## Module Specification:

# Work 4.0

Within the Erasmus+ KA2 Capacity Building Project (CBHE)

WORK4CE – Cross-domain competences for healthy and safe work in the 21st century

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# 1 Summary

This module explores the transformation of work systems in the era of Industry 4.0, covering technological, organizational, and human-centered innovations. It introduces the concepts of Work 4.0 and human-cyber-physical systems (HCPS) while emphasizing project management, ergonomics, and the role of IoT in optimizing safety and well-being in digitalized workplaces.

**Overall Learning Outcome:** This module provides a comprehensive understanding of Work 4.0 and Industry 4.0 digital transformation. Learners will gain knowledge of emerging trends in digitalized work systems, human-cyber-physical integration, and adaptive project management. They will develop skills in analyzing digital transformation strategies, implementing IoT-based solutions for workplace safety, and designing human-centered production environments. The module equips participants with the competence to lead and manage digital transformation projects, optimize work ergonomics, and integrate technology for improved productivity and well-being.

**Target Group Analysis:**

• **Master's Students (Engineering, Management, IT, Digital Transformation).** Need to understand Industry 4.0, digital transformation trends, and project management. Prerequisites include basic knowledge of industrial processes, IT, or management principles, with previous competences in digital technologies, analytics, or automation.

• **Industry Professionals (Digital Transformation, Smart Manufacturing, Work System Design).** Require up skilling in digital work environments and advanced project management techniques. Prerequisites involve professional experience in industrial operations, IT, or business management, along with familiarity with industrial automation, IoT, or logistics.

• **Researchers & Academics (Human-Cyber-Physical Systems, Work Psychology, Automation):** Need deep knowledge of work ergonomics, socio-technical system design, and research skills. Prerequisites include an academic background in engineering, psychology, or computer science, with previous competences in conducting research and analyzing Industry 4.0 transformations.

• **Decision-makers & Policymakers (Industry 4.0 Strategy, Workforce Development, Policy Design):** Require understanding of policy frameworks, workforce adaptation, and technological integration. Prerequisites involve a background in business administration, governance, or industrial policy, with previous competences in policy implementation, workforce management, or digital strategy.

**Competences & Learning Outcomes:**

| Knowledge | Skills | Competence |
|---|---|---|
| Highly specialized knowledge of Industry 4.0 and Work 4.0 frameworks, including digitalized production and human-cyber-physical systems (HCPS). | Specialized problem-solving skills required in research and/or innovation to develop new digital transformation strategies and integrate smart technologies into work environments. | Manage and lead digital transformation projects in complex, unpredictable work systems, requiring innovative strategic approaches. |
| Critical awareness of knowledge issues in the transition to digitalized work environments, including human-technology integration and ergonomics. | Ability to design and implement adaptive project management methodologies tailored for digital work environments. | Take responsibility for contributing to professional knowledge and practice in Work 4.0, including reviewing and improving socio-technical system designs for optimal efficiency and human well-being. |
| Understanding of IoT applications, AI-driven decision-making, and safety measures in digital workplaces. | Proficiency in developing human-centered and ergonomically optimized digital workspaces. | Lead interdisciplinary teams to develop and implement cutting-edge digital solutions for workplace innovation. |
| Understanding of future work skills and workforce adaptation in response to digital transformation. | Identify and develop critical 21st-century skills needed for Work 4.0 environments. | Strategically manage workforce development, reskilling, and organizational change to support digital transformation |

**Selection of Content:** The module covers key aspects of Work 4.0 and Industry 4.0 transformation, including:

- Human-Cyber-Physical Systems (HCPS) in digitalized workplaces.
- Work 4.0 production system development.
- Reference Architecture Model Industrie 4.0 (RAMI4.0).
- Adaptive project management for socio-technical digital transformation.
- Operator 4.0 and human-automation collaboration.
- Digital ergonomics.
- IoT applications for workplace safety.
- Future work skills.

**Activities and Teaching/Learning Methods:** The module employs a variety of instructional methods such as lectures, online courses, and problem-based exercises. Learning is enhanced through project-based assignments, case studies, virtual and physical lab simulations, and industry expert guest lectures. Digital case studies, real-world applications, and peer-to-peer learning discussions are also included, ensuring adaptive learning paths tailored to competency-based education.

**Teaching Materials/Literature/Media/Technical Requirements/Lab Equipment:** Students will utilize textbooks and research articles on Industry 4.0, online course materials, and e-books. IoT devices, cloud-based simulation tools, virtual labs, and specialized software for digital transformation applications are integral components. Additional resources include project management tools, adaptive learning platforms, Learning Management Systems (such as Moodle), case study databases, and AI-driven workplace monitoring software.

**Tailoring & Educational Tracks (Practical, Entrepreneurial, Scientific):** The module provides flexibility through three educational tracks. The Practical Track emphasizes hands-on project work and industry case studies, while the Entrepreneurial Track focuses on business transformation and startup methodologies. The Scientific Track is research-oriented with in-depth theoretical analysis. It is designed to accommodate students, professionals, and policymakers, with an adaptable ECTS range (4-8), ensuring it meets diverse learning needs.

**Competence Assessment:** Assessment consists of a written exam (30%) evaluating theoretical knowledge, project work (30%) measuring practical application, presentations (20%) testing communication and strategic thinking, and case study analysis (20%) assessing analytical and decision-making capabilities. Peer and self-assessments support continuous learning improvement.

**Curricula Integration:** The module is designed for implementation in master's program curricula in Project Management, Computer Science, and Software Engineering, making it a valuable addition to advanced studies.

**Quality Evaluation:** The module follows a structured evaluation approach incorporating continuous feedback from students and instructors through surveys and assessments. Regular reviews ensure alignment with industry advancements and technological updates, while peer evaluations and external review committees enhance academic and practical relevance. Performance tracking through competency-based metrics ensures learning outcomes are met, with iterative improvements based on pilot runs, learner feedback, and educational research.

**Change History & Ownership:**

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## 2 Introduction to the module

The fourth industrial revolution, synonymous with digital transformation, introduces advanced technologies and new ways of working. Work 4.0 integrates high-level technological advancements and innovative working methods, fundamentally reshaping work environments. Industry 4.0, driven by progressive digitalization, is a global phenomenon that impacts all aspects of human society and professional domains.

The Work 4.0 module aims to develop a holistic approach to understanding Industry 4.0 as a productive system and set of processes. Industry 4.0 systems inherently engage humans throughout their lifecycle, including design, installation, operation, maintenance, and dismantling at the end of life. Addressing the demands and requirements of individuals performing these tasks is essential in designing Work 4.0 systems.

The fourth industrial revolution represents a qualitative leap in industrial production by linking people, machines, and products into an integrated production system. This interconnectivity enables faster and more precise information exchange, fostering a future where humans collaborate with robots and receive support from web technologies and intelligent assistance systems in their work activities.

As digitized processes expand, there is an increasing need for employees to understand and operate digital applications. The growing complexity of industrial processes requires a broader and deeper understanding of interconnected workflows, emphasizing networked and cross-disciplinary thinking. Product and process design, alongside work process improvement and project management, will shape the digital production systems of the future. These transformations will have direct consequences for human performance, ultimately influencing overall system efficiency and productivity.

Innovative working arrangements are key to maintaining a competitive manufacturing industry and serve as critical enablers of digital transformation. However, these changes introduce new challenges for both workers and enterprise structures, which will be embedded into digital ecosystems.

Platform Industry 4.0, built on the three pillars of people, organization, and technology, aims at the sustainable design of work and learning environments. It envisions a digitalized workplace that remains human-centric, ensuring healthy, safe, fair, and self-determined work while facilitating digital transformation.

A key methodology in this shift is Human-Centered Design (HCD), which prioritizes the needs, expectations, and goals of users. HCD fosters the development of interactive solutions that enhance productivity, improve work quality, and increase user satisfaction. Within the manufacturing industry, the challenge lies in balancing digital assistance and complete

automation. For example, in order-picking processes, digitization may take the form of a “digital copy” of traditional workflows, providing real-time support without full automation.

The digital architecture of Industry 4.0 is not an end in itself but serves as a means to enhance work processes, making production and service operations smarter and more efficient. This module explores the relationship between digital architectures and the evolving nature of work. From an organizational perspective, it examines different models of work organization, ranging from routinized tasks to innovative, adaptive work structures.

Modern workplaces are undergoing a significant evolution due to digitization, affecting manual workflows, workspaces, and tools. In manufacturing, digitization refers to the transition from traditional handcrafted activities to computer-supported operations, such as operating robots or performing machine maintenance with digital assistance tools like augmented reality glasses. This ongoing transformation and its impact on employees are central elements of Work 4.0, shaping the future of human-machine collaboration and redefining workforce roles in digitalized environments.

# 3 Module Description

## 3.1 Overall Learning Outcomes

This module aims to equip learners with a comprehensive understanding of Work 4.0 and Industry 4.0 transformations, emphasizing their impact on production systems, logistics, and workforce adaptation. Upon successful completion, learners will have acquired specialized knowledge, developed critical skills, and demonstrated the competence required to navigate and implement digital transformation strategies in work environments.

**Knowledge:** Learners will assimilate a broad range of theoretical and factual knowledge, including key principles, trends, and methodologies related to Industry 4.0 and Work 4.0. They will understand cyber-physical systems, digital transformation frameworks (such as RAMI4.0), adaptive project management, and the socio-technical implications of automation and artificial intelligence in the workplace.

**Skills:** Graduates will be able to apply their knowledge to real-world challenges, utilizing cognitive and practical skills to assess digital transformation scenarios, develop data-driven decision-making models, and implement human-technology integration strategies. They will also be skilled in using IoT-enabled monitoring systems, ergonomic workplace design, and managing digital work systems for efficiency and productivity.

**Competence:** Learners will demonstrate the ability to take responsibility for designing, managing, and transforming digitalized work environments. They will be prepared to lead interdisciplinary teams, evaluate and optimize work processes, and ensure seamless collaboration between humans and intelligent systems. Their competence will extend to strategic decision-making, policy development, and the integration of new technologies to enhance work efficiency, safety, and sustainability.

**Competence domains:** The module integrates multiple competence domains to ensure a comprehensive understanding of Work 4.0 and Industry 4.0. The learning outcomes encompass technical, professional, and global competences, creating a well-rounded skill set for graduates.

- **Technical Competence:** This domain covers specialized knowledge and expertise required for Work 4.0 environments. Learners will develop engineering and IT-related skills, including cyber-physical system integration, software development, data-driven decision-making, and IoT-enabled workplace solutions. The focus extends beyond basic tool skills, ensuring the ability to design, manage, and optimize digitalized work systems.
- **Professional Competence:** The module fosters key professional skills relevant to digital transformation. These include adaptive project management, negotiation, leadership, and effective communication in technology-driven work environments. Students will also

develop critical thinking, problem-solving, and ethical decision-making abilities, crucial for managing socio-technical transitions in Industry 4.0.

- **Global Competence:** As digital transformation transcends borders, learners will gain intercultural and international competences. This includes language proficiency, knowledge of global markets, and awareness of political, social, and ethical implications in the digital economy. Graduates will be equipped to navigate international work environments and contribute to global digital transformation initiatives.

### Overarching Learning Outcomes (OLO) and Core Learning Outcomes

- **Value Judgments and Sustainability Competencies (EIT OLO 1):** Learners will assess the short- and long-term impacts of Industry 4.0 transformations on sustainability, workforce well-being, and ethical considerations. They will develop solution-focused approaches to foster sustainable digital work environments.
- **Entrepreneurship Skills and Competencies (EIT OLO 2):** The module equips students with the ability to turn Industry 4.0 innovations, such as IoT-driven automation and smart manufacturing solutions, into viable business models and strategies for digital enterprises.
- **Creativity Skills and Competencies (EIT OLO 3):** Learners will explore new possibilities in human-cyber-physical system (HCPS) integration, adaptive project management, and smart workplace design, fostering creative approaches to work system optimization.
- **Innovation Skills and Competencies (EIT OLO 4):** Students will apply technological advancements in automation, data-driven decision-making, and workplace IoT integration to develop and enhance products, services, and work processes in digital industries.
- **Research Skills and Competencies (EIT OLO 5):** The module emphasizes interdisciplinary research, enabling students to leverage data analytics, AI-driven insights, and digital ergonomics to contribute to the evolving body of knowledge in Industry 4.0.
- **Intellectual Transforming Skills and Competencies (EIT OLO 6):** Practical applications and case studies allow learners to transform real-world digital transformation challenges into structured research problems, contributing to both academic and industry advancements.
- **Leadership Skills and Competencies (EIT OLO 7):** Learners will develop leadership capabilities in managing digital transformation projects, leading interdisciplinary teams, and making strategic decisions in rapidly evolving Industry 4.0 environments.

**Core Learning Outcomes in Work 4.0 Module:** The module builds on a foundation of technical and professional competencies, focusing on digital transformation strategies, smart production and logistics, adaptive project management, and IoT-enabled workplace monitoring. Learners will gain expertise in designing and implementing Work 4.0 solutions, ensuring the integration of human-centered approaches in digitalized work environments.

**Connection to Key Topics and Module Philosophy:** This module follows a hybrid approach, combining theoretical insights with practical, project-oriented learning. It integrates collaborations with industry partners, emphasizing real-world applications, research-driven methodologies, and business-oriented innovation. The learning experience is structured to develop technical expertise while fostering professional growth, leadership, and an adaptive mindset for Industry 4.0 challenges.

**Knowledge. Students will gain expertise in:**

- Analytical thinking, critical analysis, and problem-solving strategies in a digitalized work environment.
- Leadership and social influence in human-cyber-physical systems (HCPS).
- Emotional intelligence and system analysis for workplace adaptation.
- Theoretical understanding of digital literacy, automation, and AI applications.
- Industry 4.0-related standards, frameworks, and architectures for work system innovation.
- Workplace ergonomics and human well-being in digitalized environments.

**Skills. Students will develop the ability to:**

- Interact with and utilize digital technologies for work system optimization.
- Recognize inadequacies in project plans and dynamically adjust strategies.
- Negotiate, communicate, and collaborate in interdisciplinary teams.
- Design algorithms and programming tools for big data analytics.
- Conduct experiments, analyze results, and apply technical literature in engineering contexts.
- Implement Industry 4.0 solutions through adaptive project management and digital transformation initiatives.

**Technical Competences**

- Design and implementation of big data architectures and software platforms.
- Development of applications and tools for big data analytics (Python, R).
- Cloud computing and data storage for industrial applications.

- User experience design for Industry 4.0 workplaces.
- Programming and operation of collaborative robots in smart manufacturing.
- Application of IoT, cybersecurity, and communication protocols in industrial settings.

**Professional Competences**

- Problem-solving for complex, real-world industrial challenges.
- Digital monitoring and control of production systems via smart devices.
- Integration of human-robot collaboration models in production systems.
- Cybersecurity management and data privacy strategies in industrial applications.
- Predictive maintenance and Industry 4.0-driven process optimization.

**Global Competences**

- Adapting to digital transformation challenges in global industrial markets.
- Entrepreneurial thinking to develop sustainable and innovative business solutions.
- Leadership by influence, fostering collaborative work environments.
- Continuous learning and professional growth to stay relevant in Industry 4.0.
- Digital literacy and IT competency to enhance productivity and efficiency.

## 3.2 Target Group Analysis

| Target Group | Characteristics | Prerequisites | Needs | Competence Goals | Prospective Job Field |
|---|---|---|---|---|---|
| **Master's Degree Students** | - Enrolled in or recently graduated from master's programs in technology domains (IT, Engineering).<br>- Typically aged between 22-30 years, with limited professional experience. | - Bachelor's degree in technology domains (IT, Engineering) or related fields.<br>- Foundational knowledge in mathematics, physics, and basic engineering principles. | - In-depth understanding of digitalized production processes.<br>- Advanced knowledge in engineering design and project management.<br>- Exposure to real-world case studies and hands-on projects.<br>- Flexible learning formats to accommodate academic schedules. | - Develop proficiency in digital literacy, data analysis, and the use of advanced manufacturing technologies.<br>- Enhance problem-solving abilities and foster innovative thinking.<br>- Prepare for seamless integration into the modern workforce with a focus on Industry 4.0 applications. | - Positions such as Digital Transformation Specialist, IT Project Manager, or Systems Analyst in digitalization and IT sectors. |
| **Lifelong Learning Students** | - Professionals seeking to update or enhance their digital competencies.<br>- May have significant work experience in | - Bachelor's or Master's degree in technology domains (IT, Engineering) or equivalent professional experience. | - Flexible scheduling to accommodate work and personal responsibilities.<br>- External motivation to | - Mastery of smart manufacturing techniques, IoT applications, and data-driven decision-making. | - Advanced roles in operations management, digital strategy, or systems integration.<br>- Positions such |

| | | | | | |
|---|---|---|---|---|---|
| | various industries.<br>- Balancing education with work and personal commitments. | - Basic familiarity with digital tools and manufacturing workflows. | engage in continuous learning.<br>- Practical knowledge applicable to current job roles.<br>- Supportive learning environment to encourage persistence. | - Ability to lead and manage digital transformation projects within their organizations.<br>- Cultivation of continuous improvement and adaptability mindsets. | as Digital Transformation Manager, Smart Factory Consultant, or Systems Architect. |

## 3.3 Competences & Learning Outcomes

### 3.3.1 Module course "Introduction: Re-imagining Work Systems with the Ongoing Industry 4.0 Digital Transformation in Value-Adding Production and Logistic Processes Innovative Development" (Core Course, obligatory)

*Knowledge:*

- The student knows the key dimensions of Industry 4.0 and their impact on production and logistics processes. the student understands the concept of Work 4.0 and its evolution in the context of digital transformation.

*Skills:*

- The student analyze current work systems and identify opportunities for digital innovation.
- The student is able to evaluate the effects of digital technologies on value-adding processes.

*General competences:*

- The student is capable of critically assessing the integration of digital technologies in work systems.
- The student demonstrates autonomy in proposing innovative solutions for digital transformation in production and logistics.

### 3.3.2 Module course "Work 4.0 Production System Development Based on Reference Architecture Model Industrie 4.0 (RAMI4.0) (Core Course, Obligatory)

*Knowledge:*

- The student knows the structure and components of the Reference Architecture Model Industrie 4.0 (RAMI4.0).
- The student understand the application of RAMI4.0 in developing Work 4.0 production systems.

*Skills:*

- The student can design production systems aligned with RAMI4.0 standards.
- The student is able to implement RAMI4.0 frameworks to enhance system interoperability and integration.

*General Competences:*

- The student is capable of managing complex projects involving the application of RAMI4.0.
- The student demonstrates possibility ensuring compliance with Industry 4.0 standards.

### 3.3.3 Module course "Adaptive Project Management for Context of Socio-Technical Digital Transformation" (Core Course, Obligatory)

*Knowledge:*

- The student knows adaptive project management methodologies suitable for socio-technical environments.
- The student understands the challenges of managing digital transformation projects.

*Skills:*

- The student can adapt project management techniques to digital transformation initiatives.
- The student is able to coordinate interdisciplinary teams in socio-technical projects.

*General Competences:*

- The student capable of leading projects that require innovative approaches to management.
- The student demonstrates autonomy in decision-making with complex project environments.

### 3.3.4 Module course "Operator 4.0 Concept of Complex Activities Conduct Data-Driven Decision-Making Processes and Work Situational Awareness" (Core Course, Obligatory)

*Knowledge:*

- Student understands the Operator 4.0 framework and its relevance to modern work environments.

- Student comprehends data-driven decision-making processes and situational awareness in the workplace.

*Skills:*

- Student can utilize data analytics tools to support decision-making in complex activities.
- The student is able to enhance work situational awareness through advanced technologies.

*General competences:*

- The student is capable of integrating human factors with cyber-physical systems to optimize performance.
- The student demonstrates responsibility in promoting safety and efficiency in data-driven work environments.

### 3.3.5 Module course “Work 4.0 Ergonomics and Human Well-Being Designing Towards Industry” (Core Course, Obligatory)

*Knowledge:*

- Student understands ergonomic principles applicable to Industry 4.0 settings.
- Student comprehends the importance of human well-being in digitalized workplaces.

*Skills:*

- Student can design work environments that prioritize ergonomics and human well-being.
- Student is able to assess and mitigate risks associated with digital transformation on workers' health.

*General competences:*

- The student is capable of advocating for human-centered approaches in technological implementations.
- The student demonstrates autonomy in developing strategies to enhance employee well-being in Industry 4.0 contexts.

### 3.3.6 Module course “IoT for Work 4.0: Healthy and Safe Human Operators in Production Systems and Workplaces” (Technical course: Elective)

*Knowledge:*

- The student understands the applications of IoT in monitoring and promoting health and safety in production environments.
- The student comprehends the integration of IoT devices to enhance workplace safety protocols.

*Skills:*

- The student can implement IoT solutions to monitor environmental and physiological parameters affecting workers.
- The student is able to analyze IoT data to improve safety measures and respond to potential hazards.

*General competences:*

- The student is capable of leading initiatives that leverage IoT for occupational health and safety improvements.
- The student demonstrates responsibility in ensuring the ethical use of IoT data concerning employee well-being.

### 3.3.7 Module course “Skills ofe Future and Changing the Workplace Under the Influence of the Industrial Revolution” (Technical course: elective)

*Knowledge:*

- The student understands the emerging skills required in the evolving industrial landscape.
- The student comprehends the impact of the Industrial Revolution on workplace dynamics and skill requirements.

*Skills:*

- The student can assess current skill sets and identify areas for development to meet future workplace demands.
- The student is able to design and implement training programs that address the changing skill requirements due to industrial advancements.

*General Competences:*

- The student is capable of anticipating and responding to shifts in workplace skill demands.
- The student demonstrates autonomy in pursuing continuous professional development to stay abreast of industrial changes.

## 3.4 Content

**Core courses:**

1. **Introduction. Re-imaging work systems with the ongoing Industry 4.0 digital transformation in the value adding production and logistic processes innovative development (1 ECTS)**
    - Building on the concept of Work 4.0. Taking a look at the working society of today, tomorrow and beyond in evolution: trends and scenarios regarding work organisation and digital technological innovations.
    - Digital technological developments fusion. Key dimensions of Industry 4.0 digital transformation and the innovative impact on work-related outcomes.
    - Work is proving to be a key locus of the digital transformation. The coexistence of humans and technology in the digitalised production environment from a human-cyber-physical systems (HCPS) perspective.
2. **Work 4.0 production system development based on Reference Architecture Model Industrie 4.0 (RAMI4.0) (1 ECTS)**
    - State-of-art in development of the reference architectures and frameworks to accelerate the growth of the Work 4.0 projects.
    - Multidimensional technological architecture to guide structured development and promote work 4.0 interoperability, vision and scenarios.
    - Industry 4 projects design and implementation regarding work aspects. Socio-technical approach towards work system digital innovation and human-technology integration.
3. **Adaptive project management for the context of socio-technical digital transformation (1 ECTS)**
    - The methodology of adaptive project management.
    - Work organisational project management based on socio-technical system approach and technochange methods.
    - Digitalization initiatives, that opens up innovative possibilities for designing content, process, the organization of work 4.0 projects.
    - Industry 4.0 and Work 4.0 case studies.
4. **Operator 4.0 concept of the complex activities conducting data-driven decision-making processes and work situational awareness (1 ECTS)**
    - A vision for the Operator 4.0 is in the context of productive human cyber-physical systems and adaptive automation towards human-automation symbiosis work systems.

- Typologies and enabling technologies to support work distributed decision making at the era of Big Data.
- Managing projects, that augmenting the physical and cognitive capabilities of the operators and support human work in digitalised environment. Adaptation of production system in order to allow a dynamic and seamless transition of functions (tasks) allocation between humans and machines that optimally leverages human skills and competences.

5. **Work 4 ergonomics and human's well-being designing towards industry 4.0 (1 ECTS)**
   - Human-centred components of the well-being at the digitalized workplace.
   - Framework for designing work systems in the transition to Industry 4.0 where human factor, ergonomics, work system modelling and designing strategies are integrated.
   - Digitalization opens up innovative possibilities for designing content, process, the organization of productive work collaboration.
   - Rethinking work architecture, retraining people, and rearranging the organization to leverage technology to transform business by Putting humans in the loop to create value for customers and meaningful work for people.

**4 Elective courses:**

1. **IoT for Work 4.0: Healthy and safely human operators in production systems and workplaces (3 ECTS)**
   - Intelligent Health and Safety approach to Work 4.0 based IoT.
   - Sensors, actuators, controllers, protocols, smart things, Fogy/Cloud computing under industry 4.0
   - Collect data from sensors and analysis the microclimate, emotional state of employees (heart rate, temperature parameters), equipment data collection: operating modes, data on failures and malfunctions energy consumption, air pollution, Integrity of premises, movement of people, violation of the perimeter, unauthorized access to equipment
   - Control of microclimate (optimal rate, humidity, air conditioning, lighting), equipment (stop in case of failures, breakdowns, deterioration of working conditions, harmful emissions, physical condition of workers and other emergencies), security systems (reports of perimeter violations or access to equipment (police, management and other services), accidents (reports of medical services, police, management), premises (blocking / unlocking of premises, equipment, etc.)

2. **Skills of the future and changing the workplace under the influence of the industrial revolution (2 ECTS, NUZP)**
    - The main trends that determine the nature of work in the 21st century.
    - Skills of the 21st century.
    - Strengthening social security.

## 4.1 Teaching & Learning Activity Plan

### A) Select Teaching/learning methods per competence

- **Theoretical knowledge:** virtual lecture, distance learning materials, online module. Learning outcome – performance of given assignments. Main format – e-learning.
- **Practical skills:** case study, workshops, projects. Learning outcome – project presentations, workshop and cases study activities evaluation. Main format – workshop, project presentations.
- **Scientific work:** seminar or homework. Learning outcome: scientific context. Main format: individual scientific contribution.

The module is thought as a tutored online version where the student will receive an introduction to the basic knowledge which she/he will have to apply to specific assignments.

It will require:

- Participation of students in the online life lecturing
- Individual study of available materials
- Development of individual and team assignments

### B) Define didactic concept: e.g. choose from:

The Module M05 Work 4.0 is conceived as containing 5 compulsory courses:

- Introduction. Re-imaging work systems with the ongoing Industry 4.0 digital transformation in the value adding production and logistic processes innovative development (1 ECTS)
- Work 4.0 production system development based on Reference Architecture Model Industry 4.0 (RAMI4.0) (1 ECTS)
- Adaptive project management for the context of socio-technical digital transformation (1 ECTS)
- Operator 4.0 concept of the complex activities conducting data-driven decision-making processes and work situational awareness (1 ECTS)
- Work 4 ergonomics and human's well-being designing towards industry 4.0 (1 ECTS)

And electives on the technical topics (minimum 2 electives)

- IoT for Work 4.0: Healthy and safely human operators in production systems and work-places (3 ECTS)
- Skills of the future and changing the workplace under the influence of the industrial revolution (2 ECTS, NUZP)

All courses contain a theoretical part which will be taught with the use of webinars, knowledge clips and local classroom teaching.

For the skills part of the technical courses lab sessions will be used to train hands-on. Labs can be either physical labs, either virtual or remote labs, depending on the course.

For each course a (number of) reference book(s) is given as either compulsory either extra literature.

Most of the lab sessions use a problem-based approach.

- (Virtual) Lecture, Online course, ebook, distance learning …
- Projects, problem-based
- Case-based, challenge-based

### C) Define an Activity Plan, e.g. semester schedule

**Module core courses:**

Activity 1: Core learning activity knowledge acquirement classes (15 x 2 h = 30 h)

- This classes are complemented with online lectures and distance access educational resources.

Activity 2: Laboratory works (15x 2 h = 30 h)

- The laboratory works in computer (virtual) laboratory are complemented with online tutorials and reading materials (course book).

Activity 3: Project simulation in teams (e.g. 3-5 students) or with module case study (20 h).

Activity 4: Homework and self-study (100 h).

**Module elective/technical courses**

**Module technical course "IoT for Work 4.0: Healthy and safely human operators in production systems and workplaces"**

Activity 1: Theory classes (30 h)

- The theory classes are complemented with distance learning materials (knowledge clips, reading materials).
- Homework: reading selected papers.

Activity 2: Lab session (30 h)

- Students perform lab works in virtual environment to train design and technological skills.

- Homework: writing a report about performed assignments.

Activity 3: Case-study (30 h)

- Students conduct activities on an approved case study topic (can be provided by lecturer or submitted by student).
- Homework: preparing presentation to communicate results and do a scientific discussion and reflection.

**Module technical course "Skills of the future and changing the workplace under the influence of the indus-trial revolution "**

- **Activity 1:** Theory classes (20 h)
  - The theory classes are complemented with distance learning materials (knowledge clips, reading materials).
  - Homework: reading selected papers.
- **Activity 2:** Practical session (20 h)
  - Students perform practical tasks in virtual environment to train design and technological skills.
  - Homework: writing a report about performed assignments.
- **Activity 3:** Case-study (20 h)
  - Students conduct activities on an approved case study topic (can be provided by lecturer or submitted by student).
  - Homework: preparing presentation to communicate results and do a scientific discussion and reflection.

## 4.2 Teaching & Learning Resources

- Communication software for collaboration work (Zoom, Microsoft Teams)
- Communication technologies for online learning (Moodle)
- Software for presentation (Microsoft PowerPoint)
- High-Speed Internet Connection
- Microphone, web camera, graphics tablet and stream projector
- Hardware and software for the learning process (presentation materials, cooperation work, communication, JIRA)
- Learning Management System (Moodle).
- For labs with IoT: Raspberry Pi 3, Arduino Leonardo, Packet Tracer Arduino IDE.

## 4.3 Tailoring & Educational Tracks

Educational Tracks:

- students: take all core courses and 1-2 electives
- professionals/life long learning students: take core courses + case studies + (min) 1 elective in the area of their own job-related field.

## 4.4 Assessment Methods

| FORM | % | REMARK |
|---|---|---|
| Written exam | 40 | Based on theory classes (activity 1,4) |
| Evaluation of lab activities | 30 | Permanent evaluation (activity 2) |
| Team presentation for results discussion (activity 3) | 10 | Project kick off presentation |
| Team presentation 1 for project simulation (activity 3) | 20 | Project end presentation |

## 4.5 Curricula Integration

This module is targeted to be included in curriculum of Master in Project Management, Computer Science, Software Engineering.

## 4.6 Quality Assurance - Evaluation

### 4.6.1 Quality assurance

*Assessment Timing:*

- Feedbacks are gathered to address any emerging issues.
- Interim evaluations assess the module's progress and effectiveness.
- Comprehensive evaluations provide insights into the overall module effectiveness.

*Assessment Methods:*

- Anonymous questionnaires collect students' perceptions of the module's content, delivery, and resources.
- Students compile their work throughout the module, demonstrating their learning journey and achievements.

### 4.6.2 Evaluation

- Review and release by IEB/QMB
- Pilot teaching with peer review and survey
- Via student survey after each teaching of the module
- After curriculum integration: accreditation review

# 5 Syllabus/Module Handbook

Entry for the Syllabus/Module Handbook (Example for “Managing Digital Change”)

<table>
<tr><td colspan="7">Work 4.0 (MOD-W40)</td></tr>
<tr><td colspan="2">Module Owner<br>WUNU</td><td>Workload<br>180 h</td><td>Credits<br>6 ECTS</td><td>Semester<br>1</td><td>Frequency<br>autumn semester</td><td>Duration<br>1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course Title<br>Work 4.0</td><td colspan="2">Contact hours<br>4 hours per week /<br>60 h in total</td><td>Self-Study<br>120 h</td><td>Planned Group Size<br>25 students</td></tr>
<tr><td>2</td><td colspan="6">Course Description<br><br>The aim of the Work 4.0 module is to develop a holistic approach to understanding and learning the essence of Industry 4.0: Work 4.0 as productive systems and processes.<br><br>The Module Work 4.0 is conceived as containing 5 compulsary courses and 2 elective courses on the technical topics.</td></tr>
<tr><td>3</td><td colspan="6">Course Structure<br>1. Introduction. Re-imaging work systems with the ongoing Industry 4.0 digital transformation in the value adding production and logistic processes innovative development (1 ECTS)<br>○ Building on the concept of Work 4.0. Taking a look at the working society of today, tomorrow and beyond in evolution: trends and scenarios regarding work organisation and digital technological innovations.<br>○ Digital technological developments fusion. Key dimensions of Industry 4.0 digital transformation and the innovative impact on work-related outcomes.<br>○ Work is proving to be a key locus of the digital transformation. The coexistence of humans and technology in the digitalised production environment from a human-cyber-physical systems (HCPS) perspective.<br>2. Work 4.0 production system development based on Reference Architecture Model Industrie 4.0 (RAMI4.0) (1 ECTS)<br>○ State-of-art in development of the reference architectures and frameworks to accelerate the growth of the Work 4.0 projects.<br>○ Multidimensional technological architecture to guide structured development and promote work 4.0 interoperability, vision and scenarios.<br>○ Industry 4 projects design and implementation regarding work aspects. Socio-technical approach towards work system digital innovation and human-technology integration.<br>3. Adaptive project management for the context of socio-technical digital transformation (1 ECTS)<br>○ The methodology of adaptive project management.<br>○ Work organisational project management based on socio-technical system approach and technochange methods.<br>○ Digitalization initiatives, that opens up innovative possibilities for designing content, process, the organization of work 4.0 projects.<br>○ Industry 4.0 and Work 4.0 case studies.<br>4. Operator 4.0 concept of the complex activities conducting data-driven decision-making processes and work situational awareness (1 ECTS)</td></tr>
</table>

| | |
|---|---|
| | ○ A vision for the Operator 4.0 is in the context of productive human cyber-physical systems and adaptive automation towards human-automation symbiosis work systems.<br>○ Typologies and enabling technologies to support work distributed decision making at the era of Big Data.<br>○ Managing projects, that augmenting the physical and cognitive capabilities of the operators and support human work in digitalised environment. Adaptation of production system in order to allow a dynamic and seamless transition of functions (tasks) allocation between humans and machines that optimally leverages human skills and competences.<br>5. **Work 4 ergonomics and human's well-being designing towards industry 4.0** (1 ECTS)<br>○ Human-centred components of the well-being at the digitalised workplace.<br>○ Framework for designing work systems in the transition to Industry 4.0 where human factor, ergonomics, work system modelling and designing strategiesare intrgrated.<br>○ Digitalization opens up innovative possibilities for designing content, process, the organization of productive work collaboration.<br>○ Rethinking work architecture, retraining people, and rearranging the organization to leverage technology to transform business by Putting humans in the loop to create value for customers and meaningful work for people.<br><br>**Elective courses:**<br>**6 IoT for Work 4.0: Healthy and safely human operators in production systems and workplaces (3 ECTS, WUNU)**<br>1. Intelligent Health and Safety approach to Work 4.0 based IoT.<br>2. Sensors, actuators, controllers, protocols, smart things, Fogy/Cloud computing under industry 4.0<br>3. Collect data from sensors and analysis the microclimate, emotional state of employees (heart rate, temperature parameters), equipment data collection: operating modes, data on failures and malfunctions energy consumption, air pollution, Integrity of premises, movement of people, violation of the perimeter, unauthorized access to equipment<br>4. Control of microclimate (optimal rate, humidity, air conditioning, lighting), equipment (stop in case of failures, breakdowns, deterioration of working conditions, harmful emissions, physical condition of workers and other emergencies), security systems (reports of perimeter violations or access to equipment (police, management and other services), accidents (reports of medical services, police, management), premises (blocking / unlocking of premises, equipment, etc.)<br>**7. Skills of the future and changing the workplace under the influence of the industrial revolution (2 ECTS, NU-ZP)**<br>1. The main trends that determine the nature of work in the 21st century.<br>2. Skills of the 21st century.<br>3. Strengthening social security. |
| **4** | **Application Focus**<br><br>Students will be guided through a case study project where they plan a digital work project for an example case. This example case will be taken preferably from a real company project. Companies can bring their digital work processes transformation projects as a case study for a block week or summer school workshop. Students form teams to prepare the respective project and present it in a kick-off presentation to the companies. |
| **5** | **Scientific Focus**<br><br>Literature review and analysis. Deductive own research based on the literature. Scientific reflection and discussion in the teams. |

**6 Parameters**

- ECTS: 6
- Hours of study in total: 180
- Weekly hours per semester: 4
  - Contact hours: 60
  - Self-Study hours: 120
- Course characteristics: elective
- Course frequency: every year - summer semester
- Maximal capacity: 25 students
- Course admittance prerequisites: none
- Skills trained in this course: theoretical, practical and scientific skills and competences
- Assessment of the course: contributions within case study project (team presentation) (50%) and written paper (literature review, report or survey, approx. 25 pages) and presentation (in class or at a student conference) (50%)
- Teaching staff: teachers from Open Community of Practice

**7 Learning outcomes**

**7.1 Module course "Introduction: Re-imagining Work Systems with the Ongoing Industry 4.0 Digital Transformation in Value-Adding Production and Logistic Processes Innovative Development" (Core Course, obligatory)**

*Knowledge:*

- The student knows the key dimensions of Industry 4.0 and their impact on production and logistics processes. the student understands the concept of Work 4.0 and its evolution in the context of digital transformation.

*Skills:*

- The student analyze current work systems and identify opportunities for digital innovation.
- The student is able to evaluate the effects of digital technologies on value-adding processes.

*General competences:*

- The student is capable of critically assessing the integration of digital technologies in work systems.
- The student demonstrates autonomy in proposing innovative solutions for digital transformation in production and logistics.

**7.2 Module course "Work 4.0 Production System Development Based on Reference Architecture Model Industrie 4.0 (RAMI4.0) (Core Course, Obligatory)**

*Knowledge:*

- The student knows the structure and components of the Reference Architecture Model Industrie 4.0 (RAMI4.0).
- The student understand the application of RAMI4.0 in developing Work 4.0 production systems.

*Skills:*

- The student can design production systems aligned with RAMI4.0 standards.
- The student is able to implement RAMI4.0 frameworks to enhance system interoperability and integration.

*General Competences:*

- The student is capable of managing complex projects involving the application of RAMI4.0.
- The student demonstrates possibility ensuring compliance with Industry 4.0 standards.

**7.3 Module course "Adaptive Project Management for Context of Socio-Technical Digital Transformation" (Core Course, Obligatory)**

*Knowledge:*

- The student knows adaptive project management methodologies suitable for socio-technical environments.
- The student understands the challenges of managing digital transformation projects.

*Skills:*

- The student can adapt project management techniques to digital transformation initiatives.
- The student is able to coordinate interdisciplinary teams in socio-technical projects.

*General Competences:*

- The student capable of leading projects that require innovative approaches to management.
- The student demonstrates autonomy in decision-making with complex project environments.

**7.4 Module course "Operator 4.0 Concept of Complex Activities Conduct Data-Driven Decision-Making Processes and Work Situational Awareness" (Core Course, Obligatory)**

*Knowledge:*

- Student understands the Operator 4.0 framework and its relevance to modern work environments.
- Student comprehends data-driven decision-making processes and situational awareness in the workplace.

*Skills:*

- Student can utilize data analytics tools to support decision-making in complex activities.
- The student is able to enhance work situational awareness through advanced technologies.

*General competences:*

- The student is capable of integrating human factors with cyber-physical systems to optimize performance.
- The student demonstrates responsibility in promoting safety and efficiency in data-driven work environments.

**7.5 Module course "Work 4.0 Ergonomics and Human Well-Being Designing Towards Industry" (Core Course, Obligatory)**

*Knowledge:*

- Student understands ergonomic principles applicable to Industry 4.0 settings.
- Student comprehends the importance of human well-being in digitalized workplaces.

*Skills:*

- Student can design work environments that prioritize ergonomics and human well-being.
- Student is able to assess and mitigate risks associated with digital transformation on workers' health.

*General competences:*

- The student is capable of advocating for human-centered approaches in technological implementations.
- The student demonstrates autonomy in developing strategies to enhance employee well-being in Industry 4.0 contexts.

**7.6 Module course "IoT for Work 4.0: Healthy and Safe Human Operators in Production Systems and Workplaces" (Technical course: Elective)**

*Knowledge:*

- The student understands the applications of IoT in monitoring and promoting health and safety in production environments.
- The student comprehends the integration of IoT devices to enhance workplace safety protocols.

*Skills:*

- The student can implement IoT solutions to monitor environmental and physiological parameters affecting workers.

| | |
|---|---|
| | • The student is able to analyze IoT data to improve safety measures and respond to potential hazards.<br>*General competences:*<br>• The student is capable of leading initiatives that leverage IoT for occupational health and safety improvements.<br>• The student demonstrates responsibility in ensuring the ethical use of IoT data concerning employee well-being.<br><br>**7.7 Module course "Skills of the Future and Changing the Workplace Under the Influence of the Industrial Revolution" (Technical course: elective)**<br>*Knowledge:*<br>• The student understands the emerging skills required in the evolving industrial landscape.<br>• The student comprehends the impact of the Industrial Revolution on workplace dynamics and skill requirements.<br>*Skills:*<br>• The student can assess current skill sets and identify areas for development to meet future workplace demands.<br>• The student is able to design and implement training programs that address the changing skill requirements due to industrial advancements.<br>*General Competences:*<br>• The student is capable of anticipating and responding to shifts in workplace skill demands.<br>• The student demonstrates autonomy in pursuing continuous professional development to stay abreast of industrial changes. |
| **8** | **Teaching and training methods**<br>• lectures introducing concepts, methods and tools, own literature reading<br>• group work in the case study project to practice concepts and methods, to develop skills and to work on case studies<br>• presentations to communicate results and do a scientific discussion and reflection |
| **9** | **Curricula Integration**<br><br>The module is designed for implementation in master's program curricula in Project Management, Computer Science, and Software Engineering, making it a valuable addition to advanced studies. |
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