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SHARE 4.0

SHARE4.0

WORKPACKAGE REPORT

WP3 – MMASSIST II – WORKING GROUP

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RESEARCH & INNOVATION

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1 MMAssist II – Project

The lead project MMAssist II (assistance systems in production in the context of man-machine cooperation) started on May 1, 2017 and ended in October 2010.

The goal of MMAssist II was to fundamentally investigate the nature and characteristics of assistance in the production context, to develop optimized assistance systems for future-oriented human-centered workplaces, and to experimentally implement and evaluate them in industrial environments. The fundamental basis for the implementation of assistance was formed by so-called "assistance units" - modular units that provide specific assistance functionality for the corresponding user groups or usage scenarios (multimodal). Assistance Units were defined in such a way that they could be generalized and reused across the use cases, which enabled a broad impact for the industrial partners. The implementation was done by the partners as a software framework, so that the basis for a functional application was given.

Initial situation

Austria's manufacturing companies produce high-quality goods and have access to a highly qualified workforce. However, companies are currently exposed to technological and social trends to which they must respond in order to continue to produce competitively on an international scale. These include customer demand for individualized products (smaller batch sizes, faster production cycles). Production facilities and products are becoming increasingly networked and equipped with sensors. This means increased information density and complexity for employees, and thus increased workload and stress. In addition, Austria is experiencing demographic change. The country's citizens are getting older and should be kept in the workforce longer. All these trends, and the goal of maintaining the high quality of the goods produced, lead to an increased need for optimized support for employees in the workplace.

Goals and innovation content

The goal of MMAssist II was to research and implement modular and reusable assistance systems for employees in manufacturing companies. For this purpose, the project partners have analysed the basic requirements for assistance systems from a technical and socio-economic point of view using the exemplary use cases of maintenance and repair, set-up and multi-machine operation and assembly. Based on a strongly context-oriented requirements analysis, so-called "assistance units" have been developed, modular basic modules for assistance systems that are defined in such a way that they can be reused in different application contexts. For the implementation of the assistance units a software framework was implemented, with which assistance units can be dynamically configured to assistance systems for a given use case. Different multimodal input and output modalities have been used for the configuration, as well as context generation modules, which have been also developed in the project. To measure and evaluate the efficiency and feasibility of the

project approach, defined assistance units have been prototypically implemented in the laboratory and in a real production context.

Intended Results and Findings

The outcome of MMAssist II was a profound empirical and socio-technically oriented understanding of the need and requirements for assistance systems in a production context. These consist of reusable, scientifically based and comprehensively evaluated assistance units. The solutions have been validated by employees from manufacturing companies under the respective context conditions. This has provided insights into the acceptance or user experience when using assistance systems, and have made reduction of workload for employees measurable.

2 Outcome - MMAssist II

The overall result of MMAssist II is a profound empirical and socio-technically oriented understanding of the need and requirements for assistance systems in the production context. These consist of reusable, scientifically based and comprehensively evaluated assistance units. The solutions will be validated by employees from manufacturing companies under the respective context conditions. This will provide insights into the acceptance or user experience when using assistance systems, and will thus make the reduction of workload for employees measurable.

2.1 Requirements for assistance units from the user's perspective

2.1.1 A human centred process

To develop the planned assistance units, the requirements of the future users of the assistance systems in the production context were first recorded. The starting point for a further analysis was the overarching goal of identifying opportunities and challenges for future assistance systems from the user's perspective. In order to ascertain these assistance needs; a detailed context study was conducted between August 2017 and January 2018 at nine application partners with the involvement of various groups of people (future users and decision-makers).

Specific objectives of the context study were:

- Understanding of the application contexts at the companies
- Identification of relevant experience factors
- Identification of assistance needs

The results of the study have been available since March 2018 and form the basis for the conceptual design and implementation of the modular assistance units.

2.1.2 The assistance units

Based on the results of the context study, the following assistance units were defined in coordination with the implementation and company partners, which will be further implemented in the project:

Assistenz Units		**Use Cases**		
		Montage	*Wartung & Instandsetzung*	*Rüsten & Mehrmaschinenbedienung*
1	Digital Guidence	X	X	X
2	Annotation of Atrtefacts	X	X	X
3	Physical Assitence: Ergonomics	X		
4	Documentation		X	X
5	Communication with Experts		x	
6	Status information			x
7	Collaborativ Robots	x		

2.1.3 Interaction design for assistance units

Subsequently, a series of design workshops were conducted based on the results of the context study. Conceptual designs were developed for these seven defined assistance units, which describe the interaction process with the assistance units from the user's perspective and reflect the assistance needs and requirements identified. These conceptual designs form the basis for the further human-centered implementation of the assistance units. Currently, prototypes of the assistance units are implemented and tested at the company partners.

2.2 Identification of relevant parameters for the description of assistance needs and Potentials and effects of the productivity of people and work systems

Basically, the capabilities of the person working at the workplace (person profile = capability profile) with the requirements of the activities themselves (activity profile = requirements profile). Through the implementation or support of certain work processes within the framework of an activity, the requirements of the task were adapted to the ability of the person. In this way both under- as well as overstrain at the workplace could have been avoided.

The matching of skills and requirements can take place either initially, i.e. before the job is or on a situational basis during the ongoing work process. In the case of matching in the ongoing process, the learning curve, but also the fatigue symptoms of the persons and thus adapt the respective assistance needs can be adapted accordingly.

The human and workplace factors that have been considered and quantified in the planning model are shown in the following table.

Human factors	Workplace factors
Elementary factors	Product characteristics
Gender, anatomy, culture, heredity	Height, weight, symmetry
Individual factors	Workplace design
Personality, age, intelligence, weight, Health status, Rhythmic influences	Ergonomics, Degree of mobility
Adaptation factors	Task design
Workload, fatigue, motivation, System acceptance, satisfaction, mood	Interaction with tools, Process sequences, process types
Competence factors Information sources Experience, knowledge, skills, education, Competencies	Time and type of information provision, degree of real to virtual information

By comparing abilities and requirements, each of which is derived from human and Job factors, assistance needs have been defined. Assistance needs are divided into cognitive and physical assistance and include:

- Information provision or presentation (adaptive & situational)
- Information retrieval
- Annotation
- Prioritization
- Enrichment of components or tools
- Physical assistance in the sense of ergonomic support

Key technical features for satisfying assistance needs are:

- type of knowledge sources in the sense of data provision
- Input devices or input forms
- Output devices or forms of output

In this context, a technology matrix was developed for digital as well as for physical assistance systems was developed in the form of a morphological box. Goals pursued through the use of assistance systems include:

- Reduction of learning times
- Reduction of search times
- Reduction of assembly errors
- Reduction of documentation activities
- Reduction of unergonomic postures

3 The importance of the Industry 5.0 in production environments

Industry 5.0 is the latest industrial revolution that is transforming the manufacturing industry. It is a combination of advanced technologies such as artificial intelligence, the internet of things, and robotics, which are used to create smart factories that are more efficient, productive, and sustainable. The concept of Industry 5.0 is based on the principles of circular economy and sustainability, which are essential for the future of the manufacturing industry. In this essay, we will discuss the importance of Industry 5.0 in production and its influence on circular economy and sustainability in the industry.

The manufacturing industry has undergone several transformations over the years, from the first industrial revolution in the 18th century to the fourth industrial revolution in the 21st century. Each revolution has brought significant changes to the industry, from the introduction of steam power to the use of computers and automation. The latest industrial revolution, Industry 5.0, is focused on creating a more sustainable and circular economy by using advanced technologies to optimize production processes.

One of the key benefits of Industry 5.0 is its ability to improve efficiency and productivity in the manufacturing industry. Smart factories that use advanced technologies such as artificial intelligence and robotics can operate 24/7 without the need for human intervention. This means that production processes can be optimized to reduce waste, increase output, and improve quality. By using data analytics and machine learning, smart factories can identify inefficiencies in the production process and adjust in real-time to improve performance.

Another important aspect of Industry 5.0 is its focus on sustainability and circular economy. The circular economy is an economic model that aims to minimize waste and maximize the use of resources by keeping products and materials in use for as long as possible. This is achieved by designing products that are easy to repair, reuse, and recycle. Industry 5.0 is well-suited to support the circular economy by using advanced technologies to create products that are more sustainable and environmentally friendly.

For example, 3D printing is a technology that is commonly used in Industry 5.0 to create products that are more sustainable. 3D printing allows manufacturers to create products using fewer materials and less energy than traditional manufacturing methods. This means that products can be produced on demand, reducing the need for large inventories and minimizing waste. Additionally, 3D printing allows manufacturers to create products that are designed for disassembly, making it easier to recycle and reuse materials.

Industry 5.0 also has the potential to create new business models that support the circular economy. For example, the sharing economy is a business model that allows individuals to share resources such as cars, bikes, and homes. This model is based on the principles of the circular economy, as it encourages the sharing of resources to reduce waste and maximize the use of existing assets. Industry 5.0 can support the sharing economy by creating smart factories that can produce products on demand, reducing the need for individuals to own their own products.

In addition to supporting the circular economy, Industry 5.0 can also help to reduce the environmental impact of the manufacturing industry. The manufacturing industry is one of the largest contributors to greenhouse gas emissions, accounting for approximately 20% of global emissions. Industry 5.0 can help to reduce these emissions by using renewable energy sources such as solar and wind power to power smart factories. Additionally, Industry 5.0 can help to reduce waste by using advanced technologies to optimize production processes and reduce the amount of raw materials needed to produce products.

In conclusion, Industry 5.0 is an important development in the manufacturing industry that has the potential to transform the way products are produced. By using advanced technologies such as artificial intelligence, the internet of things, and robotics, smart factories can operate more efficiently and sustainably. Industry 5.0 is also well-suited to support the circular economy by creating products that are designed for disassembly and reuse. As the manufacturing industry continues to evolve, it is important that we embrace the principles of Industry 5.0 to create a more sustainable and circular economy.

3.1 Main Topics within Industry 5.0 for Production

1. Smart Factories

Smart factories are the cornerstone of Industry 5.0. They are factories that use advanced technologies such as artificial intelligence, the internet of things, and robotics to optimize production processes. Smart factories are designed to operate 24/7 without the need for human intervention, which means that production processes can be optimized to reduce waste, increase output, and improve quality. By using data analytics and machine learning, smart factories can identify inefficiencies in the production process and adjust in real-time to improve performance.

2. Artificial Intelligence

Artificial intelligence (AI) is a key technology in Industry 5.0. AI is used to analyze data from sensors and other sources to optimize production processes. AI can also be used to predict maintenance needs and identify potential problems before they occur. This can help to reduce downtime and improve overall efficiency. Additionally, AI can be used to create predictive models that can help manufacturers to make better decisions about production processes and product design.

3. The Internet of Things

The internet of things (IoT) is another key technology in Industry 5.0. IoT refers to the network of devices that are connected to the internet and can communicate with each other. In smart factories, IoT devices are used to collect data from sensors and other sources to optimize production processes. IoT devices can also be used to monitor equipment and identify potential problems before they occur. This can help to reduce downtime and improve overall efficiency.

4. Robotics

Robotics is another important technology in Industry 5.0. Robots are used in smart factories to perform tasks that are repetitive or dangerous for humans. Robots can also be used to perform tasks that require a high degree of precision. By using robots, manufacturers can improve efficiency and reduce the risk of accidents in the workplace.

5. Additive Manufacturing

Additive manufacturing, also known as 3D printing, is a technology that is commonly used in Industry 5.0. 3D printing allows manufacturers to create products using fewer materials and less energy than traditional manufacturing methods. This means that products can be produced on demand, reducing the need for large inventories and minimizing waste. Additionally, 3D printing allows manufacturers to create products that are designed for disassembly, making it easier to recycle and reuse materials.

6. Circular Economy

The circular economy is an economic model that aims to minimize waste and maximize the use of resources by keeping products and materials in use for as long as possible. This is achieved by designing products that are easy to repair, reuse, and recycle. Industry 5.0 is well-suited to support the circular economy by using advanced technologies to create products that are more sustainable and environmentally friendly. For example, 3D printing allows manufacturers to create products that are designed for disassembly, making it easier to recycle and reuse materials.

7. Sustainability

Sustainability is a key principle of Industry 5.0. The manufacturing industry is one of the largest contributors to greenhouse gas emissions, accounting for approximately 20% of global emissions. Industry 5.0 can help to reduce these emissions by using renewable energy sources such as solar and wind power to power smart factories. Additionally, Industry 5.0 can help to reduce waste by using advanced technologies to optimize production processes and reduce the amount of raw materials needed to produce products.

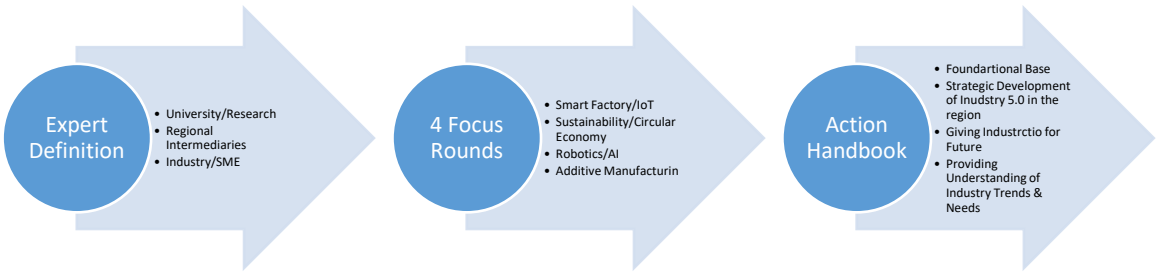
4 Conclusion & Result

Taking into consideration the results of the MMAssist II project and the current European strategy of Industry 5.0 including regional research strategies also focusing on sustainability, circular economy, future mobility and human centric production it can be said that a stronger emphasis has to made in order to boost the technology in small and medium sized companies. As a result, the SHARE 4.0 process was a creation of a basic framework/roadmap for the SK-AT region. The SHARE 4.0 project came to an understanding that the Topic of Industry 5.0 has to be worked on and developed in structural way for which the handbook shall guide policy makers, intermediaries, research and industry.

Therefore, it is necessary to bring industry, research and SMEs together in order to create a handbook of action for the regions development which should be handed out to regional, national and international policymakers and to establish the foundation of the industry 5.0 networks and platforms within the AT-SK regions.

Methodology

To achieve an effective development of the Industry 5.0 topics in the SK-AT region, the SHARE 4.0 project has created a process providing a basic framework/roadmap to the development of a handbook of actions. Furthermore, this framework/roadmap shall also provide the knowledge of the most interested stakeholders of the SK-AT region for the sustainability of the handbooks resutls and further measures.



The illustration above shows the added concept as result of the investigation done by MMAssist II and the SHARE 4.0 project. First, it defines the necessity to define Experts in the field of Industry 5.0 and human robot collaboration. These experts have to be honourable members of scientific boards & regional intermediaries with connection to authorities and policy makers. Most importantly the involvement of the renown companies which currently are mostly driving the regional/national industry forward. To foster a real impact the representative of the industry has to be in the C-Level Management or have a strong influence on the C-Level decision making otherwise the targeted impact of the Handbook's goal might be to small to make a difference to create action.

As secondary research shows 7 main Topics could have been identified. Based on these results SHARE 4.0 suggested as shown in the illustration above to conduct over a in future over a time period of a year 4 Focus Rounds/Expert Working groups which shall be hold Quarterly on the main topics covered by the Industry 5.0. Following 4 Focus Rounds have been pre-defined by SHARE 4.0

- SMART Factory & IoT
- Sustainability and Circular Economy
- Robotics and AI
- Additive Manufacturing.

However, as circumstances may change over the time and industry as well as the regional economy is continuously undergoing changes due to sudden extrema such as COVID-19 etc. it still has to be mentioned that the topics may be changed by the organizing project AI5production. Furthermore, SHARE 4.0 is only providing a base on which changes enhancing the concept are allowed and required. Which means that it is fairly to further specialize the Focus Topics of the Round table in order to gather more specialised and more concrete results.

Overall the action and discussions by the Expert Rounds/Focus Rounds shall lead to the development of a Action Handbook for national & regional policy makers in order to not only further develop the topic of Industry 5.0 but also to provide actions for the government to implement the core of Industry 5.0 across all important industries and branches as well as sectors. This shall be then signed by all participants and handed over to the policy makers.

The Action Handbook has to include following aspect:

- Introduction of Recommendation and Guidelines
    1. What is the Handbook about?
    2. Why is a Recommendation/Action Handbook needed?
    3. What is the recommendation by Research, Intermediaries & Industry
    4. How does they relate to National and European legal standards?
    5. What is the aim of this handbook?
    6. Explanation of key terms
    7. Relevant criteria for the implementation and development of the Industry 5.0

8. Needs, challenges and goals of human workforce
9. Needs, challenges and goals of corporations
10. How is the Handbook organized?

- Current Status Quo & National Frameworks
  1. Legal frameworks
  2. Policy and institutional frameworks
  3. Cooperation and coordination at national level & international level
  4. Fundamental principles
- Operational principles in practice
  1. Access to technology
  2. Rights and freedom of business enterprises
  3. Rights and freedom of the human workforce
  4. Privacy and data protection
  5. Education and Skill development
  6. Safety and protection
  7. Ethical and Moral Issues and Concepts
- International Cooperation and Coordination
  1. Relations to programs on a European Union Level
  2. Cooperation possibilities between countries
- Implication Actions and Engagement with business enterprises

Once the Handbook is completed and developed this should be signed by all participants and further important cooperation partners and stakeholder.

Conclusion

As stated in the begging of this Chapter the SHARE 4.0 project has defined that Industry 5.0 has to be developed in a systematic way. Therefore, the Handbook shall show which actions are needed to be taken in order to implemented all Industry 5.0 aspects in the national industries and branches as well as sectors thus making the regional and international economy more competitive and make future research projects more and more tailored to the industrial needs to enhance also the technological advancement which is need for a country to be competitive. Noteworthy is that the “Memorendum of Understanding” was also created by SHARE 4.0 to exactly foster the industrial development. Lastly, the AI5production, which is also active in the AT-SK region and is strongly advised by the European Commission to cooperate internationally, this handbook will be created by the given basic methodology of the SHARE 4.0 project.