SmartDIGI

Best Practice

Executive Summary

The SmartDIGI project is focusing on mastering the education concept "education as a service" to support the T-shaped skills of workers. This document presents different pilot activities organized by the SmartDIGI Consortium, and their findings.

Following the developed methodology, all pilot activities are delivered by innovative program, where students, academics, and manufacturing SMEs work together to build skills by co-creating solutions to real manufacturing challenges using Teaching and Learning Factory approaches. Those are accompanied by an open information event promoting the upcoming opportunities towards industrial SMEs across partnering countries. Under the SmartDIGI project six pilot activities are realized creating a bridge between industry and academia or connecting academia with academia.

SmartDIGI pilot educational activities

The table presents an overview of all pilot activities and the online information event, executed under the SmartDIGI project. A thorough description of each Teaching and Learning Factory can be found in the following sections of the report.

EDU Activity	Organizer & Support	Date	Companies/Universities	Topic
Teaching Factory "Academia to industry"	LMS and Cleantech Bulgaria	10/11/2022 21/11/2022	Evro Konstrult OOD, 3DBGprint, Institute of Electronics, Bulgarian academy of Sciences, Id's bg, Space Cad	Additive Manufacturing (3D Printing) Technologies
Learning Factory "Academia to Accademia"	CTU and IMH	03/11/2022 10/11/2022 10/11/2022	CTU in Prague, IMH, University of Patras	Accuracy and productivity enhancement in smart machines
Teaching Factory "Industry to Academia"	CTU and LINPRA/ Intechcentras	24/11/2022 01/12/2022 08/12/2022 15/12/2022	Axioma Metering	Production process of smart ultrasonic flow metre
Teaching Factory "Industry to Academia"	IMH and LINPRA/ Intechcentras	11/11/2022 18/11/2022 23/11/2022 30/11/2022	ABF LT	Temperature tracking system
Teaching Factory "Academia to industry"	Tecnalia and Cleantech Bulgaria	22/11/2022 24/11/2022	European digital innovation hub in construction sector in Bulgaria, Bulgarian Construction Chamber	Digital Twin of a Building and Digital Twin of an Infrastructure
Online Information Event	Cleantech Bulgaria, LMS and Intechcentras	14/06/2022 15/06/2022	VILPROS PRAMONE UAB, Domusa Teknik, JVTP, Sefini llc. Belgrade	Digitalization of SMEs for solving manufacturing challenges

‘Academia to Industry’ Teaching Factory-Pilot 1

Description

LMS together with Cleantech Bulgaria organised a Teaching Factory on Additive Manufacturing (3D Printing) Technologies. 3D BG Print - a company from Bulgaria, was identified and approached by Cleantech Bulgaria. The company works in the field of 3D printing – additive manufacturing thus having extensive knowledge and expertise.

Challenges and needs

Additive manufacturing process is a novel technology, with limited industrial implementation. Unfortunately, most of the companies in Bulgaria are new or need further details, practical examples and inspiration on how to put this technology into practice. For those reasons, the participants of the sessions were not only employees of 3D BG Print, but also representatives of their partnering companies or potential clients who are either not familiar with the topic or have some basic understanding. The goal is to enable more companies to adopt, integrate into their daily work and processes 3D printing – additive manufacturing. In that relation, the Teaching Factory aims to fill the gap, to inform industrial partners and to provide solutions about the proposed topics and address the needs of the targeted participants.

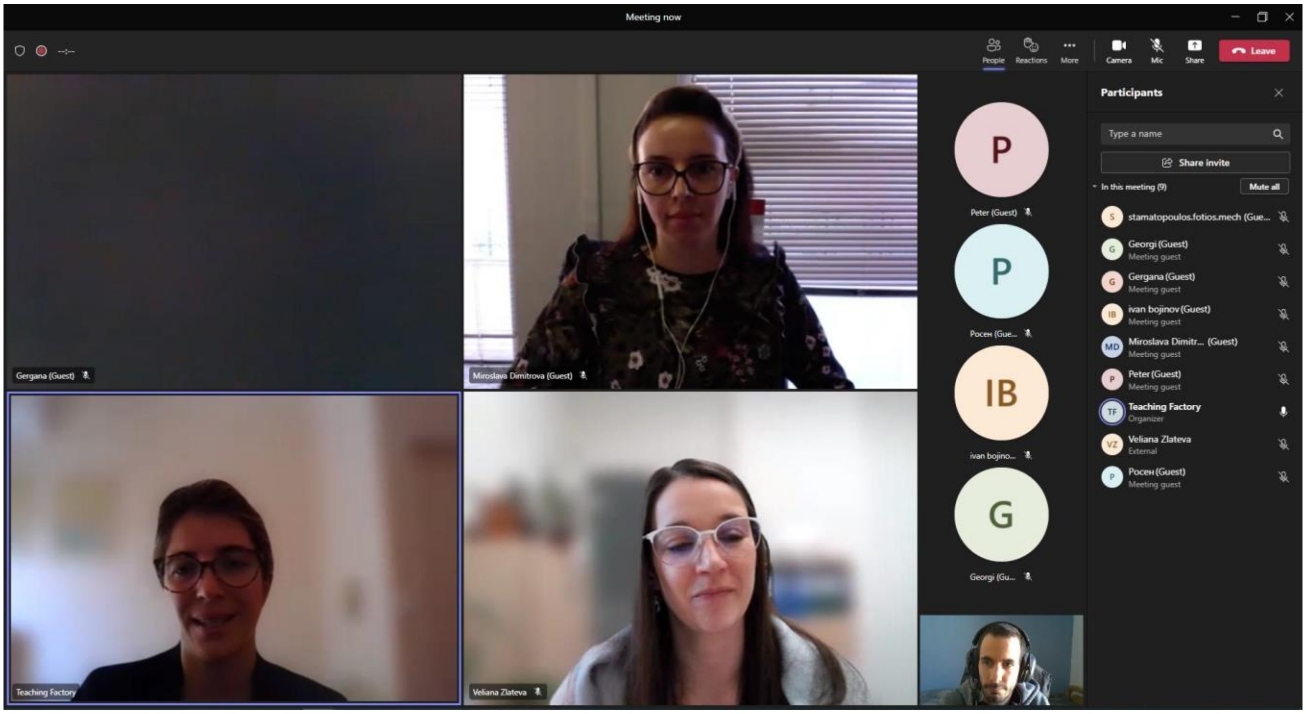
Learning Process Agenda and Schedule

The teaching factory was organised in two sessions, one hour long each, via MS Teams:

- Session I, 10th November 2022, “Introduction to Additive manufacturing technologies”
- Session II, 21st November 2022, “Additive Manufacturing process and material selection”

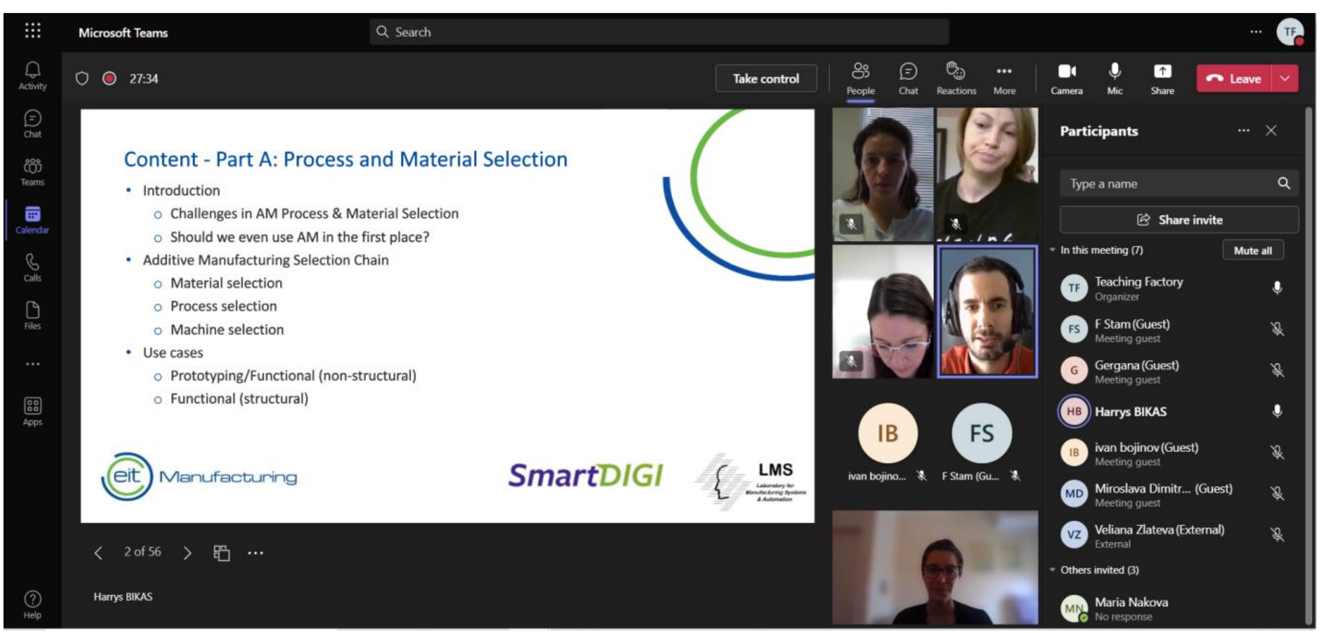
Session I “Introduction to Additive Manufacturing Technologies”

The first session focused on introducing additive manufacturing technologies, starting with an overview of the various additive manufacturing techniques and moving on to a discussion of the benefits of Additive Manufacturing. Then, to summarise the main technologies, the main additive manufacturing technologies were given, along with an overview of the additive manufacturing processes. The fields of application were identified, but also the primary difficulties for the successful implementation of additive manufacturing in an industrial environment.



Session II "AM Process & Material Selection"

The second session focused on describing the decision criteria for selecting the most suitable material, AM process as well as the most suitable machining for additive manufacturing. In addition, the different properties of different materials for additive manufacturing were described, and the characteristics and advantages and disadvantages of different families of additive manufacturing processes were compared. In addition, different typical uses and application examples per AM process were highlighted and the decision criteria on how to select the appropriate AM material and process/machine were analysed and explained in detail. Moreover, different AM use cases/case studies were presented helping employees think about where and how they can use the technology in their production.



Competency assessment method used

Following the completion of the second session, the entire teaching factory was assessed using a competency evaluation approach. The questionnaire was distributed via a google forms link. The participants expressed that the sessions were interesting, interactive and the content was useful for them.

Learning Outcomes

Employees learnt about the distinctions between different AM process families, prospective additive manufacturing applications, and the benefits and drawbacks of adopting this technology through this Teaching Factory. Finally, students learned how to choose the best Additive Manufacturing process and materials for the creation of a certain part.

'Academia to Academia' Learning Factory- Pilot 2

Description

CTU together with IMH organised with the support of LMS a Learning Factory on Accuracy and productivity enhancement in smart machines. CTU and IMH identified experts in the field and composed a Learning Factory as a blended double section meeting finished with Skills.Move SmartDIGI original and tailor-made webinar on the subject of "Monitoring and control of manufacturing processes".

Challenges and needs

A machine tool can be considered as a rigid system. However, a number of dynamic phenomena resulting in structural deformations load the machine during a working process. In addition to errors caused by manufacturing and assembly inaccuracies, the machine is exposed to static, dynamic and thermal deformations. Thermal errors accompanying machine operation contribute 40-70% to the overall MT inaccuracy detected on the workpiece. Due to the mentioned share of thermal errors, their minimization is one of the main goals of MT designers. Generally, a solution to this issue falls into one of the main groups: 1) machine structure optimization leading to lower sensitivity to heat flow; 2) temperature gradient control of the MT and its environment and 3) compensation of thermal errors. Since compensations are an economically and ecologically promising way of minimising thermal errors the direct (in-process measurements) and indirect (using predictive models) have been addressed by many researchers in the past few decades. Under the umbrella of Industry 4.0 widening the sensory equipment of machines, the combination of both approaches becomes a logical and very promising way of increasing the long-term reliability and robustness of compensation models toward intelligent manufacturing. In the light of smart manufacturing, the need for quality input information for modelling efforts and the industrial applicability of achieved scientific results are emphasised.

Learning process agenda and schedule

The learning factory was organised in three sessions, one and half hour long for lessons and one hour of Skills.Move webinar. MS Teams have been used as ICT tool for online streaming of the lessons combined with physical attendance at CTU facilities (the blended approach). The agenda can be found below:

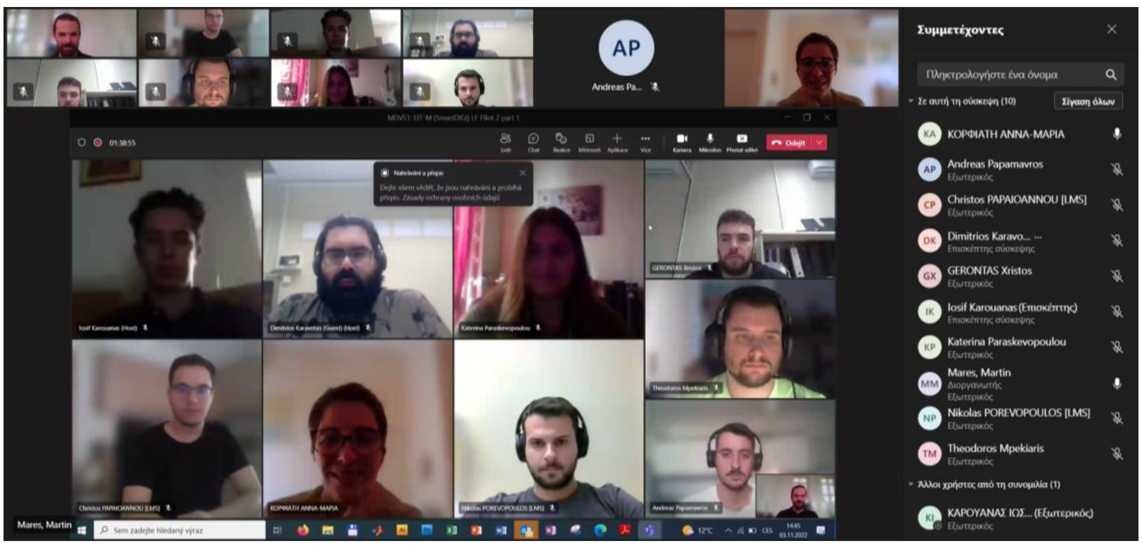
- Session I, 3rd November 2022, "Modern techniques for non-stationary geometrical error reductions"; Examples of measured data on different production machines and various conditions to show complexity of the problem and possible solutions. (CTU)
- Session II, 10th November 2022, "Smart Sensor and Cyber-Physical Systems"; Smart sensors in a deeper concept of CPS. Use of smart sensors in different manufacturing tasks and issues. (IMH)
- Session III, 10th November 2022, "Monitoring and control of manufacturing processes" Skills.Move webinar. (IMH, CTU, LMS)

Methodology

The activity took place on two days (3rd November 2022 and 10th November 2022) on two specific topics that were addressed in individual sessions finalised with guided Skills.Move webinar.

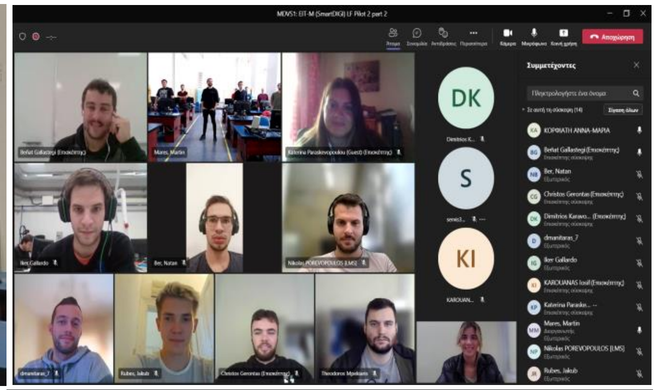
Session I "Modern techniques for non-stationary geometrical error reductions"

The first session focused on advanced methods to minimisation of undesired non-stationary thermoelastic effects on machine accuracy, starting with overview of thermal influences affecting machine structures and general methods to cope with, e.g. redesign of machine skeleton to less thermal sensitivity, heat flux control or simulation techniques for the future: thermal digital twins and issues with boundary conditions. Despite the effectiveness, the introduced techniques are possible only in the prototyping stage of the machine or result in higher purchase and operating costs. The core of the session is interested in developing an economically and environmentally advantageous solution in the form of compensation techniques based on transfer functions. The approach of software compensation is introduced on a row of machine tool structures enlarging the applicability from one case study to another resulting in 5-axis and multifunctional machines and verification testing workpieces. The attention is drawn to the quality of input signals into compensation models presented by the smart sensor and sophisticated measuring device development. The session ended by possibilities of industrial applications via direct implementation of the models into control systems and their superior environments to enlarge machine intelligence.



<u>Session II “Smart Sensor and Cyber-Physical Systems”</u>

The second session focused on smart sensor and cyber-physical systems aiming to explain how to obtain valuable data from the manufacturing processes. The session started with an introduction of what is a smart sensor and an overview of different smart sensors. Then, the session followed by an introduction to Micro Electro-Mechanical System sensors (MEMS sensors) and their applications. Afterwards, an introduction to cyber-physical systems (CPS) was made and the technologies involved to develop a CPS. CPS were also related with the concepts of Industry 4.0 in order to show how they can help in the development of the industry. Finally, the session ended with a presentation of different projects applying smart sensors developed by IMH.

Session III “Monitoring and control of manufacturing processes”

The third part consisted of Skills.Move webinar with related content to the topics of the Learning Factory. The delivery method was “frontal guided lesson” where participants in one room went through the learning path (LP) with the lecturer. Lecturer projected the LP and commented. Each participant had the LP on the screens in front of his being with the possibility to move freely in the LP content, ask questions, better understand and fill the quiz.

The learning path “Monitoring and control of manufacturing processes” is composed of 5 digital nuggets: 1) Heat transfer in machine tools – state of the art; 2) Smart sensors –applications and uses in production machines; 3) Adaptive compensation of machine tool thermal errors for smart manufacturing; 4) Introduction to Welding Technology; 5) Quiz: Monitoring and control of manufacturing processes. Duration of LP delivery was approx. 1 hour.

Competency assessment method used

Following the completion of the third session, the entire learning factory was assessed using a competency evaluation approach developed by Cleantech Bulgaria. The questionnaire was distributed via a google forms link.

Learning Outcomes

Students and researchers from CTU in Prague and University of Patras learnt about the modern techniques of machine tool accuracy enhancement and process monitoring in smart production systems. Participants also gained knowledge regarding smart sensors and their role in cyber-physical systems. Participants had an opportunity to learn about real practical and industrial applications of introduced solutions.

‘Industry to Academia’ Teaching Factory- Pilot 3

Description

CTU together with InTechCentras organised a Teaching Factory on Industrial challenge: Accuracy enhancement of automated technology. InTechCentras defined a proper industrial partner for challenge setup. CTU incorporated the challenge in the form of a hackathon into a regular course (project) for the students of fourth grade. Students worked in teams (from two to four, selected by themselves). Communication with the industrial partner representative was conducted online via. MS Teams and via e-mail communication (sharing questions and other digital material).

Challenges and needs

Industrial partner (Axioma Metering) develops and manufactures ultrasonic heat, water metering, and data management devices since 1992. In the last years, the company developed Smart ultrasonic water metre designed for accurate measurement of cold and hot water consumption in households, apartment buildings and commercial premises. It is the smallest smart water metre in the market. Accuracy of the component assembly is one of the main factors influencing the quality and productivity.

Water metre consists of five main components. The main issue in the assembly process occurs in the Measurement flow unit. This unit consists of six parts, Insert DN15 is one of them. The insert is assembled from top and bottom side. Both sides contain mirrors necessary for ultrasonic principles proper work. The mirrors are moulded into insert parts and the process of placing the mirrors into nests on the pallet for the moulding machine is the main source of inaccuracies and scrap production. The scrap production controlled by automatic optical inspection (AOI) lies between 2.5 up to 15%. The main goal of the innovation experts in Axioma is to reduce the number to 1.4%. The inspection of the automatic process starting from placing the mirrors into nests on pallet, through two robotic workstations and AOI to the moulding machine is the topic of the challenge.

Learning process agenda and schedule

The Teaching Factory was organised in four sessions, each with different durations, in a blended format. The first five-hour session was divided into one hour of presentation and discussion with Axioma experts via MS Teams and the rest of discussion with two CTU mentors. The second and third five-hour sessions were held each physically in the classroom with the mentors of CTU. Finally, the fourth session of final pitching of the solutions lasted around one hour, via MS Teams. The agenda of the Teaching Factory is listed below:

- Session I: 24th November 2022, at 14:30, “Axioma challenge set up: To review station production process and identify critical area or process parameters which have main impact for process stability and rejected part rate at AOI”, via MS Temas.
- Session II: 1st December 2022, at 14:30, “Teamwork on proposal, suggestion or solutions for station tooling update or process parameters adjustment due to improve stability of mirrors position”, physical session. Question list composition and e-mail exchange.
- Session III: 8th December 2022, at 14:30, “Teamwork on proposal, suggestion or solutions for station tooling update or process parameters adjustment due to improved stability of mirrors position – continuation and update”, physical session. Question list update and e-mail exchange.
- Session IV: 15th December 2022, at 14:30, “Final pitching to Axioma”, via MS Teams.

Methodology

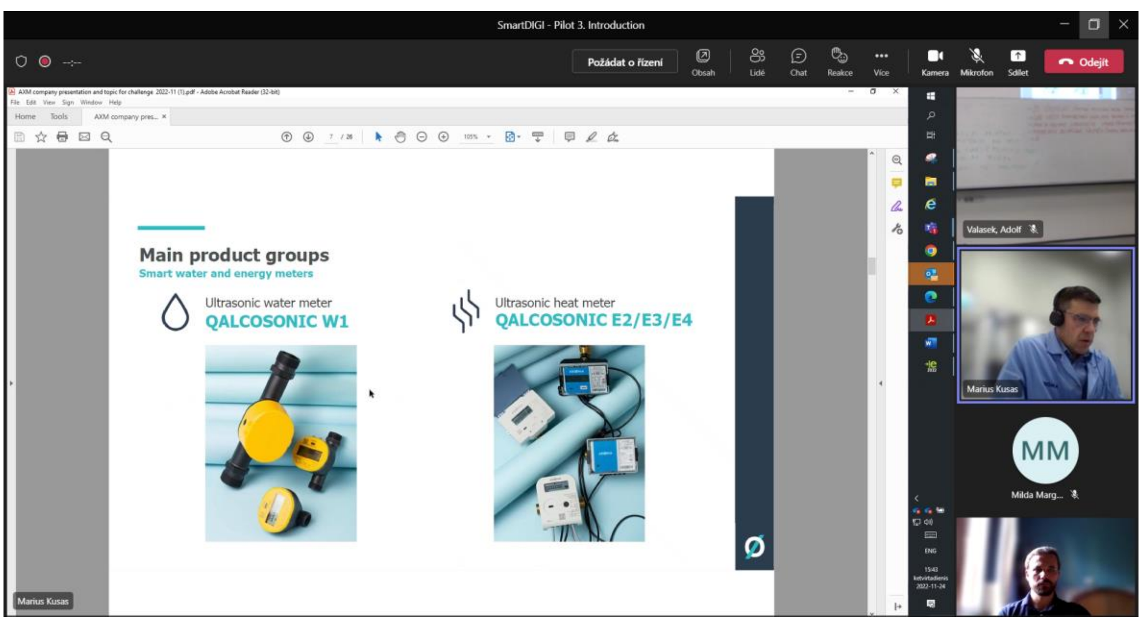
InTechCentras has a network of LINPRA members (about 130 members) - phone number and e-mail of each member. InTechCentras scouted for companies by sending an email to everyone containing a letter with an invitation to register (for those with technological challenges). Having no results, InTechCentras changed the approach and targeted companies who had been visited before and were facing challenges. At the end out of ten potential companies whose technological challenges corresponded to the required areas were selected only two - among them was Axioma Metering who took part in the Teaching Factory.

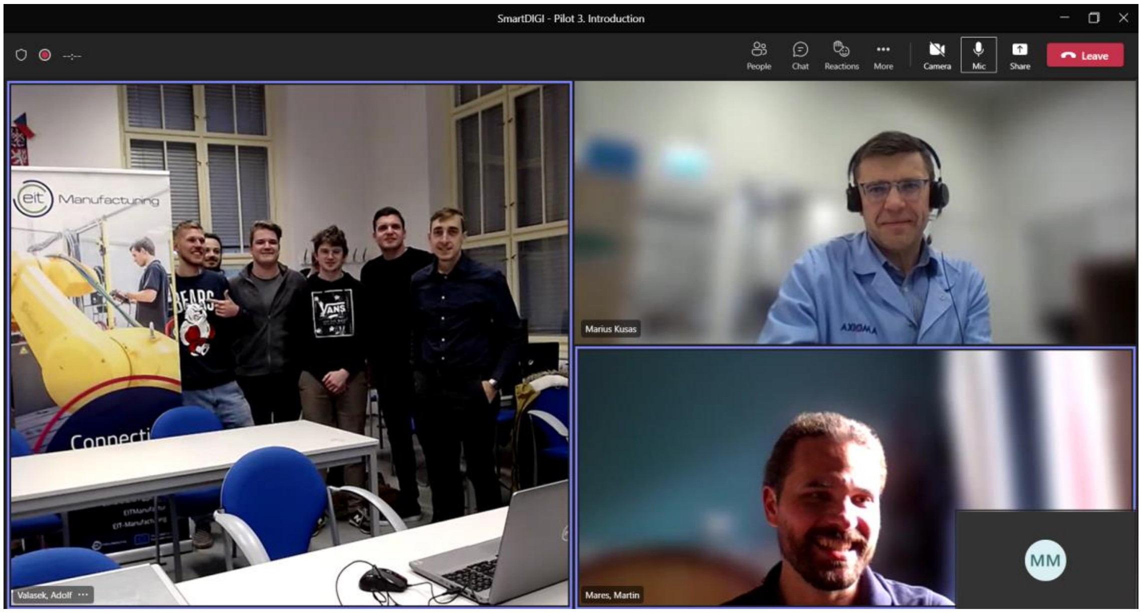
The activity was divided into four sessions (24th November 2022, 1st December 2022, 8th December 2022 and 15th December 2022). All online sessions have been recorded.

Session 1 “Axioma challenge set up”

In the first session of the Teaching Factory focused on the challenge set up. The session started with an overview of Axioma Metering, what they do, their catalogue, the sector they work in and outlook on future visions. Explanation of the ultrasonic sensors working principle, an overview of product portfolio and the applications followed the introduction. Axioma finished the presentation by setting up the challenge to the students - review station production process and identify critical area or process parameters which have main impact for process stability and rejected part rate at AOI.

The set up was accompanied by detailed descriptions of all main parts of the moulding line, robotic workstations, grippers and AOI process. Axioma expert also revealed his opinion to the scrap production problem and defined some issues that the company is researching parallelly. The introductory part finished with a Q & A section. The rest of the session was dedicated to research of the existing solutions on the market to improve orientation in real industrial challenges. Follow up questions were gathered during the week into excel file and sent to Axoma representatives for clarifications.





Session 2 “Teamwork#1-ideation”

Students divided into four working teams having started to develop their first solutions. Axioma supported CTU by 3D models of all parts of the sensor and detailed description of moulding link. Based on that input, teams have been able to design 3D models of improved parts of the nests and grippers. Further questions arose and were again addressed to company representatives.

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Co-funded by the European Union

Questions for AXIOMA

Question	Answer
Which failure is more common? Missing mirror, or misalignment?	During today trial run most of the failure was missing square mirror.
What's the precise type (Manufacturer and product number) of vacuum grippers on Kawasaki robots end-effector and also on ABB robot ?	I'll double check with EQ producer
Which products are more often missing/misaligned ? Rounded or renctangular?	Missing renctangular mirror, misaligned rounded mirror.
Are there any temperature changes in the production hall during the day ?	Now (winter time) we have temp. changes up to 2-3 oC, depend on how much molding machines is working, but in summer time environment temp vary up to 8-10 oC.
Are there any possible disrupting processes in nearby of this production line? (For example presence of forming machines that could be causing vibrations etc..)	Next to the line there are industrial refrigerator and another injection molding machine.
Is it generally possible to say that the most of errors are caused in the first segment of process during the transport from feeder to pallete by robot ?	Yes it is. From my point of view problem accour mostly on ABB robot.
Would it be possible to send us processing footage from cameras that are located over feeders + evaluation parameters on the basis of which the choice of gripped mirror is made	I'll double check with EQ producer regarding camera SW and feedback to you.
In what way is ensured the end position of pallete conveyor ? Sensor or mechanical stop ?	Mechanical stopper with amortizator + sensor.
What is reason for separation of two workplaces? Would it be possible for one robot to directly pass mirrors to second one, in the terms of manufacturing process?	
Is it possible to see jigs without mirrors?	

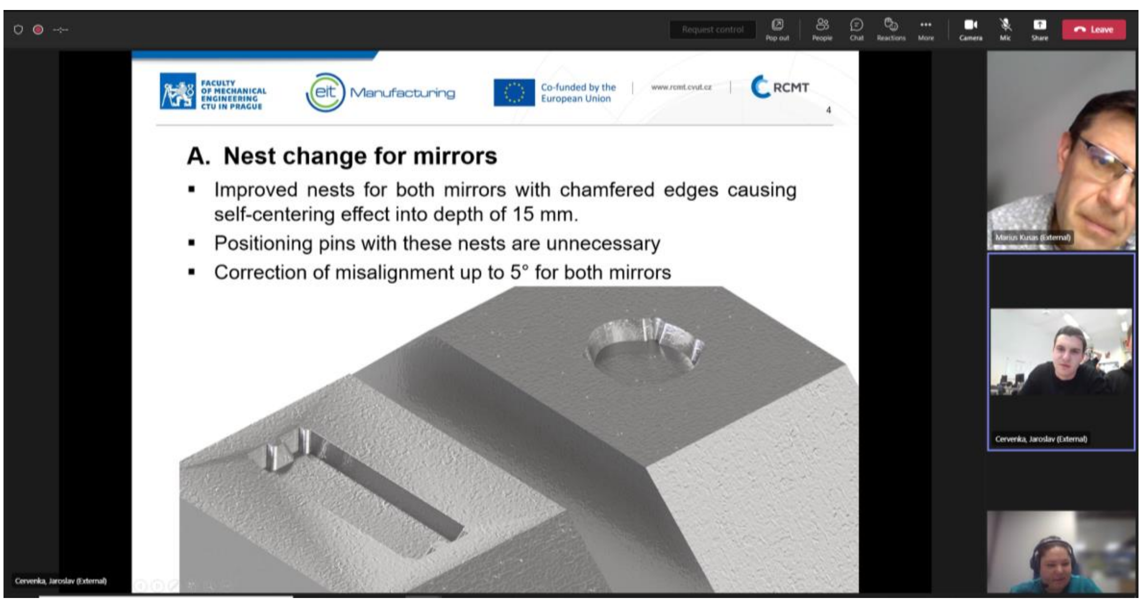
Session 3 “Teamwork#2-improving”

The third session focused on improving the initially designed solutions by teams. Students and mentors worked together on finalising the ideas and starting preparation for final pitching of the developed ideas to Axioma representatives. In the process additional inputs were required by company representatives such as 3D models of detail nest in the pallet which were provided in the upcoming few days. Teams and mentors continued their work after the session striving to improve the presentation for the final pitching day. Along the executed activities were dry runs in English.

Session 4 “Final pitching to challenge setter”

The last session was conducted via. MS Teams with teams presenting the developed solutions to Axioma representatives. Each group of participants used a different approach while explaining their idea followed by a short question and answer session. The most applicable and suitable solutions were discussed further among the team and company representatives.

At the end of the session Axioma received all presentations containing the developed solutions by teams and provided participants with feedback and comments for improvement via. e-mail.



Competency assessment method used

Following the completion of the third session, all participants in the Learning Factory were assessed using a competency evaluation approach developed by Cleantech Bulgaria. The questionnaire was distributed via a google forms link.

Learning Outcomes

While working on the provided challenge students had the opportunity to interact with business representatives thus having valuable lessons on the way. On one hand students have to think out of the box and go beyond university studies in order to solve a problem coming from a business successfully. On the other hand, they need to develop soft skills such as teamwork, communication to other stakeholders, even challenge themselves and use only the English language which is foreign to all of them. Another key point is the feedback from company representatives providing participants with unique point of view on their efforts and developed solutions. All those factors enabled students to work in an environment close to the one in the business world having to meet expectations within limited time, resources and pressure.

‘Industry to Academia’ Teaching Factory- Pilot 4

Description

IMH together with Intechcentras organised a Teaching Factory on Data Processing Techniques. Intechcentras identified and approached ABF LT, an aluminium casting company from Lithuania. The company works, mainly, in the aluminium casting, CNC turning and milling and rotary transfer machining operations thus having extensive knowledge and expertise in the machine-tool sector.

The challenge of the Teaching Factory was proposed by ABF LT to first year students of process and products innovation engineering of IMH. The Teaching Factory was integrated in the informatics course, so all students of the course participated in it.

Challenges and needs

ABF LT cannot track the temperature of aluminium in a melting furnace. The melting temperature of aluminium is 660 °C. During nights the temperature of the furnace is set to be 650 °C, and on weekends 620 °C, so as not to waste time and energy in heating the aluminium in the morning. The temperature is controlled with a thermocouple, which is connected to the furnace and shows the temperature on the screen. When furnaces are left unattended and running, during weekends for example, the temperature rises because of malfunction or issues with the gas system. Then the crucible cracks and liquid aluminium pours out through the gates to pit under the furnace. In order to avoid that, ABF LT introduced a secondary thermocouple to show the information in a web app, so it can be checked remotely. The application should immediately notify app holders when the temperature of the furnace reaches a certain point, so they could react and arrive to switch off the furnace.

The challenge consists of making a temperature tracking system algorithm that creates a notification when the temperature reaches a certain point. Additionally, students were asked to think about improvements and user-friendly functions for the system and implement them into the algorithm.

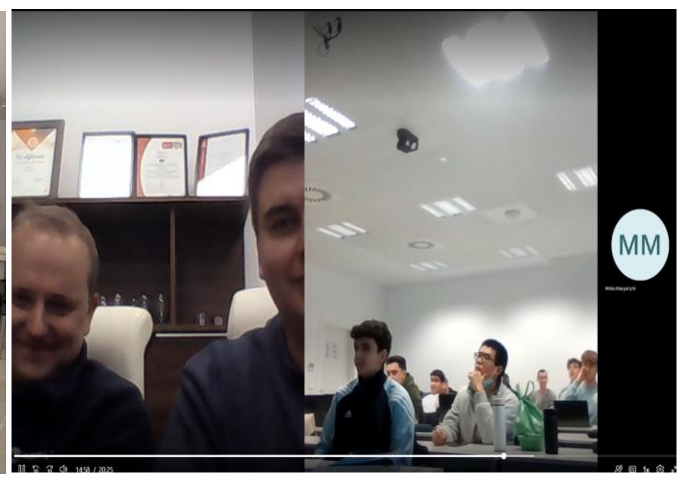
Learning process agenda and schedule

The Teaching Factory was organised in four sessions, with different durations, in a blended format. The first session was a two-hour session, divided into thirty minutes of presentation via MS Teams and 90 minutes of discussion with experts (Dr. Iker Gallardo and Kristian Sanz). The second and third sessions were two hours long each physically in the classroom with the experts of IMH. Finally, the fourth session lasts around 30 minutes, via MS Teams. The agenda of the TF is found below:

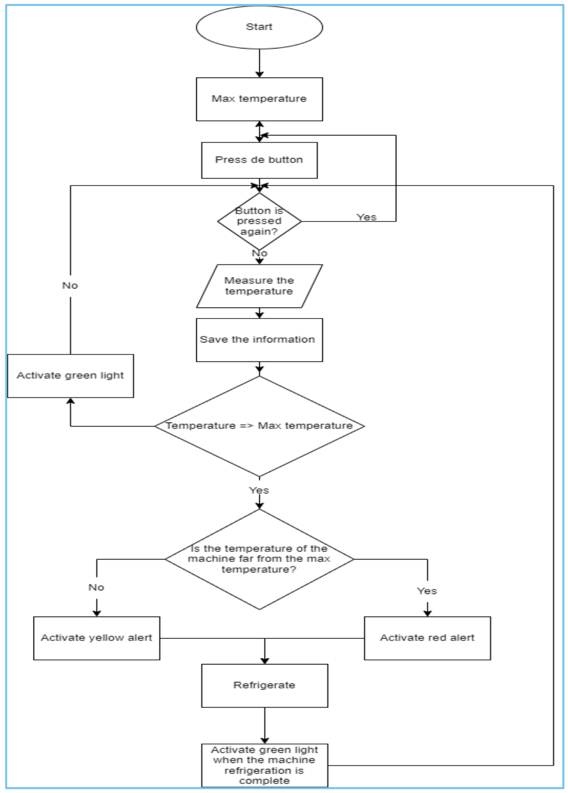
- Session I: 11th November 2022, at 10:30, "ABF LT challenge set up: Temperature tracking system", via MS Temas.
- Session II: 18th November 2022, at 10:30, "Designing the temperature tracking system", physical session.
- Session III: 23rd November 2022, at 10:30, "Improving the temperature tracking system", physical session.
- Session IV: 30th November 2022, at 10:30, "Presenting the designed tracking algorithms to ABF LT", via MS Teams.

Session I "ABF LT challenge set up: Temperature tracking system"

In the first session of the Teaching Factory focused on the challenge set up. The session started with an overview of ABF LT, what they do, which is their catalogue and the sector they work for. After that, an explanation of the working principle and an overview of the used thermocouple was given. ABF LT finished the presentation setting up the challenge of developing a temperature tracking system in order to detect when the temperature of Aluminium exceeds the critical temperature and create an alert.

After the presentation, students from IMH were divided into groups of three and started working on the project with the experts from IMH and prepared the flowchart of the temperature tracking system. This is an important step to explain how the algorithm will work.

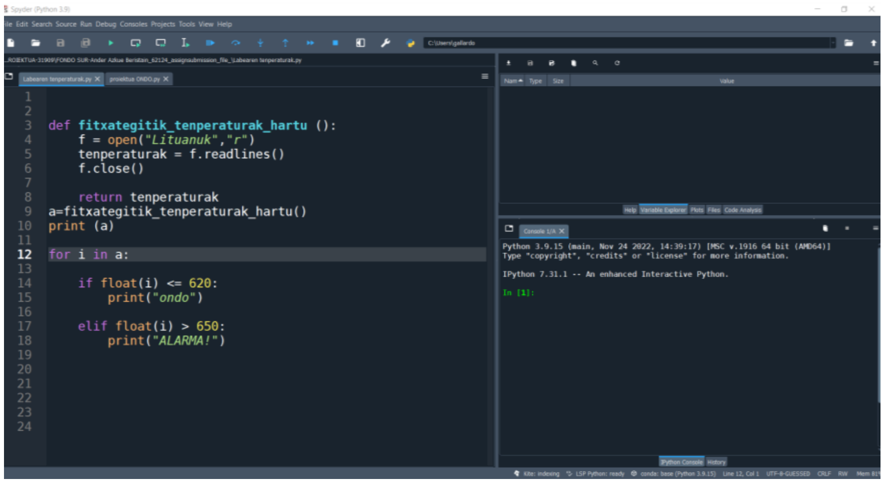


Session II "Designing the temperature tracking system"

The second session was dedicated to design and development of the main algorithm, needed variables and the type of data they will contain were defined. See the next table as an example of a table with the variables.

VARIABLE	NAME	DESCRIPTION	TYPE
1	Temperatures	Temperatures of the furnace.	Float
2	Correct_temperature	If the temperature of the furnace is correct. If not the alarm will be shown,	Bool
3	Filename	File where furnace data will be stored.	File

Also, the main program was developed.



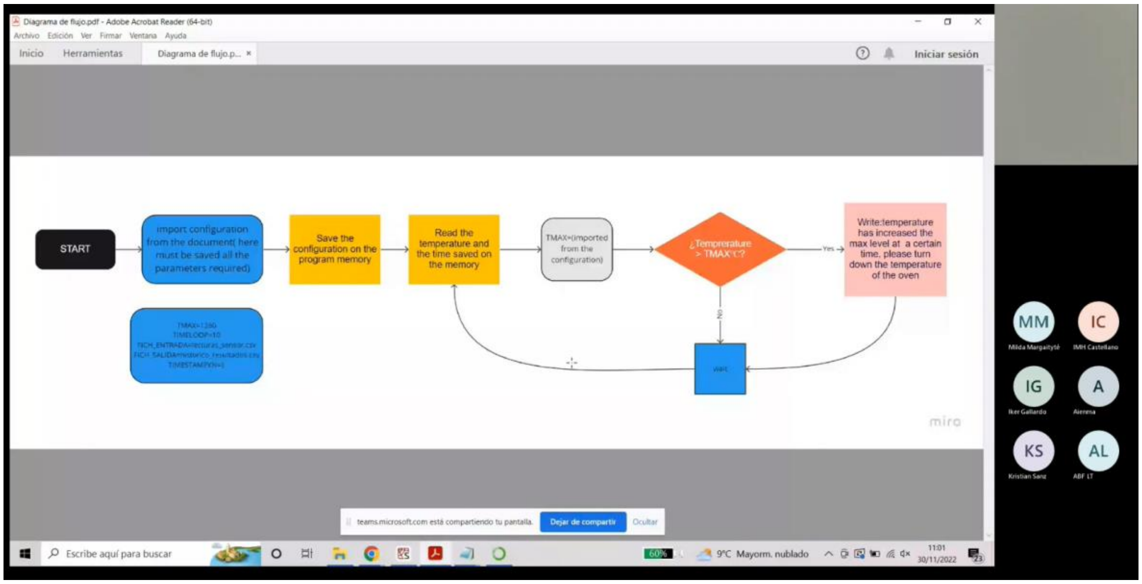
Session III "Improving the temperature tracking system"

The third session was dedicated to make improvements on the main program. Different adjustments and upgrades were proposed by the groups, such as a button to start and stop the program and a plot to show the temperature change of the furnace.

Session IV "Presenting the designed tracking algorithms to ABF LT"

In the fourth session the two best works were presented to ABF LT, via MS Teams. The first group improved the temperature tracking system by using a configuration file that is loaded to the program with the main characteristics of the program. The file contains the values of the maximum temperature to create the alarm, the time between two measures of the temperature and the input and output filenames. Using this configuration file makes it easy to change any parameter of the tracking system.

Firstly, they presented the flow chart of their program to show how it works. Then, they show the algorithm they had written and explain the functions they had created and the flow of the program. Finally, they did a demonstration with data they had created to simulate the behaviour of a furnace.



The second group, on the other hand, correctly implemented the storing of the data and plotting of the temperature during the time it is measured. In the case of the second group, they showed the algorithm written and explained how it works and made a demonstration.

<u>Competency assessment method used</u>

Before the fourth session, students had to submit their algorithm to be evaluated by the experts from IMH. All solutions were evaluated depending on the working of the algorithm and the improvements implemented:

- The algorithm works correctly: +4 points
- Data readed from a file: +1 points
- Storing data in a file: +1 points
- Plots the data: +1 points
- Divided into functions: +1 points
- Periodicity of the algorithm: +1 points
- Configuration file: +1 points

After the evaluation of the composed solutions, only the best two were selected to present in the fourth session, as there were fourteen groups and not all of them managed to create working algorithms.

'Academia to Industry' Teaching Factory-Pilot 5

Description

Tecnalia and Cleantech Bulgaria organised the Teaching Factory with the title: Digital Twin of a Building and Digital Twin of an Infrastructure. Digital Twin is novel technology that has great potential in different sectors and particularly in construction to improve workforce productivity, health and safety, allow for efficient facility management, enhance the proficiency of the workforce, improve the design process and reduce the cost of construction and operation, among other benefits. Tecnalia has a team of researchers developing applied R&D projects in these technologies in collaboration with industries.

Challenges and needs

A digital twin is a digital representation of a physical asset/object connected to real time data sources using sensors. Simulations can be run to analyse its behaviour in new scenarios. So, this digital representation allows future decision-making in order to optimise the behaviour of the asset and processes.

Construction is quite a traditional sector, and the introduction of new technologies is not easy. Construction is mainly based on manual processes, where different aspects must be coordinated in the construction phase: personnel, equipment, materials, weather conditions, etc. This manual coordination can lead to delays, inefficiencies, and cost overruns.

The digital twin technologies address the main challenges posed by buildings or other assets/infrastructures, allowing managers to focus on improving energy efficiency and sustainability, on the industrialisation and automation of processes and on key areas such as maintenance, safety, among other issues.

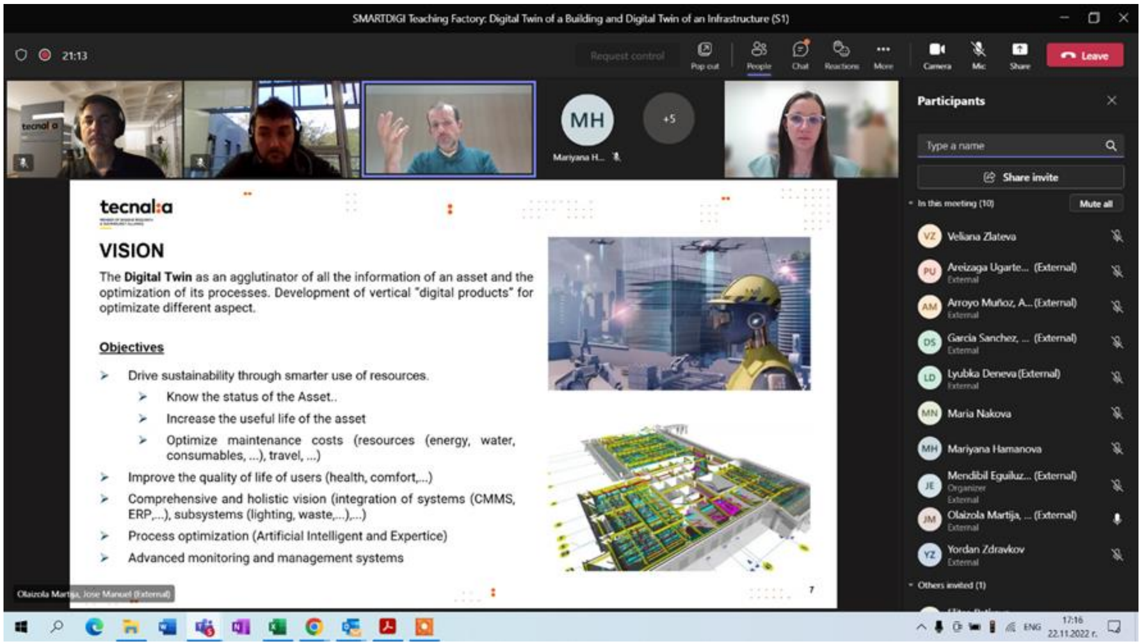
Learning process agenda and schedule

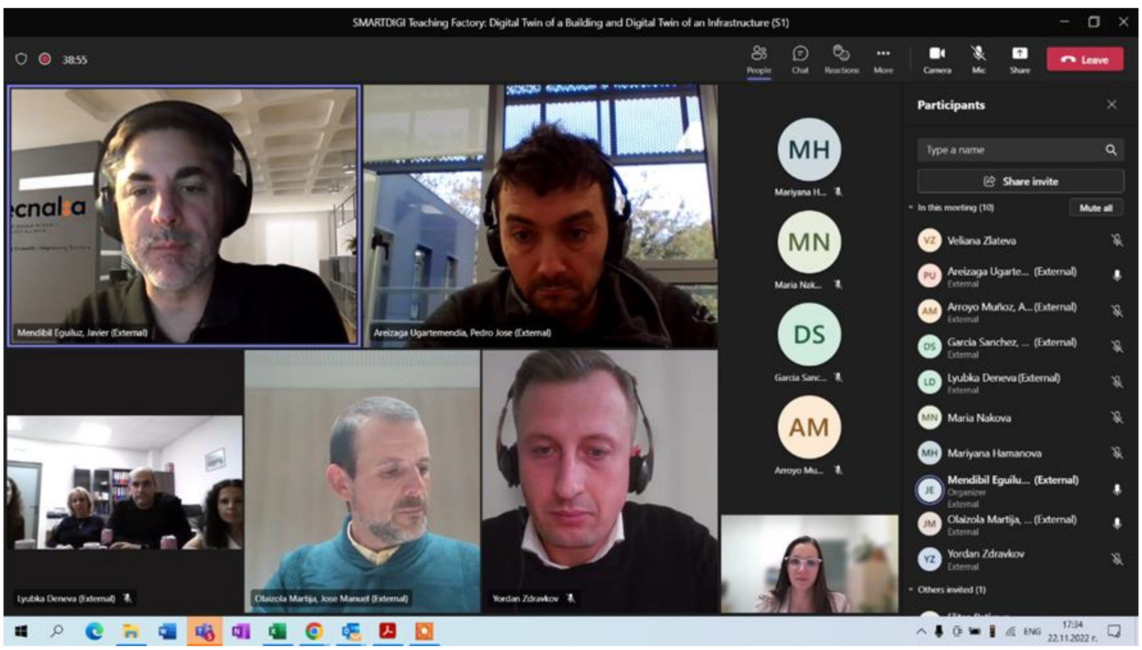
The teaching factory was organised in two sessions, ninety minutes long each, via MS Teams. The agenda was:

- Session I, 22nd November 2022, "Digital Twin of a Building"
    - Digital Twin: Concept and Technology
    - Digital Twin in building
- Session II, 24th November 2022, "Digital Twin of an Infrastructure"
    - Digital Twin in Infrastructure. State of the practice
    - Future trends and research

Session I, "Digital Twin of a Building"

The first session started with the Concept and Technology: what a digital twin is and how it can help our business grow in AECO (Architecture, Engineering, Construction and Operation) industry. Teachers presented several examples of application of the digital twin concept to the building environment so participants could know about examples in energy efficiency, indoor air quality or maintenance optimization.



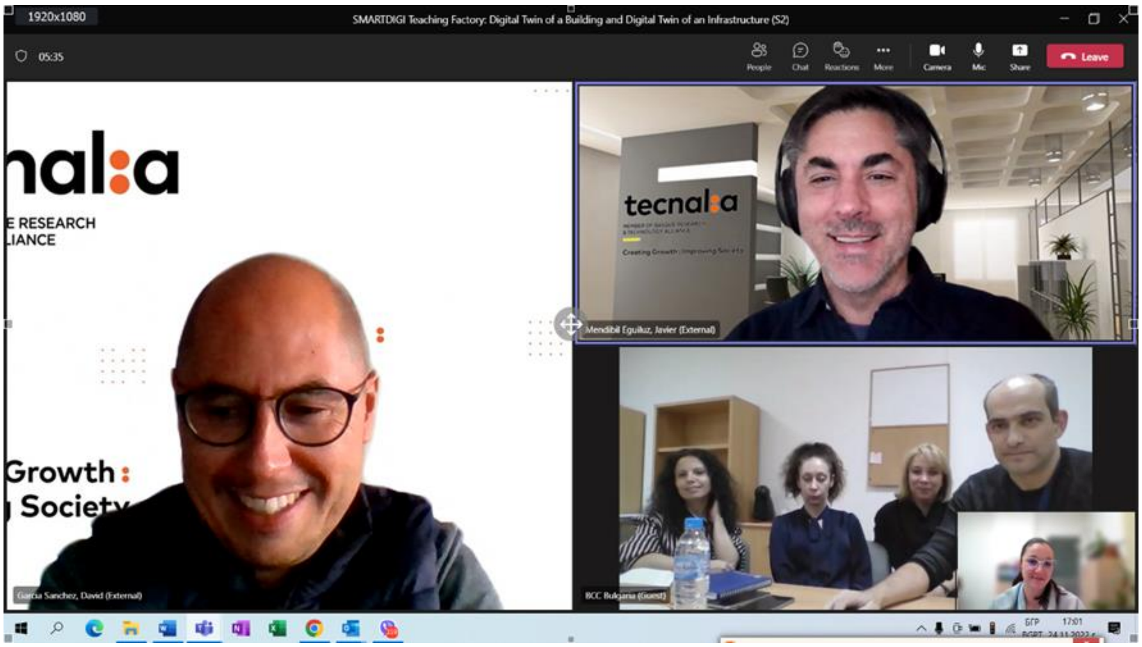


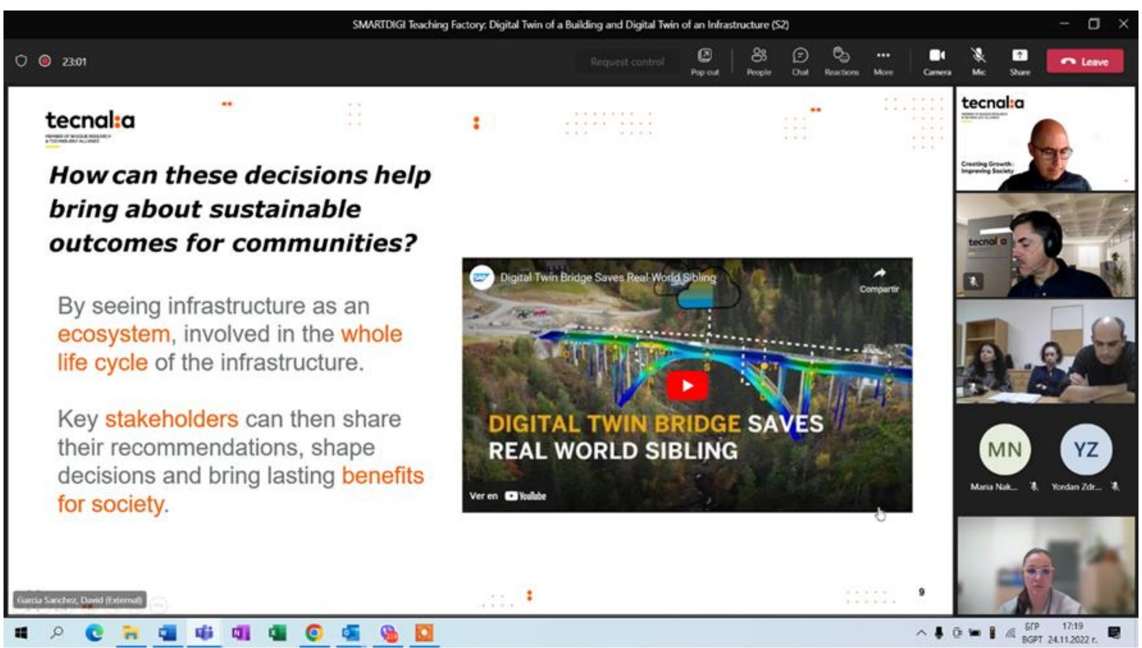
Session II, "Digital Twin of an Infrastructure"

The second session started with the state of the practice of Digital Twin in infrastructure: Digital twins applied during the planning, design, delivery, and operations phases of the infrastructure lifecycle with the goal to create value, improve efficiency, reduce waste, and improve safety. This is, how digital twins can create value in the global infrastructure exploring use cases for digital twins in the infrastructure lifecycle.

Also, future trends and research lines were presented: AR (Augmented Reality), VR (Virtual Reality) and digital twin technologies have wide-ranging potential future applications. Successful implementations of these technologies are heavily dependent on the IT network infrastructure. Digital twins are useful for diagnostics, predictive maintenance, and product development, while VR and AR have demonstrated their utility for training and equipment maintenance. As Industry 4.0 continues to incorporate technology like AR, VR and digital twins, it will ensure that processes and production can be better analysed, serviced and updated in real-time by humans while bringing in a new age of efficiency and connectivity to the IoT.

At the end of the session, teachers answered several questions from participants. Participants showed special interest in the real examples of applications of these technologies, as well as in the SW that is needed to start the design of a digital twin.





Learning Outcomes

Participants learnt about the concept and the technology of the digital twin, and its application in the design, construction and operation of buildings and of infrastructure. Through examples of real cases application of the digital twin concept to the building environment in areas of energy efficiency, indoor air quality or maintenance optimization, company representatives learned how to put the theory into practice.

Also, participants learned about examples of the use of digital twin in the planning, design, delivery, and operations phases of the infrastructure lifecycle with the goal to create value, improve efficiency, reduce waste, and improve safety.

Open Information Event-Pilot 6

This section contains information about the execution of the online information event with detailed description of the aim, agenda, covered topics in the sessions and KPIs reached.

General information

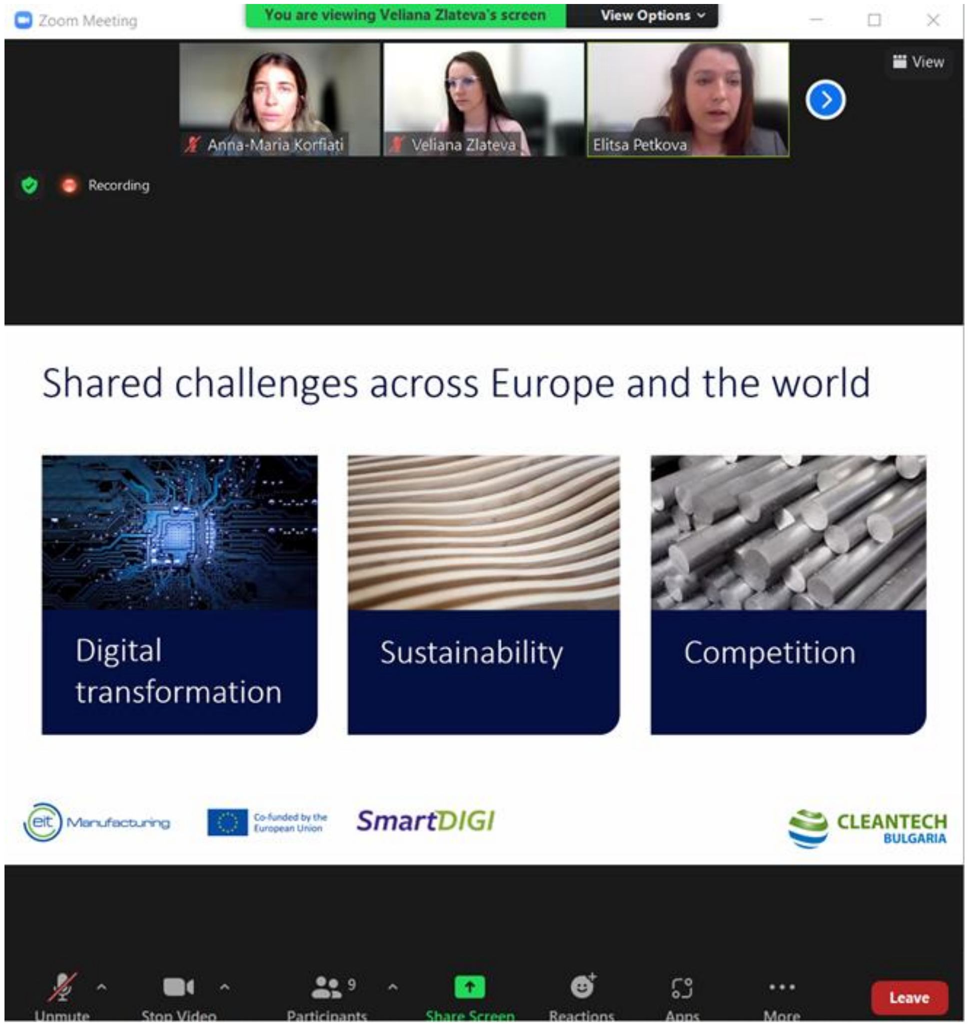
The open information event was held on the 14th and 15th of June 2022 in an online format with Cleantech Bulgaria responsible for the organisation, execution and coordination of all connected activities. Target audience are representatives from SMEs and universities from each partner country part of the SmartDIGI consortium – Bulgaria, Czech Republic, Greece, Lithuania and Spain as well as universities.

The event titled "Digitalization of SMEs for solving manufacturing challenges" aims to raise awareness about the T/L factories concepts among the target group (SMEs and universities), promote Teaching and Learning Factories planned in the SmartDIGI project within 2022 and extend SmartDIGI knowledge exchange network.

Structure and content of the event

The online information event was structured in five sessions, engaging even further participants with a questionnaire. The topics within the agenda were presented in the following order - welcome and opening, digitalization within the industry, SmartDIGI on the journey to Industry 4.0, opportunities for SMEs in 2022 and time for questions and answers.

The event "Digitalization of SMEs for solving manufacturing challenges" was opened by Elitsa Petkova - Project Coordinator at Cleantech Bulgaria, with the topic "Welcome and opening". Participants were introduced with global manufacturing challenges across Europe and the strategic objectives of EIT Manufacturing. Followed by SmartDIGI goals, key activities and outcomes, timeframe and project partners.



Having set the stage, the next topic presented by Veliana Zlateva – Project Coordinator at Cleantech Bulgaria, focused on "Digitalization within the industry". Before going to the core of digitalization in the context of industrial SMEs, participants went through the development of the sector during the centuries also known as the four industrial revolutions. Each one of them has the specific historical context, technologies used and innovations leading to the evolution and introduction of outstanding machines and processes, shaping the industry as we know it nowadays. After that introduction, participants were presented with the combination of new technologies and organisation of labour standing behind and forming the fourth industrial revolution. All of whom are closely related to and dependent on the digitalization of modern business. Going even a step further, the concept of industry 5.0 was introduced, placing modern manufacturing in the centre of the twin transition – digital and green.

Making the transformation, adapting to the innovative technologies, processes and preparing the employees for the novelties, is time consuming and challenging task for the manufacturing companies. In order to support them in this transformation and ensure that no one is left behind, the European Union has a set of policies, strategies and support mechanisms developed under the European Green Deal. Among the texts of the documents can be found the following industry trends – circular economy, twin transition (digital and green) and sustainability, all of which go hand in hand with the digital transformation of the manufacturing sector. However, in the context of industry 4.0. companies face challenges in sourcing and training people to deploy digital technology successfully, outdated systems and adaptation to new technologies, having available capital and creating a business plan for innovations, adoption of new technologies, staff training, etc. Last but not least, participants were introduced to the opportunities emerging from the SmartDIGI project enabling manufacturing SMEs to be one step ahead in the adoption of the trends and enhance their digital skills.

Afterword, logically shifting the focus to “SmartDIGI on the journey to Industry 4.0” having Anna-Maria KORFIATI - Research Engineer at Laboratory for Manufacturing Systems and Automation, presenting the topic in the role of leading organisation. Representatives of SMEs got acquainted with two innovative educational approaches which will be developed under the SmartDIGI project – teaching and learning factories. Firstly, specific attention was placed on the Teaching Factories as four pilot events will be executed under this format. Participants got an overview of the general concept thus making a bridge between industry and academia, also involving all sides of the knowledge triangle – research, education and innovation. Striving to place the information in a more tangible manner, the benefits and added value for manufacturing companies was directly communicated including access to new solutions, get access to a pool of students who have problem solving capacity and out of the box thinking and many more benefits. Also, providing a concrete case of conducted Teaching Factory on the topic of Digital twin. The second part provided an overview of the Learning Factories as a format, stiving to involve students and place them in a real industrial environment as a way of practical education and upskilling. Last but not least, Anna-Maria KORFIATI shared upcoming opportunities for participation in five Teaching and Learning Factories within the SmartDIGI project until the end of the calendar year.

In order to further grab the attention of participants and inspire them to be part of the upcoming pilot events, the last topic provided “Real cases of teaching factories in Europe” presented by Marius Kvedaravičius - Innovation expert at InTechCentras. At the beginning was placed a central topic, trend within industry gaining skills and training, support in finding funds, test before invest, innovation ecosystem and networking – the European Digital Innovation Hubs. Making a parallel between them and the SmartDIGI project as opportunities which support the twin transition of manufacturing companies on the road to industry 4.0. Finally, examples of three active Teaching and Learning Factories were provided in the fields of digital transformation, energy efficiency flexibility and resource efficiency.

The online information event concluded with a summary of upcoming opportunities for SMEs from the SmartDIGI project within the end of the calendar year. This part being a summary of the topics and further outlining the benefits for companies from Teaching and Learning Factories participation. Finally, was left a space for questions and answers.

Learning outcomes

In order to evaluate the outcomes of the conducted Teaching and Training Factories and gather feedback for the overall execution, a survey was developed and distributed to the participants both company representatives and university students. The section key learning outcomes focused on general take-aways and learning points.

Based on the results 64,5% of participants increased their awareness about the topic on which was conducted the pilot activity, 51,6% gained practical knowledge, 38,7% enlarged their understanding of novel technologies, 32,3% discovered an innovative solution and 22,6% built skills relevant to the presented technologies. Among the learning outcomes, skills and knowledge gained, participants underline as most valuable the ability to implement them in real manufacturing processes or in university studies or projects.