D.T2.1.2 – Good practices of sharing research and innovation infrastructures, i.e.pilot lines and demonstrators

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ABSTRACT

The scope of this report is to describe findings from the analysis of running and finalised projects aiming at sharing of demonstrators and pilot lines, compilation of relevant experiences on the general approach, acceptance, economic and technical feasibility and perspectives. A comparison between the five region is also provided.

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ABBREVIATIONS

(AMCD) Competence centre for additive manufacturing Dresden

(RICAIP) Research and Innovation Centre on Advanced Industrial Production

(GEAM) Genova Additive Manufacturing

(CSFT) Centre for Sustainable Future Technologies

(BIC) Business Incubator Center

(CAMT) Center for Advanced Manufacturing Technologies

1. Context and motivation

The scope of this report is to describe findings from the analysis of running and finalised projects aiming at sharing of demonstrators and pilot lines, compilation of relevant experiences on the general approach, acceptance, economic and technical feasibility and perspectives. Therefore, a comparison between the good practices adopted by the different regions is developed after each region identified its centres and clusters dedicated to additive manufacturing.

1.1. Germany: Examples for good practices on sharing infrastructures

This section presents the Centres, Clusters with dedicated infrastructure of Additive Manufacturing in Saxony.

1. Competence centre for additive manufacturing Dresden (AMCD) [1]: Within the framework DRESDEN-concept the scientists, together with partners of the TU Dresden, founded an internationally recognized competence centre, in which material and manufacturing solutions for challenging products are interdisciplinarity developed. Presently the scientists focus on research fields such as aerospace, automotive industry, tool making, energy technology and medical engineering. The centre offers a networking platform for economy, scientific basic research and application-oriented research. The process portfolio includes

- laser build-up welding with wire and powder
- selective laser melting
- electron beam melting
- 3D printing technology

for metallic and intermetallic materials, polymers, functional materials and multi-material systems. The AMCD is one of the biggest competence centres in the field of additive manufacturing in Europe.

2. FabLabDresden [2] The FabLabDresden is a high-tech workshop open to anybody. The FabLabDresden provides 3D printer, laser cutter, electronics workshop, CNC milling and much more. The Fablab is the hoster of the monthly hold master table where professionals and interested come together.
3. FabLabChemnitz [3] The FabLabChemnitz is an open workshop that provides serval 3D printers and other machines for interested and professionals. The FabLabChemnitz provides their complete inventory via an webbased formular (https://fablabchemnitz.de/inventar/). This way it is possible to make reservation and pay for the services. They do not provide commercial services.
4. Fraunhofer Institute for Tool Technology and Forming Technology (IWU) (Source: https://www.iwu.fraunhofer.de/): The Fraunhofer Institute for Tool Technology and Forming Technology (IWU) works at the Zittau site as a project group within the framework of the development of lightweight construction technologies. The focus is on knowledge transfer and the development of innovative technologies and products within the plastics processing industry. Research focuses on the generative production of plastic components, elastomer processing, the development of semi-finished products from continuous-fibre-reinforced thermoplastics and function-integrated plastic components.
5. Laserinstitute Hochschule Mittweida (LHM): (Source: http://www.laser.hs-mittweida.de/forschung-entwicklung/messtechnik/materialanalyse.html): The Laserinsitut develops two-dimensional working polygon scanners as an alternative to the previously used

beam deflection systems. In recent years, several test samples have been developed, tested and evaluated for their applicability in micromachining.

6. Leipniz-Institute for Polymer Research Dresden e.V. (IPF) (Source: https://www.ipfdd.de/de/ueber-uns/): The IPF conducts holistic polymer material research from synthesis and modification of polymer materials, characterization, theoretical penetration to processing and testing. Characteristic for the work at the IPF is the close cooperation of natural scientists and engineers. The main focus is on material questions from real applications, which can be solved by controlling the interfacial properties and the interactions at the interface and surface.
7. Institute for Lightweight Construction and Plastics Technology Dresden (ILK) (Source: https://www.ilkdresden.de/): The core competence lies in the development, design and optimisation of components and systems for high-performance lightweight construction and prototype production.

1.2. Czech Republic: Examples for good practices on sharing infrastructures

This section presents the Centers and Clusters with dedicated infrastructure of Additive Manufacturing in the Czech Republic.

1. Additive manufacturing cluster [4] supports the higher innovation and competitiveness of its members, popularizes their activities in the areas of additive production, as well as the ability to solve very complex projects using state-of-the-art 3D printing technologies. In the framework of its activities, the cluster creates a common identity of legal and natural persons, members, thus contributing to the promotion of the use of additive production as well as its popularization as an autonomous component of the manufacturing processes of Industry 4.0.

2. Protolab [5] is originated with the idea of allowing small and medium-sized companies to have access to modern prototyping technologies and enable them to compete on the regional, European, and Global levels. Protolab tries to overcome the challenge of high cost top technologies for industrial 3D printing, which become inaccessible for many small and medium businesses. Protolab offers these SMEs complex prototype services which go beyond the 3D printing to cover all finishing operations. Protolab allows the use of basic reverse engineering services that include laser 3D scanning services, and subsequent data processing. Protolab offers professional consultancy in the field of additive production with a focus on the technological and economic spheres in the implementation of additive production in the industrial environment. Protolab promotes the collaboration between the private entities in the field of testing and developing powder materials for metallic 3D printing.

3. Research and Innovation Centre on Advanced Industrial Production (RICAIP) [6] is a Horizon 2020 funded, with the participation of the Czech Institute of Informatics, Robotics and Cybernetics (CIIRC) Czech Technical University (CTU) in Prague as the coordinator and the Brno University of Technology. The centre provides European distributed services and integrated experimental testbed.

4. National Centre for Industry 4.0 [7] was established in September 2017 through the collaboration between research, industry and professional organizations. Its goals are to raise awareness about Industry 4.0 and to strengthen cooperation between academia and industry. The main founding partners include CIIRC CTU, Brno University of Technology, VŠB – Technical University of Ostrava, Siemens, ŠKODA Auto and others.

1.3. Italy: Examples for good practices on sharing infrastructures

This section presents the Centers, Clusters and fablabs with dedicated infrastructure of Additive Manufacturing in Liguria.

- "GeAM: Genova Additive Manufacturing", Genova, Italy: GeAM is a shared Lab between the University of Genoa (UNIGE–www.unige.it) and the Italian Institute of Welding (IIS – [11], member Italian Association of Additive Technologies –[12]). The Lab is focused on scientific and technological aspects, serving as a facility for university research and for supporting private-public partnerships and industrial-academic joint technological projects. GeAM provides two services (hereafter referred to as sections): i) Metal Section - Inox, Inconel and Aluminium printing facility has been created by adopting an SLS EOS M290 printing system focused to evaluate industrial application for both low temperature and high temperature applications. Ii) Polymer Section - Different polymer printers, mainly FDM based (WASP delta 20/40, 40/70 industrial, Formlabs Form 2 SLA 3D Printer were installed in the University facilities in order to deal with polymer, polymer composites and ceramic-polymers composite materials.
- Centre for Sustainable Future Technologies (CSFT), hosted @ Italian Institute of Technology (IIT). IIT was established in 2003 and successfully created the large scale infrastructure in Genova, a network of 10 state of the art laboratories countrywide, recruited an international staff of about 1100 people from more than 50 countries. IIT's research endeavour focuses on high-tech and innovation, representing the forefront of technology with possible application from medicine to industry, computer science, robotics, life sciences and nanobiotechnologies. The main goal of the Additive Manufacturing (AM) division is the development of advanced novel materials to fabricate lightweight functional systems, passing through a bio-inspired design, complex in their structure, shape, size, hierarchy, surface and materials usage. The whole group conducts research in all facets of additive manufacturing processes such as:
    - Development of advanced structural materials (lightweight alloys and composites, titanium alloys and composites, high-temperature alloys) for Selective Laser Melting
    - Characterization at the nano-scale
    - Surface post processing
    - Strengthen the design capabilities to produce lightweight complex shapes, non-assembly parts and bioinspired structures (radiant burners, heat exchangers, percolative structures, etc.
    - Improvement of additive manufacturing/3D printing techniques

- Lab2share [13]: Lab2share was founded in 2015 in Chiavari focusing on ADDITIVE MANUFACTURING with FDM technology with the aim of creating an ecosystem where creativity and technology are fused together to enable product development with innovative solutions. The business started by printing prototypes in thermoplastics and elastomers. Today, Lab2share develops design solutions employing advanced additive manufactured polymers, exploring new applications, not only in FDM but also in SLA and SLS of both plastics and metals. Lab2share also offers a DESIGN LABORATORY and equipment devoted to material tests.
- Anterem Since 1995 [14], the First Italian 3D Design and 3D Printing Studio specialized in Jewelry. In the facilities, Anterem operates the most advanced and updated 3D Printing and Rapid Prototyping technologies, with a wide range of high quality materials. Anterem offers Technical and Personal Specialized Consulting to solve any Design and Production issues. Since

2006, McNeel certified A.R.T.C., Authorized Rhinoceros Training Center and Specialized Training Partner for CAD 3D Jewelry Designers. Equipment and materials: Resins and casting; Waxes in high definition quality ideal for Jewelry; Aesthetic Resins for Functional Prototypes (AntePrima Service); Multimaterials for Co-molding; Transparent or Opaque Resins Multimaterials for Biomedical Elastomers with different ShoreA degrees.

- Astrati [15]: Astrati was founded in Genoa - Italy. The goal is to connect small and medium companies with manufacturing additive producers that are already operating on the market. With a solid background in in mechanical and industrial plants engineering, Astrati wants to provide opportunities for customers to transform the way they design and create with "additive manufacturing" solutions. Equipment and services: 1) Design: Astrati provides support for the additive design to create prototypes and molds for injection molding; 2) 3D modelling & 3D print by means various technologies, from stereolithography to SLS. Materials: ABS, nylon with glass fibre, UV resins or siliceous sand, titanium, aluminium, stainless steel etc.
- Sokar additive technology is a company based in Genoa, offers services to introduce additive technologies in production processes, and operates in the 3D field applications connected to industrial and marine application both in metal and polymer solutions. They are able to work with FDM, EBAM, SLA technologies on problems specifically dedicated on industrial and SME applications. They support the technical offices in the study of solutions that optimize the possibilities offered by additive technology for rapid prototyping, weight saving, maximization of thermal exchanges and much more. They also provide the physical realization of the prototype in both resin and metal.
- Genova Makers Village Operates in the BIC – Business Incubator Center of Genova the Maker's Village is the home of Genova Makers to support StartUp creation as well as SME development of prototyping efforts in order to create a connection between the social environment and the local production need of the town. Supporting the creation of new technology companies and their incubation in the initial phase and the provision of equipment and skills to startups and SMEs in general to foster industrial innovation and the adoption of new technologies, including through the prototyping. Moreover, they offer to new young generations of educational opportunities (including school-work alternation) and socialization through the tool of the construction of high-tech objects

1.4. Poland: Examples for good practices on sharing infrastructures

This section presents the Polish centers, parks and projects which serve as examples of good practices on sharing infrastructure - Wrocław Technology Park, Wrocław PORT and Science Infrastructure Management Support. These three cases are not directly focused on Additive Manufacturing, but can be good examples of infrastructure sharing in general, whereas the last two cases - LETIA and CAMT (located at WUST) - are equipped with Additive Manufacturing infrastructure.

1. Wrocław Technology Park:

Wrocław Technology Park is currently a place of operation for over 200 companies from the new technologies sector. It is also a workplace for over 1,600 employees of these companies. These figures alone indicate that this is a good place for business. It is a place where the business and science meet advanced technologies. Wrocław Technology Park offers modern laboratory, industrial or office areas, access to world-class laboratory equipment, support of professional advisers within technological and business consultancy and know-how transfer. More info can be found here [16,17,18, 19 ,20 ,21 ,22 ,23 ,24 ,25 ,26 ,27 ,28 ,29 ,30].

2. Wrocław PORT (Polski Ośrodek Rozwoju Technologii /Polish Center for Technology Development)

a) MASS SPECTROMETRY LABORATORY

b) NUCLEAR MAGNETIC RESONANCE LABORATORY

3. Science Infrastructure Management Support

Beneficiaries of the OPIE (Operational Programme Innovative Economy), which have achieved such spectacular success, now face a challenge of maintaining the durability of their projects, and, what follows from that, ensuring the highest quality of management of the research infrastructure.

In an attempt to meet the expectations of Beneficiaries, NCRD has invited employees of the most innovative Polish institutions of higher education and institutes conducting scientific research to participate in a system project implemented under the Operational Programmes Human Capital – Support of management of the research infrastructure of beneficiaries Measures 2.1 and 2.2 of OPIE (the SIMS project). Under the project, 120 scientists, heads of laboratories and persons responsible for construction of scientific development strategy within their organizations, will go on monthly foreign internship programmes at:

- a renowned institution of higher education managing a large research infrastructure,
- a highly-specialised research institute,
- a world-renowned company with a High Technology profile.

Moreover, interns and 60 persons additionally supporting research projects in the area of finance, law and administration, will take part in training organized in Poland and adapted to specific needs of particular Polish institutions of higher education and institutes.

http://www.projektsims.eu/en/about-project

4. LETIA

LETIA organizes and co-organizes specialized workshops and trainings for companies, related to trends in 3D printing technology and design innovation, in marketing, promotion of products and services, optimization of design services, as well as digital prototyping of products. LETIA's laboratory is equipped with FDM and Polyjet technology, which use ABS material characterized by high strength and also light-curing resins with excellent accuracy up to 16 microns.

5. Wroclaw University of Science and Technology

Wroclaw University of Science and Technology offers access to its databases related to infrastructure and laboratories: [31,32,33].

6. Center for Advanced Manufacturing Technologies (CAMT)

Centre for Advanced Manufacturing Technologies (CAMT) is located at the Faculty of Mechanical Engineering at the Wroclaw University of Science and Technology. It is one of the biggest research centers in Poland dealing with Additive Manufacturing technologies. List of key technologies in CAMT include:

- Molecular Beam Epitaxy (MBE)
- Laser based micro-manufacturing
- Hybrid technologies for deposition of functional coatings
- Hybrid technologies with laser processing
- Laser cladding and alloying
- Additive manufacturing (RM/RP/RT)
- Reverse engineering for product development
- Vision systems for process automation
- Monitoring and multi-criteria control of laser technologies Remote sensing of laser-based processes
- Design and simulation for manufacturing systems and processes
- Systems for integrated product and process development (CAD/CAM/PLM)
- Modelling and optimization of SCM (Supply Chain Management).

Laboratories and infrastructure of CAMT/FPC, located at the Faculty of Mechanical Engineering, with the total space of approx. 1200 m2 include:

Additive manufacturing technologies for metals:

- selective laser melting,
- laser cladding and micro cladding,
- electron beam melting technologies

With appropriate supporting equipment: powder sieves and conditioning chamber, part cleaning and post-processing machines),

Additive manufacturing technologies for polymers:

- stereolithography,
- polyjet,
- 3D inkjet printing,
- selective laser sintering,
- drop-on-demand wax printing,
- fused deposition modelling

- Multitude of material extrusion set-ups for various applications, including bioprinting).

The European Commission launched on 19 April 2016 the first industry-related initiative of the Digital Single Market package. Building on and complementing the various national initiatives for digitising industry, the Commission will act to trigger further investments in the digitisation of industry and support the creation of better framework conditions for the digital industrial revolution. One of the more important pillars of the Digitise European Industry effort is the activity to develop a network of Digital Innovation Hubs (DIH). Centre for Advanced Manufacturing Technologies (CAMT) - located at the Faculty of Mechanical Engineering at the Wroclaw University of Science and Technology - as a Digital Innovation Hub (DIH) is one-stop-shops that help companies to become more competitive with regard to their business/production processes, products or services using digital technologies.

More info can be found here: [34,35,36].

1.5. Slovakia: Examples for good practices on sharing infrastructures

This document shows five selected examples of sharing infrastructure and best practices in Slovak Republic. They were selected from various fields and with different background.

1. Biomedical Engineering, Kosice: Biomedical Engineering is an institute, which was established as a spin-off organisation of the mother company CEIT a.s. and the Technical University of Kosice. The team of Biomedical Engineering includes qualified experts in this field, with close relationship to scientific and academic environment. The company is focused on development of new solutions, from consulting to development and manufacturing in the field of 3D printing. Company developed numerous products in the field of implants, such as titanium skull and face implants as well as porous (similar to human bone) implants. Web: http://www.ceit-ke.sk/
2. 3DIMENZIA supported by Mymedia: 3Dimenzia is a creative company, established as a spin-off a marketing company focused on 3D models and promotional items, later developed strong focus on additive manufacturing. The company developed their own 3D printing arm and their long-term goal is to develop 3D printer (printing arm) suitable for building houses. Nowadays they are developing and testing new materials suitable for building houses via 3D printing together with Slovak Academy of Sciences.
3. Advanced Engineering [8]: Advanced Engineering is focused on additive manufacturing and engineering. Main focus is on 3D printing of plastic and metal parts according to customer requirements, the sale of 3D technologies and the introduction of additive technologies.

Centre of their work is:

- Custom manufacturing
- 3D printer, 3D scanner and software sale
- Services in the field of additive manufacturing
- Construction and engineering

4. FABLAB Bratislava [9]: Creative laboratory FabLab is an open laboratory that works as a platform for designers, developers, artists, students and general public. It offers facilities so that users can familiarize with the practice and technologies of digital fabrication. FABLAB is open for the public. It offers the possibility of creating and making various objects and materials on professional machines. We are expecting further technologies that will improve the digital fabrication experience. FABLAB encourages and supports creativity, experimentation and innovation. It gives the possibility to pursue and realize your dreams.

Aims of the project FABLAB:

- Support local development
- Access for entrepreneurs
- Support innovation

5. Creative Point [10]: Creative point is a laboratory for future/ starting entrepreneurs, well equipped and free of charge. Creative point offers these services:

- free use of machines and technologies
- prototype production, design
- workshops
- excursions

- professional and popularizing events

Machines: CNC, 3D printers, laser and cutting machines, laboratory electrical machines, tools for electrical programming

2. Comparison between regions

The five Regions have extremly interesting up to date facilities dedicated to Additive Manufacturing applications. Indeed all of them show a doublefold nature, dedicated to the scientific aspects as well as innovation and technological items. The application fields vary, from aerospace to automotive while some of them take care also of biomedical and veterinary aspects. Among the Germany facilities as well as the Italian are indicated two FabLabs that could be an interesting access gate to the social applications of 3D printing technologies.

All the facilities demonstrate to have strong connections to high scientific and low TRL level excelleneces as well tight connections with single startups, PMI or incubators and industrial parks. The adopted technologies span from polymers up to metals, in a wide spectrum of printing technologies.

In the descriptions some Regions also clearly highlighted, while other left it as an underlying task, the regulatory and standard aspects of Additive Manufacturing as well as quality control items.

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