
European
Commission
I4MS
ICT innovation for EU SMEs
Bringing the 4th industrial revolution
closer to European manufacturing SMEs
September 2019

ICT for manufacturing SMEs

Bringing Innovation closer to SMEs for a more competitive pan-european manufacturing sector.

I4MS

This brochure has been created by

FundingBox

MOBILE WORLD CAPITAL BARCELONA

In cooperation with the European Commission, DG Connect and the L4MS, MIDIH, HORSE, ReconCell, AMable and CloudiFacturing Innovation Actions.

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FoF Factories of the Future Public Private Partnership

I4MS is part of FoF

0. Introduction

This brochure presents the latest services and technologies that the I4MS initiative as part of the **Digital Innovatwion Hubs** (DIH) programme is offering to manufacturing SMEs, mid-caps and technology providers who are interested in integrating Industry 4.0 technologies into their production processes and value chain propositions. The four most outstanding services offered by the initiative are: access to **leading edge technologies** through **online marketplaces,** the possibility to test them by deploying **Application Experiments,** the **catalogue of online training** offerings and the **I4MS community.**

- **The technologies supported** by I4MS are Cyber-Physical Systems (CPS) and Internet of Things (IoT), Additive Manufacturing, Robotics and High-Performance Computing (HPC). Each technology area is represented by an Innovation Action that provides services to SMEs and mid-caps via different digital marketplaces.
- **The open calls for Application Experiments** offer financial and knowledge-based support to manufacturing SMEs and mid-caps, allowing them to conduct small pilot projects to test Industry 4.0 technologies and assess the impact of scaling them up within their companies and offer inspiration to other companies.
- **The online training catalogue** provides an overview of the skills development trajectories for Industry 4.0 topics offered by Digital Innovation Hubs and Innovation Actions across Europe to support manufacturing SMEs in the digitalization of their production processes. SMEs and mid-caps can find in this catalogue descriptions of training offerings and the contact information of the DIHs providing them.
- **The I4MS community** is an online collaborative space where companies and individuals can easily become acquainted with the latest digital technologies and get in contact with organizations and individuals who have experience deploying these technologies in industrial settings.

This brochure also intends to provide a **summary of the latest technological proposals** created by Innovation Actions working under the I4MS umbrella and examples of Application Experiments in which they were successfully deployed. Our main objective with this overview is to inspire SMEs and mid-caps to consider the adoption of I4MS technologies and contact the Digital Innovation Hubs that developed them to assess future implementation opportunities.

ACCESS TO DIGITAL TECHNOLOGIES AND COMPETENCES

INFRASTRUCTURE TO TEST DIGITAL INNOVATIONS, PILOTING

TRAINING TO DEVELOP DIGITAL SKILLS

FINANCING ADVICE

NETWORKING OPPORTUNITIES

1. Digital Innovation Hubs: One-stop-shops for digital transformation

The European manufacturing sector includes approximately 2.1 million enterprises generating **31 million jobs** and representing about **15% of the EU's GDP**[1]. 59% of all enterprises within the sector are small and medium-sized enterprises (SMEs)[2]. Given that together these companies generate about **45%** of the total added manufacturing value, they are an important pillar of the European economy. For Europe to remain competitive internationally, its companies must be able to benefit from digital opportunities. Therefore, the European Commission launched on 19 April 2016 the first industry-related initiative of the Digital Single Market package. One of the more important pillars of the Digitise European Industry effort is the activity to develop a network of Digital Innovation Hubs (DIH).

I4MS supports the European ecosystem of Digital Innovation Hubs (DIHs) by bringing SMEs closer to the digitalization services offered by Innovation Action projects and their Digital Innovation Hubs.

DIHs have different technological and sector specifications. You can choose the DIH that best matches your criteria (geography, sector, technology, type of service, etc.) via an interactive tool that helps navigate the network of DIHs available in Europe. See next page.

1.1 I4MS: helping SMEs undertake digital transformations

The I4MS initiative maximises the synergies among the participant DIHs and contributes to promote a joint approach and branding of I4MS, making possible a bigger recognition of the initiative outside the ecosystem and among end-users, increasing the chances to engage SMEs and other potential customers. These activities have to be seen as a way to raise awareness about the Digitising the European Industry Strategy and the role of the DIHs within it. In addition, thanks to the financial support of the **Factories of the Future** to I4MS has been able to achieve the realisation of research and innovation objectives linked to the transformation of the manufacturing industry by addressing its challenges

I4MS is building the largest online community for the EU manufacturing industry, bringing the smart manufacturing ecosystem together and offering information on leading-edge technologies and funding opportunities. This community aims at inspiring and offering support to facilitate the digital transformation of SMEs and mid-caps. Find more information at: *www.I4MS.eu*

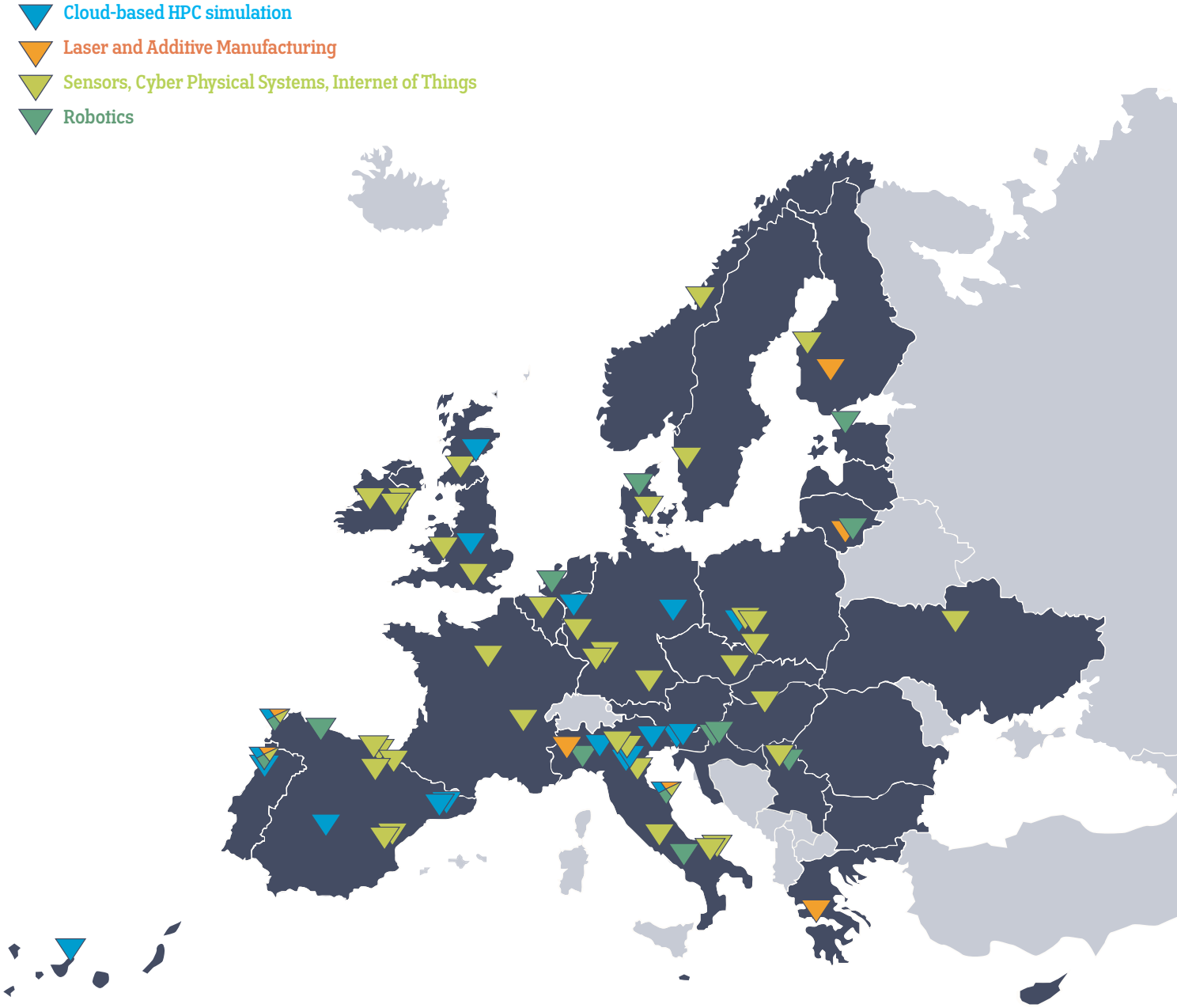
The main services offered by the I4MS initiative are:

- Access to **leading-edge technologies:** Cyber-Physical Systems (CPS) and Internet of Things (IoT), Additive Manufacturing, Robotics and High-Performance Computing (HPC) via the Innovation Actions and their digital platforms.
- Funding opportunities and technology acceleration programmes through the Open Calls of I4MS Innovation Actions, to allow **experimentation and testing with new ICT technologies.**
- Access to innovation through **information about successful Application Experiments of new ICT technologies.**
- Strengthening the relationships of SMEs with Digital Innovation Hubs and other relevant actors **through the online community, engagement activities and the training catalogue.**

[1]https://ec.europa.eu/eurostat/statistics-explained/index.php/Manufacturing_statistics_-_NACE_Rev._2

[2]An SME is a company with less than 250 employees and an annual turnover of up to EUR 50 million (Commission Recommendation of 6 May 2003).

This map shows the number of DIH and Competence Centres suported by I4MS in Europe. More information can be found: *https://i4ms.eu/dihs/map*



Updated August 2019

2. How to get involved

2.1 I4MS Application Experiments: A fast and easy way to test advanced technologies

One of the key services that the I4MS initiative offers to SMEs is the possibility of testing with one of the four technologies supported by I4MS. Such tests, known as Application Experiments, offer SMEs and mid-caps funding, training, mentorships and access to physical and virtual technology platforms. These activities enable the deployment of a pilot project to test its implications in a particular business process.

Application Experiments have a short duration, and are performed by cross-border consortia formed by combinations of manufacturing end users, tech providers and DIHs.

2.2 I4MS Open Calls: The mechanism for applying for Application Experiments

Open calls are light, quick and user-friendly application schemes for Application Experiments with a prompt start date. Each Innovation Action defines the launching and closing dates for applicants to submit their proposals. These applications are no more than 10 pages in length and are designed in a user-friendly way to make the funding application process as swift as possible.

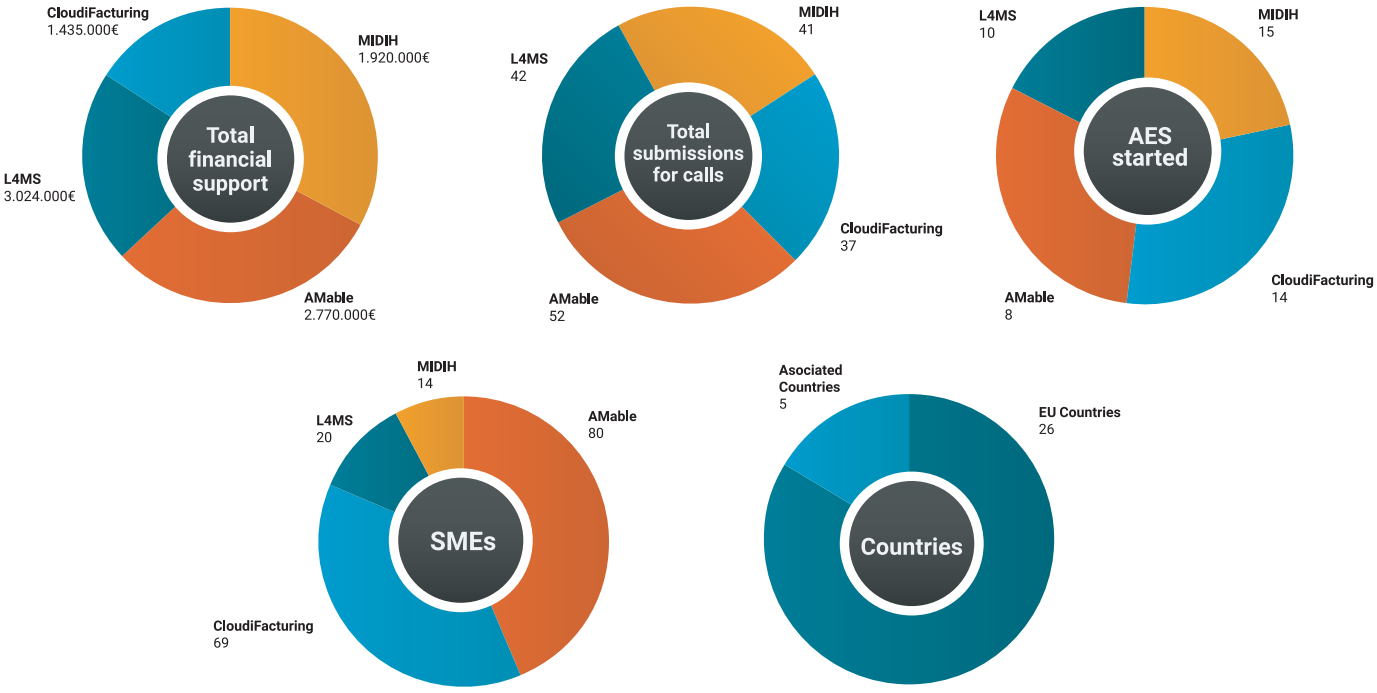
I4MS Open Calls are an attractive mechanism for SMEs and mid-caps because:

- Only a short and specific proposal is needed.
- Short project durations of approx. 6 months with immediate results.
- Offer between 50% and 100% of **equity-free funding** to SMEs, mid-caps, and DIHs.
- The funding is organized and provided through the intermediary role of the **Innovation Action,** which makes the evaluation process much quicker and effective.

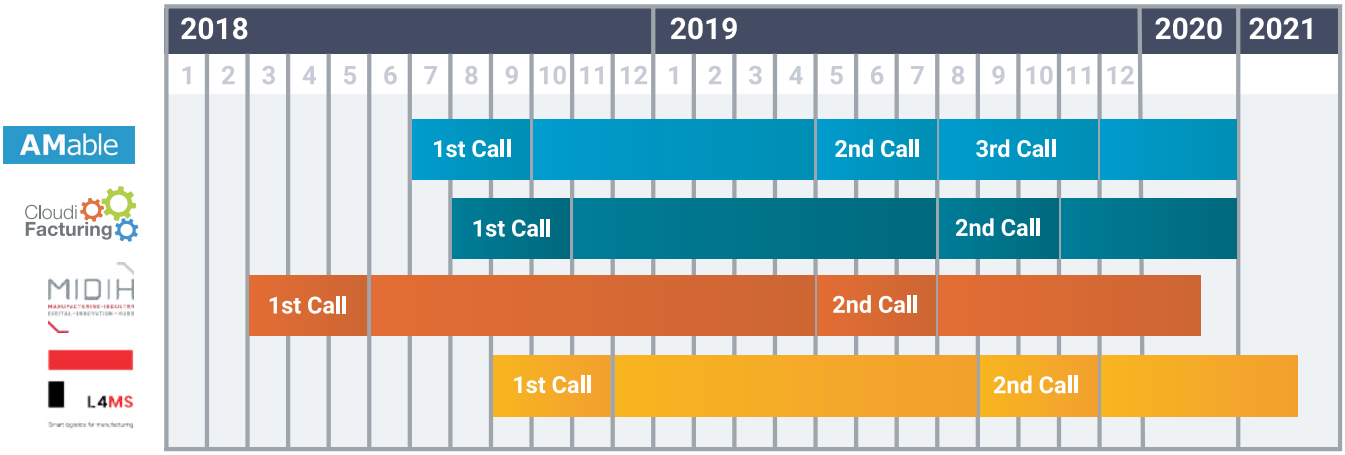
The I4MS initiative was launched in 2012 and has been structured in 4 sequential phases. All four phases follow the same structure, in which each Innovation Action supports SMEs in the implementation of an Application Experiment in their target technology. So far, phases 1 and 2 have been completed and phase 3 is currently active. The fourth phase will start by early 2020.

Phase 3 has a total of 4 Innovation Actions:

- AMable, focusing on Additive Manufacturing
- CloudiFacturing, focusing on cloud computing and High Performance Computing
- MIDH. focusing on IoT and Cyber Physical Systems.
- L4MS, focusing on mobile robots for manufacturing logistics.



To date, these 4 Innovation Actions have launched a total of 9 Open Calls, having faciliated 9 millon euros in direct financial support. Based on the feedback of the granted experiments in these Open Calls, the most valued features have been the access to funding and cutting-edge technologies, guidance and the visibility given by turning the results of the Application Experiments into success cases and joining the EU digital ecosystem. To date, **84% of the participants have been SMEs.**



Application Experiments have covered the following verticals:

CONSTRUCTION · WHOLESALE AND RETAIL TRADE · FINANCIAL INTERMEDIATION · MANUFACTURING OF LEATHER AND LEATHER PRODUCTS · MANUFACTURING OF CHEMICALS AND CHEMICAL PRODUCTS · MANUFACTURING OF OTHER NON-METALLIC MINERALS · MANUFACTURING OF MACHINERY AND EQUIPMENT · MANUFACTURING OF TRANSPORT EQUIPMENT · ENERGY · AEROSPACE

2.3 I4MS Disruptors Awards

The I4MS Disruptors Awards honour the most innovative Application Experiments in additive manufacturing, CPS and IoT, robotics and HPC. Two Disruptors Awards calls have been launched to date (2018 and 2019). The awarded initiatives are granted with the widest visibility on the I4MS website and community as well as offline visibility, namely through the participation in world-class Events where they are put in contact with other partners, stakeholders, founders and investors.

From left to right: **Mariya Gabriel**, EU Commissioner for Digital Economy and Society. Clara Garcia from Compass.

On November 27th 2018, in Warsaw, Commissioner Mariya Gabriel and the Polish Minister of Technology, Jadwiga Emilewicz, awarded the first I4MS Disruptors Award to the SME Compass at the Digital Innovation Hub annual event 2018.

The prize recognised the company's outstanding innovation in the field of simulation software for ship design. Together with the Spanish Digital Innovation Hub CESGA, and other partners within the I4MS EU-funded project Fortissimo 2, the SME improved the design of vessels' ability to withstand rough conditions at sea. Compass reduced by factor of 45 the computational time needed for assess seakeeping of vessels, making supercomputing solutions more affordable and accessible to other companies.

Disruptors Award Winner 2018

EXPERIMENT FACTSHEET COMPASS

HPC-Enabled system for enhanced seakeeping and station-keeping design (HPC-Sheaks)

HPC-Sheaks, an efficient and easy-to-use tool based in the integration of available Fortissimo HPC infrastructures with the most advanced seakeeping software, becoming a time & cost feasible solution.

Implementation:

15 MONTHS

82.560

Impact

The experiment has given Compass the opportunity to increase its expertise in HPC infrastructures and to extend its market by offering new high added-value services to evaluate simulations that have high requirements of computational time and data storage resources.

Partners

End users: **WAVEC (PT), VICUSDT (ES)**

DIHs: **International Center for Numerical Methods in Engineering (CIMNE)(ES)**

Tech Provider: **COMPASS (ES), Fundación Pública Galega Centro Tecnolóxico de Supercomputación de Galicia (CESGA) (ES)**

Description of the Project

Seakeeping is the study of the response of a ship or marine structure to waves. Seakeeping is essential to study safety and operational aspects, under different sea conditions the ship or structure can find in its service life.

The HPC-Sheaks experiment aimed to develop and demonstrate a HPC service for seakeeping assessment using state-of-the-art tools. The result was SeaFEM, a seakeeping solver for the most realistic seakeeping simulations of 3D multi-body radiation and diffraction problems.

The solver was developed by Compass in collaboration with the CIMNE, and completely integrated in the comprehensive simulation environment, Tdyn, developed by Compass. SeaFEM was successfully integrated in the CESGA HPC infrastructure.

Two end-users companies, namely WAVEC and VICUSDT, used the solver in their regular business processes. A service for seakeeping assessments based on the results of this experiment is planned to be available in the Fortissimo Marketplace.

Results

The solver was tested and benchmarks carried out by two end-users. WAVEC made an analysis of the dynamics of a floating wind turbine platform (a very computational demanding exercise) and VICUSDT analysed the behaviour of a stern trawler in different weather conditions with the aim of determining the movements, velocities and accelerations for all ships motions. For this benchmark the total computing time was reduced from about 200 hours up to 4.5 hours. Hence, for this particular type of analyses SeaFEM performance was improved in a factor of about 45.

2.4 I4MS Training Catalogue: The tool for connecting SMEs to the right training partner

Digitalization is the largest challenge faced by SMEs today, and access to digital skills is one of the three major factors constraining the digitalization of SMEs[1]. Therefore, for Europe to remain competitive internationally, its companies must develop a strong digital skillset. DIHs are helping manufacturing companies to strengthen their skills in terms of using and configuring digital technology.

The I4MS Training Catalogue collects training offers available of I4MS and DIHs and specifically aims to help SMEs to identify the right DIH for their upskilling programmes for digital transformation.

Why a training catalogue?

The I4MS Training Catalogue supplies a wide range of training programs aimed at upgrading the skills of workers in the manufacturing industry. The main objective is to create a common repository where interested parties can find information about in-demand digital skills and training materials. Having this online catalogue helps SMEs and mid-caps in Europe to determine where and how to plan their skills and competence upgrades.

Each training programme published in the online catalogue provides a summary of the technology covered, the training techniques applied, the channels used to provide the training, the phase of the technology absorption cycle, the profile of the target audience, the duration, the minimum instruction level required, and an overview of the content of the training. It is a one-stop shop for a general view of the training and upskilling programmes that I4MS and DIHs are offering to the European manufacturing sector.

Countries with DIH offering Industry 4.0 trainings.

Training in the following sectors

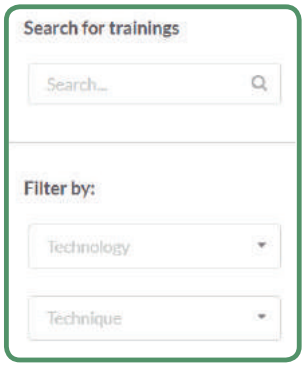
Automotive · Aerospace
Agriculture · Chemical
Computer – Software
Construction · Defence
Education · Research & Development · Energy
Plastics and Rubber · Fabricated Metal Products
Machinery · Electrical and Optical Equipment
Health · Furniture Manufacturing
Pharmaceutical · Mining · Biomass Industry
Footwear · Textiles

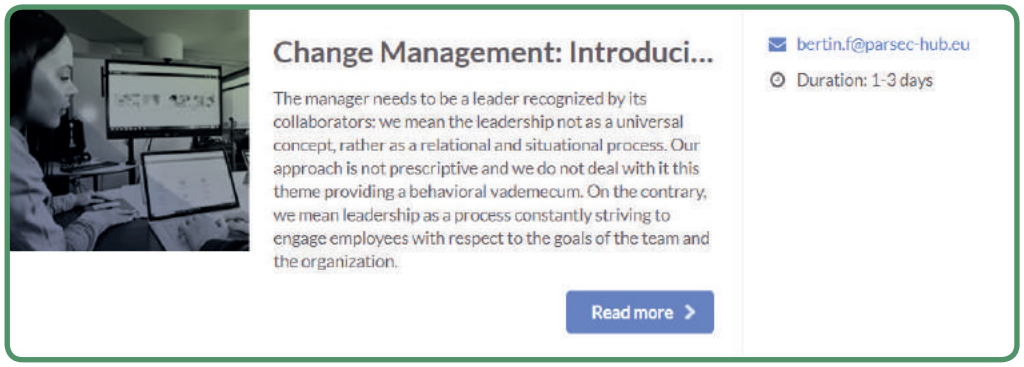
[1] https://smeunited.eu/news/digitalisation-is-the-biggest-challenge-for-smes

How to use the online training catalogue?

The online training catalogue displays the different training programmes offered by the DIHs and the I4MS projects with a link to the official website and a contact email for further information. The Read More call-to-action button takes the user to a complete information page.

The platform provides functionality for performing training searches, which is complemented by a filter structure that allows the scope to be narrowed based on different criteria.



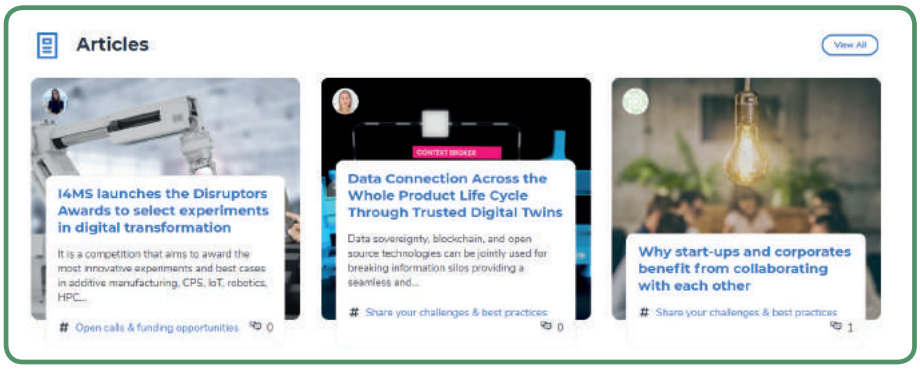


Relevant Data

- **Number of training offerings:** 86 available
- **Number of countries:** 20 countries involved
- **Technologies:**
  Robotics – 31, IoT – 38, CPS – 13,
  3D Printing – 17, Data analytics – 31,
  Artificial Intelligence – 29, Cloud Technologies – 28,
  Laser Welding – 4, Other – 36
- **Sectors:**
  Automotive – 70, Aerospace – 52,
  Agriculture – 53, Chemical – 42,
  Computer/Software – 46, Construction – 50,
  Defence – 27, Education – 45,
  Research & Development – 54, Energy – 55,
  Other – 63

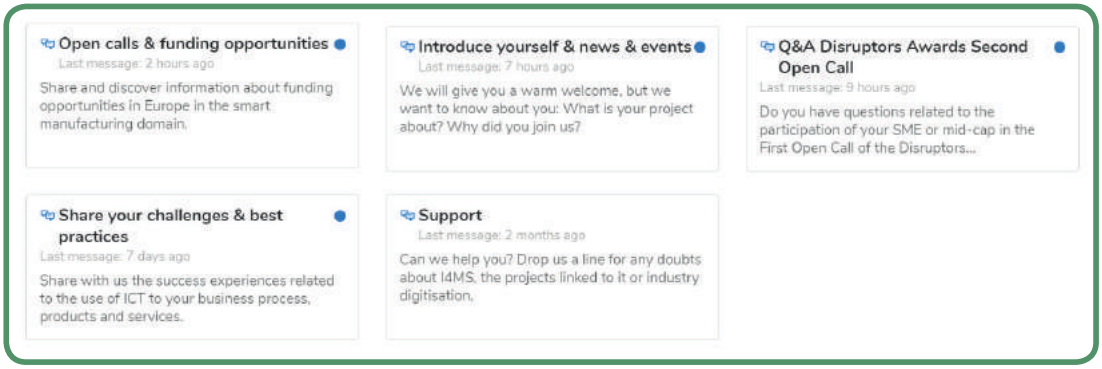
2.5 I4MS Community: The central information point where SMEs can engage with the digitalization ecosystem

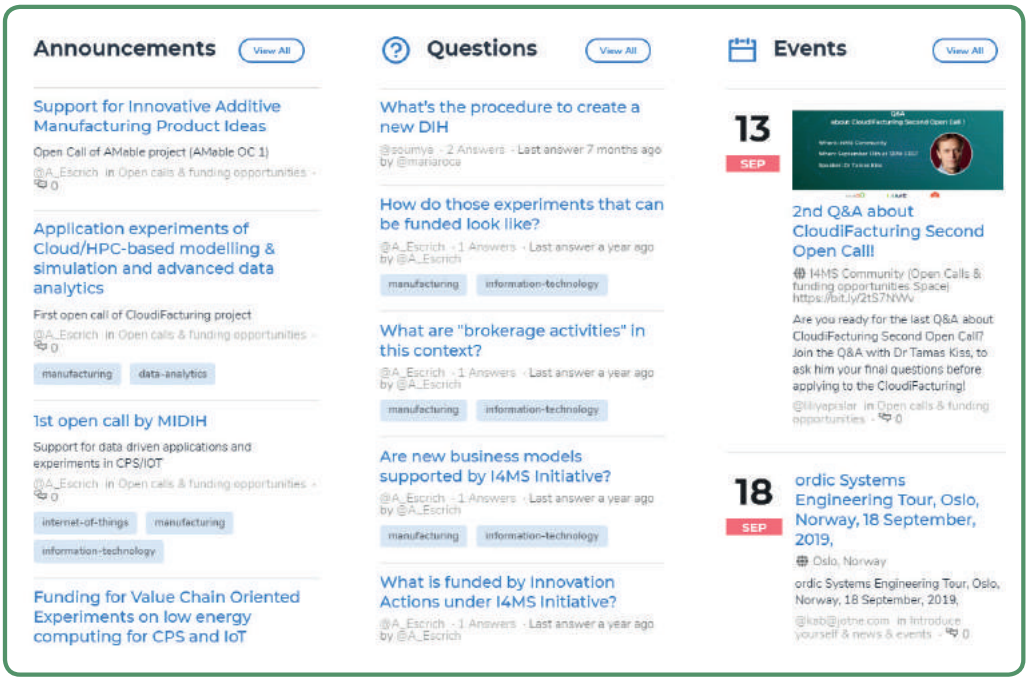
The I4MS Community is a central information point where people can meet, interact and share knowledge through articles, announcements, open questions or private chat to create synergies and build partnerships. The aim is to serve as a meeting point that facilitates the exchange of information on the latest trends, news, events, technologies and funding opportunities related to Industry 4.0.



To date, the I4MS community has gathered 900 European manufacturing players and provides information on:

- **Challenges and best practices in digital transformation,** to get inspiration on the use of I4MS technologies and its benefits. Discover and share SMEs experiences related to the use of HPC simulation, additive manufacturing, IoT and CPS in their business process, products and services.
- **Open calls and funding opportunities for SMEs and mid-caps,** to discover information about funding opportunities in Europe to facilitate the digitalisation of the manufacturing industry.
- **News and events,** about the manufacturing community and about emerging technologies applied to manufacturing.
- **Support, frequently asked questions and ideas.** The information in the I4MS community is organised in five different spaces to facilitate interaction among stakeholders, foster working in common and convey information related to funding opportunities, best practices, trends in manufacturing and ask for support.





Why to become an active member of the community?

If you are an SME:

- It will provide information on the latest trends, technologies, training and public funding available in the EU.
- It will help you to find the partners you need to start your own digitalization process.
- You will be inspired by other SMEs that have benefitted from ICT, and even get the chance to directly interact with them.
- It will put you in contact with peers and experts so you can share your doubts.

If you are a tech provider, system integrator, DIH or Competence Centre:

- Through direct interaction, or just by following ongoing discussions, you will be able to better understand the challenges SMEs are facing on their digitalization journey.
- You will be able to set up partnerships that can benefit your business and ignite new projects.
- You will have access to information on advanced technologies so you can explore the possibilities of integrating them into your value proposition.
- You will find funding opportunities aimed at bringing the latest technologies closer to the market.

If you are an expert:

- You will be able to become I4MS Ambassador and post your articles and start debates that will help you strengthen your position as an expert in the field.
- You will become a point of reference, boosting your chances of participating in challenging projects throughout the EU.

Do you want to register?

Complete a simple form at https://i4ms.fundingbox.com in less than 1 minute and get access to the community.

Who will you find there?

IT providers, Competence Centres, DIHs, Innovation Actions (IAs), clusters, associations, investors and even experts who want to share their knowledge.

Current Ambassadors:

- Andreas Ocklenburg, expert supporting SMEs in the use of HPC technologies
- Mohamed Eldessouki, expert in Advanced Technologies and Innovation
- Mayte Carracedo, expert in innovation projects and connecting with early adopters
- Hubert Mitterhofer, expert at electric machines and power electronics
- Francisco Blanes, researcher at the Industrial Computing and Real-Time Systems group
- Anne Lebreton-Wolf, business angel and evaluators of SME-related projects

2.6 Other I4MS connecting options

SMEs and mid-caps can connect to I4MS through the following channels:

LinkedIn Channel
I4MS (ICT Innovation for Manufacturing SMEs)

Online training catalogue
https://trainings.i4ms.eu/

Twitter Channel
@i4ms_europe

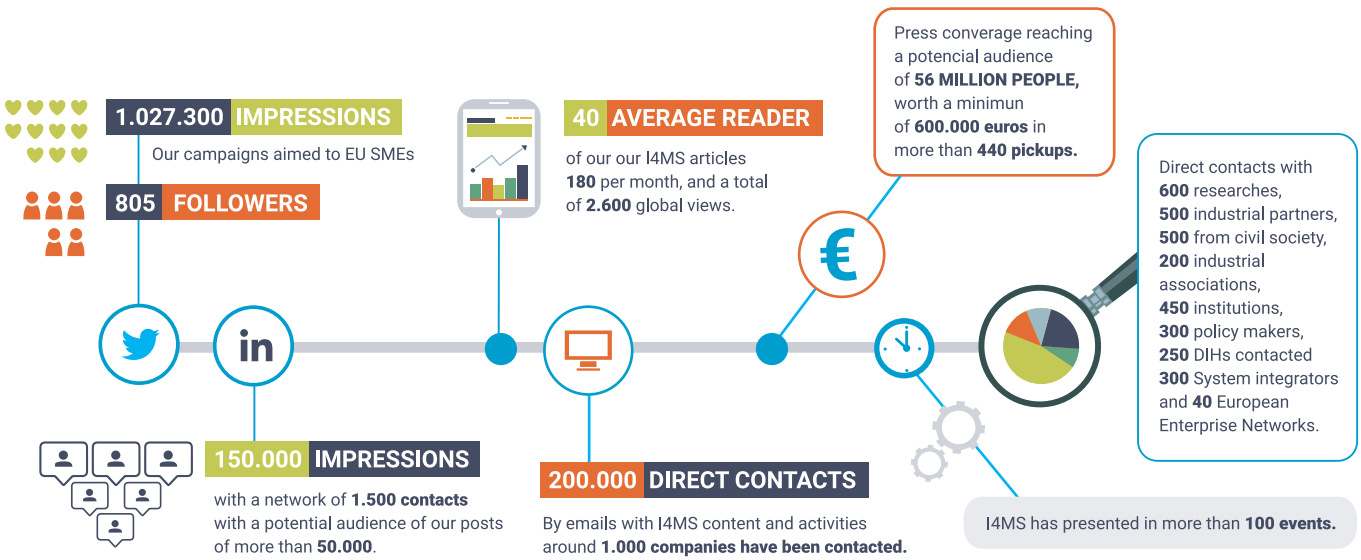
Global, European, Regional and Local Events such as:
Meet us at events like Mobile World Congress, Hannover Messe, DIHs Annual events and IoT Week. For further information, join the I4MS Community or check our website.

If you want to be involved in any of these initiatives please contact: *mayte.carracedo@fundingbox.com*

Supporting Partners

The I4MS community also provides access to its network of supporting partners: an ecosystem of organizations that are fully engaged with helping the community to connect with relevant stakeholders in their own industry ecosystem. Supporting partners are therefore instrumental in helping SMEs, tech providers, DIHs and Competence Centres to find other organizations with which to set up Application Experiments, help disseminate innovative technologies and provide access to information about events and initiatives emerging within their own networks.

The network of supporting partners can be found here *https://i4ms.eu/about/partners*



Communication reach of the I4MS initiative.

3. I4MS over time and outlook

The I4MS initiative was launched in 2012 and has been structured in 4 sequential phases.

Currently, the I4MS initiative is finishing its third phase. The fourth phase will start by early 2020.

Phase 1, was launched in July 2013, and focused on creating Digital Innovation Hubs (DIHs) and establishing a core I4MS ecosystem in four technology areas: HPC cloud-based simulation services, advanced laser-based equipment assessment, industrial robotics systems and intelligent fixtures.

Phase 2, was launched in autumn 2015, and had the aim of continuing the growth of the core I4MS ecosystem, extending its European dimension and inspiring the creation of new DIHs through a dedicated mentoring programme. Accessing EU funding became easier through the new H2020 "Financial Support to Third Parties" scheme (the so-called "cascade funding").

Phase 3 was launched in September 2017 to reinforce the I4MS ecosystem. During this phase, European SMEs and mid-caps have been exposed to new approaches and methodologies related to business models, access to funding, and training opportunities to reskill staff.

Phase 4, which begins in early 2020, will focus on accelerating the design, development and uptake of advanced digital technologies by European industry. Innovation Actions within Phase 4 will need to pay special attention to sectors with a low digitalization rate. The goal is to facilitate the secure adoption of digital technologies for products, processes and business models that lead to personalized products and efficient small-batch production.

Phase 3: Deploying cross-disciplinary technologies.

Phase 3 has focused on the implementation of cross-disciplinary technologies, receiving a total of €34 million in funding since 2017 for this purpose. The funding has been used to set up a Coordination and Support Action and four Innovation Actions along with their respective Application Experiments, with the goal of:

- shaping cutting-edge digital technologies to fit the technical and economic requirements of manufacturing SMEs (led by Innovation Actions);
- creating marketplaces responsible for bringing these technologies closer to the manufacturing sector (led by Innovation Actions);
- deploying these technologies in real industrial scenarios and improving the competitiveness of the manufacturing SMEs and tech providers involved in the Application Experiments (led by innovation Actions and performed by Application Experiments), and;
- promoting and communicating the I4MS offer and the results obtained through the creation of the largest online community dedicated to inspiring, sharing and supporting the transition of Europe's manufacturing SME base into the digital era (led by the Coordination and Support Action).

The Innovation Actions and cross-disciplinary technologies considered in Phase 3 are:

ADDITIVE MANUFACTURING

AMable

> **AMable:** focuses on additive manufacturing services, and has the aim of supporting small-batch production of personalized products without the need to acquire an expensive infrastructure.

CLOUD COMPUTING

Cloudi Facturing

> **Cloudifacturing:** focuses on HPC cloud-based simulation services, and has the aim of providing SMEs with access to advanced simulation software and routines in a cost effective, reliable and quick manner.

CYBER PHYSICAL SYSTEMS & IOT

MIDIH
MANUFACTURING-INDUSTRY DIGITAL-INNOVATION-HUBS

> **MIDIH:** focuses on Cyber Physical Systems (CPS) and Internet of Things (IoT) in manufacturing processes, and has the aim of enabling interoperability, decentralization of the decision-making process and the digitalization of products, manufacturing processes and business process behaviours.

ROBOTICS

L4MS
Smart logistics for manufacturing

> **L4MS:** focuses on robotics, and has the aim of supporting SMEs in deploying cost effective and rapid automation of logistics on the manufacturing floor.

4. I4MS Application Experiment

This brochure presents the technologies developed by the Innovation Actions and the related Application Experiments that were funded during Phase 3 and late Phase 2. Therefore, the focus here is set on the following Innovation Actions: CloudiFacturing, L4MS, AMable, MIDIH, HORSE and ReconCell.

PHASE 3

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AMable

ADDITIVE MANUFACTURING

AMable provides assistance and services to SMEs and mid-caps for their individual uptake of additive manufacturing to support the evolution of a product idea at all stages of the product creation process.

www.amable.eu

Participating DIHs and Competence Centers

Name	
FRAUNHOFER	INSPIRE
IDSA	DTI
VTT	SUPSI
LORTEK	PWR
MTC	LMS
FRC	TWI
SIRRIS	POLITO
AIMEN	TNO

PHASE 3

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CloudiFacturing

HPC CLOUD-BASED SIMULATION

CloudiFacturing project helps to optimize production processes using Cloud/HPC-based modelling and simulation, leveraging online factory data and advanced data analytics.

www.cloudifacturing.eu
contact@cloudifacturing.eu

Name	
FRAUNHOFER	MTA SZTAKI
CETMA	UNIBO
DFKI	UOW
SINTEF	IT4I
SUPSI	
LCM	

PHASE 2

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HORSE

ROBOTICS

HORSE aims to develop new flexible models of smart factory involving collaboration of humans, robots, AGV's and machinery to realize industrial tasks in an efficient manner.

www.horse-project.eu
anastasia.garbi@eurodyn.com
george.boultadakis@eurodyn.com

Participating DIHs and Competence Centers

Name
CEA
CETIM
EURECAT
FZI
TNO
TUM

PHASE 3

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L4MS
Smart logistics for manufacturing

ROBOTICS

L4MS provides a complete virtualization of logistics automation (Open Platform for Innovations in Logistics + 3D simulator) to enable cost effective deployment of logistics solutions.

www.l4ms.es / ali.muhammad@vtt.fi

Participating DIHs and Competence Centers

Name
VTT
ICENT
POLIMI
FRAUNHOFER
CUT

PHASE 3

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MIDIH
MANUFACTURING-INDUSTRY DIGITAL-INNOVATION-HUBS

CYBER PHYSICALS SYSTEMS

The MIDIH project supports the ICT Innovation for Manufacturing SMEs by developing a "one-stop shop" of services with access to advanced digital solutions and financial opportunities.

www.midih.eu

Name	
CEFRIEL	LTU
FORTISS	POLIMI
IDSA	VTT
IMT	IMR
INNOVALIA	CRF
FRAUNHOFER	TUKE

PHASE 2

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ReconCell

ROBOT ASSEMBLY IN RECONFIGURABLE WORKCEL

Reconcell aims at supporting robot assembly experiments in a reconfigurable workcell, in large productions but also in few-of-a-kind production, which often takes place in SMEs.

www.reconcell.eu / ales.ude@ijs.sl

Participating DIHs and Competence Centers

Name
JSI
UGOE
MMI
SDU

This brochure presents both an overview of technologies developed by the Innovation Actions as well as the Application Experiments in which these technologies were applied to solve the challenges of SMEs.

Technology

www.amable.eu

AMable

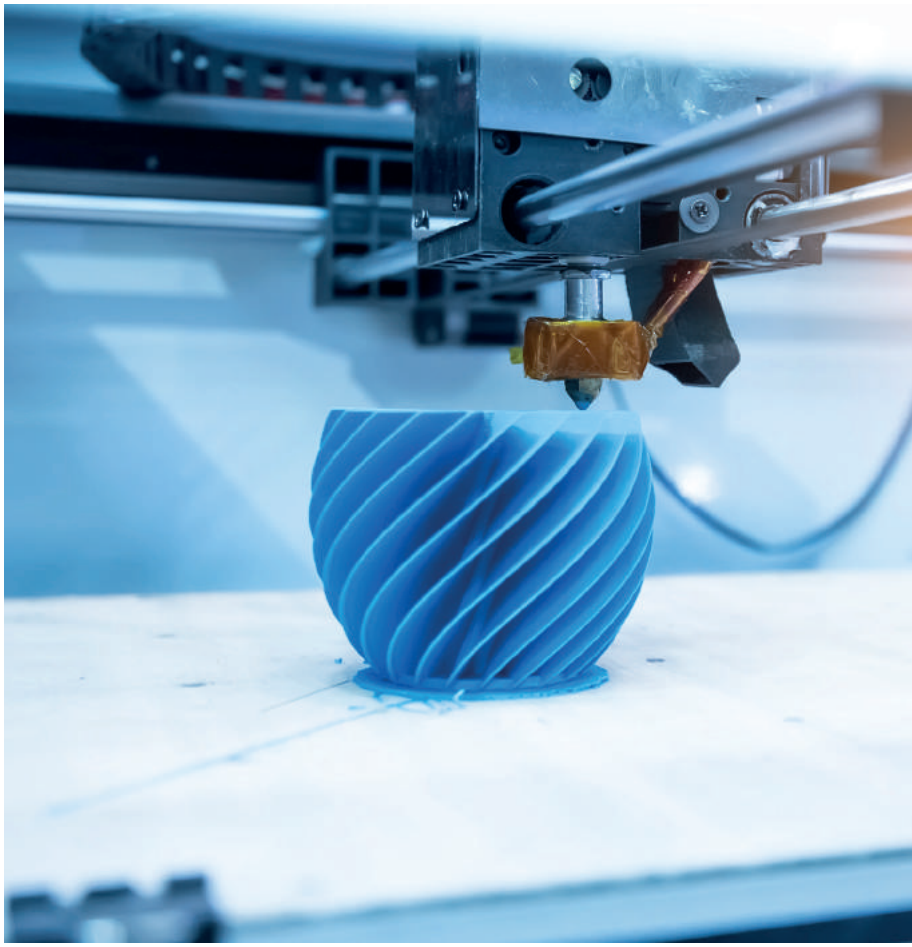
Technology solution:

AMable Digital Data Chain

AMable develops a **Digital Data Chain** that securely **connects** all **manufacturing** steps and **stakeholders** – from the design of a part, through all its manufacturing stages to its ultimate use – with a strong focus on data privacy and traceability.

AMable IDS Connector – a front end to the AMable Digital Data Chain in the form of a certified piece of hardware that allows the owner to securely transfer data to a partner.

AMable Blockchain – a pillar of the AMable Digital Data Chain that enables tamper-proof documentation of file content and transmission protocol.



TRL of the technology

7	AMable IDS Connector
6	AMable Blockchain

Expected target user

The AMable Digital Data Chain is a key feature for SMEs and mid-caps that engage with service providers and partners across the value chain in additive manufacturing. It provides the ability to define and execute data transfers between dedicated end points and to document the transferred content. For companies, the value of this technology is that **it can ensure tamper-proof data transfer** between selected end points while guaranteeing that said data remain with those parties.

Challenges the technology solves

Ensuring data protection for customer files or a company's own product designs and production data.

Ensuring data exchange between the right partners based on collaboration contracts or production agreements.

Documentation of file content to be prepared for liability claims or functional safety of produced products.

Key Performance Indicators (KPIs) this technology improves

- INCREASED PRODUCTIVITY
- ENABLING NEW BUSINESS POSSIBILITIES
- IMPROVING AGILE PRODUCTION

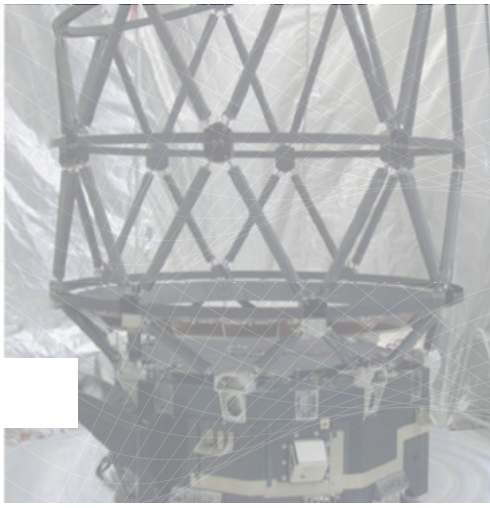
Application Experiment

AMable ▶▶▶▶▶ @IK4 LORTEK

Supported by

AMable

Additively manufacturable fittings save energy on earth and in space.



Implementation:

16 MONTHS

20,000

Impact

Moving away from conventional manufacturing like metal die casting or milling of solid metal blocks adds a number of new options for the design of a component. The challenge when creating a new design is handling all these options. Designers' skills need to be developed, new manufacturing technologies need to be understood and new production chains need to be managed.

The AMable Services Arena supported the experimenting SME in the creation of a new component that was ready for deployment in the record breaking time of just four months. The target objectives were achieved and the experimentation team significantly improved their skills in the world of additive manufacturing.

Partners

End users: **LORTEK (ES)**

Tech providers: **MTC (UK), Frederick Research Center (CY)**

Challenges

Space satellites work in orbit day after day and deliver more benefit the longer they operate. For most missions, robustness over their lifetime and weight during the launch are driving factors of cost and energy. One of the first AMable Application Experiments looked into **using additive manufacturing** for a **structural component of satellites** that connects carbon reinforced tubes through 3D-printed metallic fittings. These fittings face two simultaneous challenges: they need to be both **lightweight and sufficiently robust** to handle the loads that a satellite must withstand during its operation in space.

In addition to these two challenges, additive manufacturing allows for the production of individualized components at minimal additional cost. Therefore, the basic design of the component required variations to suite individual loads at different positions within the construction.

Results

The experimentation team created a design that achieved both **cost reduction for production** and **weight saving** to minimize energy consumption during the launch. The construction of the component is now **45% lighter** than when it was manufactured conventionally. After optimization of the shape and internal structures of the component, it could even be **produced at half the price.**

Overall, the new component **cuts production costs by 50%** and also saves energy during manufacturing and later use.


PRODUCTION
Operation mode
Administration
01
STATUS
View data
02
DIAGRAM
View data
03
SETUP
View data
Dashboard
Monitoring
Problems
Group and tag
Tactical views
System
Configuration
External
Home / Dashboard
Automatic mode
WORK MANAGER
DAILY TARGET
WEEKLY TARGET
MONTHLY TARGET
MACHINE PRODUCTION
TEMPERATURE CHART
Power Realtime
419 W
Machine A
289 W
Machine B
103W
Machine C
15 W
Machine D
Machine E

Technology

www.cloudifacturing.eu

Technology solution:

CloudiFacturing Digital Marketplace (DM)

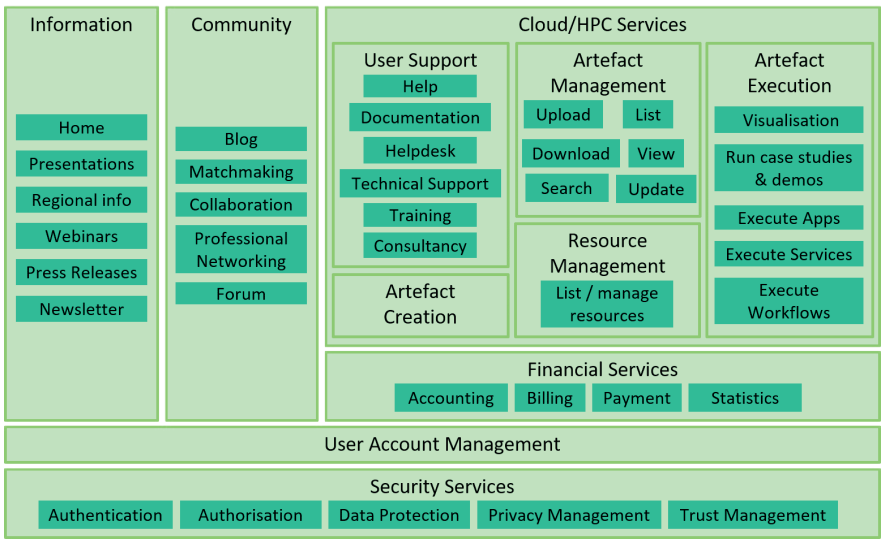
Commercialization hub and space for community-building around cloud-based engineering software for the manufacturing industry.

TRL
of the technology

5 6

The digital marketplace provides the required functionality to support customers in exploiting CloudiFacturing services. The main functionalities are clustered as:

- **Information services** to keep the DM visitors informed, by providing general information about CloudiFacturing and its technology in the form of presentations, news, webinars, etc.
- **Community services** that facilitate interaction and information exchange between community members. The community members are stakeholders in CloudiFacturing technology aiming to learn more about the technology, use the technology, offer services based on the technology, or be supporters of the technology.
- **Cloud/HPC services** support the operation of executable artefacts within the DM. This support involves access to documentation, training, and consultancy, as well as to the configuration of the software offering and computing resources. Through these services, the DM visitors can operate the executable artefacts and process the generated results.
- **Financial services** aim to provide the required functionality to manage the orders, transactions, and history of the consumed services. This set of services create transparency and accountability for members and multiple users of organizations.
- **User management services** to enable organization managers to handle the profile, users, and roles of their corresponding organization within the DM. This way, the organization managers can define what kind of services will be available to their users or delegate this responsibility to trusted users within their organization.
- **Security services** to guarantee the lawful and secure processing and handling of data, including personally identifiable data and organizational data (e.g. data provided for the operation of executable artefacts or data generated through the executed services). The security services enable the organization to define the expected sensitivity of its associated data.



Expected target user

Any product development or manufacturing company requiring the use of cloud-based services to run simulations.

Cloud-based providers interested in offering their services through the digital marketplace.

Challenges the technology solves

- End users can gain access to all of the aforementioned technologies with just a single set of credentials, including central billing and invoicing, data management and software execution. For an end user who merely consumes executable artefacts on the CloudiFacturing platform, there will no longer be a difference between executing a CloudFlow workflow or a CloudBroker application (or any other artefact).
- ISVs will still be able to implement software using the technology of their choice, while gaining access to software on other technologies with almost no effort.
- This enlarges the possible breadth and variety of software solutions, benefitting both ISVs and end users. By keeping the existing technology stacks intact within the CloudiFacturing solution, the loss of existing customer groups is prevented.

Key Performance Indicators (KPIs) this technology improves

- SHORTER DESIGN CYCLES
- LOWER SIMULATION SOFTWARE AND INFRASTRUCTURE INVESTMENTS
- IMPROVED PRODUCT QUALITY

Application Experiment

Manufacturing of Electro-Mechanical Devices ▸ @Hanning

Supported by CloudiFacturing

SyMSpace is a platform for designing electric motors with the aim of improving efficiency, lowering costs, improving power density and speeding up the manufacturing process.

Implementation:

12 MONTHS

N/A

Impact

SyMSpace optimizes electric drives by linking several simulation tools that pass data from one to another (e.g. the geometric and winding data to an electromagnetic solver, the obtained losses to the thermal model, and so on) and automatically running this simulation chain. The simulation model is constructed to be generally applicable to the design of electric drives. Therefore, other companies addressing the electrical drive design market in other areas of application (automation, aerospace, automotive, consumer, etc.) can also make use of this model.

Partners

End users: **Hanning Elektrowerke (DE)**

Tech providers: **Scale Tools (CH), LCM – Linz Center of Mechatronics, GmbH (AT)**

DIHs: **Lund University (SW), DFKI (DE), Cloudbroker (CH)**

Challenge

The design process of high-quality electro-mechanical electric drives with flexible prototyping and manufacturing requires **finding optimal geometric, electric, magnetic and thermal parameters** for the rotor, stator, winding and power electronic components. The complex interdependencies of these parameters affect the thermal behaviour, efficiency and production costs of these products.

Solution

CM has developed a software platform to carry out the digital development and optimization of mechatronic components and systems from the design stage through to prototype testing. It supports holistic optimizations.

SyMSpace optimizes electric drives by linking several simulation tools that pass data from one to another (e.g. the geometric and winding data to an electromagnetic solver) and automatically running this simulation chain.

Results

The resulting cloud-based simulation is demonstrated by optimizing the design of drives of Hanning, a company that specializes in the development and production of customized drive systems and components.

This allows for a **drastic reduction in simulation and optimization time,** which results in an important reduction of the design to prototyping cycles. As the platform charges users through a pay-per-use model, large hardware and software investments are no longer required by companies that need high performance simulations to improve their products and processes.

Application Experiment

Optimizing Solar Panel Production @EndeF

Supported by

Cloudi Facturing

Optimizing the manufacturing process of solar hybrid panels, with a time and cost reduction that is reflected in panel profitability.

Implementation:

12 MONTHS

N/A

Challenge

EndeF needed to **optimize** the **lamination process** involved in **hybrid solar panel manufacturing.** During the lamination process, the adhesive between the photovoltaic module and the heat recovery unit is melted and cured using a thermal process in an oven, thereby achieving the joining of both components. The configuration of the oven (temperature ramp, air mass flow, and distribution) is critical to ensuring proper thermal treatment of the adhesive along the whole panel, avoiding hot spots and reducing energy consumption. This challenging **simulation consumes significant computational resources.** The aim is to minimize the energy consumption and power needed by the oven, while minimizing the time required per panel and the number that have manufacturing defects.

Solution

A fluid flow and heat transfer simulation software package – based on Computational Fluid Dynamic (CFD) techniques – was adapted and ported to the cloud to simulate and optimize solar panel manufacturing. The model in the cloud is capable of **predicting the performance of the oven when laminating a PVT system.** The results of implementing the computational model as a cloud service in EndeF's production process is an **8% decrease in the energy consumption** of the panel manufacturer, an increase in the daily manufacturing capacity, a decrease in the number of tests required to set up the oven for a new panel, and a reduction in the time and costs required to give responses to clients.

The reduction of the manufacturing costs allows EndeF to create a more competitive panel, with a **10% increase in sales** expected thanks to the new production process.

Impact

By implementing this new solution, EndeF expects to increase panel production (10,000 panels/year), turnover (5 million euros) and jobs (80 jobs); another positive effect will be lower emissions per year (4,542 TCO2 of emissions avoided per year). The expected impact for Nabladot is gaining experience that will allow them to approach potential customers associated with the rolling sector and show them new skills, in the hope of leading the development of an ad-hoc tool for their specific process. With sufficient experience, a turnkey tool of this type could be offered for around €50,000.

Partners

End users: **EndeF (ES)**

Tech providers: **Scale Tools (CH), NablaDot (ES), IT4! (CZ)**

DIHs: **Cloudsigma (CH), Innsomnia (ES)**

Results

EndeF **reduced manufacturing time by 20%** and made **energy savings of 20%** (short-term) and 30% (medium-term) in the lamination process. This allows more solar panels to be supplied to their customers in less time.

Technology

www.midih.eu

Technology solution:

MIDIH Open Platform

CPS/IoT MIDIH Reference Architecture and Open Source Middleware supporting the digitalization of manufacturing SMEs.

MIDIH Open Platform aligns reference architectures and proposes reference implementations in essentially three domains:

- **Firstly,** considering edge/fog computing and advanced distributed analytics as a key priority in CPS/IoT domains, as opposed to a pure cloud/HOC approach;
- **Secondly,** considering Open Source platforms as a means of interoperability to increase openness and compliance with standards of commercial platforms for industrial CPS/IOT;
- **Thirdly,** considering a full data-driven approach (rather than a software-component driven one) for implementing Data in Motion and Data at Rest analytics, stemming from the interoperability of two major OS initiatives such as FIWARE and APACHE.

A first release of the MIDIH Open platform is already available for experimentation.

TRL
of the technology

7 8

Expected target user

MIDIH Open platform is based on an open source, modular technological stack and also provides value added services including tailored customization and integration. **MIDIH offers** a small-scale, versatile and **configurable environment** made up of a federation of different **open source platforms and tools,** which at little cost can be customized for the specific needs of manufacturing companies, especially SMEs.

The use of open source solutions conceived for business (such as the FIWARE software) is an added value layered on top of the clear advantages of open source itself. An additional advantage is the modularity of the proposed solution which enables it to be more easily adapted and potentially updated. Given the current ever-shortening technological turnover, this is a strong selling point in terms of sustainability, especially for SMEs, because it means they do not have to lock in to either technologies (including machines) or software.

Challenges the technology solves

Digital transformation challenges within the manufacturing sector.

Supporting companies that are willing to grasp the real business benefits of digital manufacturing.

Overcoming the main obstacles preventing actual adoption and push, which are various but mainly boil down to technical/infrastructural, organizational/competence and vision/management.

Key Performance Indicators (KPIs) this technology improves

INCREASED PRODUCTIVITY: fast assignment of data transfer, clear status overview with protocol.

ORGANIZATIONAL: agile product development; reduction of the risk that actions taking place externally are not documented with respect to changes in digital data.

Application Experiment

MIDAS @TRIMEK

Active Deep Monitoring of Large-Scale Connected Smart Industry 4.0 Services

Supported by

Implementation:

6 MONTHS

86,398

Impact

The solution developed in this project has a good commercial perspective – particularly in manufacturing environments – as security is one of the major concerns of industries deploying smart connected solutions for Industry 4.0. The solution is highly exploitable and integrated in the redBorder Open Source NTA platform. The "Life as a Service" model is particularly well suited for the cybersecurity needs of industrial SMEs. Furthermore, the active collaboration between ENEO and IDSA to make the solution compatible with the IDS RA will allow redBorder to provide security services to companies implementing IDS connector technologies.

Partners

End users: **TRIMEK (ES)**

Tech providers: **INNOVALIA (ES), ENEO (ES)**

DIHs: **LTU (SW)**

Challenge

Industrial Data Space (IDS) Reference Architecture (RA) and connectors have recently been proposed to ensure trusted data sharing in industrial B2B environments. However, empowering manufacturing SMEs with an active monitoring framework for Industry 4.0 connected services operating on top of B2B digital infrastructures and networks still remains a challenge.

Solution

By using the MIDIH Open Source architecture and big data enablers combined with the IDS RA and the latest TensorFlow algorithms, ENEO has expanded the MIDAS cybersecurity event engine embedded in their redBorder open source platform. **MIDAS protects shop floor communication chains from third party interference,** where a series of "Industry 4.0 business rules" are applied to trigger new events, alarms, or actions to prevent risks associated with smart connected operations at a large scale.

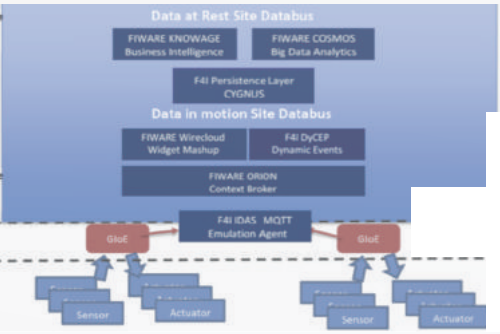
Results

In detail, the redBorder platform delivered an improvement in the number of security incidents mitigated (26%), network infrastructure resilience (15%) and network usage performance (7%), as well as a reduction in false positive generation (12%) and incident resolution reaction time (less than 10 minutes). MIDAS demonstrated the effectiveness of redBorder to visualize and detect vulnerabilities and abnormal use of the network and act accordingly.

Application Experiment

DELTA @Tera S.R.L.

DELTA – Data-driven experiment for energy saving and quality assessment.



Supported by

MIDIH MANUFACTURING·INDUSTRY DIGITAL·INNOVATION·HUBS

Implementation:

6 MONTHS

86,282

Challenge

The goal of the project was to set up a **"plug-and-play" energy efficiency assessment system** and product quality assessment system on a specific production line in the Sachim plant (Italy).

Solution

GIoE (Gateway for Internet of Everything by TERA) was customized and used in the experiment. The IT application collected data via sensors that were installed on the production line as well as software and sensors that were already in use at the plant. For communication with the MIDIH architecture, the MQTT standard was utilized. Specifically, the information retrieved by the GIoE Gateway was sent to the backend via MQTT; thanks to the FIWARE IoT Agent the MQTT messages were transformed in NGSI to be used in the FIWARE Environment. Orion Context Broker received these messages and transferred messages to Wirecloud and Cygnus. Wirecloud received updates thanks to a proxy that was able to transform from the http connection of Orion to the https NGSI source provider of Wirecloud. The Wirecloud interface showed the real time value of observed measures.

Results

More than **90% of the machinery** is now **covered by** the **monitoring system** provided by the MIDIH solution, with more than two measures per piece of machinery. The expected **reduction in MWh** per year is **from 5280 to 5030.** For the following year, an energy saving of 10% is expected for the two lines. Average time of a work cycle per package is also reduced.

The experiment resulted in the definition of the general architecture of the DELTA system following a two-level structure based on Data in Motion (Industrial IoT) and Data at Rest (Industrial Analytics). MQTT communication was deployed in the plant, especially between the GIoE Gateway and the MIDIH platform installed on a server in the SACHIM Data Centre.

Impact

The solution could potentially be used by other MIDIH champions or factories to provide energy efficiency analyses. Therefore, generally speaking the results and the algorithms of this experimentation may be used in many plants, buildings or productionlines.

The final goal of the developed solution is to maximize process sustainability and, as a result, achieve energy efficiency with minimal impact using generic production settings (plug-and-play approach).

Partners

End users: **Sachim (IT)**

Tech providers: **Tera S.R.L. (IT)**

Technology

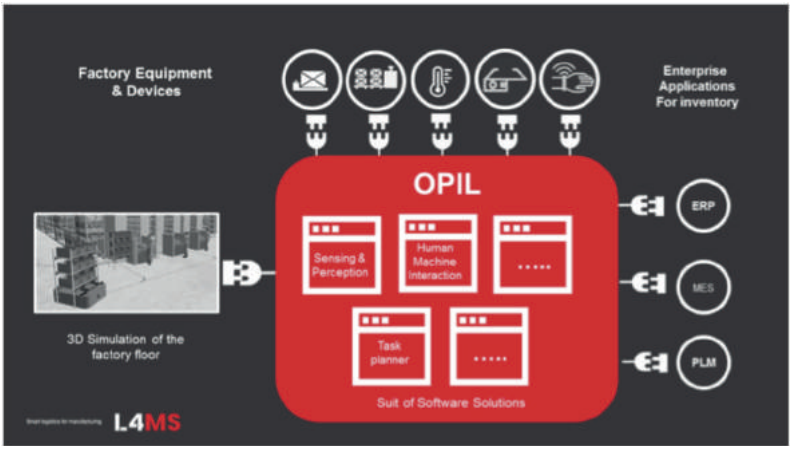
www.L4MS.eu

L4MS
Smart logistics for manufacturing

Technology solution:

OPIL (Open Platform for Innovation in Logistics)

IoT platform for automating internal factory logistics



The key value of OPIL to manufacturing SMEs is providing connectivity and interoperability for all software and hardware systems used in an automated logistics system with little effort required for integration. This allows a highly **flexible and reconfigurable system** to be set up quickly with low integration costs.

OPIL facilitates the fast implementation of intra-factory logistics systems by:

- Providing an IoT platform to **connect Enterprise Applications** (MES, ERP, WMS) to AGVs, Mobile Robots and operators.
- **Managing fleets of Automated Guided Vehicles** (AGV) and mobile robots by optimizing transportation task schedules, real-time route planning and performing real-time assignment of transportation tasks.
- Supporting the design of factory layouts and logistics processes through the integration of OPIL with the Visual Components® simulation software.
- Integrating physical devices like sensors, wearables and computer devices with OPIL to get real-time data from the production and transportation tasks, and to provide operators and plant managers with information to manage logistics tasks.

TRL
of the technology

5 6

Expected target user

OPIL end users are **manufacturing SMEs or mid-caps** that need to automate their material handling systems. OPIL is especially interesting for **companies that deal with demand fluctuations** and changes in product configurations. In such cases, OPIL can significantly reduce the set-up time for implementing new logistics tasks and coping with layout changes on the manufacturing floor.

System integrators can benefit from OPIL by developing **highly customized logistics solutions** for manufacturing SMEs that communicate with new and legacy hardware and software. This enables the integration of hardware and software products from different vendors and providers to achieve full interoperability among the different systems.

Mobile Robot and Automated Guided Vehicle (AGV) suppliers and software companies can use OPIL to develop products and components (e.g. track and trace systems) that are state-of-the-art, cost-effective and interoperable with products from other suppliers.

Challenges the technology solves

- Managing fleets of mobile robots and AGVs for material handling systems in manufacturing facilities and warehouses.
- Facilitating **connectivity and interoperability** between enterprise applications, mobile robots, operators, sensors and simulation software.
- Designing intra-factory logistic systems in a virtual environment using real production data and scenarios.
- Reducing the time and installation costs of intra-factory logistics solutions.
- Providing a flexible platform that allows for easy modifications with low integration efforts.

Key Performance Indicators (KPIs) this technology improves

- **Improvement in productivity.**
- **Improved flexibility and efficiency of the factory logistics processes.**
- **Reduce accidents and improved factory safety.**

Application Experiment

Automated Logistics @CHEMI-PHARM

Supported by

L4MS
Smart logistics for manufacturing

Improving the overall material flow of raw materials inside the factory with an automated logistics solution and improving quality control by reducing the time workers spend making manual data entries on ERP systems

Implementation:

3 MONTHS

N/A

Impact

OPIL enables the customization of internal logistics, which is crucial especially for small- and medium-sized companies. Through virtual testing, companies can reduce the quality cost processes and quickly identify optimal solutions. OPIL also reduces “vendor lock-in”, i.e. the dependency on one service provider, and allows solution providers to develop customized solutions more quickly.

Challenge

Chemi-Pharm requires different quantities of ingredients to be moved, which can lead to production downtime if the necessary components are not available at the right time in the correct locations.

- Due to large quantities of fast-moving incoming and outgoing units, **raw materials and prepared products need to be continuously transported** from one location to another. Failure to do this on time results in **interrupted workflows,** leading to downtime and lower efficiency.
- Reallocate factory operators from repetitive data-entry tasks to more demanding tasks, while reducing human error in IT systems.

Solution

- Using the 3D **visualization model to streamline manufacturing** processes and optimize AGV tasks based on the data OPIL collects and analyses.
- Using OPIL to **steer the fleet of AGVs and operators** involved in material handling tasks.
- Automating AGV movement data collection and production data entry to **keep track of materials** during every internal logistics movement.

Results

Increased efficiency and productivity of logistics processes by eliminating unexpected inefficiencies. Interaction between human forklift operators and AGVs. Reduced human error in terms of entries into IT systems and keeping better track of real production outputs. Support and logistics know-how by the execution of the analysis of material flows and bottlenecks.

Partners

End users: **Chemi-Pharm (EE)**

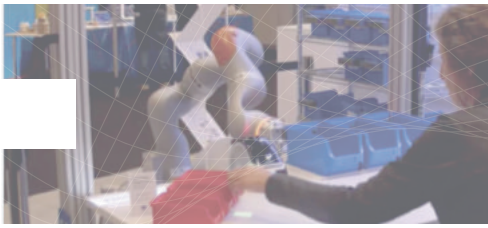
Tech providers: **KINE Robotics (FI)**

DIHs: **Tallinn-based IMECC (EE)**

Technology

www.horse-project.eu

HORSE



Technology solution:

Horse framework

Support dynamic process management of humans and robots, IoT integration, coworking with robots, multilevel safety and Augmented Reality.

The framework contains the following elements:

- An integrated, process-oriented management model for high-level control of the producti online process online, **automatic allocation of resources** (robots, human workers, interaction components, etc.) and its rapid and straightforward dynamic re-allocation as necessary.
- The implementation of the above-mentioned model adopting an IoT approach using the OSGI middleware software, that enables and facilitates **remote control and monitoring of the production line** and the available resources. Here, robot controllers, sensors and human-robot- interfaces are integrated and controllable as active agents in production.
- The following technologies enabling the autonomous and effective cooperation between robots and humans with no barriers:

1. Multi-modal supervision and control modes for a variety of existing and novel robotic co-workers: **cooperative robots (cobots)** and "third hand" robots for diverse manufacturing applications.
2. Innovative hybrid position/force control for intrinsically safe flexible robots
3. Demonstration-based **robot programming techniqzs** for an intuitive programming of robots tasks by non-robotics experts.
4. The development of a multi-layered safety approach that incorporates both robot and system level safety.

TRL
of the technology

6 7

Expected targeted user

SMEs requiring highly flexible and near-autonomous robotics systems to enable fast adaptation to the manufacturing of different product ranges.

System integrators supporting the automation of high-mix low-volume production systems.

Challenges the technology solves

- Building a **cyber-physical, process-oriented hybrid manufacturing system,** involving humans, robots and other automation equipment.
- Efficiently enabling the collaboration of human workers and robots in industrial tasks.
- Enhancing the **safety of humans** working in spaces shared with robots.
- Facilitating the allocation and execution of tasks by human workers, thereby reducing the need for previous experience and extensive training.

Key Performance Indicators (KPIs) this technology improves

INCREASED FLEXIBILITY · INCREASED QUALITY · LESS HAZARDS TO SAFETY AND HEALTH · SYSTEM SCALABILITY AND INTEROPERABILITY · BUSINESS DEVELOPMENT OF COMPETENCE CENTRES

Application Experiment

BEAUTY, Process Supervision ▸▸ @ TETRA

Supported by

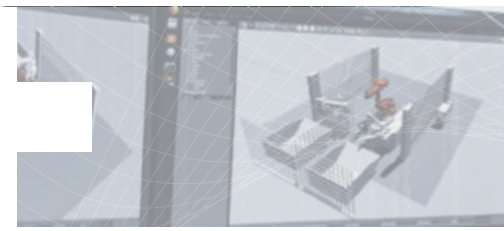
HORSE

Automate a fully manual production process, demonstrating that with equipment worth 80,000 euros we are able to perform a task worth 400,000 euros.

Implementation:

9 MONTHS

200,000



Impact

This experiment is ongoing. Results indicate the solution can be applied to a wide range of different Application Experiments that require the integration of legacy equipment and existing tools in a complete smart industrial platform, enabling their control and monitoring while maintaining a very low cost.

Challenge

The BEAUTY project addresses the sector of custom designed lot-size single-metal components made from bent pipes. These components are important in the manufacturing of steel yacht or stair railings and aluminium frames for kitesurfing. Currently, they are mostly manufactured using manually operated equipment, which often suffers from repeatability and quality issues.

Solution

- An industrial robot is controlled via the Hybrid Task Supervisor, utilizing the intuitive programming tools offered by HORSE for efficient and error-proof operation of machines that were previously manually operated.
- RFID identification is introduced for easy process management and product traceability integrated with the HORSE framework.
- A Global Awareness System is used for constant monitoring of workspace production cycle deviations.
- The highest possible safety standards are achieved thanks to the introduction of laser scanners and light curtains which are directly connected to the robot and the machines, and also to the MPMS to handle exceptions that may occur.

Results

- Fully automated production process.
- Introduction of state-of-the-art automation tools at a low cost thanks to their incorporation in existing equipment.
- A decrease in material loss caused by incorrect processing.

Partners

End users: **Tetra (PL)**

Tech providers: **CMBIT (PL)**

Application Experiment

COMPLEMANT, Robot Collaboration @GHEPI – Plastic Engineering & Innovation

Human-centred robot collaboration in an injection moulding process.

Supported by

HORSE

Implementation:

10 MONTHS

199,640

Challenge

GHEPI SRL has various injection moulding workstations that still require on-board machine processing for finishing, forcing the worker to stay in step with the press, leading to high physical and mental stress. The COMPLEMANT project aims to support this process, increasing its performance and reducing mental and physical stress for workers by relying on the HORSE infrastructure integrated with modules that are developed ad hoc.

Solution

Different process configurations have been designed, characterized by a variable assignment of process tasks to operator and cobot, allowing real-time interventions to be made whenever operator and system behaviour deviates from optimal and safe performance. Cobot capabilities become an extension of those of the worker and are modulated to cope with worker-specific characteristic.

Results

The introduction of the COMPLEMANT system allows process performance to be significantly improved from different perspectives:

- Quality checks increased from 70% (without the COMPLEMANT system) to 100% (with the COMPLEMANT system).
- Quality Issues reduced from 2.9% to less than 1%.
- Process Productivity increased by 16%.
- Operating costs reduced by 11%.

The introduction of the COMPLEMANT system increased the well-being of workers. All operators with previous experience of the process who validated the COMPLEMANT system agreed that:

- the system reduces mental and physical stress;
- the system increases job satisfaction;
- the system is useful for supporting process activities.

Impact

The introduction of the “intelligent” workcell supported by the COMPLEMANT system has been positively received by GHEPI and its workers, with an increase in both production rate and job satisfaction, as well as a reduction in the risk of injuries and monotony.

Partners

End users: **GHEPI (IT)**

Tech providers: **HOLONIX SRL (IT), University of Applied Science and Arts of Southern Switzerland (SUPSI) (CH)**

DIHs: **University of Modena and Reggio Emilia (UNIMORE) (IT)**

Application Experiment

ENDORSE @ENICON Aerospace (EnAe)

Supported by

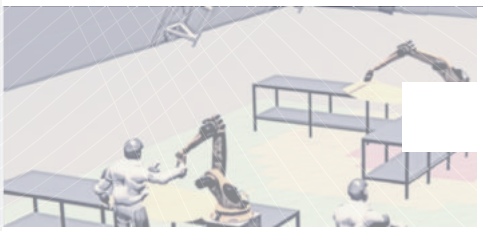
HORSE

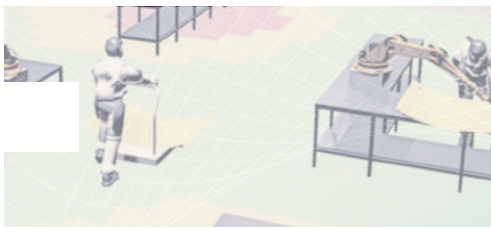
The Endorse experiment gives robots a sense of touch, allowing them to perform delicate sanding of highly sensitive components for the aircraft manufacturing industry.

Implementation:

10 MONTHS

193,462





Challenge

Automate the grinding and sanding of the delicate surfaces of aerospace components.

Solution

- Augmented Reality assistance to accelerate the assembly of production tools without the need for experience.
- Monitoring and orchestration of automated and manual tasks by the HORSE MPMS to enable flexible and effective production.
- Automated stacking and unstacking of parts in boxes and transferring the boxes between lines by AGV, encompassing the integration of robots of different vendors.

Results

- Increasing the number of treated products from 2 to 3.
- Increasing the robot-ground surface area with a robot from 60% to 80%.
- Automated quality control that detects surface roughness on a micrometre scale and localizes it with centimetre precision.

Impact

This case demonstrated how robotic technology has a place in even the most demanding tasks, where one is expected to control both the position and the force applied on the environment. These preliminary results show the potential of incorporating increasingly robotic technologies in the EnAe productionline.
In addition, the scope of this algorithm is not limited to grinding and sanding, but can also be applied to various other tasks that require the robot to provide a delicate touch.

Partners

End users: **Enikon Aerospace (HR)**

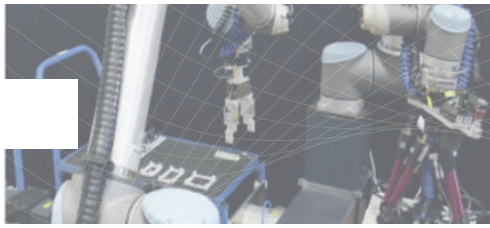
Tech providers: **Larics Laboratory (HR), ICENT (ES)**

DIHs: **Faculty of Electrical Engineering and Computing, University of Zagreb (HR)**

Technology

www.reconcell.eu

ReconCell



Technology solution:

Reconfigurable Robot Workcell

Automated production cell for the rapid set up of automated assembly processes using robots.

A PnP connector that guarantees stable mechanical coupling and also provides communication, power, and compressed air.

Innovative reconfigurable fixtures (hexapods) with pneumatic brakes, which have been patented and commercialized.

A passive linear unit with a pneumatic breaking system to enable automatic relocation of robots.

A passive rotary table with holes and plungers that can lock the table at discrete orientations, thus enabling robots to handle workpieces from different sides.

Pneumatic vice jaws to ensure repeatable positioning of workpieces.

A power-over-ethernet servo gripper to reduce the number of cables.

A spacer gun to support the insertion of nylon spacers into prefabricated holes.

A robotic screwdriver with exchangeable screw bits to enable automatic reconfiguration for different applications.

A finger and fixture design methodology based on imprints and using 3D printing technologies, where an objective function that expresses the quality of a gripper/fixture for a certain task context is optimized in simulation.

The developed workcell is equipped with several capabilities and operations that are needed for effective robot assembly:

Kinaesthetic teaching supported by suitable user interfaces to acquire new assembly skills and calibrate the workcell.

Several types of **kinematic movements** to implement optimal robot motion in assembly operations.

Force-controlled robot motions to realize (a) force-based quality control processes and (b) assembly operations that require predefined interaction forces.

Operations for automatic reconfiguration of fixtures with passive degrees of freedom.

TRL
of the technology

6

Operations for automatic robot base repositioning along passive linear guides.

Re-orientation of workpieces positioned on a rotary table.

Robot movements and operations for the automatic exchange of end effectors and hand-mounted cameras.

Robotic screwing, including automatic screw bit exchange.

Grasping based on 3D-printed grippers and fixtures.

The visual programming toolchain in VEROSIM provides a convenient way to implement processes and tasks in the assembly application.

A one-click calibration method for camera and robot parameters was implemented. The calibration system provides a basis for a set of tools for 2D- and 3D-based pose estimation, which are used for various pose estimation problems in ReconCell.

The developed workcell control system is based on ROS (Robot Operating System), which fully supports modular design of the ReconCell system, including communication between all active workcell elements.

Expected target user

SMEs, mid-caps and manufacturing companies dealing with discrete high-mix low-volume production.

Business challenges solved

Support SMEs in adopting flexible assembly cells and robot devices by providing an option with reduced interruptions in the setting up of robotic–based automated assembly solutions. Solving such interruptions usually requires expert knowledge and also significant time for testing and fine-tuning. This innovation allows SMEs to react quickly, efficiently, and in an economically justified way to market changes.

Key Performance Indicators (KPIs) this technology improves

QUALITY OF ASSEMBLY · **RECONFIGURATION TIMES**
TIME TO IMPLEMENT THE AUTOMATED ASSEMBLY
SOLUTION · **CYCLE TIMES TO ASSEMBLE THE**
PRODUCTS

Application Experiment

Flexible Manufacturing of PBC @HOP Ubiquitous

Assembly of a variety of printed circuit boards (PCBs).

Supported by

ReconCell

Implementation:

0,5 MONTHS

225,000

Impact

The provided solution has a payback time of 11 months, which is very attractive for a typical manufacturing company. The solution is not limited to the current product specification and can be adapted in the future to cope with changes to the product design. It can also be used by any company dealing with the assembly of PCB boards. The implemented solution shows that it is feasible to use robots at SMEs for automated assembly.

Partners

End users: **HOP Ubiquitous (ES)**
Tech providers: **Jožef Stefan Institute (SI), University of Southern Denmark (DK), Universityof Göttingen (DE)**

Challenge

HOP Ubiquitous has a manufacturing process that involves the assembly of different printed circuit boards (PCBs). **Handling orders** for a system such as Smart Spot with multiple configurations presents **a key challenge in terms of automation.** The physical device consists of three main parts: firstly, the backplate that holds the different PCBs; secondly, the PCB boards, which are mounted on the backplate; and thirdly, the sensor probe mounting. The development of automated solutions required the company to adapt the design of the product.

Solution

The reconfigurable and modular design of ReconCell enabled the integration of various innovative technologies to address assembly challenges. Firstly, for spacer insertion an innovative spacer gun was designed which facilitates the mounting of PCBs on the required backplate. In order to grasp various PCBs, three pneumatic grippers would be required. To reduce the number of grippers to one, **a power-over-ethernet servo gripper was designed,** which is compliant with the ROS-based software architecture that drives ReconCell.

Results

Reduction of manual work: the ReconCell solution can reduce the amount of manual work so only one worker is required per shift instead of three.

Reduction of changeover time and cost: currently, an hour of manual work is required to configure production for a known item; ReconCell can reduce this to zero.

Improved assembly quality of PCB boards: the rejection rate is lower with the ReconCell solution.

Application Experiment

Assembly of Automotive Light Housings @ELVEZ

Flexible workcell with very low changeover times for assembling automotive parts.

Supported by

ReconCell

Implementation:

16 MONTHS

225,000

Impact

A Production Part Approval Process (PPAP) procedure was carried out to confirm the repeatability and reliability of the assembly process in the workcell. By implementing the ReconCell solution, ELVEZ expects to cover the cost of investment in a 1.5 year, with savings of up to 1.6 million euros over the next five years. The implemented solution was demonstrated at industrial fairs including Hanover Fair 2017 and Automatica 2018. A company called Flex-Hex was spun off to market the passively reconfigurable fixtures developed.

Challenge

Slovenian company ELVEZ manufactures automotive light housings where each light requires its own unique assembly device, which is typically very large and cumbersome. When ELVEZ stops producing a part to match the regular demand, assembly devices cannot be discarded because they are required so that the supplier company is able to produce spare parts for at least the next five years. This means that the **assembly devices are stored at the company for five years after production has ceased.** It happens few times per year, posing a problem devices must be swapped into the production process to cover the demand for spare parts.

Solution

ReconCell implemented the assembly of two different automotive light housings for ELVEZ, where **swapping from one assembly process to another can be done in minutes.** The keys for this implementation were the innovative, passively reconfigurable fixtures (non-actuated Stewart platforms) developed at ReconCell. They are integrated into the workcell as peripheral modules using a plug-and-produce connector developed during the project. The ROS-based software architecture that has been developed enables quick integration and control of different modules that can be added to the cell on the fly.

Results

The current production process at ELVEZ has a reconfiguration time measured in hours, as a new large assembly device must be installed for each new light housing. With the ReconCell system, the **reconfiguration time is reduced to four minutes.**

Partners

End users: **Elvez (SI)**

Tech providers: **Jožef Stefan Institute (SI)**

DIHs: **University of Southern Denmark (DK), University of Göttingen (DE), University of Aachen (DE)**

5. Conclusions and lessons learned

The I4MS initiative helps to reinforce the competitiveness of the manufacturing sector in Europe through the innovative use of digital technologies. The simple financial support scheme offered to SMEs and mid-caps within I4MS allows these companies to access **high-quality infrastructures, demonstrators and testing facilities for advanced digital technologies,** thereby improving their capabilities in the use of these technologies. The advantages of this type of funding come from a simpler administrative and submission process and a quick funding decision, without entering into a complex contract with the European Commission.

However, there are still limitations and barriers to application for SMEs, such as the lack of internal resources that can be devoted to the implementation of the Application Experiments, the difficulties SMEs experience identifying the right funding opportunities to tackle their challenges, and the lack of knowledge of the advantages that I4MS technologies can bring to their daily business operations. Also, the role of regional authorities and DIHs to facilitate the uptake of ICT needs to be further explored.

Moreover, Innovation Actions facilitate the work of DIHs supporting SMEs, by bringing together the application experiments technology providers system integrators and SMEs to understand what the challenges are, how to optimise the solutions and which advanced technologies are best suited. Joint mechanisms are needed to guarantee the full adoption and technology readiness of the solutions developed under I4MS Experiments and increase their chances to leverage private funds.

I4MS has actively promoted the participation of SMEs, mid-caps and DIHs via interviews, success stories and the Disruptors Awards. The involvement of the Application Experiments participants in events and communication activities, such as the DIHs Annual Event and Disruptors Awards ceremony, has been very much appreciated by the participating SMEs and mid-caps. International networking opportunities, such as the participation in event, as well as the visibility given to the Application Experiments, contributed to making **SMEs and mid-caps active members of the I4MS ecosystem** and highlighted the benefits of using I4MS technologies to tackle real industrial challenges.

During Phase 3, the main objective of the Innovation Actions and the Coordination and Support Action has been to facilitate the digitization of SMEs and mid-caps through **access to funding, testing facilities and the upskilling** of their workforces. The focus has been put on emerging innovative technologies and processes, which need to be tested and validated before being released on the market. Special emphasis has been placed on strengthening the staff of European SMEs and mid-caps by offering training solutions for the different technologies and creating a catalogue of advanced training to reskill workers and raise awareness about the benefits of the I4MS digital innovations.

The I4MS central information point launched under Phase 3 has facilitated a deeper engagement, allowing members to benefit from information about funding opportunities and to discover and explore state-of-the-art-technologies and best practices supported by DIHs and I4MS Innovation Actions. The I4MS online community provides the opportunity to interact in real time with the stakeholders involved in the I4MS activities, resolve doubts about participation in open calls, discover funding opportunities and connect with other SMEs, Innovation Actions, DIHs, IT providers, etc. Success stories shared in I4MS show the benefits of participating in I4MS, such as the acquisition of new knowledge on the leading-edge I4MS technologies, the support offered in adopting these new technologies and the understanding on how these technologies can contribute to SMEs daily operations the most valuable aspects by SMEs.

6. What's next? I4MS Phase 4: Accelerating the uptake of advanced digital technologies

DIHs play an important role in ensuring that all companies can fully benefit from the digital revolution and synergies with other key enabling technologies, thereby creating new jobs and improving regional competitiveness. Beyond the support for integrating specific advanced digital technologies in the processes and products of industrial companies to create significant business opportunities for European SMEs, **DIHs in I4MS Phase 4 should facilitate the access of SMEs and slightly bigger companies to digital transformation services,** promote highly innovative cross border experiments, include plans to attract investors, address training and skills development needs, and aim for better geographical coverage of the funded Application Experiments.

Innovation Actions need to be able to support the experimentation and testing of SMEs and midcaps in one or more of the areas identified:

- **smart modelling; simulation; optimization for digital twins.**
- **laser-based equipment in advanced and additive manufacturing.**
- **innovative artificial intelligence in manufacturing and cognitive autonomous systems.**
- **human-robot interaction technologies, to ensuring human acceptance.**

During Phase 4 there will be a shift in the technology areas that SMEs will be able to access towards artificial intelligence. Moreover, to ensure that Europe makes the most out of the opportunities offered by the digital economy, I4MS Phase 4 will provide funding to expand the project in regions which have so far been underrepresented in Smart Anything Everywhere and I4MS. The objective is to enhance the collaboration of hubs with the Innovation Actions, promoting highly innovative cross-border experiments. The EU wants to ensure that every SME and mid-cap, regardless of their location, can access and test digital innovations and gain the required digital skills, to make possible their digital transformation

Improving support for innovative SMEs and mid-caps across Europe

The total funding for Phase 4 is €71M, of which at least 50% will be distributed among SMEs and mid-caps through several open calls, either as direct funding or as innovative services linked to the technology areas of I4MS Phase 4. Services to SMEs range from access to leading-edge technology centres and support from key experts to business development and training. At least one Innovation Action per technology area will be supported.

ICT for manufacturing SMEs

Bringing Innovation closer to SMEs for a more competitive pan-european manufacturing sector.

I4MS Glossary of terms

AE: Application Experiment

AGV: Automated Guided Vehicle

AI: Artificial intelligence

B2B: Business to Business

CFD: Computational Fluid Dynamics

CPS: Cyber-Physical Systems

DFKI: German Research Center for Artificial Intelligence

DIH: Digital Innovation Hub

DM: Digital Marketplace

ERP: Enterprise Resource Planning

EU: European Union

GDP: Gross Domestic Product

HPC: High-Performance Computing

HRC: Human-Robot Collaboration

I4MS: ICT for Manufacturing SMEs

IA: Innovation Action

ICT: Information and Communication Technology

IoT: Internet of Things

ISV: Independent Software Vendor

MES: Manufacturing Execution System

Mid-caps: Companies with a market capitalization (value) between $2 and $10 billion.

PCB: Printed Circuit Boards

ROS: Robot Operating System

RTO: Research and Technology Organisations

SME: Small and Medium Enterprise

WMS: Warehouse Management System

www.i4ms.eu

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