JoInME

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R2/A2: DEVELOPMENT OF THE SPECIFIC MATERIAL RELATED TO AI IN INDUSTRY 4.0/5.0

Unit 1

"General introduction about the targeted industry"

REVISION HISTORY

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REFERENCED DOCUMENTS

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Unit 1 of the Specific Training Program "General introduction about the targeted industry".

I. An introduction of the academic programme that is developed in JoinME

A. The context of the programme

Background of the partners, previous collaboration, EVV-project, Covid-19 as a facilitator of the search for new hybrid forms of training and new I4.0 AI-based solutions

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Restrictions caused by the outbreak of the pandemic Covid-19 have highly affected many domains and fields, including educational and industrial sectors. The "new normal" has forced countries to seek new hybrid forms of teaching/training, as well as new solutions to facilitate the resilience of industrial processes and businesses.

In the industry, the multidirectional pandemic pressure has accelerated the digital transformation of various business processes and resulted in the wider adoption of AI-driven solutions, hence the fast growth of the global artificial intelligence market. At the same time, it has become obvious that efficiency and customization in manufacturing brought about by advanced technologies are not enough in the situation of major disruptions, such as the ones caused by COVID-19. Sustainable and resilient processes require even more advanced technologies for greater autonomy, adaptability, and self-optimization, as well as highly educated human decision-makers.

To address these challenges and others, a new vision of industrial development was introduced. Thus, Industry 5.0 incorporates advanced technologies such as artificial intelligence, the Internet of Things (IoT), and cyber-physical systems, as well as human-centricity of industrial decision making.

In light of the changing industrial paradigm, education has also undergone changes. The World Manufacturing Forum declared that, in order to help current and future students, it is important that nations promote and improve education programs that highlight not only excellent digital skills, but also an entrepreneurial mindset, emotional intelligence, communication, and team-working skills. Traditional methods of learning and teaching have also required adaptation to remote learning due to the pandemic situation.

All these inspired Kharkiv National University of Radio Electronics (NURE) and ECAM-EPMI to initiate the search for a new format of entrepreneurial university education for Industry 5.0 and to start the JoinME project. As a starting point, the long-running joint education program of NURE and ECAM-

EPMI - European Virtual Venture (EVV) [1] - was taken and scaled up to include cooperation from a cross-regional EU perspective. The project consortium was composed and balanced between industrial and academic sectors by inviting one more university (KTU-LT) and business partners from the Netherlands (Atremon), Cyprus (HEARTHANDS SOLUTIONS LIMITED), and Greece (ATLANTIS ENGINEERING).

B. Erasmus+ JoinME project

Brief description of the Erasmus+ project, its results that can be used in the training programme.

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"JoinME" is a project funded by the Erasmus+ program from 2021 to 2024. Its main objective is to help higher education teachers provide quality education and training to students on the topic of entrepreneurship in the field of AI and Industry 5.0. The project aims to create a sustainable future for students who aspire to start their own successful companies, regardless of global situations. That's why JoinME designs a new, up-to-date, intercultural, and multidisciplinary training program on entrepreneurship in the field of AI for Industry 5.0.

JoinME has developed important resources for future educators, students, and businesses, including:
- Educational content on entrepreneurship in the field of AI and Industry 5.0;
- A review of the current Industry 5.0 situation including an analysis of the challenges and good practices;
- A Case Study Workbook, describing current high-priority topics for Industry 4.0/5.0 and showing the promising business ideas
- Guidance on organizing hybrid entrepreneurship seminars;
- Online resources, such as, Personalised Assistant, an e-learning platform, and an online environment for cooperation between HEIs and industrial companies.

These resources make the program replicable, adaptable, and flexible, allowing easy integration into various master programs or LLL studies and personalization for specific countries or professional sectors.

In the long run, the JoinME project will result in:
- an international, multicultural, intersectoral, and multidisciplinary environment;
- new Industry 5.0 startups;
- new innovative products/services created by startups of the former students.

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[1] French and Ukrainian teachers and industrial professionals train students to create international ICT (mainly, AI) startups. The program is implemented in hybrid form: using videoconferencing and other Internet-based collaboration and learning tools.

C. The scope of the developed JoinME training programme

The target groups, the priority of the AI-based I4.0-oriented business ideas, Industry 5.0, the specific innovative approach to teaching/learning entrepreneurship in cutting edge fields within intercultural multidisciplinary and intersectoral environment

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The training program is designed for higher education students interested in entrepreneurship in cutting-edge industries. The primary focus of the program is on the Industry 4.0/5.0 business ideas.

However, the JoinME resources will be also useful for:

- teachers/trainers looking for the content in the field of entrepreneurship and Industry 4.0/5.0;
- higher education institutions interested in new resilient teaching techniques and study programs;
- industrial and business community requiring academic approach towards Industry 4.0/5.0 development and eager for networking and cooperation in multicultural entrepreneurial environment across Europe.

The JoinME program aims at effectively facilitating the links between HEIs, companies, and business incubators to prepare the students/trainees with required hard and soft skills. It creates an international multicultural, intersectoral and multidisciplinary environment where students of different fields of study (e.g., Engineering or Artificial Intelligence), academics, industry professionals and entrepreneurs successfully collaborate.

The hybrid approach based on the combination of the online and offline teaching/learning modes enlarges opportunities for international and multidisciplinary cooperation even in case of limited options for onsite cooperation caused by lack of travel budget, pandemic, war, any other force-majeure circumstances, etc.

D. The learning objectives

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The learning objectives of the JoInME training program are as follows:

- To develop the entrepreneurial skills of students by improving their hard (professional) skills in their respective fields through the development of solutions for real cases in Industry 4.0/5.0. This is done by scaling the innovation mindset needed to thrive in an entrepreneurial rapidly growing environment of cutting-edge industries, inspired by relevant examples of successful high-technology businesses.
- To boost the technical (professional) skills of students in the specific fields of engineering and ICT/AI by developing and launching innovative AI products or services for Industry 4.0/5.0 using insights into real-life challenges and solutions.

- To form students' soft co-developing skills through collaborative teamwork within a unique virtual intercultural, multidisciplinary, and intersectoral environment close to reality, using hybrid teaching and learning methods.

To acquire the above-mentioned skills, students will be trained to develop comprehensive business plans that should reveal the business strategy of the innovative business idea (generated independently or suggested by a company working in the cutting-edge industry), identify potential roadblocks, determine the needed resources, and evaluate the viability of the project idea and its growth in the market. After thoroughly elaborating the business plan, students will present and defend it before a jury of teachers and IT professionals. The detailed instructions for the development of a business plan are provided in Units 2-12 of the core material for the joint training program on entrepreneurship.

II. General introduction of Industry 4.0, Industry 5.0, AI

A. The state of Industry 4.0./5.0. Business attractiveness of the industry

Industries are nowadays being shaped by two different paradigms: Industry 4.0 proclaims the transition to digitalization and automation of processes, while emerging Industry 5.0 emphasizes the human-centricity of industrial processes.

Technological progress has revolutionized modern industries and accelerated the transition towards unprecedented digitization, networking, automation, and artificial intelligence. Development periods are getting shorter; individualization of production on demand is no longer news; product development is becoming much more flexible and efficient. Several years ago, it looked like digitalization could be the key to all industrial problems. But life appeared to be more complex.

The current world geopolitical crisis and related hybrid threats (hybrid wars), including cybersecurity threats in the form of massive cyberattacks; wars (such as the aggression of Russia against Ukraine); related refugee and other humanitarian crises have a huge impact on the global industry and economics and particularly on Industry 4.0 and smart manufacturing. After the first excitement from the digitalization effects, it became obvious that the world requires a much higher level of process resilience, production sustainability, and decision-making quality than it has been foreseen according to the Industry 4.0 concept. This explains the growing popularity of the Industry 5.0 concept, which (unlike Industry 4.0) is supposed to bring humans back into the loop of the industrial processes to address the emergent resilience and sustainability concerns.

The implementation of AI should not diminish key aspects of humanity - morality, human relationships, cognitive acuity, freedom, and privacy, and the dignity of work. A virtues-based approach should be used to resolve ethical dilemmas, rather than utilitarian ethics.

The biggest challenge that awaits future entrepreneurs is to find reasonable ways to marry the two extremes of automation and value-based human-driven processes, which inherit the most valuable features of both - efficiency of the Industry 4.0 processes and sustainability of the Industry 5.0 decisions.

Successful co-existence of Industry 4.0 and Industry 5.0 concepts would mean an increase in productivity without removing human workers from the manufacturing processes. It is also impossible without further development of collective intelligence technologies enabling human and machine collaboration, among others, for efficient value-based decision making. Therefore, collective intelligence, where humans will be involved in the control of industrial processes together with other autonomous assistants, including software robots and humans' digital cognitive clones as autonomous decision-makers, could be an enabler (both efficient and human-centric) for a potential Industry 4.0 + Industry 5.0 hybrid. From this perspective, resilience becomes a key concept of the requested global change along with recovery, robustness, sustainability, and for industry, business, our world, and society as a whole. One of the enablers for the complex concept of resilience could become the collaborative decision-making power of cognitive clones that are smart bridging technological artifacts and keep particular humans (donors for the clones) within the loop of responsible decision-making processes.

B. The main trends that will affect the Industry 4.0/5.0

Green technology: The concept envisages workers at the center of the production process and uses new technologies to provide prosperity beyond jobs and growth while respecting the planet's production limits. Many industries are turning to technology to make their industrial processes more sustainable. Now, more than ever, the manufacturing industry is working on reducing its carbon footprint.

Sustainable Technology is a framework of solutions that increases the energy and efficiency of IT services; enables enterprise sustainability through technologies like traceability, analytics, emissions management software and AI; and helps customers achieve their own sustainability objectives.

Further digitalization of data: Using tools like 3D scanners, CAD software, motion capture systems, and the like, to record every detail of their product in real-time. Augmented reality helps visualize processes and data, analyze, or carry out complex tasks. This generates visual instructions in real-time using backup equipment located around the world. Cloud technology allows storing digital data, saving a lot of money, and helping to innovate businesses with greater ease. A good indicator is that cloud providers released several Industry 4.0 solutions in 2022. The importance of these new frameworks or paradigms is justified by Google, which introduced the Google Cloud Digital Twin framework.

AI and ML evolution: From recognizing patterns and predicting consumer behavior to reusing equipment and freeing up resources and decision-making, AI can help reduce tasks that waste energy, materials, and time. It will automate manual tasks, optimizing the process, reducing costs, and ensuring decision-making for a resilient model of functioning. According to Gartner[2], there are AI-related topics among top strategic technology trends for 2023 are AI-related:

Applied Observability, works from the data emitted by an organization, using AI to analyze and make recommendations which allow a company to make more thorough future decisions.

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[2] https://www.gartner.com/en/articles/gartner-top-10-strategic-technology-trends-for-2023

Adaptive AI, which allows for model behavior change post-deployment by using real-time feedback, to continuously retrain models and learn within runtime and development environments, based on new data and adjusted goals, to adapt quickly to changing real-world circumstances.

The promising sectors for future entrepreneurs in AI are:
- AI-powered healthcare and personalized medicine;
- Autonomous vehicles and transportation systems;
- Cybersecurity and fraud detection;
- Natural language processing and chatbots;
- AI-powered financial services, such as investment analysis and risk management;
- Predictive maintenance for manufacturing and other industries;
- Robotics and automation;
- AI-powered marketing and advertising;
- Smart home technology and the Internet of Things (IoT);
- Education technology and personalized learning;

Metaverse, which allows people to replicate or enhance their physical activities. This could happen by transferring or extending physical activities to a virtual world or by transforming the physical one. It is a combinatorial innovation made up of multiple technology themes and capabilities

Expansion of IoT networks and Industry Cloud Platforms. IoT networks further expansion is caused by the current Industry 4.0 trend of a smart and hyperconnected world (interconnected sensors, devices, and infrastructure that collect, transmit, and process data). It enables streamline operations and improved efficiency of industry-specific cloud-based solutions.

Digital Twinning: development of virtual representations or digital models of physical objects or systems, including their properties and behaviors. This means that people will be able to gain data insights to understand how to fine-tune their processes and ensure proper and resilient work of manufacturing (equipment, whole systems, entire production lines).

Cybersecurity as a pressing issue. As the rising number of cyberattacks is giving nightmares to business leaders, the integration of AI and machine learning is creating a hyper-converged infrastructure that aims to provide robust security to these businesses. Security is among top strategic technology trends for 2023 according to Gartner too. They predict the growth of:
- **Digital Immune Systems** which create an enhanced customer experience by combining multiple software engineering strategies to protect against risk.
- **AI Trust, Risk and Security Management (AI TRISM)** which supports AI Security, such as AI model governance, trustworthiness, fairness, reliability, robustness, efficacy and data protection. It combines methods for explaining AI results, rapidly deploying new models, actively managing AI security and controls for privacy and ethics issues.

Superapps emergence. Superapps combine the features of an app, a platform and an ecosystem in one application, providing a platform for third parties to develop and publish their own miniapps on.

C. Innovations that will facilitate generative AI advancement

AI simulation combines application of AI and simulation technologies for joint developing AI agents and the simulated environments where they can be trained, tested and deployed.

AI TRISM (Trust, Risk and Security management) enables AI model governance, trustworthiness, fairness, reliability, robustness, efficacy and data protection.

Causal AI utilizes cause-and-effect relationships to go beyond correlation-based predictive models and toward AI systems that can prescribe actions more effectively and act more autonomously.

DL&A (Data labeling and annotation) is a process where data assets are further classified, segmented, annotated and augmented to enrich data for better analytics and AI projects.

FPAI (First-principles AI) - physics-informed AI incorporates physical and analog principles, governing laws and domain knowledge into AI models. FPAI extends AI engineering to complex system engineering and model-based systems.

Knowledge graphs are machine-readable representations of the physical and digital worlds. They include entities (people, companies, digital assets) and their relationships, which adhere to a graph data model.

Foundation models are large-parameter models trained on a broad gamut of datasets in a self-supervised manner.

MAS (Multiagent systems) is a type of AI system composed of multiple, independent but interactive agents, each capable of perceiving their environment and taking actions. Agents can be AI models, software programs, robots and other computational entities.

Neurosymbolic AI is a form of composite AI that combines machine learning methods and symbolic systems to create more robust and trustworthy AI models. It provides a reasoning infrastructure for solving a wider range of business problems more effectively.

Responsible AI is an umbrella term for aspects of making appropriate business and ethical choices when adopting AI.

D. Some prediction for Generative AI (following Gartner)

By 2025:
- 70% of enterprises will identify the sustainable and ethical use of AI among their top concerns;
- 35% of large organizations will have a chief AI officer who reports to the CEO or COO;
- up to 70% will be reduced the volume of real data needed for machine learning due to using the synthetic data;
- 30% of outbound marketing messages from large organizations will be synthetically generated. That's up from less than 2% in 2022.

Through 2026, despite all the advancements in AI, the impact on global jobs will be neutral.

While by 2033, AI solutions will result in more than half a billion net-new human jobs.

By 2030, AI could reduce global CO2 emissions by 5 to 15% and consume up to 3.5% of the world's electricity.

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