Digital Transformation in Advanced Manufacturing

DTAM Curriculum

DTAM

DIGITAL TRANSFORMATION IN ADVANCED MANUFACTURING

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Deliverable factsheet

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Contents

1 Introduction

This deliverable describes the curriculum of the DTAM project. The aim of the DTAM curriculum is to provide technicians of advanced manufacturing with the competences needed, in terms of knowledge and skills, for the transition to the fourth industrial revolution (IoT Industry 4.0). Thus, the DTAM curriculum aims to be a reference curriculum for quality training and certification in digital transformation competence for Smart Industry.

Note, that this is the first version of the DTAM curriculum. The final version of the curriculum will be produced in M30 taking into account the main findings derived by the pilots.

1.1 Structure of the deliverable

The structure of the deliverable is the following:

- Section 1 is the introduction of the deliverable that describes each scope and structure, the target audience and the dependencies with other WPs and deliverables of the DTAM project.
- Section 2 describes the methodology that has been adopted for the development of the curriculum.
- Section 3 provides the description of the curriculum, i.e. the description of each training module.
- Finally, Section 4 provides the references used to conduct this deliverable.

1.2 Target audience

The target audience of this deliverable are:

- Technicians of advanced manufacturing as the “end-users” of the curriculum.
- Education and training providers both at vocational level, i.e. VET providers and higher level, i.e. HEIs, which are interested to update their offerings with new training programs at the domain of advanced manufacturing.
- Enterprises that are operating in the manufacturing sector and want to upskill/reskill their technicians.
- Research institutions that are working at the domain of education and training.
- Policy makers at the domain of education and/or manufacturing.

1.3 Dependencies with other WPs and deliverables

This deliverable is directly connected with the deliverable "R2.1: Digital Transformation Skills Index" of WP2, as it has used the competences of the digital transformation skills index to identify the knowledge and skills of the separate training module. Moreover, it has dependencies with the following deliverables:

- "R2.3: DTAM Training Methodology" of WP2: this deliverable will offer VET staff and organizations delivering the DTAM curriculum in future IVET and CVET courses with both theoretical and practical guidelines.
- "R2.4: DTAM Teacher/Trainer Manual" of WP2: this deliverable will provide an integral guide to the DTAM curriculum for H/VET staff who will deliver the training as part of formal accredited training in IVET and CVET courses.

2 Curriculum development

This section describes the methodology followed for the development of the DTAM curriculum. More specific:

- Section 2.1 describes the key characteristics of the DTAM curriculum
- Section 2.2 describes the key terms used in the curriculum
- Section 2.3 describes the process adopted for the development of the curriculum

2.1 Key characteristics of the DTAM curriculum

The main documents that have been used as reference for the development of the DTAM curriculum are the following:

- The "Digital Transformation Skills Index" developed by the DTAM project. This index has been used as a base for the definition of the knowledge and skills of each separate training module of the curriculum.
- The CEDEFOP report for defining, writing and applying learning outcomes [1]. This report provides guidelines for effectively defining, writing and applying learning outcomes at VET.
- The EC Curriculum guidelines for Key Enabling Technologies (KETs) and Advanced Manufacturing Technologies (AMT) report [2]. This report provides a new curriculum framework for AM.

The DTAM Curriculum has been developed following a student-centered approach. Its main characteristics are the following:

- Multi-disciplinary: The curriculum provides the learners with technical competences at digital technologies for AM (e.g. big data, artificial intelligence, Internet of Things), as well as competences covering non-technical non-technical/transversal areas (e.g. leadership, communication, project management).
- Modular: The curriculum includes a set of training modules. Each module is further divided into learning units. This permits the learners to build their own learning pathways based on their needs.
- Innovative: The curriculum promotes problem (challenge)-driven learning, collaborative (collective) learning, technology-enabled learning, as well as experience-based learning.

2.2 Key terms used in the curriculum

The key terms used in the DTAM curriculum are the following:

- Learning outcomes
- Competence
- Knowledge
- Skill
- Leaning units

2.2.1 Learning outcomes

Learning outcomes are statements of what a learner knows, understands and is able to do on completion of a learning process, defined in terms of knowledge [3], skills [4] and competences [5]. Education and training institutions are increasingly describing their qualifications [6] in terms of learning outcomes following the approach adopted by EQF.

Learning outcome descriptions form part of the metadata of qualifications in ESCO. Member States or awarding bodies include information on learning outcomes when providing data on qualifications for the ESCO qualifications pillar [7].

Learning outcomes descriptions were also an input when developing the skills pillar of ESCO [8]. Combining functional analysis of occupations with the analysis of learning outcome descriptions ensures that the skills terminology covers use cases in both, the world of employment and of education and training.

2.2.2 Competence

ESCO applies the same definition of "competence" as the EQF. According to this "competence means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development." They are described in terms of responsibility and autonomy.

Example:

Working as a "civil airline pilot" requires the competence to combine knowledge on "emergency procedures" and "equipment malfunctions" with skills on "reading position coordinates" and "following the air route". This application of knowledge and skills takes place in a partly unpredictable setting where technical and organisational problems occur on a daily basis and

where solutions have to be immediately identified and applied – either by the pilot alone or through team-working (e.g. involving the cabin crew or the ground staff).

2.2.3 Knowledge

ESCO applies the same definition for knowledge as the EQFhttps://ec.europa.eu/esco/portal/escopedia/European_Qualifications_Framework__40_EQF_41_. According to this, "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."

Both skills and competences rely on factual and theoretical knowledge, the difference lies in the way this knowledge is applied and being put into use.

Example:

Working as a "construction manager" requires the competence to combine knowledge on engineering principles with skills on project management and people management. This application of knowledge and skills takes place in a partly unpredictable setting where technical and organisational problems occur on a daily basis and where solutions have to be immediately identified and applied – either by the construction site manager alone or through team-working.

2.2.4 Skill

ESCO applies the same definition of "skill" as the EQF. https://ec.europa.eu/esco/portal/escopedia/European_Qualifications_Framework__40_EQF_41_According to this "skill means the ability to apply knowledge and use know-how to complete tasks and solve problems". They can be described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).

While sometimes used as synonyms, the terms skill and competence can be distinguished according to their scope. The term skill refers typically to the use of methods or instruments in a particular setting and in relation to defined tasks. The term competence is broader and refers typically to the ability of a person - facing new situations and unforeseen challenges - to use and apply knowledge and skills in an independent and self-directed way.

2.2.5 Training module

A training module includes a set of learning units that are delivered using various means (i.e. online, face-to-face, blended) to get the students the desired competences in terms of knowledge and skills.

2.3 Development of DTAM curriculum

The DTAM curriculum has been developed taking into account European tools and instruments, like the EQF, ECVET and ESCO, ensuring its transferability and recognition among European countries.

The process followed for developing the DTAM curriculum will consist of three stages

- Defining curriculum goals and specific learning outcomes. For the case of the DTAM curriculum, its main goals are two:
    - Provide AM technicians with technical and non-technical competences that meet the industry's demand.
    - Develop an innovative AM learning ecosystem, that promotes problem-based learning, technology-enhanced learning, and experience-based learning

  Note that the learning outcomes of the DTAM curriculum, i.e. knowledge and skills of each separate training module, have been considering the ECVET recommendations [9].
- Developing relevant teaching methods and forms of assessment. At this stage is defining the methodology for the delivery of the DTAM curriculum in different learning scenarios, as well as the methodology for learners' assessment. As an initial approach, the DTAM curriculum will be delivered combing both online and face-to-face training exploiting the IoT labs that will be developed under WP4. For learners' assessment, we are currently considering both self-assessment and exercises/challenges. However, all the details about the training methodology of the DTAM curriculum will be defined at the deliverable "D2.3: DTAM Training Methodology" under WP2.
- Reviewing and refining the curriculum. As the curriculum development is a continuous-learning process, the DTAM curriculum have been reviewed by the DTAM partners involved at the development of the training material (WP3), i.e., APRO, UPATRAS, ATLANTIS, DA VINCI, TXORRIERI and IDEC. Moreover, it will reviewer again after the completion of the pilots, in order to make fine-tuning changes based on their findings.

The separate training modules (courses) of the curriculum have been developed by each partner that is responsible to develop the respective training material under WP3. Thus

- APRO developed the “TM1: Information Technology and Operational Technology”.
- UPATRAS developed the “TM2: Big Data”.
- ATLANTIS developed the “TM3: Machine Learning”.
- DA VINCI developed the “TM4: Internet of Things and sensors”.
- TXORRIERI developed the “TM5: Cyber Security”.
- IDEC developed the “TM6: Transversal Competences”.

3 Curriculum Description

The DTAM curriculum follows a multi-disciplinary approach, combing technical with non-technical competences for AM technicians. It also follows a modular approach that support the need for micro-learning. The 6 training modules (courses) that consist of the DTAM curriculum are the following:

- TM1: Information Technology and Operational Technology
- TM2: Big Data
- TM3: Machine Learning
- TM4: Internet of Things and Sensors
- TM5: Cyber Security
- TM6: Transversal Competences

The description of each training module includes:

- A general description of the module aiming to give a short overview of its content and objectives.
- The competences that the learners will have at the end of the module.
- The skills & knowledge needed to achieve the competences.
- The training methods used to deliver the training module.
- The assessment methods used to assess the knowledge and skills of the learners.
- The means by which the IoT labs will be exploited during the delivery of the training module.
- The separate learning units of the training module.
- The ECVET credits that will collect those who will successfully complete the training module.

3.1 Description of training modules

3.1.1 TM1: Information Technology and Operational Technology

TRAINING MODULE: INTRODUCTION (TM1)
General description
This introduction gives the needed skills to start with the Dtam course. The result of the Digital Self Evaluation Tool will indicate to the user which part of the Introduction has to be completed, in order to acquire and/or improve the missing or low level skills. The Introduction is composed by five courses, to learn about fundamentals of PC systems, Networking, Phyton and Databases, Electronics, Sustainability. After the Introduction you will start Dtam course with a solid base also thanks to some exercises that will help you to understand the arguments in a easy way.
Competences
• Recognize and use hardware components in a standard network system • Examine, interpret and use the Internet Protocol Standard • Operate with network communications • Getting started with a personal computer system • Apply basic electrical concepts in industrial automation systems • Programming fundamentals • Energy conservation • Waste management • Apply the circular economy concept
Skills & Knowledge needed to achieve the competences
After the successful completion of this module, the learners will get the following knowledge: **PC systems** • PC Hardware characteristics • Operative systems characteristics

- IT Virus topologies
- General classification about cyber-attacks/dangers
- URL Composition

Networking

- Network component types and characteristics
- Network components installation
- Network components configuration
- Test of network components
- IPv4 and Ipv6 address structure
- Network masks determination
- Configuration of a Router as Default Gateways
- Different network types of characteristics and connections
- Network components configuration
- Client/Server communication
- Types and structure of HTML tags
- IP address resolution in URL
- DNS functioning

Python & Database

- Variables and types of data
- Arrays of data
- Condition instructions
- Loop instructions Functions

Electronics

- Main electrical quanitities
- Components of a electrical system
- Structure of a basic electrical circuit
- Types of electrical actuators
- Types of electrical sensors
- Connection of a electrical system

Sustainability

- Energy saving techniques
- Alternative energy resources

- Energy from Renewable Resources
- Avoid superfluous energy consumption
- Reduce waste
- Reusing items is another way to stop waste at the source
- Design for disposal or recycling
- Track waste
- Legislation
- Reduce consumption of raw materials
- Techniques to reduce consumption of raw materials
- Alternative resources
- Minimize waste
- Value of Energy and Resources
- Re use material
- Minimize waste from production
- Principles of Recycling
- Design products to be reused
- Minimize waste

Moreover, they will get the following skills:

PC systems

- Choose and install the Operative System
- Choose and install an AntiVirus application
- Check a system with an AntiVirus
- Choose and install a Browser Web

Networking

- Install and configure a network interface card
- Install and configure a nework switch
- Install and configure a network router
- Recognize Internet Protocol parameters
- Configure Internet Protocol parameters
- Categorize different network types
- Configurate the speed negotation between NIC and Switch
- Test the commuincation between network components

- Class choose and device IP address setting
- Communicate with ICMP Protocol
- Recognize HTTP/HTTPS protocol caracteristics
- Recognize HTML caracteristics

Python & Database

- Use and configure variables
- Use and configure arrays of data
- Use Condition and Loop instructions
- Configure and use functions

Electronics

- Measuring electrical quantities
- Connecting actuators and sensors in a electrical system
- Testing of a electrical circuit

Sustainability

- Environmental awareness skills
- Critical thinking
- Identify necessary energy resources for each task
- Ability to apply environmental friendly energy resources that effectively serve the purpose of the task
- Green skills
- Social responsibility

Training methods
The training methods that will be used to deliver the course are online courses at the MOOC https://e-training.dtamproject.eu/ as well as hands-on sessions at the IoT labs.
Assessment methods
Self-assessment quizzes during the online courses Exercises to run at the IoT labs

IoT Lab
• Use of Raspberry PI to realize **Phyton** Exercises • Use electronic components to realize **Electronics** exercises • Use of the Lab Network as example to the **Networking** lessons
Learning units
PC systems • Introduction to the Personal Computer • Basic concepts of Information Technology • Structure of Computer • Interfaces • Central Processing Unit • Input devices • Output devices • Memory devices Mass • Files and Folders • Quick memories • Software • Single Board Computer • Raspberry PI **Networking** • Networks Fundamentals • The basic elements for creating a network • Networking Technologies Overview • Ethernet protocol • The correct network connections • Network Design Questions and Answers • Short list of key networking components **Python & Database** • Python programming fundamentals

- Python introduction
- Programming fundamentals
- Arrays
- Decisions
- Loops
- Functions

Electronics

- Electronic Fundamentals
- Electrical quantities
- Fundamental laws
- Electronic signals
- Sensors & Actuators

Sustainability

- Sustainability
- Sustainability of development: terminology, circular economy and green economy
- Conscious use of resources in technology sector: raw materials, waste and energy
- Life Cycle Assessment (LCA)

Credits
We assume that 25 hours of training correspond to 1 ECVET credit.

3.1.2 TM2: Big Data

TRAINING MODULE: BIG DATA (TM2)
General description
This course is for technicians and professionals who would like to understand the core tools used to wrangle and analyze big data, as well as the core tools used for distributed processing of large data sets across clusters of computers. Although the tools that are presented are generally applicable for data processing, analysis and visualization, the module is mainly oriented for advanced manufacturing use cases. At the end of the module, you will learn how to use Python for data analysis and data visualization. Moreover, you will learn how to use the Hadoop framework for distributed processing of large data sets.
Learning Outcomes
Competences
• Carrying out data collection and integrating data storage systems. • Use data processing techniques for decision making. • Work with data generated within the industrial environment, from its capture and storage to its exploitation through data processing methods. • Exploit data to derive insights regarding the operation and maintenance of machines. • Design the architecture of an infrastructure for the distributed processing of big data. • Communicate engaging data visualizations to support decisions towards the improvement of the digitized processes in industrial environments
Skills & Knowledge needed to achieve the competences
After the successful completion of this module, the learners will get the following knowledge: • Big data main characteristics • Big data at advanced manufacturing • The data analysis process and different types of data

- How to use the Jupyter Notebook to write Python programs
- Main Python tools for exporting and importing data
- Reading, different types of files in Python
- Missing values and how to handle them with Python
- Processing different types of data with Python
- The NumPy package in Python for the creation of large, multi-dimensional arrays and matrices
- The Pandas library in Python for data analysis
- The Matplotlib library in Python for data visualization
- Main features and components of Hadoop framework
- The Hadoop Distributed File System
- The Hadoop Yarn
- The Hadoop MapReduce
- Basic administration of an Hadoop cluster
- How to develop MapReduce programs with Python
- Pig programming language

Moreover, they will get the following skills:

- Preparing data for analysis using Python
- Importing and Exporting Data in Python
- Dealing with Missing Values in Python
- Performing data preprocessing using Python
- Performing simple and complex data analysis using Python
- Calculating basic statistics with Python
- Performing data visualizations using Python
- Using the Hadoop framework for data storage and processing
- Using the storage (HDFS) and processing (YARN) services of Hadoop
- Using the MapReduce framework
- Submitting and managing jobs in Hadoop
- Managing key Hadoop services
- Writing simple MapReduce programs
- Writing MapReduce program with Python
- Using Pig programming language to interact with Hadoop

Training methods
The training methods that will be used to deliver the course are online courses at the MOOC https://e-training.dtamproject.eu/ as well as hands-on sessions at the IoT labs.
Assessment methods
• Self-assessment quizzes during the online courses • Exercises to run at the IoT labs • Challenges to run at the IoT labs
IoT Lab
• Use the data collected by the IoT labs for data analysis and visualization using Python. • Use the data collected by the IoT labs for running large-scale data processing jobs at Hadoop.
Learning units

• Introduction to Big Data
  ○ What is Big Data
  ○ Different types of data
  ○ Big data benefits
  ○ Big data applications for advanced manufacturing
  ○ The data analysis process and roles in data science projects
  ▪ The data analysis process
  ▪ Different roles in data science projects
• Introduction to Python for data analysis
  ○ Python installation
  ○ Using the Jupyter Notebook
  ○ Downloading files with Python
  ○ Main Python tools for exporting and importing data
  ○ Reading local files, XML files, JSON files and excel files

- Missing values and how to handle them with Python
- Processing of Raw Data to Tidy Data
- Reading tabular data and large tables
- Main libraries of Python for Data Analysis

- Python libraries for data analysis and visualization
  - The NumPy library in Python for the creation of large, multi-dimensional arrays and matrices
    - The NumPy Array
    - The ndarray Class
    - Array Creation
    - Printing Arrays
    - Indexing, Slicing and Iterating
    - Shape Manipulation
  - The Pandas library in Python for data analysis
    - Data Frame
    - Combine Data Frames
    - Rows and Columns Selection
    - Sorting
    - Descriptive Statistics
    - Group By
    - File I/O
  - The Matplotlib library in Python for data visualization
    - Creating Basic Plots
    - Creating scatter 2D plots
    - Histograms and Density Plots
- The Apache Hadoop framework
  - Introduction to Hadoop
  - Hadoop advantages and disadvantages
  - The Hadoop Architecture and major components of Hadoop ecosystem
  - Hadoop clusters
  - Hadoop master-slave-topology
  - Single-node vs multi-node Hadoop clusters

- Building an efficient Hadoop cluster
- The Hadoop Distributed File System
  - HDFS Architecture
  - Block replication in Hadoop
  - Rack Awareness
  - Hadoop HDFS Operations
  - Interacting with HDFS
- The Hadoop Yarn
  - Hadoop Yarn architecture
  - Resource Manager
  - Node Manager
  - Application Master
  - Interacting with YARN
- The Hadoop MapReduce
  - What is MapReduce
  - MapReduce job execution flow
  - MapReduce data processing example
  - How Hadoop runs a MapReduce job
  - Hadoop streaming
  - Running a simple MapReduce job
- Hadoop Administration
  - Common commands for Hadoop administration
- Hadoop MapReduce with Python
  - Writing a MapReduce Program in Python using the Hadoop streaming utility
  - Writing a MapReduce Program in Python using mrjob
- Hadoop and Pig
  - Pig installation
  - Pig Latin
  - Writing a Pig script
  - Running Pig scripts

Credits
We assume that 25 hours of training correspond to 1 ECVET credit.

3.1.3 TM3: Machine Learning

TRAINING MODULE: MACHINE LEARNING (TM3)
General description
This course is for technicians and professionals who would like to understand the core tools used to implement machine learning techniques and analyze the shop floor data based on regression, classification, and clustering in order to train the systems for improved operations. The presented tools are the basic techniques and types of machine learning, the algorithms and the methods for it and their basic implementation in Python programming language. At the end of the module, one will learn the theoretics of machine learning, classification, regression, and clustering analysis. Moreover, the practical background with Python libraries and implementation will be covered by the modules.
Learning Outcomes
Competences
• Understand and analyze basic concepts of machine learning. • Design and implement machine learning models using real-world data sets • Understand how machine learning algorithms work and how they can be applied in industrial applications. • Be able to understand and analyze data from diagrams. • Report the results of analyzes and machine learning models in constructive plot.
Skills & Knowledge needed to achieve the competences
After the successful completion of this module, the learners will get the following knowledge: • Machine Learning theory

- Basic Machine Learning techniques (regression, classification, clustering, association)
- Basic Machine Learning types (supervised and unsupervised)
- Regression algorithms in Python
- Linear, Non-Linear, Simple, and Multiple regression with Python
- Application on simple data sets
- Classification and clustering in Python
- Advanced manufacturing applications of Machine Learning

Moreover, they will get the following skills:

- Preparing data for analysis using Python
- Test scripts in Python for Machine Learning
- Regression algorithms with Python
- Classification technique with Python
- Decision Tree implementation in Python
- Machine Learning techniques for improved digitized maintenance processes

Training methods

The training methods that will be used to deliver the course are online courses at the MOOC https://e-training.dtamproject.eu/ as well as hands-on sessions at the IoT labs.

Assessment methods

- Self-assessment quizzes during the online courses
- Exercises to run at the IoT labs
- Challenges to run at the IoT labs

IoT Lab

Use the data collected by the IoT labs in order to run machine learning algorithms for use cases in advanced manufacturing, such as predictive maintenance.

Learning units

- Machine Learning – Introduction

- Definition
- Machine Learning Categories
- How it's made
- Why insist on Machine Learning though?
- Examples of machine learning use
- Machine Learning advantages and disadvantages
  - Advantages
  - Disadvantages
  - Advantages applications
- Machine learning for manufacturing applications
- Real World Applications

- Supervised Learning
  - What is supervised Learning?
  - From Bananas to real-life Manufacturing
  - Advantages and disadvantages of Supervised Learning.
    - Supervised learning advantages
    - Supervised learning disadvantages
  - Types of supervised learning
    - Classification
    - Regression
- Unsupervised Learning
  - Types of unsupervised learning
    - Clustering
    - Association
  - Unsupervised learning advantages
  - Unsupervised learning disadvantages
- Machine Learning – Regression with Python for ML
  - Linear Regression with Python
    - Step 1: Import packages and classes
    - Step 2: Provide data
    - Step 3: Create a model and fit it
    - Step 4: Get results
    - Step 5: Predict response

- Multiple Linear Regression with scikit-learn
  - Step 1 and 2: Import packages and classes and provide data
  - Step 3: Create a model and fit it
  - Step 4: Get results
  - Step 5: Predict response
- Polynomial Regression with Python
  - Step 1: Import packages and classes
  - Step 2a: Provide data
  - Step 2b: Transform data
  - Step 3: Create a model and fit it
  - Step 4: Get results
  - Step 5: Predict response
- Advanced Linear Regression with statsmodel
  - Step 1: Import packages
  - Step 2: Provide data
  - Step 3: Create a model and fit it
  - Step 4: Get results
  - Step 5: Predict response
- Cost Function in the Linear Regression

- Machine Learning Algorithms in Python
  - Simple k Nearest Neighbor (kNN)
    - Pros and Cons of kNN
    - kNN Algorithm in Python – The Model to Predict Sea Slugs Age
  - Decision Trees
    - Pros and Cons of Decision Trees
    - Decision Trees in Python
  - Comparison of Decision Trees and KNN

Credits
We assume that 25 hours of training correspond to 1 ECVET credit.

3.1.4 TM4: Internet of Things and sensors

TRAINING MODULE: INTERNET OF THINGS AND SENSORS (TM4)
General description
This course is for technicians and professionals who would like to understand the core hardware and tools used to generate data from an industrial environment and adjust parameters in the intelligent manufacturing environment. You will learn different technologies, architectures and protocols to make an IOT ecosystem possible. You will learn how to use a Raspberry and advanced sensors to improve the production process and make connected devices that can make the right choices based on data.
Learning Outcomes
Competences
• Characterize existing production processes by defining and measuring appropriate key performance indicators (KPIs). • Reprogram and/or adjust manufacturing parameters in the intelligent manufacturing environment. • Apply industrial communication solutions, carrying out data collection and integrating data storage systems. • Integrate the production control system with the company's digital management systems. • Identify the different technologies, architectures and protocols that make an IOT ecosystem possible. • Design and deploy communications networks for IoT devices, selecting the most appropriate technology. • Do a preliminary assessment of IT/OT network. • Adapt the processes and/or machines by incorporating the selected digital technologies taking into account safety, efficiency and sustainability criteria. • Reprogram and adjust operating parameters and re-adjust the system to new operating and monitoring requirements in the maintenance process environment.
Skills & Knowledge needed to achieve the competences

After the successful completion of this module, the learners will get the following knowledge:

- Basic knowledge of wide variety of sensors
- Basic knowledge of production processes
- Advanced knowledge of the applied sensors, what is the input/output
- Knowledge in programming languages used to collect data from sensors and adjust parameters of the process
- Knowledge of ETL processes
- Data types / Data conversion
- Previous programming skills
- Basic knowledge of DMS
- Knowledge of collecting serial data
- I2C bus
- PoE
- Zigbee
- Analog/Digital data pins
- SPI
- Voltage systems
- Advanced Ohms law
- NB-IoT communications
- WiFi communications
- LoRa communications
- Bluetooth communications
- 4/5G communications
- ZigBee and other local protocols etc.
- Knowledge of firewalls, proxys, network ports, protocols
- "Knowledge of safety regulations identified per country
- Sustainibility
- Certification of IEEE, ISO, NEN and CE
- Knowledge of update intervals (For example Python builds)
- Knowledge of vulnerabilities, what can go wrong"

Moreover, they will get the following skills:

- Define KPIs by using KPI Karta
- Write scripts to collect data from sensors
- Programming in Python
- Write scripts in Python to copy data from Raspberry Pi to data storage using HTTP(s)
- Collect and sending data using Python
- Apply the concepts in advanced sensorica device like a Raspberry Pi
- Write scripts to send data using the most appropriate network
- Reprogram and/or adjust manufacturing parameters in the intelligent manufacturing environment. Apply industrial communication solutions, carrying out data collection and integrating data storage systems."
- Build a simple setup to verify if the data collected is transferable
- Interpreting of regulations during the advanced sensorica module
- Check for updates
- Check for vulnerabilities

Training methods

The training methods that will be used to deliver the course are online courses at the MOOC https://e-training.dtamproject.eu/ as well as hands-on sessions at the IoT labs.

Assessment methods

- Self-assessment quizzes during the online courses
- Exercises to run at the IoT labs
- Challenges to run at the IoT labs

IoT Lab

Using/programming Raspberry Pi and sensors to collect data from different resources and send them to a web-based dashboard for data visualization.

Learning units

- Introduction in sensorica
  - What are sensors
  - Why sensoring
  - Digital sensor: types and connection
  - Analogic sensor: types and connection
- Introduction in IoT networking
  - IoT Networking; WiFi, LoRa, Bluetooth, GSM, Protocols
- Introduction in Python
  - Basics of Python, datatypes, syntax, developing in Python
- Usage of sensoring
  - Connect Sensors to Raspberry Pi
  - Electronical knowledge
  - Ohms Law,
  - Voltage systems
- Setup connections
  - Programming a connection in Python between Raspberry Pi and sensor
- Receiving data
  - Read data from sensor with Python
- Sending data trough connections
  - Send data to the cloud via different connection types via Pyhton
- Change behavior of sensoring using data
  - Receive data from the cloud and readjust sensors
- Building IoT project
  - Build a 'smart plant'

Credits
We assume that 25 hours of training correspond to 1 ECVET credit.

3.1.5 TM5: Cyber Security

TRAINING MODULE: CYBERSECURITY (TM5)
General description
This course is for technicians and professionals who would like to define and implement security strategies in industrial organizations and infrastructures. At the end of the module, you will learn how to perform cybersecurity diagnostics, identifying vulnerabilities and implementing the necessary measures to mitigate them, applying the necessary measures to mitigate them by applying the current regulations and industry standards, following the sector standards, following the protocols of quality, occupational risk prevention and environmental respect.
Learning Outcomes
Competences
• Integrate the production control system with the company's digital management systems. • Determine organizations' cybersecurity risk profiles by identifying good practices, standards and applicable regulations. • Identify the different technologies, architectures and protocols that make an IIOT ecosystem possible. • Establish the configuration of industrial control systems minimizing the risks of the organization. • Apply industrial communication solutions, carrying out data collection and integrating data storage systems.
Skills & Knowledge needed to achieve the competences
After the successful completion of this module, the learners will get the following knowledge: • Understanding of the changes needed for the IT /OT convergence • Basic understanding of industrial control systems (ICS) • Industrial communication networks and protocols • Types of cybersecurity hazards

- Types of credentials and access control systems (Digital signatures…)
- Main concepts of zoning and segmentation in ICS
- Know what is the vulnerability management system (CVE…)
- Main industry standards and applicable regulations related to cybersecurity
- Main features of cybersecurity policies and measures
- Network control and supervision devices for secure communications in ICS (IDS, IPS…)
- Basic principles of data security
- Basic principles of access controls
- Basic principles of secure coding
- Relevant information for cybersecurity reports

Moreover, they will get the following skills:

- Analyze IT and OT environments
- Implement IT/OT network coupling
- Segment an industrial network
- Search for information on known vulnerabilities in industrial control systems.
- Identify Vulnerabilities
- Identify people, devices and systems
- Identify the cybersecurity main policies in an organization
- Analyze the features of the communication protocols
- Propose solutions for secure remote access
- Propose solutions for secure industrial communications
- Apply Intrusion detection systems (IDS)
- Apply standards for secure communications

Training methods

The training methods that will be used to deliver the course are online courses at the MOOC https://e-training.dtamproject.eu/ as well as hands-on sessions at the IoT labs.

Assessment methods

- Self-assessment quizzes during the online courses
- Exercises to run at the IoT labs
- Challenges to run at the IoT labs

IoT Lab

Design security measures to ensure the protection of data privacy and integrity both from internal and external cyberattacks.

Learning units

- IT / OT environment features
  - Definition of OT and IT
  - IT and OT integration
  - Cybersecurity for the IT /OT convergence
- Risk scenarios evaluation
  - Types of industrial control systems.
  - Physical and logical network architecture
  - Types of cybersecurity hazards.
  - External risks and cyberattacks.
  - Common vulnerabilities and Exposures - CVE
- Cybersecurity policies
  - Industry standards and applicable regulations
  - Cybersecurity policies
  - Security measures: back-up, log files, updates, access control
  - Identification of people, devices and systems
  - Management of users' roles and permissions
  - Configuration of allowed IP addresses
  - Management of system updates
  - Management of back-up copies
- Secure communications in industrial networks
  - Zoning and segmentation

○ Secure communications ○ Data security ○ Access control systems and credentials ○ Secure coding • Anomaly detection ○ Monitoring and detection systems ○ IDS, IPS, SIEM tools • Cybersecurity reports ○ cybersecurity diagnosis and reports
Credits
We assume that 25 hours of training correspond to 1 ECVET credit.

3.1.6 TM6: Transversal Competences

TRAINING MODULE: INFORMATION TECHNOLOGY AND OPERATIONAL TECHNOLOGY (TM6)
General description
This course is for technicians and professionals who would like to access and improve learning process on a different and pioneering way. At the end of the module, on a personal level you will have the ability to achieve individual learning, adapt on different situations, find innovative ideas and surpass difficulties. It is well known that a strong and complete personality is the first step on professional success. Furthermore, on social level you will be able to communicate with other people and cooperate properly. Last but not least, you will enrich your knowledge with the ability to handle effectively big information volume.
Learning Outcomes
Competences

- Have the ability to diagnose their needs and learn themselves, by taking the initiative.
- Be flexible and adaptable to handle new situations.
- Learn the right way to solve their problems.
- Find solutions to difficult or complex issues by breaking down information into smaller categories.
- Obtain a more critical and at the same time innovative way of thinking.
- Be able to communicate on a fundamental and effective level.
- Cooperate and work in teams, achieve an effective collaboration.
- Efficiently deal with the stress and stains of the modern workplace.
- Be able to lead teams successfully.
- Attain an intercultural understanding and an interest about internalization.
- Collect, process and analyze information.
- Plan and create projects by creating content.

Skills & Knowledge needed to achieve the competences

After the successful completion of this module, the learners will get the following knowledge:

- Learn by doing/ capitalizing new knowledge- new opportunities to learn/ Critically assess the resources/ learn how to learn/ individual learning
- Basic knowledge on project management/New tools- technologies/ Strategy development/Adaptive thinking/ receptive to new ideas, solutions, considerations
- Problem solving techniques/Creativity techniques/Analytical Tools for solving problems/ Complex thinking
- Ability to understand and count the value of information/social intelligence/ knowing your knowledge/ self-abasement
- Communication techniques/ Active listening/ Reflective Listening/ Picking the right medium/ Non-verbal communication/ Give and receive feedback appropriately/ Clarity and Concision/ Emotional Intelligence
- Group Dynamics/ Communication techniques/ Communication Technology/ Conflict resolution techniques/ Methods of Team Working/ Stress Management
- Self-motivation/ goals achieving, exchange and propose ideas/ take decisions/ utilize proposals/ leading teams

- Respect for diversity/ intercultural understanding/intercultural ideas/ worldwide identity
- Analyze available information/ Compare, Verify and Interpret Information/ Categorize Information/ turn data into insightful interpretations
- Prioritize, organize and manage, principles of project management

Moreover, they will get the following skills:

- Creative thinking skills/ Learning by experience skills/ Cognitive skills/ knowledge management skills/ Research skills/ Lifelong Learning
- Critically analyze the situation/ Change strategies and mindset in order to adapt to new situations/ critically analyze former strategies and their application to new situations/ Create new strategies/ Innovation Thinking
- Identification and definition of the problem
- Research skills
- Analytical skills
- Break down the issue to its critical components
- Create alternative solutions
- Evaluate alternative solutions
- Risk assessment skills
- Evaluation and Identification of the best solution to the problem
- Evaluate and identify alternative solutions that can be applied if the chosen one does not work
- Observation/ analysis/interpretation/evaluation/ inference/ creativity skills
- Communication Skills/ Social Skills/ Listening communication/ presentation skills/ verbal communication skills/written communication skills/ Empathy/ Open Mindedness
- Collaboration skills/ Team Management Skills/ Networking skills/ Stress Management Skills/ Negotiation Skills/ Conflict Resolution Skills
- Advising/ coaching/ conflict resolution/ decision making/ diplomacy/ team spirit/ cooperation
- Acceptability/ globalization/ broad reach of interests
- Analytical Skills/ Identification of critical components of an issue/ Critical Thinking towards information
- Planning and Organizing Skills/ Goal setting and Management skills

Training methods
The training methods that will be used to deliver the course are online courses at the MOOC https://e-training.dtamproject.eu/
Assessment methods
• Self-assessment quizzes during the online courses • Exercises to run at the IoT labs • Challenges to run at the IoT labs
IoT Lab
• Not applicable
Learning units

• Self-learning
  ○ Learning styles to learn faster
  ○ Way to assess learning resources
  ○ Tact to engage in learning process, diagnose formulate learning goals
  ○ Evaluate learning outcomes
  ○ Motivation for learning
• Flexibility & critical Thinking
  ○ Flexibility and adaptability to new situations
  ▪ Characteristics of an adaptable and flexible person
  ▪ Ways to make successful changes
  ▪ Methods, procedures, and techniques to increase the effectiveness of changes.
  ○ Critical and innovative thinking
  ▪ Process of critical thinking
  ▪ Components of the process
  ▪ Critical thinking abilities
  ▪ Meaning of innovative thinking

        - Ways to develop innovative ideas
- Problem solving
    - Find and define the problem
    - Generate, evaluate, and select alternatives
    - Ways to implement solutions
    - Recommendations to handle the complexity of the problem
- Communication and Cooperation
    - Effective communication
        - Methods of communication
        - Reasons for communication problems
        - Main set of principles to achieve effectiveness
    - Team Working
        - Strategies to create a well-balanced team
        - Ways to divide roles and responsibilities between members
        - Criteria of a successful teamwork
- Leadership
    - Ways of leading
    - Characteristics of a good leader
    - Handle responsibilities and decisions
- Globalization
    - Definition of interculturalism
    - Different cultures and way of thinking
    - Value of respect and acceptance
    - Cultivate positivity
- Analysis of Information
    - Methods of data collecting
    - Types of content analysis
    - Control reliability and validity of information
- Project Management
    - Definition -types of projects Project lifecycle
    - Project Planning
    - Risk assessment

○ Planning tools-IT solutions ○ Monitor and control project baselines ○ Communications ○ Change management ○ Project closure
Credits
We assume that 25 hours of training correspond to 1 ECVET credit.

4 References

[1] CEDEFOP, Defining, writing and applying learning outcomes.

[2] EC, Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning.

[3] ESCO, Knowledge definition.

[4] ESCO, Skill definition.

[5] ESCO, Competence definition.

[6] ESCO, Qualification definition.

[7] ESCO, ESCO qualification pillar.

[8] ESCO, ESCO Skills pillar.

[9] ECVET, Identify Units of Learning Outcomes.