



NUCLEI

PROJECT HANDBOOK

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Interreg

CENTRAL EUROPE



European Union
European Regional
Development Fund

NUCLEI



NETWORK OF TECHNOLOGY
NODES FOR ENHANCED OPEN
INNOVATION IN THE CE
ADVANCED MANUFACTURING
AND PROCESSING INDUSTRY

Aim of the project

Welcome!

In these pages you will find out how the NUCLEI Project brought to a transnational level activities and ideas that were only implemented at local level before.

The 10 partners involved in the project all have similar background and activities. They all have connections with large, medium and small enterprises and offer to them services to support their innovation process.

Is the innovation process different in Italy from Germany or Czech Republic or Austria or any other country in Europe? If so why? And how can we learn from each other to grow all together?

These are the starting questions that were posed at the beginning of the NUCLEI Project, and in this booklet, you will find the answers.

In fact, you will find out how each partner contributed with his best practices and tough them to the others. You will also understand how by collaborating, the same activities crossed the borders involving stakeholders from different countries and acquired an international dimension.

All together this project demonstrated that it is possible to create a super-network of local EU clusters generating new opportunities for all the enterprise connected to that network.



Wrocław University
of Science and Technology





Kick off meeting - September 26th 2016 - Modena (IT)



Transnational training: Open innovation and advanced manufacturing - September 27th 2016 - Modena (IT)



Steering Comitee Meeting (No.3) - December 5th 2017 - Prague (CZ)

Short Description of the project

NUCLEI stands for “Network of Technology Transfer Nodes for Enhanced Open Innovation in the Central European Advanced Manufacturing and Processing Industry”.

NUCLEI aimed to establish a transnational innovation management model in Central European regions and to create a transnational pool of knowledge that supports advanced manufacturing innovation beyond regional borders.

The main objectives of the project were:

- Increase linkages with innovators beyond regional borders of the project regions
- Accelerate the time-to-market of R&D concepts from EU-funded research and Central European labs to companies
- Increase R&D expenditure and patent applications of mid-term turnover
- Create thematic focus groups as regional managers
- Collaborate on transnational technology transfer.

Partners from six Central European countries have joined forces to improve innovation management across regional borders.



The starting point

The knowledge- and technology-transfer is essential for the economic development of any region in the world. That is the reason why it is important to **shift available knowledge into concrete business relevant ideas**. Besides technical product and process innovation it is also necessary to focus on economic knowledge, the exploitation of new sales opportunities, design development as well as innovative organizational models. In this context, the **advanced manufacturing industry** is facing major challenges due to rapid growth and ever shorter development times. In connection with new technologies innovation management approaches must take these developments into account.

Central Europe area is the backbone of EU advanced manufacturing industry. The NUCLEI regions like Emilia-Romagna, Veneto, Upper Austria, Bavaria have long global leadership while in other regions like Lower Silesian, Košice or Eastern Czech Republic the potential has been unleashed by the quite recent access to EU, new research and development infrastructures and foreign direct investment. However, in these regions, innovation support services are limited in the scope as they are mainly focused on doing brokerage and tech-transfer within a given territorial domain and transnational cooperation is poor. This traditional “local-based” approach to tech-transfer is a limit and doesn’t foster rapid transfer of new key enabling technologies concepts into industrial exploitation (especially for SMEs). Furthermore, research and development performers from different regions are poorly connected with each other.

The NUCLEI project was intended to improve these conditions. Main objective of NUCLEI was and still is to change traditional innovation management services for Central Europe advanced manufacturing industries **from a “local-based” support approach to a transnational pool of knowledge** supporting innovation in businesses beyond own regional borders.

Therefore, the purpose of NUCLEI project was to assess the “distance-to-target” between the actual needs and technological interests of advanced manufacturing industrial companies and the technology transfer services currently provided by the 7 excellence nodes concerned in NUCLEI. The point-zero was to **screen the specific regional potentials and various cluster approaches experiences** in Central Europe projects as well as surveys to identify companies needs in the broad field of advanced manufacturing. Under consideration of European and worldwide technological trends, specific industrial pools were identified to profile NUCLEI transnational business services. The knowledge gained was the basis for all further steps in the project.

Companies needs in a global context

Developments on a global, European or national/regional level are significantly influenced by a wide variety of technology trends. Different studies like the “OECD Key and Emerging Technologies 2016”, “The Gartner Hype Cycle for Emerging Technologies 2015-2018” or the “Production and Technology Radar 2017” show that the production of the future will be decisively changed and influenced by Key Enabling Technologies (KET) especially in the field of digitalization.

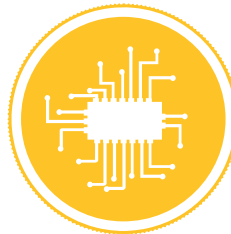
Topics like Cloud Computing, Artificial Intelligence, Blockchain technology, Internet of Things, Smart Robots, Virtual and Augmented Reality, Simulation and Big Data or IT-Security are just a few trends, that will change Advanced Manufacturing significantly.

These trends are also reflected in the multi-annual roadmap for the **factories of the future**. Topics like: advanced manufacturing processes, mechatronics for advanced manufacturing systems, modelling, simulation and forecasting, information & communication technologies (ICT), were selected for a survey to assess current and upcoming needs of industrial companies. For the survey we focused on these four key technologies. Additionally, we split the area of “Mechatronics for advance manufacturing systems” into “Robotics” and “Electronics (for production)” as suggested by the project partners.

More than 270 companies/institutions have participated.



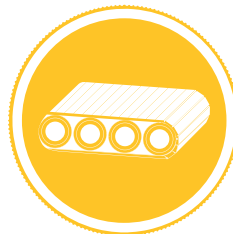
ROBOTICS



ELECTRONICS



ICT



PRODUCTION
PROCESSES



MODELING AND
VISUALIZATION

Key Success Factor for “Technology Transfer”

The objective of the NUCLEI project is to assess the “distance-to-target” between actual technical needs of industrial companies, grouped into the domains set by EU manufacturing industrial roadmap to 2020 and readiness of 7 excellence nodes (clusters, business intermediates) so called Business intelligence services to foster the transnational technology transfer.

Technology transfer is the process of transferring scientific findings from one research organization, e.g. a university, to another institution, e.g. an enterprise for the purpose of further development and commercialization of a technology. Many universities and (regional) governments have founded a so-called office for technology transfer to identify research results which have potential commercial interest. Additionally, they support researchers and companies with strategies for how to exploit the knowledge.

The process to commercially exploit research varies widely. It can involve licensing agreements or setting up joint ventures and partnerships to share both the risks and rewards of bringing new technologies to market. Another possibility is the founding of spin-offs, which is used where the host organization does not have the will, resources or skills to develop a new technology forward to market launch. Often there is a need for raising of venture capital as a means of funding the development process.

NUCLEI project collected a variety of worldwide top technology transfer business models from all over the world.

Technology transfer institutions:

- Technion T3, Israel
- MADE, Denmark
- Steinbeis, Germany
- UnternehmerTUM, Germany
- TA CR, Czech Republic
- MTC, UK
- MIT-TLO, USA

Technology transfer services:

- Offering support regarding intellectual property rights
- Licensing of patents
- Offering high-tech workshop or/and production facilities
- Offering legal support for company establishment
- Helping with business strategy

In addition to the analysis of international best practice examples the involved clusters identified a variety of methodologies for technology transfer and divided these methodologies into the areas information, qualification and cooperation.

The most important services offer in this context are:

INFORMATION

- Information Vouchers: Information for micro, small and medium-sized enterprises to help innovate existing business.
- Innovation Tools: Actively managed online and offline search to find people and processes with specific innovation knowledge.
- Law and Economics: Especially SMEs should be supported regarding intellectual property rights (patents) and further gain of knowledge and economics.

QUALIFICATION

- Events/Trainings: Event formats promoting joint innovation across industries closing the gap between science and industry, thus achieving a high level of innovation and founding dynamics, and securing growth, jobs and prosperity.
- Exchange of experience rounds: Problems are rarely unique and have usually already been managed by someone. In mutual exchange valuable practical knowledge is developed, this can be adapted to each company's needs.

COOPERATION

- Matchmaking: A tool to match partners based on strengths, resources, goals, values and other strategic issues.
- Projects: In the case of cooperative projects, several companies work together, usually with an R&D institution. Such business cooperation strengthens the competitiveness of the partners in the area of technology innovation.

In summary, it can be said that there are various approaches for transnational technology transfer. However, this must be designed accordingly, taking all relevant players into account. This was done in the NUCLEI project in the following sequence within a genetic modification of new business services for innovation a tech-transfer described in the following chapters.

A joint transnational business model for modern business services

A range of factors, including globalization, advances in information and communications technology (ICT), and growing technological complexity, has induced businesses to engage increasingly in innovation collaborations.

The collaborative approach to innovation, termed “open innovation”, may be contrasted with the traditional “closed” approach to innovation, which entails the complete integration of research and development (R&D) within the boundaries of a firm.

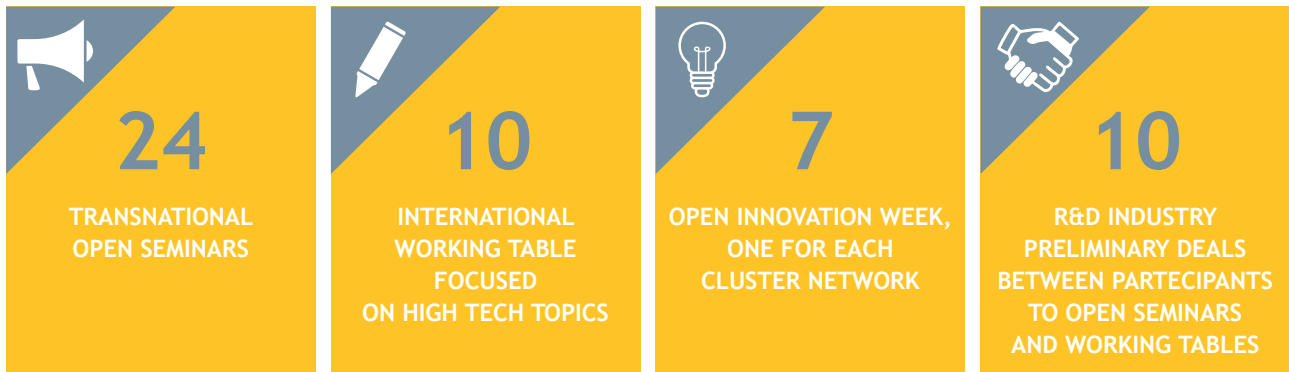
The actions realized through NUCLEI project were aimed to:

- To share needs and knowledge between different enterprises in Central Europe to generate new ideas and access enabling technologies to create value for enterprises.
- Foster knowledge transfer from enterprises to other sectors
- Stimulate the dialogue between enterprises on technology thematic areas of common interest
- Support enterprises in establish networks to be able to gain more competitiveness and a higher degree of innovation.

Technology transfer stories

The core activity of the Nuclei project format, to achieve the goal of maximum diffusion of **Open Innovation practices** at companies, was the realization of a series of activities by the various partners, concerning different topics related to the world of manufacturing industry.

During the project the partners involved Central Europe companies in:



Transnational Open Seminars

Every OS is organized in each NUCLEI cluster with local industries & external R&D and P&P performers (KETs) around specific technology domains to do foresight & diagnostics of tech evolution & quickly introduces mature tech-concepts within NUCEI selected companies.

To coordinate the action, some practices have been put in place by t2i, in particular an online agenda shared with all partners in order to do the Promotion of the Open Seminar, publication of program with speakers details on partner website collection of photos/videos, presentations and comments after the open seminar to be added to the website dedicated to hosting all the open sowing seeds made.

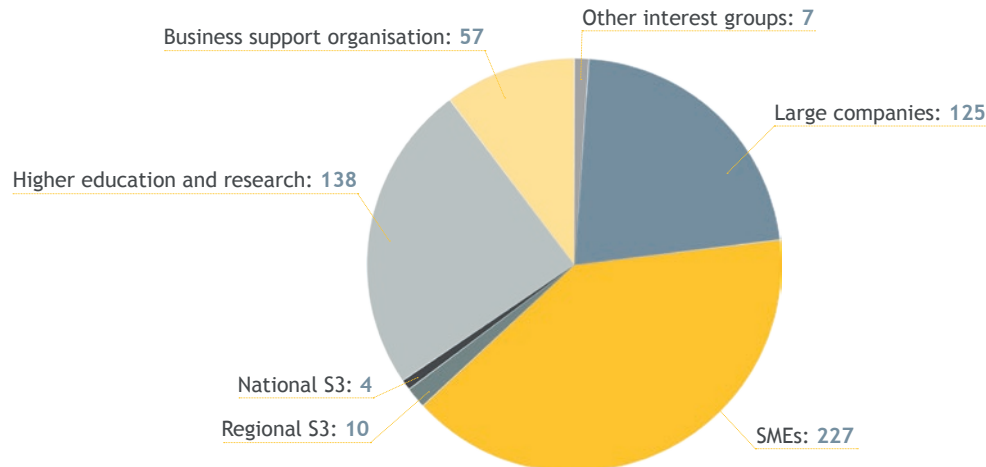
We have achieved these goals:

24 open seminars

- Additive manufacturing (2)
- Big data and cyber security (5)
- Human Machine Interface (2)
- Innovation models (2)
- Social and circular economy (4)
- Internet of things and Process monitoring (5)
- Robotics (4)

727 participants

- Large companies: 125
- SMEs: 227
- Regional S3: 10
- National S3: 4
- Higher education and research: 138
- Business support organisation: 57
- Other interest groups: 7



Transnational Open Seminars

1. Innovative technologies in Additive Manufacturing industry - 30/06/2017

Representatives of research organizations and industrial companies exchanged experiences and discussed their needs and competences in 6 thematic fields: AM, Industry 4.0, Open Innovation, Production Processes, Materials and Robotics.

2. From Process data Acquisition to Cyber Security - 04/07/2017

During a factory tour through the Industry 4.0 factory of B & R, the participants of the event immersed themselves in the entrepreneurial practice and learned about the B & R production processes and systems.

3. Process monitoring with software tools - 18/07/2017

The meeting was focused on technologies such as VR (Virtual Reality) that are suitable for both factory planning and product & plant development, as a basis for decision-making for design concepts, training and education as well as marketing in virtual showrooms or at trade fairs.

4. Human-Machine Interface and adaptive manufacturing - 28/09/2017

The program was attended by experts from research institutes (CNR ITIA, Fraunhofer IAO) and from University of Modena and Reggio Emilia. Company case histories were presented to show how a “skills ecosystem” allows SMEs to increase the impact of IIoT applications in adopting unconventional business models.

5. Customer orientation in digital business models and digital business processes - 10/10/2017

The seminar was a follow-up of NUCLEI companies' wish to receive input on innovative topics in digitalization. The meeting was then placed within a company to allow for more b2b interaction and see best practice examples in situ.



6. Sustainability and Competiveness: New technologies to provide indicators of economic, environmental and social performances - 16/11/2017

The seminar has approached sustainability integration within companies' strategy, with focus on how Innovation and Key Enabling Technologies can contribute to it. Therefore, both assist decision makers monitor in real time operation fluxes and performances, improving decisions quality, making competitiveness and Corporate Social Responsibility fully compatible.

7. Human Machine Interaction: Assistive Robotics - 22/11/2017

The Open Seminar gave an insight into application areas of human-machine interactions. The participants were able to develop first specifications for specific applications and try the robot configuration by themselves.

8. Industrial internet-of-things (IoT) and supply chain integration - 23/11/2017

The program was attended by experts from research institutes (Fraunhofer FOKUS) and representatives of the University of Padua. Case histories were presented to show how a skills ecosystem allows SMEs to increase the impact of IIoT applications in adopting new business models.

9. Industry 4.0 in Mechatronics, Robotics and Automation Manufacturing Systems - 28/11/2017

The seminar involved representatives of industry, academia and local government. The researchers presented their researches useful to set up a platform bringing the research results into practice with the involvement of the companies, authorities and services.

10. Tips and Tricks of Additive Manufacturing - 06/12/2017

The seminar aimed to increase confidence in Additive Manufacturing potential and to face the challenges that characterizing these technologies, such as the creation of a continuous process between AM and the subtractive post-process, secure data transfer and new materials potential.

11. Open innovation 2.0 -15/12/2017

The seminar focused on how to manage philosophy based on the opening up of organizations for suppliers, employees and customers to generate value for the organization and how to develop open innovation by technological elements and deeper integration in the value chain.

12. Human-Robot Collaboration (HRC) and ergonomics - 08/02/2018

The program saw the participation of experts from research institutes (ITIA-CNR, Fraunhofer IPA, Centro Ricerche Fiat) and representatives of the academic world of the University of Padua who reported methodologies to understand the technological potential transferable to companies.

13. Cyberphysical Systems, Big Data Processing and Digital Security in Industry 4.0 driven Manufacturing - 16/03/2018

The seminar was a part of the Academia-Industry Matching Event on the Mutual Impact of Industry 4.0 and High-Energy Physics organized by HepTech in CERN, Geneva, and Technical University Košice and Cluster AT+R. The seminar focused on the issues in cyber-physical systems and big data applications for Industry 4.0 with links to results of research projects.

14. ICT - PLM, Machine configurators and standardization, Big data processing - 05/04/2018

Increasing productivity and reducing costs are keys for maintaining business competitiveness. The seminar showed that combination of data integration and some advanced analytics can be highly valuable for companies. The workshop involved academic and industrial lectures.

15. Circular Economy - 19/04/2018

Circular Economy is going to represent a new paradigm for a sustainable and profitable growth. The seminar has provided key elements to understand the new industrial paradigm and its potential applications for manufacturing companies.

16. Ecodesign; efficiency of advanced manufacturing - 03/05/2018

Energy efficiency and operating costs are fundamental for sustainable and competitive production. The aim of the seminar was to show how to achieve these goals in modern production facilities. Solution, options and successful cases were presented by all speakers.

17. Robotics in production machines - 07/06/2018

Industrial robots are the future for automation of production processes and in join with existing machines open up additional possibilities for increasing production efficiency. The seminar introduced the possibility of integration and use of robots in connection with production machines.

18. Effective Production - 28/06/2018

The open seminar was a follow-up of NUCLEI companies' wish to see applied modern manufacturing methods in the fields of resource efficient production in SMEs abroad. Two companies in the network of the partner cluster BIZ-UP were contacted. Within the seminar, two company visits and one cluster-networking event between the Bavarian cluster and the Austrian cluster took place.

19. Cyber-physical Systems, Big Data Processing and Digital Security in Industry 4.0 driven Manufacturing - 15/11/2018

NUCLEI provided an opportunity for business companies, educational institutions and S3 managers



to discuss innovation management in industry for SMEs, large companies, and educational institutions.

20. Big data and digitalization in the era of Industry 4.0 - 22/11/2018

The seminar was focused on four main contents: virtual prototyping tools and digital twins for industry 4.0, image processing and data management process 4.0, data science for industry 4.0 and agile education in the era of digitalization.

21. Blockchain in Industry - 26/11/2018

The seminar dealt with possible applications of Blockchain in industrial environments. International and national experts gave an insight and showed - on the basis of already existing industrial applications - the great potential of this technology, its capabilities and its benefits.



22. Retrofitting of Brown-Field-Plants - 11/04/2019

Modernity and tradition are daily companions in industry: modern management methods and tools and quality work by tradition, even with “old” machines. You will find one in almost all workshops and production facilities in Austria: Machines from back then. The company Faschang have showed how it works.

23. Robotics in production machines - 11/04/2019

Industrial robots are the future for automation of production processes and in join with existing machines open up new chances for increasing production efficiency. The seminar introduced the possibility of integration and use of robots in connection with production machines.



24. Industry 4.0: digital twin - 08/05/2019

The seminar was focused on the topics of “Digital twins”: perfect copy of a manufacturing product or process interacting only in the digital world.

International Working Tables

Some partners then realized Working tables, “closed” meetings that involved companies and research centers and international experts on topics of Open Innovation in the world of manufacturing industry. In particular.

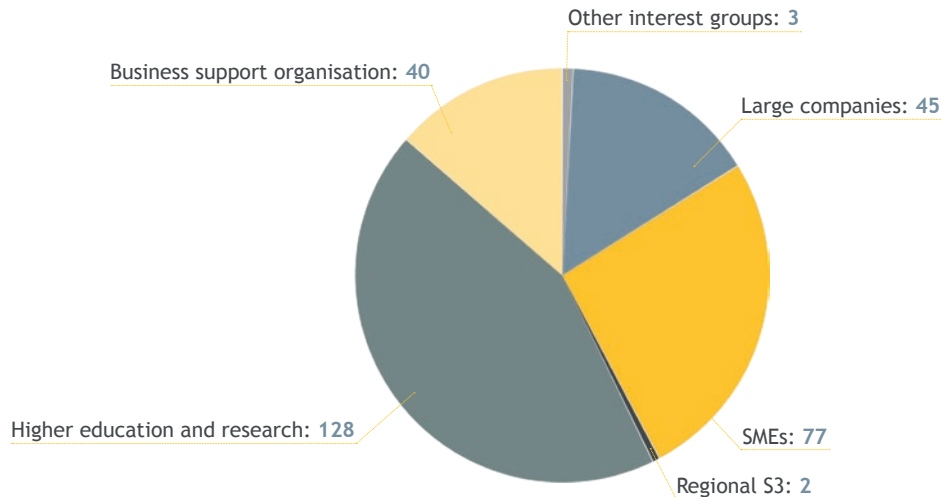
We have achieved these goals:

10 working tables realized

- Innovation Management (5)
- Design methodologies and approaches (2)
- New Technologies and solutions (3)

319 participants

- Large companies: 45
- SMEs: 77
- Regional S3: 2
- National S3: 4
- Higher education and research: 128
- Business support organisation: 40
- Other interest groups: 3



Topic 1 - Innovation Management

Innovation management: Human Robot Collaboration, Industry 4.0 - 18/07/2017

A benchmark of participating companies technology portfolio and innovation management practices in the field of Robotics and Industry 4.0. The three main participants approach the robotics field in a complementary way: Pilz is specialised in engineering services, Datalogic in sensors and optics development and Gaiotto in robot integration and manufacturing for specific purposes and fields (ceramics, finishing, etc.). University of Modena and Reggio Emilia facilitated the discussion providing insight on the latest research trends in artificial intelligence.

Innovation management: Human Robot Collaboration, Industry 4.0 - 23/11/2017

A continuation of the benchmark among participating companies technology portfolio and innovation management practices in the field of Robotics and Industry 4.0, for which three participants (Unimore; Pilz and Datalogic) had already met in Ostfildern on July 18th 2017. One former participant (Gaiotto) was substituted by IMA allowing to discuss a possible use case for an innovative HRC application in packaging machinery. University of Modena and Reggio Emilia facilitated the discussion providing insight on the latest research trends in AI and object recognition for robotics.

Strategy for Additive Manufacturing Technologies - 08/12/2017

Transnational events organized as networking dinner with companies and partners interested in Additive Manufacturing mainly. The form of evening meeting allowed taking part for more participants and set the free-networking atmosphere for ease the cooperation and the creation of new contacts. The meeting was a follow-up of the Open Seminar “Innovative technologies in Additive Manufacturing industry”.

Scientific teams’ approach - 19/12/2017

Transnational working tables organized in a form of networking dinner with researchers from different domains focused on advanced manufacturing. Among the topics covered: Additive manufacturing, Industry 4.0, Robotics, Materials and Production processes. Several participants expressed interest in organizing such events more often to exchange experiences connected with innovation, management of research activities and exchange knowledge on possible collaboration in future.

Innovation and technology management - 20/06/2018

A transnational working table was organised during the ICE/IEEE International Technology Management Conference in Stuttgart in June 2018. It supported the exchange of information, ideas and experiences between companies which are not direct competitors. Within this workshop Festo (Germany), John Deere (Germany), and Holonix (Italy) have shared and discussed experiences and best practices in Innovation Management and Open Innovation approaches.

Topic 2 - Design methodologies and approaches

Working Table Mechatronics Alliance (1) - 17/06/2018

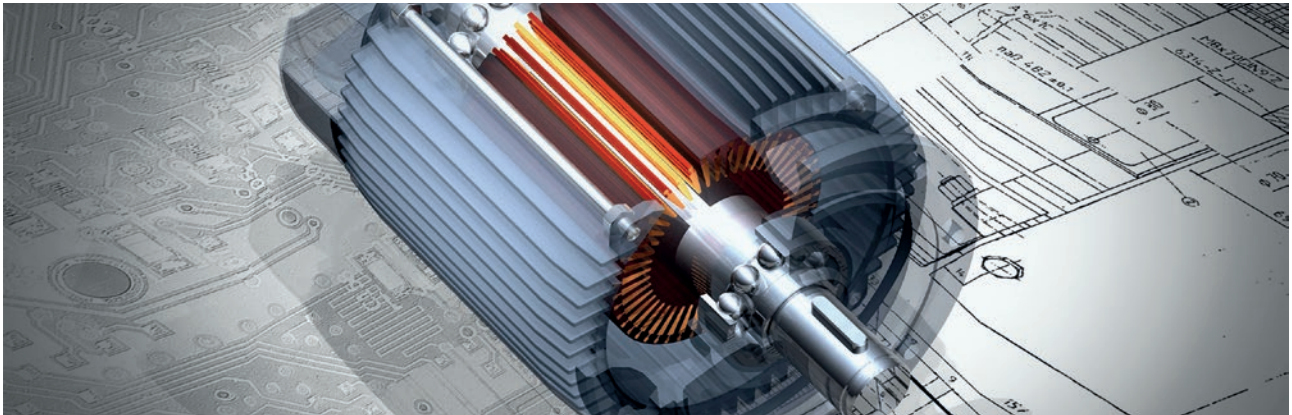
The goal of the Working Table Mechatronics Alliance was foster innovation in the field of Advanced Manufacturing with building a European-wide alliance, where specific topics are hosted by regional representatives.

From 17.06.2018 to 18.06.2018, 18 mechatronics initiatives from 10 countries, including Slovakia, Romania, Great Britain, Italy, Belgium, Hungary, Czech Republic, Netherlands, Germany and Austria have met in Austria in Linz. The meeting was organized by the “Mechatronic Cluster OÖ” (Upper Austria) together with the Dutch mechatronics network to widen the impact out of NUCLEI. The aim of this meeting was to explore innovative technologies across borders and to promote cooperation.

Every network reported about their current topics, priorities and expectations. On the basis of the presentations of the individual representatives, concrete topics were identified in the areas of research and development, production and management support, to which the participants have assigned themselves accordingly. An important point for the participants was, above all, the establishment of technology-oriented platforms for transnational knowledge transfer in order to be able to make use of synergy potential. In addition, an attempt has been made to create a thematic map, which focuses on the research priorities of the individual regions.

Working Table Mechatronics Alliance (2) - 13/12/2018

After an introduction there were the presentations of the experts Florian Eicher and Thomas Kent Rohrberg that provided valuable and inspiring information on their experience on Industry 4.0, Maturity Model and Intelligence, and AI Technology. After the presentations there were a very successful discussion thought the participants of the meeting.



Topic 3 - New Technologies and solutions



4.0 Tech Meetup - 28/03/2018

Wrocław University of Technology was organizing a Tech Meet Up in collaboration with 3YOURMIND, the Polish-German Chamber of Industry and Commerce and the Heart Warsaw. 4.0 Tech Meetup was a meeting to build a network of company knowledge and relationships. Believing that the most interesting and noble ideas come to mind during conversations with people, the organizers came up with an idea, by gathered in one place, Professional and enthusiasts of new technologies. The focus was on Industry 4.0 and new manufacturing technologies like 3D Printing. Some renowned speakers, e.g. from 3D Center, VSHAPER, Evatronix, Elmodis, VIX and Bibus Menos, have been invited to share their experience and knowledge regarding the trends in Industry 4.0.

German-Italian b2b meeting - 12/04/2018

The working table aimed to benchmark Italian and German companies in the field of mechatronics technologies. Italian participants presented their activities and approach to CMAB, that was present in behalf of German companies from Baviera and shared interests, technological topics and future development belonging to their companies. CRIT facilitated the discussion.

New technologies and solutions - 21/06/018

Companies in the field of factory automation from both Germany and Italy joined in on a guided event for matchmaking, pitching and follow-up talks for tech cooperation. The transnational working table between German and Italian companies that took place in Munich was collaboration between CMAB and CRIT as well as the German Italian Chamber of Commerce in Munich. It was a follow-up of a first meeting that took place between both networks on 12th of April in Mirandola, Italy. In mutual pitch rounds, guided matchmaking talks and assisted discussions, all companies involved were able to present to each other their fields of work, the technologies in question and the aims that they had for collaboration in the future.

R&D Preliminary Deals

During NUCLEI project 7 clusters managers offer business support to industries and R&D players that have participated to the open seminars and to the working tables to formalize contractual agreements or concrete collaborations. In the next two boxes three examples:

Rossini Project

As an outcome of the discussions starting during some international working table, a project proposal was submitted under the Horizon 2020 program in the field of Human Robot Collaboration (HRC). The project, called ROSSINI, aims at developing a disruptive, inherently safe hardware-software platform for the design and deployment of HRC applications in manufacturing by the combination of innovative sensing, actuation and control technologies able to promote the spread of HRC applications. In April 2018, participants received confirmation that the proposal had been funded.

Human Assisted Programmable Robotic based on Visual Learning

Following the participation in the Open Seminar “Human-Machine Interface (HMI) and adaptive manufacturing”, the company Bnp expressed interest in deepening the topics covered by the seminar speaker Matthias Peissner. T2i has organized a meeting to deepen the possible technologies. Following this meeting, a direct contact was made with Fraunhofer Institute for Industrial Engineering, which led to the signing of a collaboration in a research project for the developing of a Human Assisted Programmable Robotic based on Visual Learning.

Innovative system of individual public communication

After participating in the networking workshops “ETNO business science mixer” during the Open Innovation Week at the Wrocław University of Technology, several scientists and the company Solid Solutions sp. z.o.o. started cooperating on the project Frengo PRT. The Knowledge and Science and Technology Information Center organized a meeting inviting the partners, during which scope for the joint project were set. At subsequent meetings, financial, schedule and operative details were set. After several meetings, a cooperation agreement was signed, and then a joint application for co-financing was submitted.

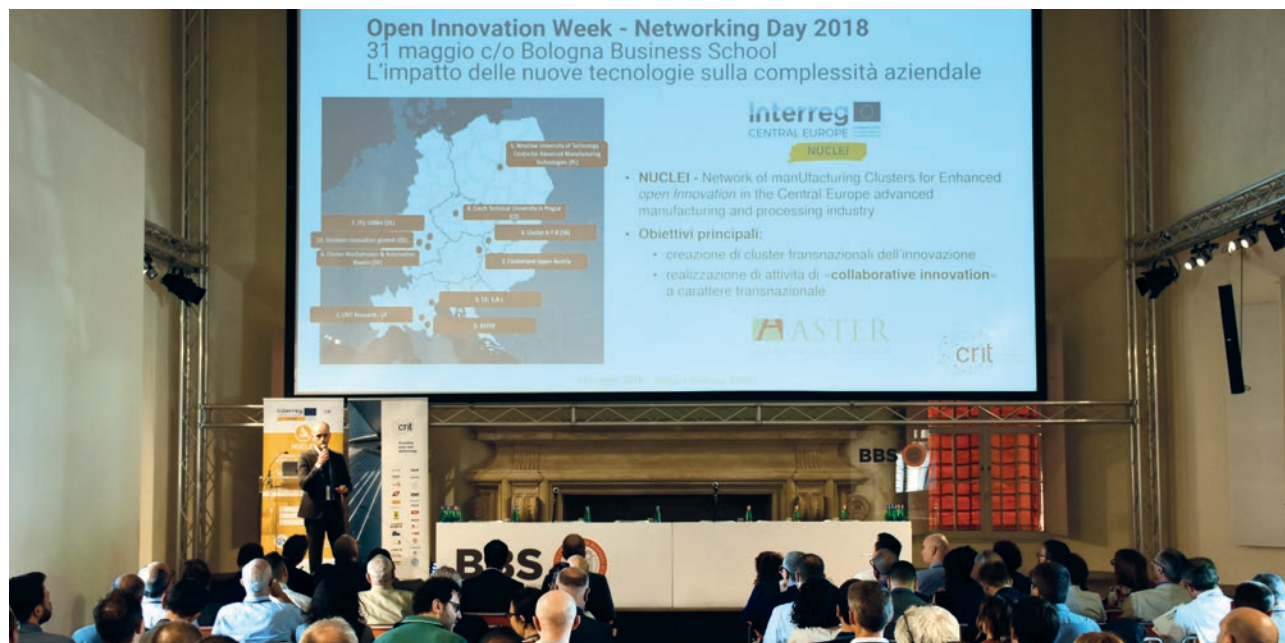
Open Innovation Week

All the 7 clusters have realized their Open Innovation Week, an event focused on the dissemination of Nuclei topics and activity also for universities and business schools.

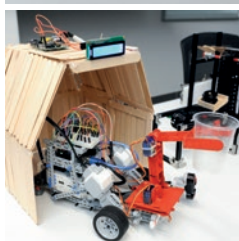
The Open Innovation Week organized by CRIT (with the support of ASTER and ITQ) took place in Emilia Romagna from May 26th to May 31st. Two major events animated this week:

The first one was dedicated to students and creativity. About 60 students were hosted in a local SME and addressed in teams a challenge on the future of automation in the industry. They had to come up with innovative ideas to use robotics and colors in a hypothetic industrial environment.

A second large event named Networking Day was dedicated to SME and consisted of a full day event where about 100 companies had the chance to meet and discuss their innovation process with specific focus on Industry 4.0 technologies. During this event round tables and 1to1 meetings took place, with the specific scope to allow both a general introduction of the background of the participating companies and also to promote a more technical interaction prone to a possible concrete follow up.



Open Innovation Week



Open Innovation Week

Biz-Up organized a three-day Open Innovation Week - more than 40 participants took part and got qualified in three different topics.

The four-day event organised by **PWR** was addressed to entrepreneurs, start-ups, scientists and students interested in the subject of open innovation and commercialization of knowledge. PWR team was presenting information about NUCLEI project and its main tasks and outputs for rising awareness and increasing knowledge about project.

The Open Innovation week organized by **CMAB** at Augsburg's FMB Sued targeted SME exhibitors and SME-related visitors of the Exhibition alike. Together with PP SIG and ITQ, a full-range speaker's corner with a two-day programme could be implemented, hosting various expert lectures and discussion rounds.

In **RCMT**, many young people from several levels of academic area attend the events during the week. Mainly the contact with representatives from industry and local makeathon was interesting for participants.

With reference to **t2i**, the open week was held in the context of DigitalMeet 2017, one of the major Italian events dedicated to Citizens and businesses are at the center of the DigitalMeet 2017 event, which from October 19 to 22 engaged over 200 speakers participating in 100 events spread across 60 locations.

For **ATR**, The NUCLEI Open Innovation Week was organized in connection with the national Week of Science and Technology (5-9 November) and the European Robotics Week (16-18 November).



Strategies for standardization

In the frame of the actions related to standardisation, NUCLEI analysed the needs of the mechatronic sector and developed services. The three mechatronics sectors chosen to be investigated in order to deepen NUCLEI's partner expertise are energy, cyber-security and Internet of Things (IoT). Those areas are indeed of primary importance for our societies and the development of the industry.

ENERGY

The **Energy** sector in the perspective of the climate change and the new regulations put into place, is a strategic sector. De facto, pollution and CO2 emissions reduction are tightly linked to lowering the energy consumption. In this context, the introduction of labels to evaluate the environmental or at least the energy consumption performances of industrial machines, are more than welcome. Indeed, consumers favour more and more companies with an eco-friendly reputation than their competitor. For example, some consumers are ready to spend more money to use 'green' electricity. Consequently, any official evidence of eco-friendly behaviour is good for the reputation of a company and can be part of a marketing strategy.

IoT

The **Internet of Thing** sector and especially in this case the Industrial IoT (IIoT) is at the heart of Industry 4.0 and therefore linked to the future of our economies. IIoT is meant to increase the productivity of the industry across all sectors as well as to revolutionise the relation that human have with the machine. One of the main challenges to achieve this transformation is the interoperability between machines and systems. Till now each machine manufacturer would develop its own system without caring much about the communication with other systems. In the change of paradigm induced by the IIoT, machines with many sensors communicate with other machines. Consequently, a common ground for understanding is needed; this common ground is brought by standards.

CYBER-SECURITY

In view of the many interconnections induced by the IoT it is easy to understand why the third sector of interest: **Cyber-security** is of primary importance. Hacking and cyber-attacks are happening always more often, and data are having always more value, therefore the economic risks are increasing. Concretely, it also means that industrial secrets can be stolen, thus jeopardising companies on the market. Besides the risks for the industry, cyber-security is also very important concerning personal data and privacy and it is a major concern in modern societies. Therefore, rules are needed to regulate the use of data and company should take measures to lower the risk of cyber-dangers.

Standards are an important vector of the innovation and one of its triggers: bringing a common understanding for all actors as well as a baseline to build something bigger without standards it would be harder to communicate. Because of diffused standards, nowadays, it is commonly accepted that the second, the meter and the kilogram are standard units, but it wasn't the case few centuries ago. Each country had their own measure system and even before the take-off of the railway each city had their own time reference. It is then easily understandable that the establishment of standards brings simplicity and efficiency. Standards are criticised because they would create too many norms and restrain creativity, which is true in certain cases, e.g. if they are imposed too early by the authorities. The different industries are still competing to offer the best solutions to their clients. Nevertheless, open standard such as OPC UA that specifies information exchange for industrial communication has been developed by a neutral organisation, the OPC foundation accounting huge players as ABB, IBM and Siemens, and set the common ground for the whole industry.

According to the European Union the benefits of standards include: quality and safety of products, services designed according to service standards, environmental protection and consumers' health, better access to markets and improved interoperability between products or services. Standards are regulated by authorities: European standards are adopted by one of the 3 European standardisation organisations (ESOs) while at national level, standardisation is managed by national standardisation bodies (NSBs) who adopt and publish national standards withdrawing conflicting national standards.

NUCLEI aims at helping companies in the mechatronic domains by transferring the generated knowledge on standardisation processes and the responsible regulation authorities in the three already described strategic domains, enabling partners of NUCLEI to offer guidance to companies of central Europe.



Description of the 3 case studies

Case Study 1: Environmental sustainability

Today industrial activity, and in particular the manufacturing sector, consumes significant amounts of energy with substantial stress on the environment. Actually, standardization in the fields of environmental sustainability is crucial to increase market competitiveness and it is an attempt to bring together some leading corporations.

In the manufacturing industries, since the selection of an industrial machine is finalized when the mechanical part is defined, energy consumption is typically not taken into account. However, in the last few years energy consumption is becoming a major concern, because of the increasing cost of electricity.

Ultimately, machine manufacturers do not still have a proactive attitude towards energy standardization. The reasons behind this lack of interest can be summarized as follows:

- Being part of a multiple level process, if an energy saving machine doesn't impact on the whole process, a customer could consider a high energy efficiency as a secondary characteristic with respect to productivity and price.
- The high number of customizations of industrial machines used by the manufacturing sector makes it difficult to apply energy labels such as those used in household appliances.
- Manufacturing companies generally demonstrate poor knowledge about energy efficiency standards for industrial machines and do not place emphasis on the energy efficiency of their products.

The scope of this case study is about the standardization of mechatronics in the fields of environmental sustainability and aims to set shared parameters and lay the basis to rate the environmental sustainability and energy class (i.e. A+ class) of industrial plant-machineries.



For these reasons, CRIT prepared a comprehensive overview of the state-of-the-art of the rating systems for environmental sustainability and energy class of industrial plant-machineries, and presented a set of relevant Case Studies with high potential of replication, aiming to assess the distance between actual rating systems for environmental sustainability and energy class of industrial plant-machineries.

The first evidence reached by the Case Study is that Environmental Product Declaration (EPD), based on ISO 14025 and EN 15804, is the best environmental standardization tool for industrial plant machineries. In this contest, CRIT described a relevant application of EPD in the packaging sector. This real case study underlines the importance of Product Category Rules (PCR) to define the rules and requirements for EPDs of a certain product category, enabling transparency and comparability. Moreover, it sets an example to follow for other manufacturing industries, demonstrating the relevance of the communication of life cycle based environmental information. The case study involves all the stakeholders, starting from the owner, to employees, customers, suppliers, investors, governments and others.

The report prepared by CRIT and the specific case study intend to show the way for an effective specific support measure to facilitate the introduction of standards at company level: the key to overcoming the barriers for energy efficiency, is in helping manufacturing industry understand that adopting energy-efficiency measures creates a ‘win-win’ situation for the whole value chain and for the environment.

In other words, CRIT believes that it is possible to develop a new type of technological scouting, identifying the most suitable players to support companies in the standardization process and in the related dissemination activities. This activity could be particularly useful for SMEs, as it could offer them a set of tools for starting a standardization project and help companies to define standardization objectives and methodologies and to evaluate the resources required.



Case Study 2: IoT

In the industrial sector there is difficulty in developing international standards which can be accepted and implemented worldwide. At the same time, innovation is boosted by the employment of all types of intellectual and technological resources, as well as by internationalization. In this context, the interconnection of the mechatronic manufacturers with their own providers and customers is becoming necessary with regard to efficiency. Here, the creation of mechanisms for making compatible different technologies and the prompt development of novel personalized products is a priority.

ITQ developed a case study in order to investigate the requirements and difficulties of standardization of the new IoT technologies. The demonstrator developed for the Case Study 2 contains the digital twin of the previous demonstrator: Smart4i, a modular “plug and produce” mechatronic system able to package power banks that could be personalized by the user. NUCLEI enabled its evolution to a cyber-physical entity by the addition of IoT technologies.

The Case Study 2 developed the digital twin of a Comau robot in the first step programmed to pick up one power bank with the color selected by the user. There is a second robot, controlled remotely, receiving the same order from the user. Once the client sends the order of picking a power bank in a selected color, the Comau robot picks it up and the digital twin executes the same order enabling the second robot, placed anywhere else, to do the same.

In Smart4i, to carry out the most general case, the communication protocol used was OPC UA (Open Platform Communications Unified Architecture). The interface of OPC UA affords the connection of plants with quite diverse characteristics, purposes and technologies. It is accepted by a significant number of providers, affording the interconnectivity of components from different manufacturers with integrated security and allowing implementation of local networks. Standardi-



zed interfaces increase the efficiency of engineering processes by enabling the reuse of software components in different applications.

From the analysis of standardization of the Case Study 2, it emerged that standardized metamodel and state model are required for enabling information on connected components and the synchronization of the dynamic behaviour of complex systems. Moreover, it must be underlined the important of assist vendors and system integrations for interoperability and the lack of standardized real time interfaces (similar to IEEE 802.1)

Nowadays, the main purpose of standards must be to serve as a good-practice guide aimed at fulfilling high-quality, functionality, universality, safety and security requirements. The standards must have an interdisciplinary vision and the general sight of all kinds of technologies integrating cyber-physical systems.

The standards should be flexible enough to allow the reuse of existing solutions and easy customizing, new functionality and services. The compatibility between new and existing data formats should be possible and it should not depend on the communication technology.

There is increased interest about the necessity to adapt to the new technological framework and that proper specific standards are missing. Strategies can be devised for the exploitation and development of new standards and high-quality adaptable products. The workshops should encourage the participation of the audience to enable the sharing of problems and points of view. Ma-keathons open a very good opportunity for acquiring practical skills in new technologies, sharing common challenges in an environment with participants from different areas.

Standards shouldn't represent, under any circumstances, an impediment for the development of new technologie. The development of common rules should serve the promotion of the creation of high-quality and functional products and technologies.



Case Study 3: Cyber Security

The aim of the case study was the evaluation of the quality and accuracy of the informative defense protocols of a manufacturing company in the Veneto region, through the simulation of a “hacker” penetration test by a company specialized in cyber security. In the activity were involved ASKOLL, a manufacturing company based in Vicenza, specializing in the production of electric motors and Intutity, a company in Padua operating in the field of cyber security.

The objective of the case study was to test the reference standard in cyber security, namely ISO 27001 series of standards (formally known as ISO / IEC 27001: 2005), and its effective yield in the event of an attack. ISO 27001 was developed to “provide a model for establishing, implementing, operating, monitoring, reviewing, maintaining and improving an information security management system”. It uses a top down, risk-based approach and is technology-neutral. The specification defines a six-part planning process:

1. Define a security policy
2. Define the scope of the ISMS
3. Conduct a risk assessment
4. Manage identified risks
5. Select control objectives and controls to be implemented
6. Prepare a statement of applicability.

The most significant shortcoming is that the entire process, including the Risk Assessment, is mainly a “paper work”, where, both the risks and the level of risks are defined based on a personal perception, not on empirical measure. Is not a limit of the ISO itself since its purpose is to provide guidance for a well-managed information security system, not to evaluate its efficacy. The problem is when people confuses the compliance with a standard (ISO27001 in our example) with



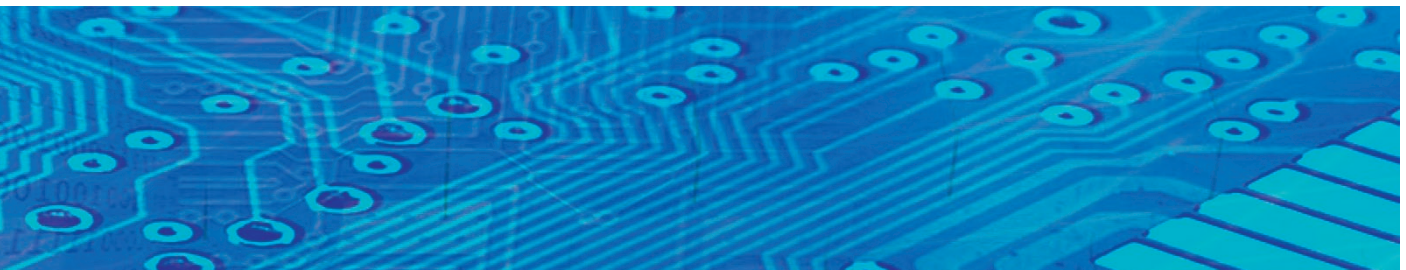
an acceptable level of security. Often is not the case.

ISO2700x define methods and guidelines for the correct management of an Information Security system through the application of specific controls, sometimes of a technical nature and other procedural ones. It is not the goal of ISO to guarantee the effectiveness of controls.

The challenge for the future is to standardize a method of assessment and identification of risk that takes into account the emerging aspects of the problem: the increasingly central role of people, hyper-connectivity, IoT, etc., but at the same time this method have to be really applicable to all companies with the aim of understanding the real and specific risk and as a result, implement investments that respond to clear and documented needs.

We have work on the Involvement of AGID (Agency for Digital Italy) in a dialogue to standardize the system of control and verification of empirical safety. AGID is the technical agency of the Council Presidency which has the task of guaranteeing the achievement of the objectives of the Italian Digital Agenda and contributing to the dissemination of the use of information and communication technologies, encouraging innovation and economic growth. As guarantor, it could have imposed the method at least to the public administration and critical infrastructures as defined by the NIS (Network and Information Security) directive. The directive NIS (EU) 2016/1148 of the European Parliament and of the Council, will be particularly important at European level, because it goes to define the so-called OSE (Operators of Essential Services) companies, which due to their nature of national interest, must undergo specific IT security requirements.

Every company can finally enjoy a “standardized test service, and that acts with the empirical method of the test” on the security of its web / information security network with following actions: direct test of its reality and of the validity of the ISO standards adopted, remedies in case of flaws in computer security and training of personnel to respond to hacker attacks.



A policy framework to support technology transfer

Integration of new knowledge and good practices at decision making level is a fundamental process to foster innovation that should be encouraged in the regional, national and European contexts. The possibility that interregional projects achievements are taken into consideration in the definition of new policy programs depends on three main factors:

- the relevance of the project results;
- the efficacy of the actions put in place to transfer results to policy makers;
- the open-mind and ability of policy makers to integrate such results in their local strategies.

In order to address this process, 7 consultation networks have been created between NUCLEI partners and the Research and Innovation Smart Specialization Strategies (RIS3) managers of the Public Administrations responsible for their respective regional/ national policies. In doing so it was possible to establish a continuous communication channel, useful for both parties to enhance a collaboration galvanizing innovation strategies that will last hopefully beyond the project duration. The permanent consultation networks met regularly at regional level, in the period from Jan 2017 to May 2018. The regional meetings with S3 managers offered to the cluster managers the opportunity to obtain detailed information on RIS3 adopted in the regions, allowing to identify the regional measures and actions that can be influenced by the NUCLEI results. Moreover, they enabled the identification and discussion of the topics during Transnational Thematic Focus Groups, providing inputs for their organization.

1

Investigate potential impact or integration with other regional projects or relevant policy initiatives.

2

Carry out analyses at trans-regional level of the policy instruments adopted in Central Europe regions, in collaboration with S3 managers, outlining those measures that can be investigated more in depth and potentially taken as inspiration for new policy initiatives.

2 Transnational Thematic Focus Groups between project partners and S3 managers have been organized to discuss approaches and current initiatives and catch higher commitment in designing and supporting the transnational business model to cope with S3 goals. Each transnational event allowed to analyze more thoroughly the value of the action and its potential application in other Central European regions.

The final assessment of the NUCLEI results carried out in the last part of the project proved that transnational cooperation provides added value to the evolution of EU manufacturing companies within advanced competitive value chains. The innovation services successfully tested during the project pilot actions are difficult to be effectively organized without availability of public financial contribution.

The support to interregional working tables focused on common cross-cutting innovation issues among companies of different countries and to the organization of yearly regional Innovation weeks at regional level, involving local ecosystems, foreign speakers and trainers, represent a couple of potential policy measures to support in the future the most promising transnational initiative implemented by NUCLEI.

RESULTS

3

Transfer to S3 managers the results obtained by NUCLEI, outlining the requirements resulting from the contacts with the companies involved in the project pilot actions.

4

Obtain a careful analysis of the different regional contexts with a focus on regional R&D goals for advanced manufacturing, to be considered in the design of innovation services, made by the NUCLEI partners.

Strategies for a common space of knowledge

The purpose of NUCLEI partners is to continue and extend the NUCLEI project activities and to promote its results and values beyond the duration of the project.

This “**NUCLEI Collaboration Network**” will be a group of stakeholders operating in the area of innovation, advanced manufacturing and processing, mechatronics, robotics, and related fields and it will consist of the former NUCLEI project members and of further affiliated members in the EU countries.

The new member may be small, medium or large companies, clusters, business support organizations, academic organizations, universities, research organizations or government related agencies from any of the EEA (European Economic Area) countries active in the NUCLEI Collaboration Network areas.

The “**NUCLEI Collaboration Network**” will be focus on the following objectives:

FOSTER AND SUPPORT EACH PARTNER'S WORK, ACTIVITIES AND BUSINESS OPPORTUNITIES THROUGH INVOLVEMENT OF OTHER PARTNERS

CONTINUE INVOLVEMENT OF REGIONAL S3 DEVELOPMENT AND INITIATIVES

COOPERATE WITH OTHER ORGANIZATIONS IN THE FIELDS OF MECHATRONICS AND ADVANCED MANUFACTURING (E.G. EUROPEAN MECHATRONIC ALLIANCE, EUREKA, MANUFUTURE, EFFRA)

INVOLVE INDIVIDUAL MEMBERS IN FINDING FUNDING OPPORTUNITIES AND JOINING NEW PROJECT CALLS AND PROPOSALS (INTERREG OR OTHER PROGRAMS)

PROVIDE A CATALOGUE OF EACH PARTNER'S COMPETENCES AND OFFERS TO EASILY MATCH THE NEEDS AND EXCHANGE SOLUTIONS

SUPPORT THE INNOVATION PROCESS AND TECHNOLOGY TRANSFER.

Outlook

NUCLEI project has built and practically tested the vision of a new model of transnational collaborative environment in the area of advanced manufacturing, mechatronics, robotics, technology transfer, and innovation in the Central European area. This model is based on sustainable links between regions and countries, and between industry, research and local authorities in charge of regional development, and it uses several tools to help collaboration and its meaningful output.

The common work of the project partners on the project deliverables resulted, in addition to the specific deliverable outputs, in the **10 NUCLEI “Golden Rules”**: key factors for strengthening and extending the collaboration among the participating partners and their regions.

- 01** *Common technological background, common understanding, common language*
The collaboration is most effective when it takes place within the platform of stakeholders who can easily find shared background in terms of the technology areas they operate in as well as the challenges they face and who understand one another as they speak the same language regarding their needs and expectations.
- 02** *Meeting together*
It is impossible to maintain successful relationships without communication and in the present digital age it is natural to meet virtually. However, we can confirm that meeting face to face brings also business relationships to the next level helping them thrive. We have also discovered that meetings in small groups provide most benefits to all participants.
- 03** *Taking the meetings further transnationally*
Nevertheless, just meeting is not enough: it is important to follow the meetings up in order to generate deals. The development of the full potential of the business contacts created in meetings is supported by involving the stakeholders in common transnational activities.
- 04** *Key role of cluster managers*
Cluster managers have proved to be vital highly specialized transnational contact points in NUCLEI technological fields. Their active role in establishing and maintaining transnational initiatives to involve stakeholders is irreplaceable as they are in the best position to foster the exchange of contacts to initiate and develop business relationships.
- 05** *Bridges between industry, research and regions*
Another crucial task of clusters and their managers is serving as a point of connection between the partners from industry, research institutions and local authorities to facilitate syner-

gies promoting and accelerating technological transfer, innovation, time-to-market and R&D expenditure in the NUCLEI areas.

06 *Customized offer*

In the NUCLEI activities we have observed that to keep the network productive, it is necessary to cater to various needs of different stakeholders. For example, SMEs tend to look for exchange of best practices and business opportunities whereas large companies to technological benchmarking, therefore they all need adequate opportunities to fulfil their demands.

07 *Practical demonstration of technologies*

A picture paints a thousand words and similarly being able to see the cutting-edge technologies and their development in real life is invaluable for shared technological transfer and transnational cooperation. Technological tours and demonstrations are one of the most popular ways to promote practical understanding and share concepts among the stakeholders.

08 *Digital platform*

With current fusion of virtual and physical life it would be unthinkable to function without a supporting digital platform used to inform the stakeholders and the public about the transnational activities organized and to foster communication and contacts.

09 *Incorporation of S3 priorities*

To strengthen the relevance of NUCLEI approach and environment it is inevitable to make it work with respect to S3 priorities of each region and thus organically link its topics, activities and transnational collaboration to the individual S3 regional strategies through building relationships with local S3 managers.

10 *Young people*

To ensure the continuation and further development of NUCLEI transnational network it is necessary to focus on current stakeholders but also to plan ahead involving new rising generation of innovators, researchers and technology experts, who would continue the good work started, through events like makeathon, hackathons and other activities targeted especially at students and young people.

In the future, after the end of the project, we are planning to keep this successful collaboration going strong and hopefully even to expand it through cooperation with other technological platforms active in Europe and thus fortify the linkages and global competitiveness of European industry.

