delivery mechanisms used etc., in comparison with other industrial learning courses you may have followed in the past ?

…………………………………………………………………………………………

…………………………………………………………………………………………

O3 - What has been the *weak* point of this ILPE, e.g. with respect to the knowledge delivery mechanisms used etc., in comparison with other industrial learning courses you may have followed in the past ?

…………………………………………………………………………………………

…………………………………………………………………………………………

O4 – During the ILPE activities, participants have been grouped in heterogeneous teams. Based on your overall ILPE experience, indicate which were the major pros and cons of this approach.

Pros ………………………………………………………………………………

………………………………………………………………………………

Cons ………………………………………………………………………………

………………………………………………………………………………

O5 - To what extent do you think the Teaching Factory concept demonstrated during the ILPE can help in making a sales/business decision ?

Minor contribution ☐ ☐ ☐ ☐ ☐ Major contribution

O6 – Do you have any further comment (e.g. with respect to your answers in O1) that could help up us to further improve the industrial learning methodology & knowledge delivery mechanisms used in our ILPEs ?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

## *6. Experiences in performing Industrial Learning*

E1 - Do you perform industrial learning courses as a trainer? ☐ Yes ☐ No

If no, please skip the next questions

E2 – Disciplines

ICT ☐

Manufacturing ☐

Management ☐

E3 - Experience of performing industrial learning

☐ < 1 year ☐ 1 to 3 years ☐ 3 – 10 years ☐ >10 years

E4 – Which are some typical major challenges you are facing in performing industrial learning courses?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………