PROJECTS IN MECHANICAL ENGINEERING, 3D METAL PRINTING AND SOME EXAMPLES OF OTHER RDI AND STUDENT PROJECTS

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1. ABSTRACT

Digitalization is shaping the manufacturing industry, and especially additive manufacturing has been called the next industrial revolution. This article describes how Tampere University of Applied Sciences contacts these ideas to different projects.

2. OPENLAB INTRODUCTION

2.1. Background to Openlab Concept

Global change happens very rapidly nowadays. However, continuous technological change, creativity and fast innovations influence economic growth. Recent digitalization and new technologies have changed the humans' way to live and co-operate permanently: Global and fast communication, international networks and competition, Real time worldwide knowledge and technology transfer, time and place independent services and education, from company internal innovation to open innovation, robots in work round-the-clock.

2.2. Openlab as a Learning Environment

New roles of a teacher/professor: Teacher/Professor has become a coach for students, a specialist for companies, a project member or manager, a salesperson for university products (education, RDI-projects, services).

New roles of a student: Student has become an individual with PEP and personal study path, a lifetime customer for an education organization, and a team and network player with a huge amount of information on hand, Figure 1.

The OpenLab teaching environment makes it possible to combine teaching and RDI activities [5]. Good examples are found from references [6] and [7].

Figure 1.
New roles of a student

2.3. Student Project Examples

TAMK has built Openlab in 2015 to integrate all players and needs. Openlab is a learning environment. Openlab is also an industrial ecosystem/ RDI-platform and rolls as a living lab: a user-centered, innovation ecosystem integrating research and innovation processes. TAMK is a member of ENoLL (European Network of Living Labs) [8], Figure 2.

Objectives (why & what): Industrial student projects, e.g. Intelligent machine projects, Problem based learning (workshops and student innovation in teams), New investments and learning environment development to support new operational model of collaboration and learning and Enable engineering students' invention & startups (e.g. TAMK students co-operative companies).

Figure 2.
TAMK has built Openlab to integrate all players and needs

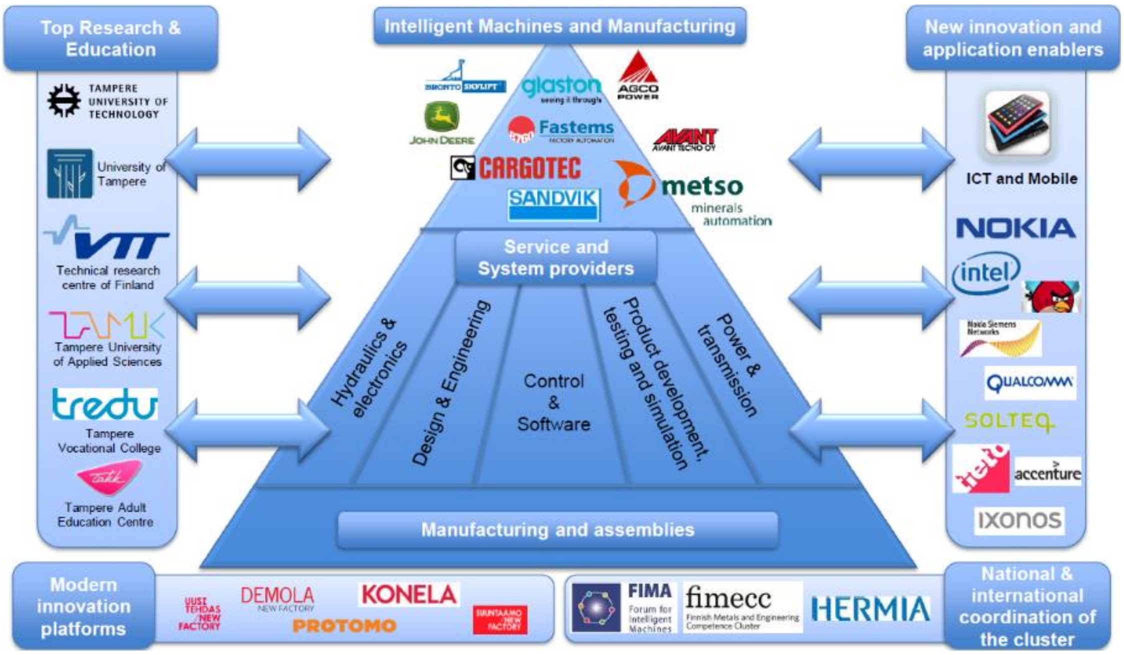

Figure 3.
Industrial ecosystem in Tampere region – Intelligent Machines, it is connected to top research & education

RDI-project collaboration with companies Tampere region and educational units expand the network of members and partners (international partners). Technology sharing: Advanced robotics (case ABB, Social robotics' TBD), 3D printing (scanning and measurement) and AR&VR environment / platform. Innovation platform, hackathons, seminars & workshops: Industrial internet (IoT), Digitalisation, Forums related to Global network operation, Sourcing, Supply chain, Product development, etc. Laboratory services in mechanical engineering. Visit website for more: http://www.tamk.fi/fi/web/tamk/openlab [5].

Industrial ecosystem in Tampere region – Intelligent Machines, it is connected to top research & education. We connect it also to new innovation and applications enablers, Figure 3, [5].

Openlab focus areas: Combining experiencing safely, enable doing & learning and challenge yourself. Students' projects, laboratory services, innovation projects, seminars & forums and courses & training are all possible in Openlab environment. Companies, TAMK staff, TAMK students and collaborators are working together in different projects. Facilities & services, equipment & machines, skills & expertise, students & projects have all-important role when we are discussing to solve different problems.

In Openlab environment is possible to use new technologies, AM &3D printing, modern manufacturing technologies, quality measurements and verification, re-engineering, product design and simulation, prototyping in collaboration with Pirkanmaan Protopaja Network, digitalization and IoT, robotics and automation. Experiencing safely, enable doing, learning, and Challenge yourself. Operational model for collaborative RDI-projects: The characteristics of the operational model for collaborative RDI-projects are easy access, trust & confidentiality, quick response, flexible curriculum, project organisation is in charge, simple rules (true network model) and visible pricing & productized offering. Ongoing: Integration to SMACC, working together with VTT and TUT also toward T3, Figure 4, [5].

Collaborative business model: Membership fee bases on the size of company. Fee covers the fixed costs from network management and general services such as meeting arrangements, single point of contact services and Seminar and project proposal & planning support. Network fee and project fee is described on Figure 5.

SMACC services: The description of SMACC services, project implementation models and project classification and pricing are presented on Figures 6 to 8. Figure 9 presents an example of a student project.

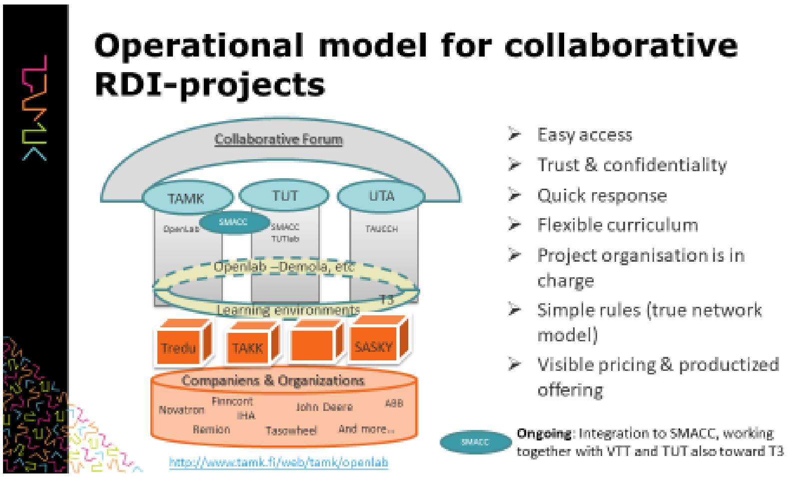

Figure 4.
Integration to SMACC, working together with VTT and TUT also toward T3

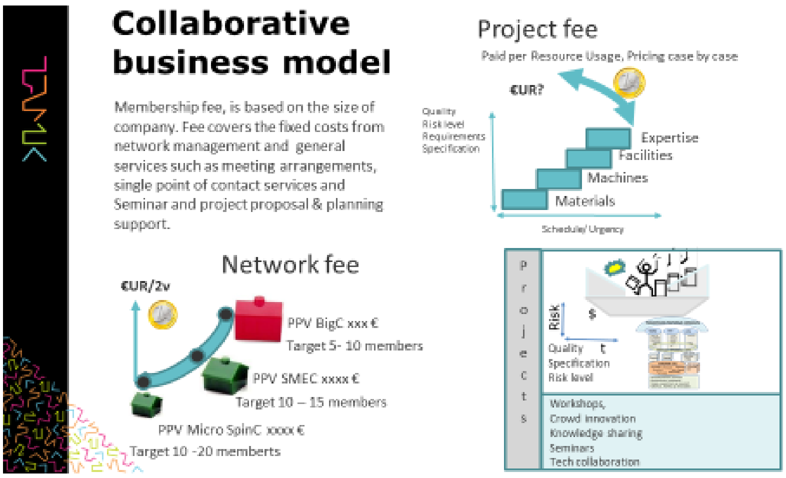

Figure 5.
Description of network fee and project fee

Figure 6.
The description of SMACC services

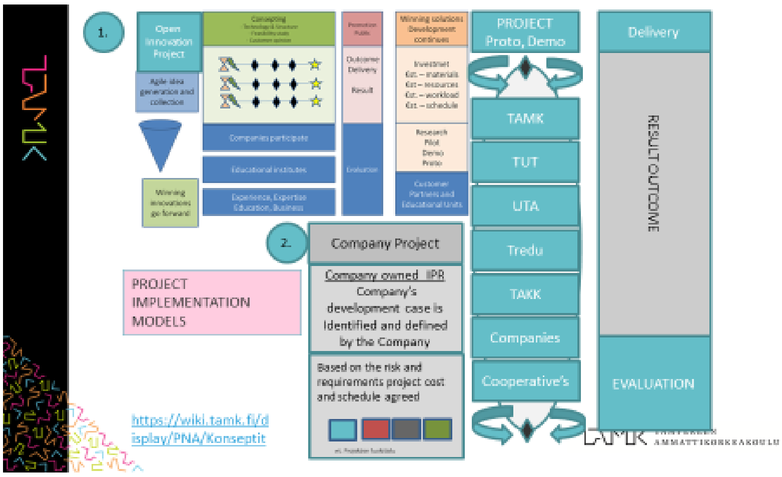

Figure 7.
The description of project implementation models

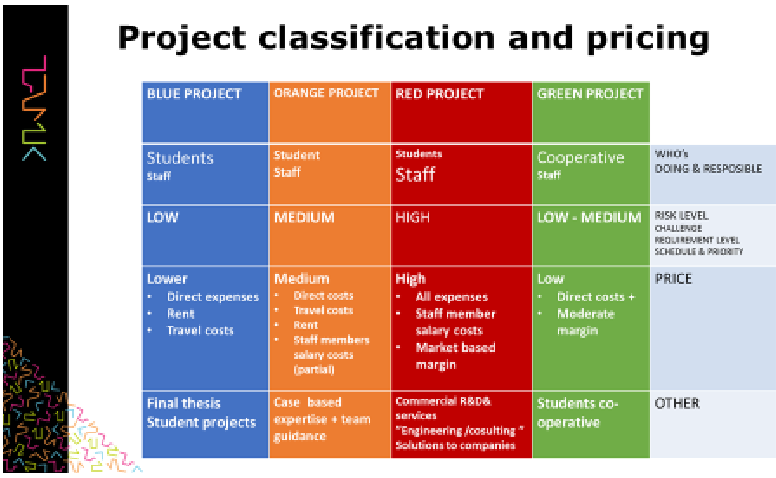

Figure 8.
The description of project classification and pricing

Figure 9.
Very large 3D-printer (1.2 m^3)

3. UPDATING DIGITAL CAPABILITY IN A NETWORK ECONOMY SOCIETY

Coordinator: University of Oulu more partial. Oulu University of Applied Sciences. University of Turku. Turku University of Applied Sciences. Tampere University of Applied Sciences. Cooperating with organizations in charge of business development in the area.

1.9.2018 – 31.12.2020 Improving the supply and quality of education for growth and structural change EUR 1,137,148. Target group: People employed by businesses who update their skills, as well as the unemployed and highly educated people under threat of redundancy.

Strong structural change in the industry and the skills needs of digitalization –> the need to increase both the number of professionals and the level of expertise of companies: Marine industry and health technologies in Southwest Finland Printable intelligence and ICT in the Oulu region Robotics, digital product development, digital manufacturing and 3D printing in Pirkanmaa.

What is done in the project?

Identify the skills and labor needs associated with the digitalisation of businesses in the “Time Cities”. Based on the needs mapping, new flexible training packages are planned and implemented. The content of the coaching programs is based on the knowledge needs of the companies in the regions, which improves the employability of the participants. The skills of the company's own employees are also updated to meet the new needs of companies. The coaching programs emphasize the working life orientation of the studies. Predictive methods are used to regularly update business knowledge needs.

In Oulu: Printable intelligence is one of the fast growing areas. In recent years, a number of companies using printing technology have emerged in the area, and there is a shortage of specialized experts in the field. The University of Oulu and OAMK are part of the PrintoCent community, coordinated by VTT. The activity is based on cooperation between companies and research and education organizations in the field of printed electronics. The project will prepare digital professionals for the needs of print electronics companies and link training activities to the needs of other 6Aika business areas.

In Turku: In Southwest Finland, the forefront of economic growth is health technology and the marine industry. Turnover in the marine industry has grown by a third since 2010 The employment effects of the Turku shipyard alone in the region are significant. Approximately 10% of the growth conditions in the health technology sector are estimated per year. The project focuses on addressing the challenges of availability with up-to-date training in the technological needs of the focus areas (digital capabilities such as AR, VR, IoT and AI).

In Tampere: The manufacturing industry is picking up in Pirkanmaa, and at the same time, digital restructuring and the shift of traditional industries to digital service production have created new skills for companies. Knowledge needs relate to areas of digital product development and manufacturing, 3D printing and robotics. Digital product development in machine building enables extensive use of computer-aided software (CAD / CAM / CAE), digital (twin) models, and design platforms at different stages of the product life cycle. The key competencies in digital manufacturing are computer-assisted manufacturing methods and software (CAM) and computer-assisted machining of machine parts manufacturing using computer-controlled (CNC) machine tools. AM (Additive Manufacturing, Substance Manufacturing, 3D Printing) offers significant benefits to manufacturing industry as well as new business opportunities. The core competencies offered by the coaching are the capabilities, features and constraints of the various 3D printing technologies and methods, the 3D printing design and manufacturing chain from the material to the finished component (DfAM, printability), the design methodology of the 3D printable part, computer-aided design tools, 3D print materials and their selection. 3D printers and their choice. Light robotics, ie the use of service robots or collaborative robots in industry, will increase significantly. Key competencies needed in this area include: identifying potential robotisation targets for manufacturing processes, efficient implementation of robot investment projects, taking into account technical and economic boundary conditions, safety and user experience perspectives, the applicability of robotics in agile small-scale production, and consideration of robotic production in product design.

TAMK's partial implementation goals are. Objective 1: Study state-of-the-art research on the basis of the digital capability model in the areas of digital product development and manufacturing, and 3D printing and service robotics. Goal 2: Identify training needs in collaborative companies and, based on surveys, produce skills development planning for company employees and job seekers without work. Goal 3: Contact and activate unemployed people or people at risk of unemployment with sub-measures and training in a personal competence development plan. Objective 4: Organize work-specific, tailor-made training to meet the needs of business employees and the unemployed. Goal 5: Produce digital training materials for the subproject as online material for 6Aika-cities and businesses in the areas of digital product development and manufacturing, and 3D printing and service robotics. Goal 6: Also implement online trainings / webinars in 6Aika cities in other project promoters.

4. PROJECT 3D-BOOSTI

Three beneficiaries of the project: Tampere University of Technology (TUT), Tampere University of Applied Sciences (TAMK) and Sastamala Municipal Education and Training Consortium (SASKY). Search for a technological leap in exploiting digital knowledge by dint of additive manufacturing.

The aim of the project is that all phases of manufacturing, from design into a ready-made item, can be concretized in R&D, learning and innovation environments developed during the project. The aim of the project is to organise the R&D, training and innovation activities of the field in Tampere region into effective cooperation in a way that enables the broader introduction of the 3D printing techniques in industry. The aim of the project is to create the highest know-how on the field, transfer the knowledge, expertise and the best practices to the enterprises and boost the commercial utilization of the expertise.

The objective of the project is to form a remarkable hub of expertise in Tampere Region. The objective of the project is to boost the manufacturing knowledge in Finnish SMEs, and in particularly in SMEs located in Tampere region. The objective of the project is to enhance the competitiveness of the enterprises and products and to increase the added value.

The main activities of the project are to form a network of relevant actors and define the hardware to be purchased (promoters involved: SASKY, TUT and TAMK), to gather and disseminate the information (TAMK, SASKY and TUT), to launch the R&D activities and publish the results (TUT and TAMK), to cooperate with the enterprises (SASKY, TUT and TAMK), to observe the sustainability (TAMK, SASKY and TUT), to take part to the international network (TUT and TAMK), to further develop the learning environments (TAMK, TUT and SASKY) and to evaluate the activities (SASKY, TUT and TAMK).

Regional network.

The project will form a network which actors cover all sections of the 3D printing technology, i.e. basic research, development, integration, testing, application and training. The efficiently functioning network will enable the emergence of new innovations – not only in technological sense but also as new targets of applications. The knowledge and expertise gained during the project, as well as the cooperation with the enterprises, will ensure that after the project the beneficiaries have the capacity to carry out education and training related to 3D printing.

5. PROJECT 3DINDESIGNER

3D InDesigner: What is missing from the new production method?

During the late autumn 2016 and spring 2017, the 3D boost was actively marketed with direct contacts, various trade fairs and invitations to targeted teams. As a result of marketing, more than 20 companies were able to discuss more about metal printing.

Print themes were made for example. SLM-125 with metal printer and Stratasys. Objet polymer printer for businesses. In discussions with companies, the biggest problem was identified the lack of necessary new know-how of the companies' own design department. The old methods of deformation are well known, yet the possibilities provided by the new method are not yet fully understood.

What types of things do companies lack? Corporate top management information and vision for 3D printing. The concrete experience of the people responsible for production and design in utilizing 3D printing Personal expertise in product development and design for implementing 3D printing on products.

What skills do we lack? Corporate top management: General knowledge of 3D printing opportunities; technology, business, service? How could we benefit from providing our customers with added value? Ad-hoc knowledge: Production and product development. Personal knowledge Traditional machining methods control design. On the other hand, there is a lack of knowledge of the possibilities and constraints of 3D printing.

Content of training; An example of an ongoing training. Day 1: AM Basics, AM Techniques, Case Examples, Planning Formatting. Day 2: Metal Printing, Design Rules, Scan Theme and Own Scan Exercises. Design task start. Day 3: Continuation of the design task, topological optimization, (plastic) start of the print. (Temporary metal printing of the track). Day 4: Completion of the design task, completion of the finished piece, finishing of the finished metal printout. What do we learn from this process? Day 5: Unloading the Design Task Continues, Direct Layer Printing and Other Printing Methods.

6. 3D METAL PRINTING

Digitalization is shaping the manufacturing industry and especially additive manufacturing has been called the next industrial revolution. As can be seen from picture 10, plastic is still the most used material in 3D printing, but it has lost its share from 88% in 2017 to 65% in 2018. At the same time metal has increased from 28% to 36% [9].

TAMK wants to be part of the revolution and has therefore been active in gaining and sharing information about AM-technology. TAMK was one of the first and is still one of the few educational institutes in Finland to possess own metal printer. In project 3D-Boosti TAMK, together with partner SASKY, acquired a metal printer, which is based on selective laser melting technology. Picture of the equipment is presented in Figure 11. Ever since the investment, TAMK has been actively working with several companies by sharing knowledge of the metal printing technology and organizing training related to design for additive manufacturing.

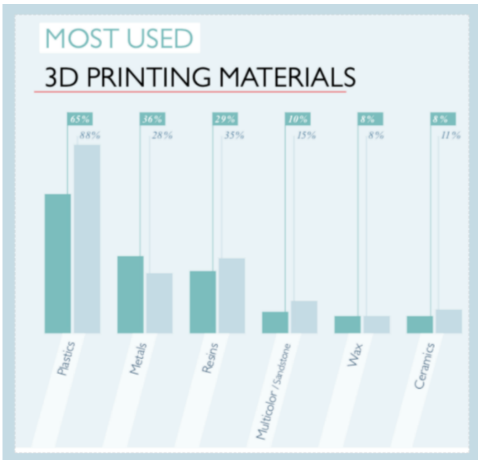

Figure 10.
State of 3D Printing 2018: The rise of metal 3D printing, DMLS, and finishes!

Figure 11.
Metal printer owned by TAMK and SASKY

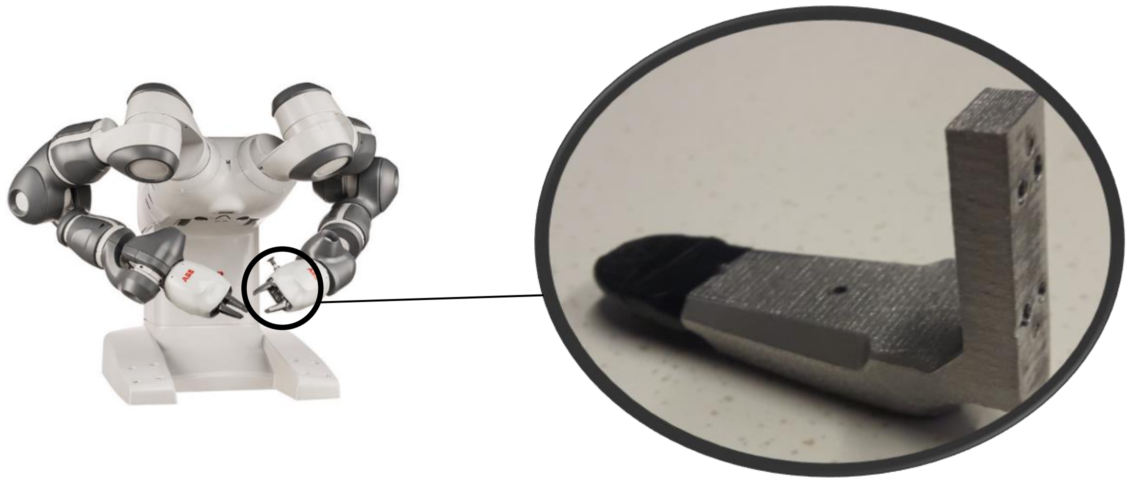

Figure 12.
Metal printed grippers for ABB Yumi robot. Gripper were designed and used by student in Robot Academy

Figure 13.
Fatigue test samples printed as a part of a Master thesis [2]

One example of projects involving students, faculty, industry and use of AM is Robot Academy. In the project students have worked with company ABB developing showcases with ABB Yumi robot. Many kinds of grippers have been designed and manufactured using AM-methods. In Figure 12 is presented an example of a gripper made using metal printer.

TAMK has also been active in research with international partners. Several Bachelor and Master theses has been completed by international students related to metal printing and AM in general [1], [2]. In Figure 13 is shown metal printed test pieces used in fatigue tests. Testing was part of a Master thesis work in which effect of printing parameters to strength were investigated [2].

One of the design tools strongly related to additive manufacturing is Topology Optimization. TAMK has been active in using and teaching topology optimization. Topology optimization has been added as part of the courses in additive manufacturing and finite elements. Short introduction sessions have been given to students in international partner universities and to company employees during design for additive manufacturing training. Topology optimization tools used by TAMK are ANSYS Workbench and Altair simulation tools.

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