LABS.4. SMEs

space for innovation

Final publication

Interreg
Italia-Österreich
European Regional Development Fund

EUROPEAN UNION

CONTENT

INTRODUCTION

The emergence of novel and powerful digital technologies, digital platforms and digital infrastructures has transformed innovation and entrepreneurship in significant ways. Beyond simply opening new opportunities for innovators and entrepreneurs, digital technologies have broader implications for value creation and value capture[1]. It becomes vital for companies to stay ahead of the curve of digitalization and innovation.

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Digital Transformation is the corporate-led strategy for implementation of technology to improve business and meet the ever- changing needs and demands of the consumer. It results in a new reality, which will remain valid until the time for next change is sparked by innovation. Innovation is one of the drivers of Digital Transformation and in most cases, precedes the change process[2].

Developing Innovation requires the creation of a suitable environment, promoting the flow of new ideas, curiosity and creativity.

Innovation does not come out of a blue, it is an interactive, collaborative process, involving private and public knowledge providers. The ability to develop, identify and select organizational approaches and technologies for successful innovation is one of the core competences ensuring a competitive advantage. Whereas this is obvious for Large companies, Small and Medium Sized Enterprises (SMEs) are much more limited in terms of time, access to human resources and capital as well as know-how.

In such a situation, the role played by Fab Labs, Digital Innovation Labs and similar type of facilities can lead to a symbiosis where micro and small companies can cost-effectively learn and use know-how, machines and services and learn empirically how to develop a strategy for Digital Transformation.
Labs are “a place to express themselves, create, learn, and invent”, aspects that have great potential for innovation of SMEs as well as for applied research; the facilities they offer and the range of services available can, in a smart and lean way, support companies in a co-design process to make products and services internationally competitive. Indeed, SMEs are too often penalized by their size in order to face investment in R & I. The project Digital Labs 4.0 for the innovation of cross-border SMEs (Labs.4.SME) aimed to fill in this innovation gap for the cross-border SMEs through a model and cooperation tools that can enhance the innovative role of Labs for SMEs on the one hand

and provide SMEs with a “user friendly” R & I with reduced times and costs. The aim of this publication is to provide an overview and share the successful practices of cooperation among SMEs and Labs generated by Labs.4.SME.

The document is divided into four main sections

1. **The cooperation tool: Exploreinnospaces.eu**
   The first provides insights of the foundation infrastructure needed to trigger cooperation among Labs and SMEs, a well-defined mixture of practices showcase, map of services, tools and people and a collaboration tool.

2. **The model of cooperation**
   The second deploys the Cooperation Model (CoMod) applied. Although a successful cooperation hinges on countless factors, the CoMod is intended as a systematic approach, providing aggregated information about types of cooperation, enablers and barriers.

3. **Successful cooperation practices**
   The third collects and share the results of collaboration projects, defined as “Innochallenges”, carried out from October 2018 until July 2019 in the Autonomous Province of Bozen, Friuli Venezia Giulia, Veneto, Tyrol, Salzburg regions, co-funded by the Interreg V-A Italy - Austria Programme 2014-2020.

4. **Learnings and future perspectives**
   The fourth illustrates learnings and perspectives for future development and research, in order to scale up the results and insights gained during a two-year cooperation between stakeholders in Italy and Austria.

This publication presents a contribution toward the strengthening of the smart, sustainable and inclusive growth of the European Union through economic, social and territorial cohesion. It was designed and delivered thanks to the commitment and ruthless efforts of Ecipa Scarl, Fablab Castelfranco Veneto Srl, Associazione Artigiani Piccole e Medie Imprese di Trieste - Confartigianato, LVH/APA-Formazione e Service Coop., Fachhochschule Kufstein Tirol Bildungs GmbH, Salzburg Research Forschungsgesellschaft m.b.H.

1

THE PLATFORM

THE EXPLORE-INNOSPACES PLATFORM

The ExploreInnoSpaces platform (www.exploreinnospaces.eu) was implemented in the context of the Labs4SMEs project. It serves as a meeting point for virtual communication and integration between Labs and SMEs, aiming at maximum innovation through cooperation. Maximum innovation through cooperation is one of the key results of Labs4SMEs project. In the Innolabs, Collaborate, Explore and Idea Challenge sections, Lab deliverables, success stories of innovation resulting from cooperation between SMEs and Innolabs (open laboratories) and ideas for future projects are presented in an interactive, easy-to-use way.

1. The ExploreInnoSpaces platform of the Labs4SMEs project

The InnoLabs area currently presents 19 open laboratories from the regions participating in the project (INTERREG V-A Italy-Austria – AT: Salzburg, Tyrol and IT: Friuli Venezia Giulia, Veneto, South Tyrol). All Labs involved are equipped with digital machinery and technologies. In addition, they also offer many services, including consultancy and prototype production. Users can choose to view a map or a list of InnoLabs. With the list display users can use filters (machinery, services, country) to narrow down their search for the most suitable Lab.

2. Map or list of InnoLabs with filter criteria

In the long term, the ExploreInnoSpaces platform is meant to strengthen cooperation between small and medium sizes enterprises (SMEs) and the Innolabs, facilitate the generation of new know-how and promote cross-border innovation. Thanks to the wide choice of Innolabs, which can be compared through the platform, SMEs can choose the most suitable Lab with which to cooperate in order to support the evolution of innovative products and services. This will make innovation easier and faster, and also more sustainable economically as the number of innovative SMEs increases.

1


EXPLORE
InnoSpaces
Innovazione tramite collaborazione
con Maker nei Innolabs!
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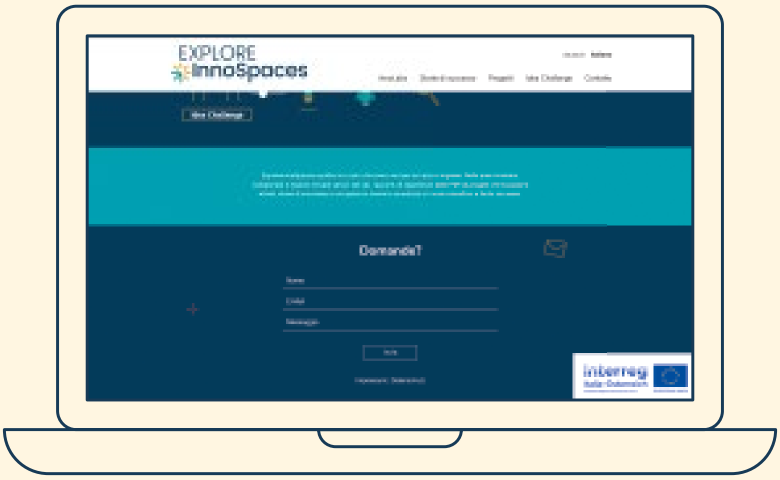
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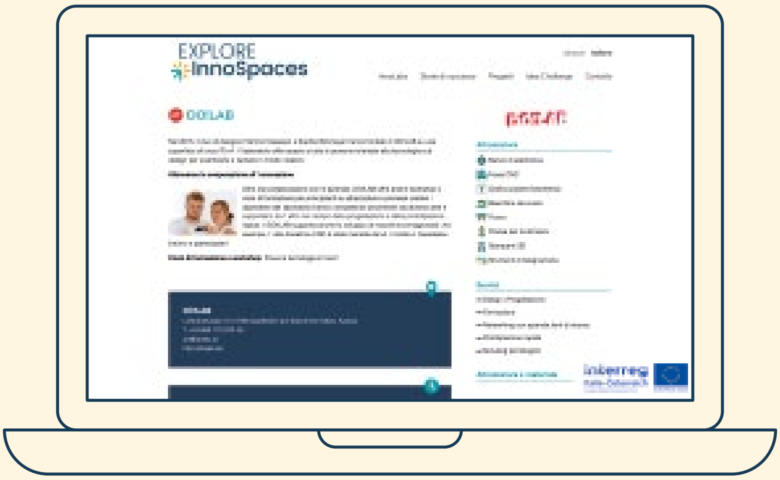
3. Description of a Lab in the ExploreInnoSpaces platform

In order to better communicate the advantages and opportunities offered by cooperation, the Explore section of the platform presents a number of success stories of Italian and Austrian SMEs working with the Labs. The list of innovative projects can be filtered according to specific interests, such as the type of project, prototype (function, aspect), small series and market segment. The 20 projects from Italy and Austria, which were presented and selected with the 2018 Ideas Competition, were made possible by cooperation between the SMEs and Innolabs and will continue to be present in the Idea Challenge section of the platform.

4. Overview of success stories and example of SME-InnoLab cooperation

Anybody who has ideas for a project or is looking for technical-professional assistance or needs special machinery can upload a brief description in the Collaborate section of the platform. This section also contains details of the projects currently under way or other ideas. In case of interest, the person presenting the project can be contacted.

3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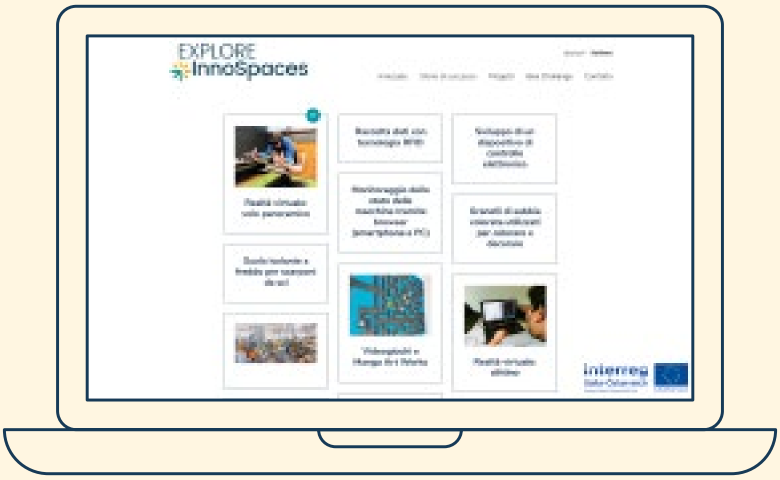
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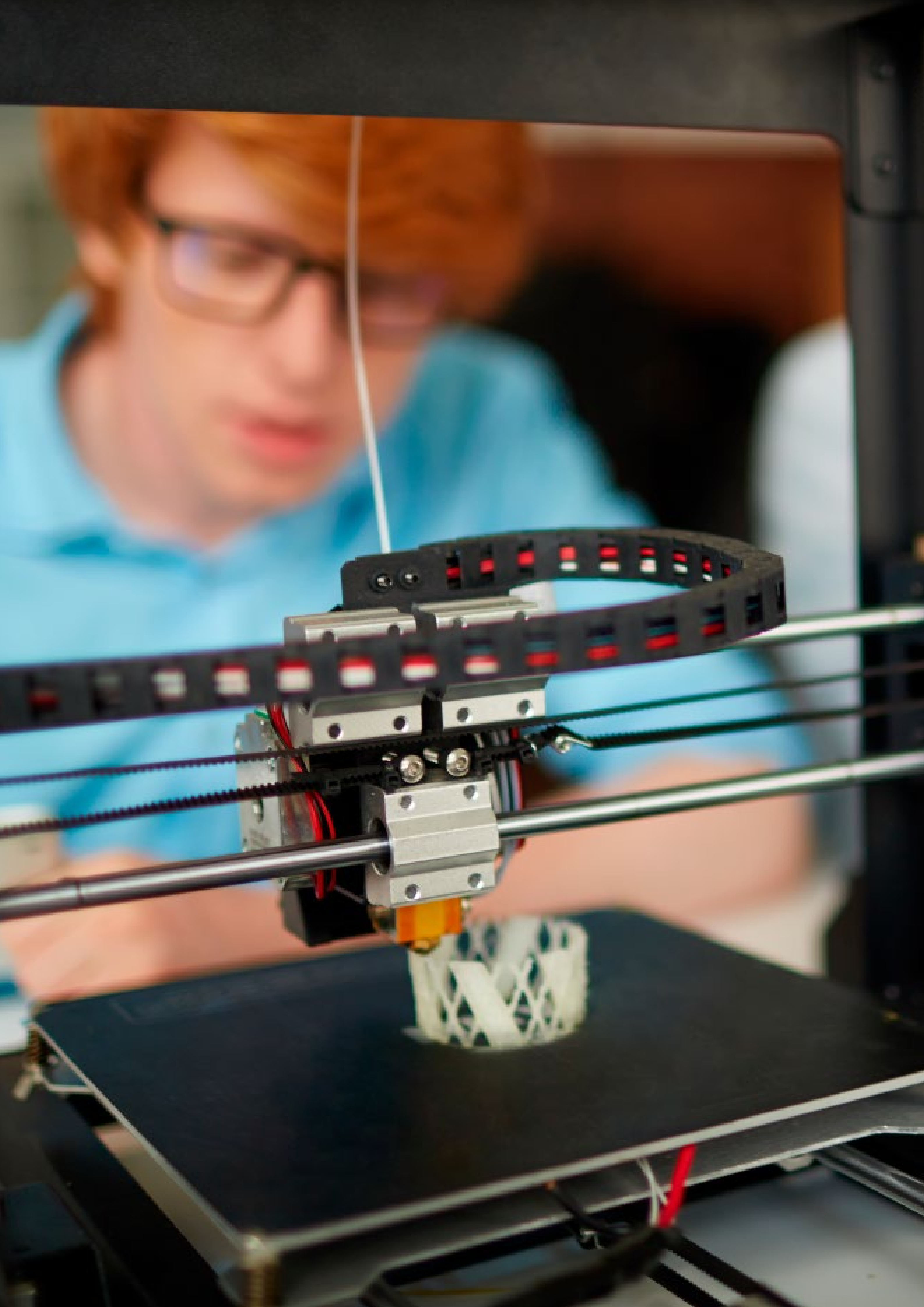

2

COMOD

COMOD

A Model to Support Collaboration and Innovation between Digital Innovation Labs and SMEs.

The cooperation between Digital Innovation Labs[3] (e.g. FabLabs) and Small and Medium Enterprises (SMEs) is currently **not being used to its full extent**. There seem to be a number of reasons that lead to this situation:

- Despite the fact that Labs offer interesting resources and knowledge, SMEs are often not aware of those resources, sometimes not even of the existence of the Labs themselves.
- Sometimes the SMEs do not know how they could initiate and successfully execute a project together with a Lab.
- Likewise most of the Labs see themselves merely as a resource provider and not as a facilitator for the generation of new knowledge or even as a knowledge hub connecting different sets of expertise from a group of experts, possibly in different organisations.
- Labs are usually a regional knowledge hub for a wide range of expertise, some offered directly by the staff of the lab and some provided by external partners when needed.
- There seem to be hidden benefits for both sides as every project always represents a learning process in which new knowledge is generated on each side and existing knowledge exchanged in a continuous project. Thus, the first project often is the initiator for a longer and more intensified cooperation – it is the door opener for a sustainable cooperation.

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3-6 months for each pilot-project

This paper reports on the results of an applied research project in Italy and Austria that addresses the cooperation between Labs and SMEs and sheds light on the challenges and benefits of such a cooperation. The project, that brings together **research organisations**, **practitioners**, **companies**, **labs** and **mediating organisations,** stimulated and supported the collaboration between SMEs and Labs and supported the collaboration throughout the period of 3-6 months for each pilot-project.
Besides the direct support of the activities in the pilot project the authors conducted an accompanying research with quantitative and qualitative methods in order to elicit the effects of **knowledge generation**, **knowledge transfer** and **knowledge use** in the context of **inter-organisational innovation** with a specific goal.

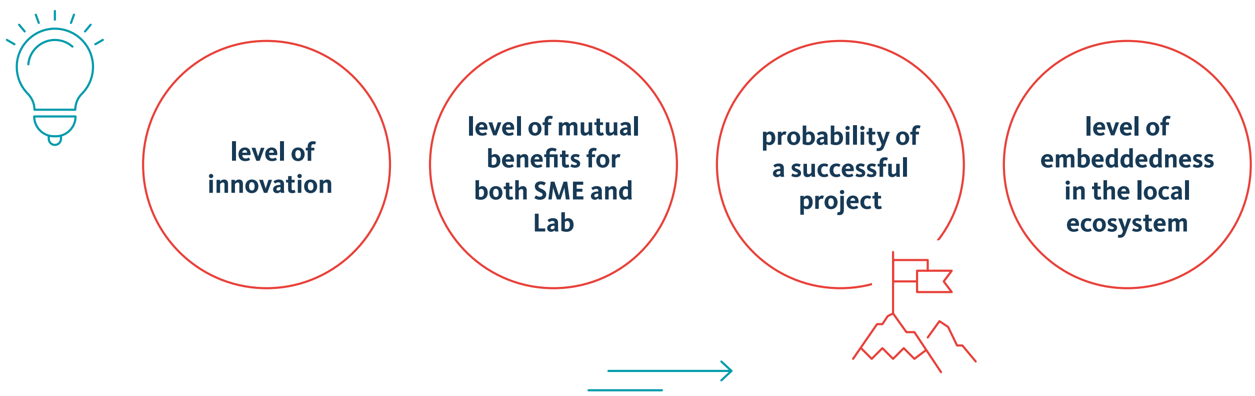
This paper reports about the specific outcomes of the collaboration between different SMEs and Labs in two European countries.
It will explain how such collaborations can be facilitated. The findings of the specific projects are used to generate a general Cooperation Model ("CoMod") by comparing different projects. The model subsumes and generalizes the specific collaboration results and focusses on impacts that might not be obvious such as the generation of new knowledge or the root causes for innovations within the collaboration. Those results will provide guidance to other Labs and SMEs to realize the benefits of a collaborative Innovation project. For the KM community the project demonstrates, that the collaboration between Labs and SMEs involves significant amounts of tacit knowledge, which can be made more visible using "CoMod".

The paper is structured in the following way: In the next section the **research methodology** and the data acquisition method is described. We summarize **important aspects from the data gathering** in the following section and aggregate these data into the **cooperation Model ("CoMod")**, that is introduced in the following section. In the final section we conclude the paper and provide an outlook to future research.

1. Research Methodology and Data Acquisition

In order to achieve an overview about the current cooperation of Labs and SME a number of surveys were executed to elaborate the state of the art in the covered regions which stretched in two regions in Austria (Tyrol and Salzburg) and several regions in the northern part of Italy (Autonomous Province of Bozen, Friuli Venezia Giulia and 3 Provinces in Veneto namely Treviso, Vicenza, Belluno). In order to support the cooperation of Labs and SMEs a number of cooperation projects targeting specific innovations of SMEs had been initiated (11 in Austria, 10 in Italy).

These pilot projects were called Innovation Challenges since a call based mechanism was used for project proposals that were rated according to a number of criteria for each project:



Process of selecting the Pilot Projects for the collaboration of SME and Labs

1 Information Events

2 Workshops

3 Business Hubs

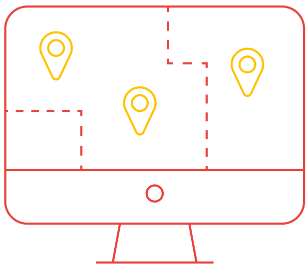
4 Innovation Challenges

5 Pilot Projects

A step wise approach was used to identify potential candidates for the Innovation Challenges: a first round of information events with brief but general information for the SMEs were held, then more in-depth workshops with selected companies were used to talk about possible ideas and within another event (called Business Hub) the final idea for the innovation challenge was outlined. Those proposals were submitted to the Innovation challenge competition and after a blind peer-review the resulting 20 pilot projects were selected. Figure 1 illustrates this process.

All along the process, a digital infrastructure facilitated the virtual communication and interaction, paring the face- to-face events, both during the initiating phase as well as during the implementation one. Namely, the platform **ExploreInnospaces.eu** provided

- a map of labs willing to cooperate within the Programme area
- a collection of successful practices of product/service development from the involved Labs
- an interactive online space to propose ideas and identify competences
- a call for ideas of cooperation Labs-SMEs to be co-funded.



web-based map

The implementation of a web-based map featured on the web platform with the Lab description including the facilities, services and tools offered enhance the **visibility** of the Labs in the area.

A first finding on those initial steps were, that most of the projects were innovative according to our criteria, but needed some **coaching** support to emerge from an initial idea or initial conversation. The resulting project often differed quite a bit from the initial starting point and usually required a moderation from an external partner (facilitator) that stimulates and structures the communication between the Lab and the SME in the initial phases.

When communicating to SMEs what a Lab does and what results can be expected usually the explanations of previous success stories was the most successful way of providing information to SMEs, esp. to those that were not used to a cooperation with a Lab. The information about available resources, tools and competences as it could be found on almost every Website of a Lab was less useful for this purpose. From a Knowledge Management point of view, it is noteworthy, that in an initial cooperation setting without previous experience the method of storytelling works well to create awareness on the side of the SME about what to expect from the Lab.

Another difference that could be noted, was the approach to innovation projects in the two countries. While the **Italian companies** were more **open towards a competitive cooperation** with a Lab, **Austrian companies** seemed to be **more cautious** and **required more guidance** before entering into a collaboration with a Lab (for the first time).

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The selected Pilot Projects were carried out over a period of about six months

The selected Pilot Projects (Innochallnges) were carried out over a period of **about six months** on average and involved a SME and a Lab in each case. Each project was **facilitated** and **supported** by the authors in a more indirect role to **supervise** and coach the project. The monitoring phases started with an initial **kick-off meeting** and involved status updates about by the authors approx. one a month to track usual project properties like the use of resources, the achievement of milestones and similar characteristics. In order to learn more about the nature of the cooperation and the knowledge creation and knowledge sharing the authors executed **qualitative interviews** after approx. 3 months (interim interviews) and at the end of the pilot projects after approx. six months (final interviews). The individual interviews took the form of physical meetings for each pilot project with representatives from the SME and the Lab together with the authors. Every meeting was recorded and later transcribed to make it accessible for a qualitative analysis.
While the focus of the interim interviews was more on the process and the ongoing collaboration, the final interviews took a reflective position that took the final result(s) into focus, together with the learnings for each participant.

The interim interviews showed that an active collaboration could be established after relatively short time and that an active communication process helped to **identify challenges** during the innovation process. One intention of the interim interview methodology was to identify challenges across all pilot projects early and have the opportunity to improve the innovation and collaboration process when needed. It turned out that an intervention by the authors in their facilitating role was not really needed, was most of the projects were running rather smoothly. On closer inspection it turned out that the Labs applied their lessons learned in one project already to other pilot projects, when this was appropriate. So, the Labs worked a **knowledge hub** also in the sense of applying rather process knowledge concerning the core innovation projects.

The final interviews were used to reflect on the result(s) of the pilot project and it can be said that in most cases the result were not only achieved in a single artefact (e.g. a prototype) but usually a set of variations that emerged from different trails in the innovation process (e.g. prototypes in different shapes, for different use cases or made of different materials). Quite often the participants also mentioned their insights from the project as intangible results that can be exploited in further projects and activities. From a KM perspective it was interesting to see, that the participants reflected on the innovation process actively as a process of knowledge creation and knowledge sharing.

It turned out, that the initial proposal phase in the innovation challenge was a substantial aspect to derive an initial structure (rough project plan with milestones and a definition of the intended target), which could be used as a basis to build the project on. Most pilot projects worked in a rather agile style, which sometimes led to unexpected paths based on results that were derived during the collaboration. Quite often small obstacles or challenges led the innovation project into new directions regarding the solution space.

Thus, the knowledge creation process was a constant and ongoing activity that was not actively perceived by the SME or the Lab. In those phases the facilitator role helped to make this knowledge creation process more conscious to the participants, leading to new insights. For the labs, for example, was the fact that they are a centre of a knowledge hub for a wide range of expertise not perceived as an important aspect of their work. Still, their ability to identify and mediate required skills for a project were quite substantial for the success of many of the projects. On the side of the SME often the insights into the capabilities of new technologies, like laser cutting or 3D-printing became only explicit knowledge to them, while using them in their own project that represented the domain of their expertise. From a Knowledge Management perspective, it seemed that the learning and the knowledge creation was successful when addressed in the problem domain of the SME (domain specific knowledge). The innovation often came from a different domain and the application of knowledge across different domains seemed to be a typical property of the Labs. The Labs however also learned from the domain knowledge in the pilot projects as they applied technologies that were already known to them in a field that was completely new to them. This sometimes lead to interesting side effects, for examples when they realized that a technology feasible solution was not possible due to safety regulations in that domain.

The next section will present the most important result from those interviews in more detail.

2. Results from the Interviews on the pilot projects

In this section the results of a qualitative analysis are shown that were based on a series of interviews of the project partners towards the individual pilot projects and collaborators in the respective project. Typically this has been a single SME and a single Lab, although there has been no restriction on such a 1:1 relation. The series contained an interview at approx. the middle of the project and a final interview. The results presented here stem from the analysis of Interview in the region of Salzburg and Tyrol and contained about ten pilot projects to date. Some more insights might be added at a later stage in the project, when the results of the Italian projects become available. The results are used to construct the CoMod, which is aggregating and structuring the results in a more general way.

The tables below present the impact of certain factors in the area of project management. They are intended to create awareness for the reader for various aspects, which influence such types of cooperation. Presented are general pieces of information which could prove to be useful when initially entering a cooperation. The positive and negative aspects are illustrated, along with possible effects to inform the reader about certain topics regarding project management and general advice.

2.1 General Advice/ Project Management:

Positives & Advantages	Effects
Workshops work very well.	They help to solve emerging questions through the collective knowledge of everyone attending. Also helps to define the next steps.
Fixing regular meetings and work-shops.	Helps to get new Input, fresh ideas and new POVs, as well as how to approach product development.
An external person (facilitator) who encourages the work.	Encourages constant progress and helps to avoid long periods of no productivity.
A constant, direct exchange with the FabLab, where difficulties or alterna-tive solutions are pointed out.	FabLabs bring in know-how they have from other projects in, provides a head start.
Smaller, shorter projects in a more frequent manner are better than large projects.	If the projects are shorter, both parties will continually work on it, as time is always pressing. 3 months is a good timeframe and as a result, projects don't feel overwhelming.

2.2 SME Tips and Best Practices

In the following table, the positive aspects of working with FabLabs are depicted. The effects and learnings of the aspects are also listed. The table is intended to highlight the benefits for SMEs when cooperating with FabLabs.

What can be learnt from FabLabs?

Positive aspects	Effects & Learnings
FabLabs give an overview of all the possibilities, which they offer.	New ideas are generated by seeing the possibilities.
Learn how to use the machinery, like using the laser cutter to make signs and inscriptions for yards and garden beds. They also offer support with material questions.	Know-how is generated and adds value on a personal and business layer.
They have vital know-how, access to specialists, time and capacities, which some SMEs might not have to that degree. An SME typically does not have a specialist for every area like a large company, so a cooperation with a FabLab can be very useful.	Such a cooperation can bring an SME together with specialists from the FabLab, which saves the SME from having to hire or train anyone, which is not possible because of time and financial constraints.
Such a cooperation allows an SME to venture into a project, which they could not initiate without a FabLab as the partner.	This opens the opportunity to work on a project, without having to invest 100% of their time into the project. "We dare to venture into new areas with the FabLabs".
It is extremely important to do a lot of prototyping. It is always a good idea to make a sketch, regardless of its quality.	This can serve as a basis for further ideas, help to visualise the idea for the FabLab and prevent forgetting the idea.
Know-how in certain areas, which provides the basis for diving deeper into those areas.	The SMEs learn to adapt to the approaches and methods of the FabLab, which can be useful in future projects.
Discussing ideas usually leads to new ideas.	FabLabs can be asked important questions about the product and offer a different perspective.
	FabLabs prefer to work with smaller SMEs, as the communication is more direct and not over 5 people. Decisions can be made more quickly.

The following table depicts the different stages or phases in which knowledge is transferred, exchanged or generated.

At which stage knowledge is transferred, exchanged or generated:

In which phases	Effects
It is constant and steady. No phase is to be neglected.	However, the Kick-off meetings and the workshops provide increased knowledge generation and transfer.
For SMEs who are cooperating with FabLabs for the first time, much knowledge is generated and exchanged in the beginning. If an SME and FabLab have been working together for a long time, the knowledge is more likely to be generated in the workshops with hands-on activities.	In the beginning, both sides can get to know each other, before learning about the strengths and weaknesses of the other. Then, each side can do their part and combine their efforts. If both parties already know each other, the initial phase can be skipped, and the project can be productive right from the beginning.
It is crucial to be in contact regularly and avoid long periods of no communication.	It is useful to always communicate the last and next steps of what each partner did and is going to do, to avoid miscommunication and work efficiently.

The **geographical location** of the FabLab plays a substantial role in the cooperation. Depending on the distance between the SME and FabLab, the amount of times the two parties see each other can change. If both sides are within the close vicinity of each other, it is easier to stay in contact. Workshops can be more frequent but are shorter, while two parties who are a significant distance apart, usually plan their meetings and tend to spend between half a day to a full day to gain more from the session. Both approaches are viable and the following table illustrates the aspects of the geographical location of the FabLab.

The impact of the geographical location of the FabLab:

Positives	Negatives
SMEs that live in the immediate vicinity of the FabLab tend to be very happy with the personal exchange and neighbourhood of the FabLab.	2 or 3 hours away from the FabLab is too much for a regular cooperation.
If a FabLab is only a few minutes away, an SME is more likely to go there for their first time, as well as any subsequent visits.	The aspect of time is crucial. SMEs tend to be short on time, so any time that is spent by having to drive hours to the next FabLab is a negative.
Some SMEs only meet once a month with their FabLabs, so driving 50km is not an issue, because of the long meeting intervals. This provides flexibility in the cooperation, as FabLabs and SMEs can agree on meeting less often but for a half a day in contrast to meeting weekly but only for an hour, if they are not in the immediate vicinity of each other.	

Trust is one of the most important factors in a cooperation. Some aspects of trust are required for a positive cooperation, while others are only recommended and optional, yet still have a beneficial impact on the cooperation.

Importance of trust when cooperating with a FabLab

Required	Optional factors
A certain degree of trust is a prerequisite for a successful and intensive cooperation.	A facilitator can help with the initial trust. If both the FabLab and SME know the facilitator, both are more likely to trust each other initially.
Trust is important, because an SME enters a public environment with their ideas. However, the advantages outweigh the fears.	A cooperation agreement or contract can still help and take some initial fears away but is not always required.

Required	Optional factors
Informal trust is built through mutual interests and personal sympathy.	Not all FabLabs display the same amount of trust to outsiders. Some FabLabs are affiliated with large companies and organisations, which raises their trust in the eyes of some SMEs.
The FabLab must be open to all ideas from the SME and not pretend that their approach is the only solution.	The size and machinery of FabLabs also plays a factor. Larger FabLabs tend to seem more trustworthy.

2.3 FabLab Tips and Best Practices

The following subsection is dedicated to the FabLabs, highlighting tips, best practices and benefits of such a cooperation. In the following tables and graphics, it will be explained what can be learnt from SMEs, how to spend time in the FabLab and different possible types of cooperation.
Due to cooperating with numerous different SMEs, FabLabs are usually able to learn from each cooperation, as two projects are rarely alike. It is vital for FabLab to continue to develop their know-how in as many areas as possible, in order to offer their members and guests the best possible experience.

What can be learnt from SMEs?

Learnings	Benefits and Effects
FabLabs usually learn specific knowledge like plant growth or medal minting, rather than general workflows or project management-related information.	A FabLab does not have the time to specialise in a certain field like an SME, so SMEs can provide in-depth know-how to FabLabs.
FabLabs see themselves as service providers and hubs, that can never have access to all machines, but help to connect other people. SMEs can receive feedback at trade fairs and expos and pass it on to the FabLab, which then in turn learns from the SME.	When a FabLab works with an SME in a new field for the first time, the learning curve is the steepest and therefore most rewarding in terms of knowledge generation.

Learnings	Benefits and Effects
FabLabs can learn a lot from each SME, as almost all projects are different, and the learning process never stops for the FabLab. There are always new machines, materials, use cases, situations and issues.	FabLabs and SMEs who have been working for multiple years usually have hardly anything to learn from each other. They might be a good and productive team but aren't learning as much.

2.4 Different possibilities in a cooperation

In the image below, four different types of cooperation are depicted. This only represents four of the most common methods discovered throughout the research of this thesis. It does not equate to describing all different types of cooperation. The figure is designed to provide the reader a summary of the possibilities and potentially provide new ideas in this regard.

Figure 2: Cooperation Types in Pilot Projects

→ **The SME lead the process (from design to prototype), the Lab provides technical support.**

→ **Idea Design and technical workload is divided between SME and Lab and then results are compared and integrated.**

→ **The SME set the goal and provides knowldge and materials, the Lab mainly implements.**

→ **The SME only set goal and requirements, the Lab autonomusly provide results.**

3. The relation between Innovation and the pilot projects

The following section displays innovation and all entailing factors. Innovation is one of the most important features of a cooperation between SMEs and Labs and is the goal of many projects. Through the empirical research, numerous aspects regarding creating innovation and the driving forces behind innovation have been discovered.

Creating Innovation	Driving forces behind Innovation
Innovation is usually found without explicitly searching for it. Most of the time, it is not even required to have a huge innovation, as innovation is also subjective and in the eye of the beholder.	Research and development, as well as a good understanding of design.
Sometimes, even going through a digital workshop with a FabLab can be innovative for an SME, because they used to do all their work in 2D before, before going into 3D modelling.	Not being satisfied with the current products on the market and developing an own solution.
The idea might not be creative, but the process can be. Sometimes, setting the requirement should remain simple and easy to duplicate can be considered an innovation. Some SMEs want a good design through choice of materials and composition, rather than through high material costs.	Finding a time-saving solution, if anything changes, adaptions can quickly be made.
Designing the product in a way that is cost and time-efficient can often be more valuable than trying to find the next innovation.	Getting Feedback from expos and trade fairs can often be enough input to solve the next problem or find a new idea or solution.
Innovation does not always have to be something new. It can be a symbiosis between something old and new, for example an old, traditional wooden furniture with a new algorithm for producing it. It is a transformation from tradition to the digital future, so taking something that already exists and rethinking it.	Innovation should not be forced. If the project is not progressing, a fresh start should be considered. This is where working with other people is a factor, since a larger number of people tend to come up with more new ideas. A simple conversation can suffice here.

Creating Innovation	Driving forces behind Innovation
Working with traditional SMEs and introducing digital aspects into their company can also often lead to innovations.	Communication and exchange. Sometimes, both parties can get stuck in their own ideas, so when they show each other their progress and input, they can both get new ideas and complement each other.
There are at least two different types of innovation: product and process. Even if a product might not seem innovative, the process behind it might be.	Giving ideas and projects to universities can have positive effects, as Bachelor or Master's Theses can arise, pushing the idea to the next level.

3.1 Facilitator Tips and Best Practices

In this subsection, the role of the Facilitator is evaluated and presented. The Facilitator was part of all pilot projects, but is likely to be absent from such types of cooperation, if not explicitly hired or attained. Therefore, the Cooperation Model is intended to replace at least some of the responsibilities of the Facilitator.
In the following table, the benefits and effects of the Facilitator are presented.

How the facilitator helps the cooperation:

Positive Aspects	Effects
The facilitator can organise kick-off meetings, which can be extremely important to start the project off in the right direction, define requirements and help to get on the same page.	Help can be provided with project proposals, documents and financing, allowing the SME and FabLab to focus more on the project and less on paperwork.
They also can organise workshops with all SMEs within a FabLab to allow some exchange between the companies.	Workshops can be offered for other aspects like business models and crowdfunding, which can be beneficial for SMEs.
The facilitator serves as a motivator, who makes sure that the project is progressing with constant questions and occasional surveying.	The facilitator can offer an outside view on the project, which can sometimes help the FabLab and SME, who are very involved.

Positive Aspects	Effects
The milestone-oriented working and project planning suggested by a facilitator helps the project to stay on course.	However, it is important that the FabLab and SME are not obstructed by the facilitator with constant monitoring, which would paralyse the progress.
The facilitator also can connect an SME with a FabLab to initiate the cooperation.	The collection of data and processes which the facilitator does is also useful for all parties, as documentation is always a good idea.
The facilitator helps to build trust, in communication and in understanding the needs of the SME.	A facilitator can also offer tools like project management software to help in organising the project better.

3.2 Lab Network of Competencies

Labs possess a Network of Competencies, which can they contact if required. This usually occurs when the know-how of the Lab is limited in a certain field and a third party in the form of another Lab, organisation or individual expert is approached. This network is vital to Labs, as it allows them to cover numerous areas, which provides the members or cooperation partners with additional sources of knowledge. The following points further elaborate on the concept of (Fab)Labs and their Network of Competencies.

(FAB)LABS AS A NODE INSIDE A NETWORK OF COMPETENCIES:

- All FabLabs have partners with which they can cooperate and work with, if required.
- These partners can range from large businesses to private persons with expert knowledge in a certain field.
- This network can and should be utilised, if the situation arises.
- This network can be used to get external know-how if required.
- Some Labs see themselves as a service provider, meaning that they offer cost-effective access to digital production machines like 3D printers, laser cutters, electronic work stations and so on. Some Labs have many members (350) who all have different competencies, so the Lab acts as a hub where exchange takes place. Through contacts to universities, companies and other freelancers, missing know-how can almost always be provided.

TYPES OF POTENTIAL PARTNERS OF A (FAB)LAB

The following figure depicts some of the potential partners of a FabLab. Most possess at least one of each of the illustrated partners.

- → Online communities
- → Other Labs
- → SMEs or other businesses
- → Professional schools or universities
- → Private persons or freelancers
- → Enterprise/ economic associations

In the table below, a few facts and recommendations are provided, regarding how far certain know-how has to be for, in order for a FabLab to contact a third party or partner. For instance, some issues are too far away from the FabLabs area of expertise, which is why their network of partners is activated. In some scenarios, the problem can lie in a field in which the FabLab has wanted to expand their knowledge, upon which they dive deeper into this area of study and acquire the know-how.

How far know-how must be from the area of expertise, for FabLabs to reach out to other partners:

Fact	Recommendation
FabLabs usually have a very broad spectrum of knowledge. As soon as they realise that a project becomes very in-depth in a certain regard, a partner within the network can be consulted.	A good rule is: "If the know-how isn't there and can't be gained with a quick Google search, contact to a third party is established, as a FabLab can't invest countless hours into such issues.
FabLabs are good in many areas, but rarely absolute experts, so they rely on other partners for such in-depth know-how. In almost all projects, some type of third party or partner is involved.	FabLabs also have certain areas where they want to develop further. If the topic matches the request, a FabLab can be ready to invest the time, if not, a partner is immediately consulted.

INFLUENCES OF THIRD PARTIES OR PARTNERS

In graphic below, the influences of third parties are depicted. Generally, a third partner, which aids in the cooperation can be considered beneficial. However, there are certain aspects, which can harm the cooperation. In the figure below, the positive and negative aspects are juxtaposed.

Positive

- Consult and provide input in the planning phase, to avoid any major stumbling blocks.
- Can help in the research phase with their know-how and network.
- Can aid in the production and “making” phase.
- External partners often have much experience and a vision in their field, so they know what works.

Negative

- Can slow the communication and productivity down
- Might requires more communication

3.3 SME Network of Competencies

Similar to FabLabs, SMEs also can possess a Network of Competencies. If an SME is a start-up or relatively young, the network might be non-existent or insignificant. However, if an SME has been operating for a number of years, the tendency is that they possess such a network to at least some degree. In the table below, the characteristics of this are depicted, while also illustrating the benefits and effects of such partners.

3.4 SME Partners

Characteristics	Benefits & Effects
Almost all SMEs have some type of partner, with which they cooperate with.	Some partners can even provide ideas or new market strategies for SMEs, especially start-ups. It is then important to take one step at a time and planning the entry into new segments. It is usually not a wise idea to venture with a new product into a new market, one step at a time seems to be better suited.
Can range from suppliers for materials to distribution and sales partners.	These partners can and should be utilised in any cooperation, if it makes sense for all partners.
When a FabLab and SME work together, it is usually a cooperation. If two SMEs work together, it can often lead to a service provider and consumer relationship.	For example, if an SME works with a FabLab, the FabLab will be very transparent in their works and try to involve the SME and build up know-how. If an SME works with another SME or service provider, an order is given and the provider carries out the task or project, without the SME learning anything about the process. For this reason, FabLabs can be much more interesting in terms of cooperation partners, because they actively try to transfer know-how and are much more transparent in their workflows and processes.

HOW EXTERNAL PARTNERS ARE HELPING OR COOPERATING

In figure below, a range of different factors are displayed, how external partners benefit the cooperation. It depicts various positive aspects of possessing such partners and provides the reader with an idea on how to utilise third parties in their cooperation.

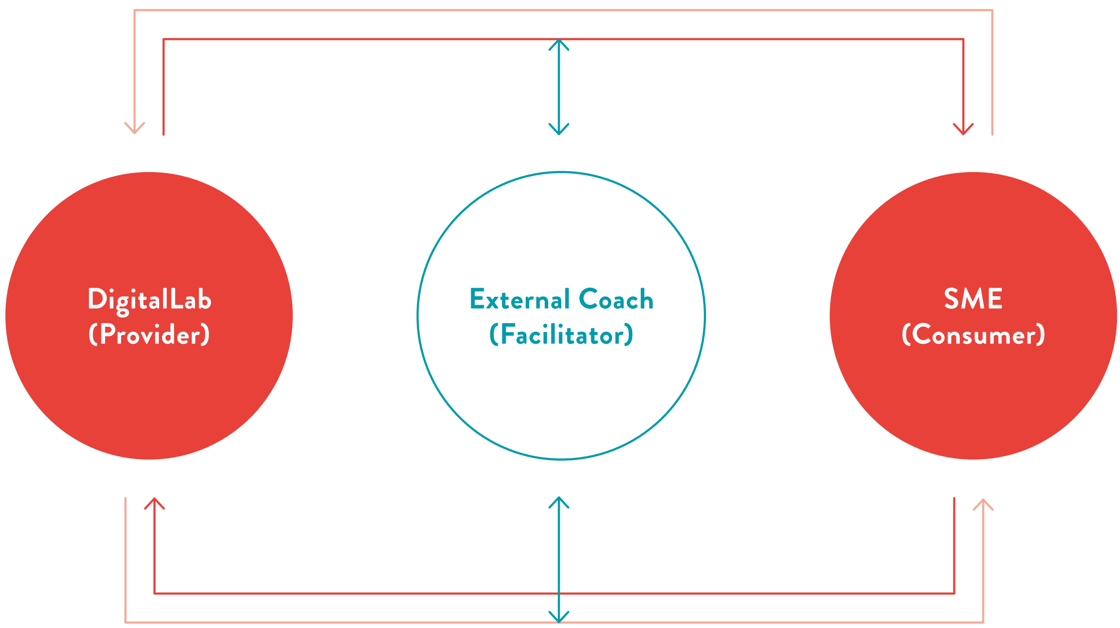
3.5 Aspects regarding the final Result

The final result is arguably one of the most important aspects of such a cooperation. The final result can vary and include a finished prototype, a production series or a workflow, amongst others. However, the following points provide information to the reader regarding necessary and suggested approaches when discussing the final result.

Required	Recommended
In order to gain a positive final result, milestones and a clear structure have to be defined. This includes the planning of the financial resources, as well as setting time windows for each milestone.	The final result of such a cooperation should be integrated into the company as soon as possible, if appropriate. Only then can further progress be made, when the product or prototype is used in the daily workings of a company.
It is important to concentrate on the important milestones of the project and not get side-tracked. This can be tempting, but the focus should always be on the most important features. Another feasible approach is to define tasks, work on these and then evaluate the results together and repeat.	Milestones can naturally change during a project and should be adjusted accordingly. If the project is approaching a dead-end, new approaches and milestones should be defined, rather than spending too much time trying to force a solution. Accept the trial & error process!
Communication is key. If something is not working, communicate with your partner, rather than being embarrassed or ashamed.	For programming projects, use repositories. They can visualise transparency and allow easy communication via tickets. Project management tools in general can be a good idea.

4. "CoMod" – A Cooperation Model for FabLabs & SME

This section explains how the different results from the interviews are aggregated into a model that can be used by other partners (other Labs or other SMEs) for future projects. Concerning the roles that are involved in the collaboration between a Lab and a SME there are three roles taken into account in our setting: the Lab that usually has the primary role of a provider of services, resources and knowledge, the SME in the primary role of a consumer of the provided resources and services. The third role is that of a facilitator, which is trying to support the collaboration as a more external partner, e.g. not being affiliated with the SME or the Lab. The relation between those three roles is depicted in the following figure.



1. The Lab provides resources and knowledge, might build new skills and gain domain knowledge.

2. The SME requests services and uses existing knowledge, provides problem statements and domain knowledge

3. The external coach facilitates the cooperation by observing the collaboration and providing external feedback.

4. The network of the Lab or SME might contribute with knowledge or resources that are not available internally

As can be seen there are other aspects are present there, which are not such obvious. One of them are the secondary roles of Labs and SMEs in which a Lab can be the receiver of **new knowledge** that comes from the SME. This is often the case for domain specific knowledge. In the same way the SME might in this situation work as a provider of knowledge, sometimes even of specific resources that are available in the company and can be used in the collaboration. A second aspect is the existing network of the Lab and sometimes of the SME that can be used to include in the collaboration in cases that the needed resources are not available in the lab. This usually happens for aspects/resources/knowledge that is not central to the activities of the Lab or that is rarely needed. This aspect is esp. relevant for the Labs which usually act as a knowledge hub throughout different technology fields that are connected to its core competences.

When the collaboration on the pilot projects was elaborated a bit more in detail, it turned out that there are three different dimensions of aspects in the collaboration. **Such categories could be summarized on three different levels:**

1

Obvious aspects that were related to the artefacts of the innovation project, such as prototype versions that emerged during the projects. It is useful, to mention that ere is an iterative nature of such prototypes in innovation projects. Mostly this relates to the interaction between the SME and the Lab. There was a no clear role model by whom the active role was taken, but more often it was on the Lab side.

2

The structure of the project was mentioned as important. The defined time and resource frame seemed to be important to generate results (no open research although open question). The role of the facilitator was more important here. It seemed that otherwise the cooperation would be more continuous but maybe also less focussed. Another interesting aspect that was mentioned: as a reflection on the projects it was recommended to do small but individual projects. Smaller projects provide a better more specific focus than larger projects – this might be a viable approach to handle complexity for small organisations like Labs and SME (this might be perceived in an intrinsic way).

3

The generated knowledge: Was visible on both sides, explicitly and often a specific result, although not as explicit as the prototype – here a relation to Knowledge Management could be identifies: it seems that the level of explicit knowledge (in the artefact(s)) and implicit knowledge (in the learning(s) is very present here. The awareness varies and became visible in the interviews only. The role of the facilitator important in this step.

Those levels will now be elaborated in more detail below.

The most obvious aspects are the level of the direct artefact based objectives of the collaboration in the pilot projects. In most cases these have been some sorts of **physical objects** (artefacts) such as **prototypes**. Most of them emerged in an iterative process of collaboration between the Lab and the SME. Starting from initial **sketches** and the **selection of materials prototypes**, sometimes partial ones, were developed produced and evaluated against the goals of the project. The collaboration was in all cases very much driven by the physical properties of the goals and the experiences that were made during the manufacturing steps. From a knowledge based perspective this was an aspect in which initial assumptions on the right **physical materials**, for example, where verified using the **practical experiences** that were gained during the interaction with the material. Upfront research on the possible solutions retrieved external knowledge but only the application with the specific target could validate the correctness of the decision. External knowledge was thus put into the context of the right application. **Not always the first choice developed as the optimal solution**; therefore, an iterative approach needed to be employed. Another aspect was the explorative nature that resulted from the more open research questions of all the pilot projects. In that sense the projects resembled true innovation projects as they intended to create new ideas (creating new knowledge) with the intention to put them into practise and create new products and services with them (applying the new knowledge).

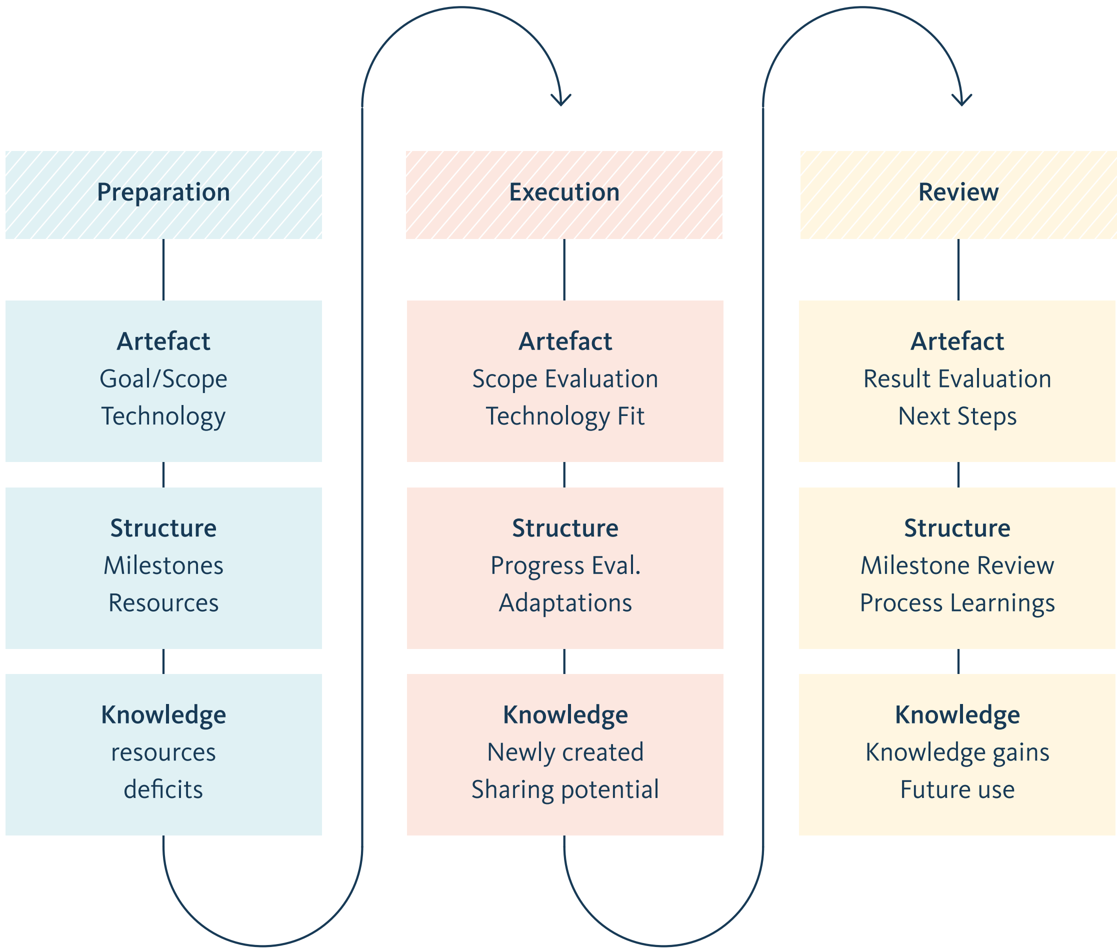
The second level of the cooperation addressed the **structural aspects** of the collaboration. Since the pilot project emerged from a more structured approach with the Innovation Challenges, the process of transforming the idea into a pilot project resulted in a more specific project structure that the usual cooperation between a Lab and a SME that are usually more ad-hoc and less focussed on a specific goal. The milestones in the project provided both a structure and an orientation during the execution of the project. They were reported as useful guidance to stick to the original set goals and not felt as restrictions. It is worthwhile to mention that the duration which limited to ca. 6 months contributed to scoping the project in the same way like the limited budget did. It seemed useful to have those restrictions in order to keep the scope of the project manageable for the small teams that worked on the project both on the side of the SME and on the side of the Lab. Given those limitations, upcoming new ideas where either postponed to a follow up project or prioritized according to the goal setting of the project. It was the external role of the facilitator that provided a **framework** for the projects in order to provide some form of similar structure as a basis for a comparison. But this was perceived as a positive aspect by the provider and consumer role, also since it was referred to by the facilitator regularly. The facilitator also took the role of being the **constant reminder** on the progress of the pilot projects, which helped to get the SME and the Lab at the project as everyday responsibilities in other tasks often distracted the involved persons, which is due to the limited personal resources in both the Lab and the SME (all the personnel that worked on the projects had other responsibilities and duties apart from the project). From the Knowledge Management perspective, it seemed important to provide a structural framework in which new knowledge could be created but in which this knowledge could also be evaluated against the benefits for the set targets of the project. This helped to ensure the use of the knowledge for the benefits of the created artefacts.

Finally, the third level in the collaboration is dedicated towards the **knowledge based aspects**. The focus here is on **knowledge creation** and **sharing** between the Lab and the SME. In the assessment before that project starts the following aspects should be taken into account: Which knowledge is necessary to employ the technologies that are supposed to be used? Usually the main source for this knowledge is the **Lab**, but it might also be the case that knowledge from the external network need to be included. Next, which knowledge about the application domain will be relevant for the execution of the project? Here, usually the SME is the main provider of relevant knowledge, but some aspects (such are legal or safety regulations) might be included from external partner, often from the network of the SME. While the project is running, it is important, that the aspects of **knowledge transfer** and **knowledge sharing** aspect are explicitly taken into account. Often the facilitator can help here to make those processes more aware to the SME and the lab as they might not be aware of the created knowledge that can be shared or externalized in a more explicit way. The types of knowledge involve both technology and domain specific knowledge types.
There was one situation, for example, in which a lab realized a new form of knowledge in one project (a computer generated form of dovetailing for connecting wooden boards) that also had an application potential in another project, exploiting the interesting design aspects of dovetail connections that were an implicit result from the other projects. The projects have been executed by different people from the Lab and it was only by a facilitated review of the facilitator the inter-project transfer of that knowledge was made aware to all participants. Therefore, **as more projects evolve** it becomes **more important to realize** and **document** the **generated knowledge** in order to make more implicit practices in a project visible for people that have not been involved in the project. Currently, this is mostly done through socialisation within the final debriefings after the project had been finished. This aspect is probably more relevant on the Lab side, as the number of projects is usually higher than on the side of the SME. Again the method of story-telling could be used to create awareness about the generated knowledge and create awareness about the generated knowledge and to provide a source of inspiration for future projects and activities.

It also proved to be useful for the SME and the Lab to investigate way for the exploitation of the generated knowledge as further steps after the project has finished. These questions, asked by the facilitator, helped to contemplate also about those outcomes of the project that are less visible and present than the physical artefacts. For the Lab-side it is also relevant to make those knowledge gains visible in their communication (e.g. their Website) as they become more solid and robust because they've been proven useful in several project. Currently, this is often not one in an explicit form but part of the tacit knowledge of the staff at the Lab (usually not too many key people, running the Lab).

In order to provide a more general model for the cooperation of Labs and SME the authors have derived a process based view along the different phases of the execution of the project that could serve as a guideline for future projects (see Figure 4 below). It reflects on root cause of challenges/benefits by reflecting them from the KM-perspective, focussing on Knowledge Sharing/Innovation/Dynamics – a view that was not the primary focus of the Lab/SME but considered very useful for improving future collaboration processes.

4.1 The Cooperation model between Labs and SMEs



During the innovation project the authors divide **between three phases** (**Preparation**, **Execution** and **Review**) and uses the **three different aspects** explained earlier (**Artefact**, **Structure** and **Knowledge**). The resulting matrix of 3x3 is being filled with some core activities that should be focussed on by the participants.

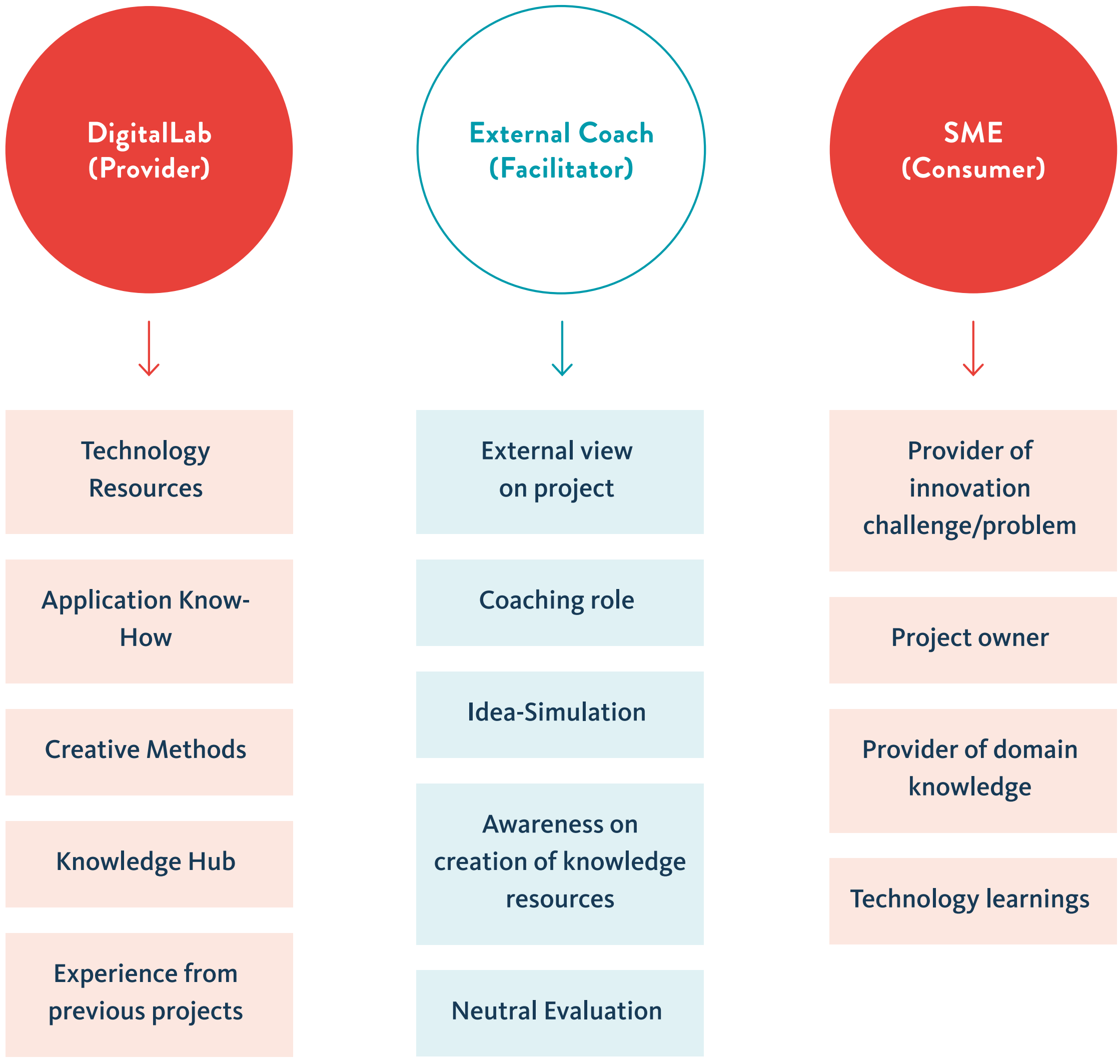
This view is complemented by a role based view that uses the three roles mentioned earlier (the **Lab**, the **SME** and the **external facilitator**, see Figure 5, below). In this Role Guideline of the CoMod-model the authors focus on the main activities that are central to the primary role of the involved partner.

The guideline focus on the most important activities of each role.
From the role of the Provider the focus is on the activities of providing the relevant technology and the application know-how for these technologies. Other relevant aspects that are as important are the application of **creative methods** and the inclusion of **experiences from previous projects**. Finally, the role as being a knowledge hub for additional competences from other organizations is an important activity, too.

The **facilitator** is the only role that is not directly and actively involved into the innovation project and can thus provide an **external view on the project**. This could be helpful for a coaching support on the project and for the stimulation of **new ideas** for the project. Another aspect is the possibility to create awareness on the creation of intangible results of the project. Finally, the role is able to provide a **more neutral** and **objective evaluation** of the result.

The consumer role is the primary provider of the **innovation challenge or problem**. It acts as the project owner and provides the relevant domain knowledge for the project. In this respect the role is the initiator of the activities in the project and the same beneficiary of the results – therefore, it is the driving force behind the project. At the same time the role also has the primary role of adopting the learnings of the technology for the application in other activities of the organisation. Within the different projects this less obvious aspect has been present in different intensity.

4.2 The Cooperation model between Labs and SMEs



From the view of Knowledge Management, the main aspects are probably in the area of **Knowledge Creation** and **Knowledge Transfer**. Knowledge creation is also a mutual process here and both partners (Lab and SME) did benefit in **every project** under investigation although this was not always clear to the actors at the beginning.

It was also stressed several times that the constant communication and collaboration was one of the keys for generating the insights that led to the results. Sometimes this was done in a continuous fashion, sometimes in a workshop style, in which more intensive phases of interaction interchanges with phases in which every partner worked on her own tasks.

5. Conclusion

This contribution reported on the results of a research on the current forms of co-operation between Digital Labs and SMEs and showed, that the results from several individual projects could be aggregated into an more general model that could help to structure and facilitate the cooperation between SMEs and Labs. The results of the initial feedback of the CoMod-model look promising and encourage the authors to validate the findings in future research. This contribution also shows that there is a strong relation between the typical cooperation between Labs and SMEs and the typical Knowledge Management activities, although those concepts are not frequently or explicitly used in the domain of Innovation Projects in Digital Labs.

6. Acknowledgements

The research presented in this contribution has been party supported by the European INTERREG V-A Italy-Austria research fund under grant no.: ITAT1008.

3

PILOT PROJECTS

PROJECT 1

LONG LAPS PHOTO

Challenge

Develop a prototype of an easy-to-use, low-cost device that makes Time-Lapse videos (strings of images stitched together into fast moving videos) that capture long manufacturing/construction processes for communication purposes.

Description of activities

At the beginning of their cooperation the SME and FabLab Castelfranco Veneto analysed a prototype previously developed by the SME which already met certain requisites but nonetheless needed technological improvement. After a number of meetings, the SME and the FabLab jointly identified a possible development of the existing prototype, in line with the SME's objectives regarding a new prototype. After an initial analysis and the definition of objectives and identification of the key technological characteristics, the FabLab began a series of fast electronic prototyping cycles, each of which ended with a debate with the SME in order to validate the development, agree on the materials used and decide on the next steps. This on-going, iterative process allowed the partners to purchase ad-hoc materials and work on the key aspects in order to finally develop a prototype that fully met the expectations.

Outcomes

The prototype developed takes high-resolution photos at pre-set intervals (with no restrictions in terms of time). The photos are then stored in a removable USB data storage device; in addition to being stored locally, they can also be stored in a cloud folder via a Wi-Fi connection. The user can choose any of these two alternative options according to specific requirements.
Programming of the photo shooting and forwarding functions is made through a user interface; a power ON/OFF button preserves the longevity of the electronic device.
The hardware materials make the prototype resistant and also give it an anonymous appearance that blends well with any context of use; this makes the device even more versatile, as it can also be used in contexts where photo shooting is not meant to be evident. As far as the electronic components are concerned, the shooting lenses, the cases and materials used were optimized in order to minimise energy consumption and reduce the bulk of the device; special attention was also paid to the choice of lenses, so as to guarantee high-quality images. With this prototype the SME is now in a position to conduct tests with potential customers.

Level of innovation reached

●●●○

Equipment

- Electronic bench
- Welding tools and bench

Service

- Rapid prototyping
- Design/Engineering

SME

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FABLAB

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PROJECT 2

INDUSTRY 4.0 APPLIED TO THE OIL SEPARATION INDUSTRY

Challenge

The SME is a manufacturer of oil separators. Its goal was to improve its main product by implementing the features specified in the Industry 4.0 Plan. The main challenge was to develop a prototype based on the existing product, equipped with a network-based communication and control system.

Description of activities

At the beginning of their cooperation SA Disoleatori and FabLab Castelfranco Veneto had two kick-off meetings that established the details of activities to be carried out by the FabLab's experts and the technical expert designated by the SME, in accordance with their skills and expertise. The major milestones were an analysis of existing components and the identification of new components to be added to the product, to be tested. The Fablab then trained the SME's technical staff to develop the management interfaces for the new product components. After a number of meetings and training sessions, the FabLab's experts managed to develop a prototype that would connect to and control the oil separator. After this milestone was reached, a meeting took place between the FabLab's and the SME's representative and technical expert for the validation of results and identification of the next areas for improvement and further cooperation.

Outcomes

Cooperation between the SME and the FabLab made it possible to develop a functional prototype that would allow the development of the SME's flagship product. The SME already sells oil separators, and is now in the position to implement new 4.0 functions. Interconnection of the equipment was made possible by developing a hardware system that allows remote communication and control.

To this end, the partners identified the technology to be used for monitoring and controlling the main functions, as well as industrial-type sensors to be used for monitoring purposes. Subsequently, the partners identified protocols for transmitting the collected data and selected the hardware to be used for transmitting and managing the data. Upon completion of these phases, a functional prototype was developed, together with a system for displaying the collected data and controlling the key functions remotely.

The SME is now able to offer the market a functional prototype that performs the major monitoring and control functions envisaged by the Industry 4.0 Plan.

Level of innovation reached

●●●●

Equipment

- Electronic bench
- Welding tools and bench

Service

- Rapid prototyping
- Design/Engineering

SME

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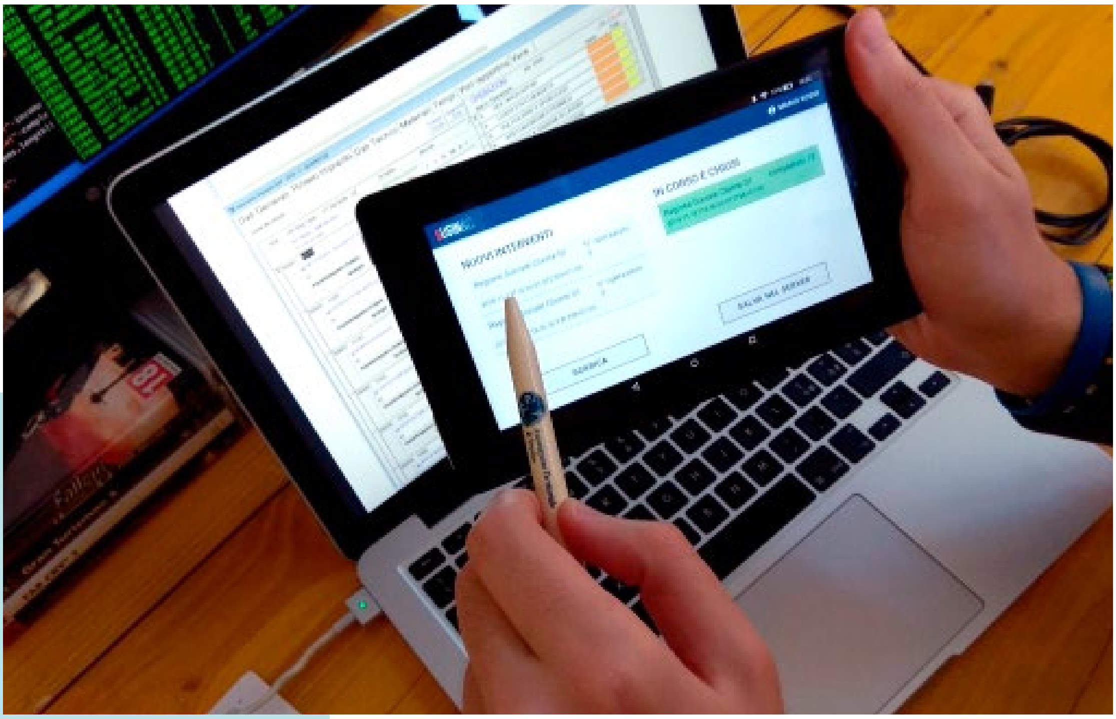
PROJECT 3

MOBILE TECHNICAL ASSISTANCE SERVICE

Challenge

The SME's goal was to analyse the voice recognition technology with a view to integrating it in its system for the management of electrical system maintenance operations: operators would enter their activities in real time and access any information relating to the electrical systems in 'hands-free' mode.



Description of activities

Cooperation between the FabLab and SME began with three meetings, which had the aim of identifying the characteristics of the ERP (Enterprise Resource Planning) system already used by the SME for managing maintenance operations. The partners focused on identifying a scalable voice recognition tool that could be integrated in the systems already being used by the SME. To guarantee alignment with the protocols used for data exchange, the ERP supplier participated in some of the meetings. The most suitable tools for interfacing with the ERP system and for creating an interactive web APP were subsequently identified, together with the phases of the process that required voice recognition (for which a specific vocabulary was defined). The FabLab then developed a web APP mockup, which was validated by the SME; once the prototype was created, a testing phase began with the SME and the ERP system supplier.

Outcomes

Thanks to fruitful cooperation, the three parties involved (the SME, FabLab and ERP supplier) were able to develop a web APP prototype that supports the work flow of operators performing installation or maintenance operations. The App, which is installed on a tablet strapped to the operator's forearm, uses voice commands for entering key information; the vocabulary for giving commands is simple and intuitive, and can be used while carrying out the installation or maintenance operation, leaving the App in listen mode. With this tool operators can also add documents, pictures and other types of information to the installation and/or maintenance report, and so generate a final, complete document. The App can communicate with the SME's ERP system thanks to the alignment of processes and exchange parameters between the two tools. It also allows registered users to accept and carry out installation and/or maintenance operations assigned to them. With this prototype the SME is now able to evaluate the feasibility of voice commands as well as the usability of a system for assigning installation and/or maintenance services to individual operators and for generating reports via a mobile App. Both scenarios represent and important strategic development for the SME.

Level of innovation reached

●●●●

Equipment

- Electronic bench
- Welding tools and bench

Service

- Rapid prototyping
- Design/Engineering

SME

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PROJECT 4

ROS-INDUSTRIAL

for the sustainability of assistive mechanical robotics

Challenge

The SME owns a welding station with an anthropomorphic arm for continuous wire welding, which is not equipped with suitable software; it wants to control the arm via the ROS - Robot Operating System.

Description of activities

When the project was presented, the partners made a rough assessment of compatibility between the robotic welding arm already owned by the SME and the ROS (Robot Operating System), a set of open-source tools for controlling the robotic equipment that fully met the specific requirements of the SME: cost-effectiveness, suitability for customized production based on customer's drawings, suitability for use with tools that were not of the latest generation. An in-depth analysis by the FabLab of the physical driver supplied with the welding arm revealed some compatibility issues, therefore the FabLab advised the SME to purchase a new driver which it had identified. This solution turned out not to be financially sustainable. The FabLab identified another operating system for controlling the welding arm: the RobotWorx operating system was not open-source but nonetheless met the SME's requirements in terms of cost-effectiveness. Once this choice was confirmed, the FabLab proceeded with the installation, setups and functional tests.

Outcomes

The most evident result of cooperation between the FabLab and the SME is the automation of a robotic welding system. What was less evident yet equally important, was the ability to successfully identify a different, economically sustainable strategy to tackle the issues that had emerged during the initial analysis (non-compatibility of the welding arm with the ROS operating system initially identified). For a small company like Carpenteria Pastro, purchasing a robotic arm and using it for production purposes play a strategic role, even if the equipment is not of the latest generation and requires software upgrades. Innovative development requires investments that should be sustainable and appropriate for the size of the company.
Right from the beginning, constructive dialogue between the FabLab and SME made it possible to examine all possible and viable solutions to the difficulties encountered; following a thorough evaluation, the SME, supported by the FabLab, opted to purchase a closed-source software (RobotWorx) which, although not providing the possibility of further developments and customizations, made it possible to use the tool immediately and in a user-friendly way, with the best results in terms of production.

Level of innovation reached

●●●○

Equipment

- Electronic bench
- Welding tools and bench

Service

- Rapid prototyping
- Technological scouting

SME

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PROJECT 5

SMART CLIMATE CONTROL

Challenge

Tecnoimpianti is planning to design and prototype a device that collects environmental data (temperature and humidity) of individual rooms and sends it to a central control unit that controls the heating/air conditioning systems, in order to enhance comfort while reducing energy consumption.

Description of activities

The first activity undertaken by the parties was an analysis of expectations and requirements related to the development of the prototype. In this first phase, the SME and the FabLab had two meetings at the FabLab's office in order to collect the necessary technical information for the choice of materials.
The FabLab identified the necessary tools for collecting and processing the environmental data and for developing an interactive WUI (Web User Interface); the SME purchased the materials for the prototype and test installation. The FabLab then developed an App mockup, which was submitted to the SME for acceptance before it was further developed. The SME and the FabLab developed a prototype for the test installation and environmental data monitoring tool, which were tested upon completion of the data collection system and App.

Outcomes

Throughout the process of prototype and test installation analysis and development the FabLab and SME shared their technical and technological expertise and managed to create a strong synergy. The SME's expertise in the field of hydraulic systems, which helped identify limitations and opportunities of the tools being used, was combined with the FabLab's technological know-how, which was fundamental for improving control and smart development of the equipment.
From the hardware point of view, the environmental monitoring prototype linked to the test installation uses open-source tools: this is an important aspect, as it helped speed up the development process and also contain costs, in addition to guaranteeing neutrality towards specific vendors and their licence and price policies.
From the software point of view, the platforms used for the App prototype (which makes it possible to define the required environmental parameters, monitor and display the data in real time and control the system remotely) can be integrated with different protocols and products and guarantees a high level of scalability of the project.
Both the hardware and software systems were installed on a test installation developed by the SME in cooperation with a vocational school for plant engineers.

Level of innovation reached

●●●●

Equipment

- Electronic bench
- Welding tools and bench

Service

- Rapid prototyping
- Design/Engineering

SME

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FABLAB

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31033 Castelfranco Veneto - IT
www.fablabcfv.org

PROJECT 6

URBAN MICROPHONE MONITOR

Challenge

Bluewind is active in the field of software and hardware development. The goal of the project was to develop a device that collects data on car traffic to be used for traffic monitoring purposes as well as to create statistics and provide a database for traffic optimization.

Description of activities

Bluewind is a company that deals with technological innovation in the domains of software and hardware development. Goal of cooperation with the FabLab was to identify technologies and materials needed for developing a prototype of the traffic monitoring device. The project involved the analysis and improvement of the microphones used, the housing for the electronic components and a machine learning algorithm to be developed by the SME for environmental data monitoring. The first two activities were carried out through the cooperation between the SME and FabLab. For the development of the machine learning algorithm, the Fablab launched a technological scouting and found the Joanneum Research Centre in Austria as the possible partner with acoustics expertise. This cooperation was not judged financially sustainable, therefore the Fablab selected a research centre of the University of Padua, Italy. With the support of the Italian research centre, the first phase of analysis and optimization of the algorithm was concluded.

Outcomes

The project presented by the SME is one of the phases of a wider project for the development of a traffic monitoring and optimization device. In this phase it was important to identify the type of microphones that would be used to collect the data, and the enclosure that would house the electronic core of the device. These goals became secondary once the need to optimize the machine learning algorithm previously developed by the SME was identified as the primary goal. Automatic learning is based on the construction of algorithms that can learn from a set of data and make predictions by creating inductively a model based on the samples collected. The algorithm is therefore the core element for operation of the device. With the support of the Fablab, 8 meetings took place between the SME and the Italian research centre, during which the algorithm was analysed and improved.
This experience has shown the SME the complexities and also the potentials of this project. Discussions with the research centres (including the Joanneum Research centre) showed the level of innovation of the device that had been designed but was still being developed.

Level of innovation reached

●●●○

Equipment

- Electronic bench
- Welding tools and bench

Service

- Rapid prototyping
- Design/Engineering

SME

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FABLAB

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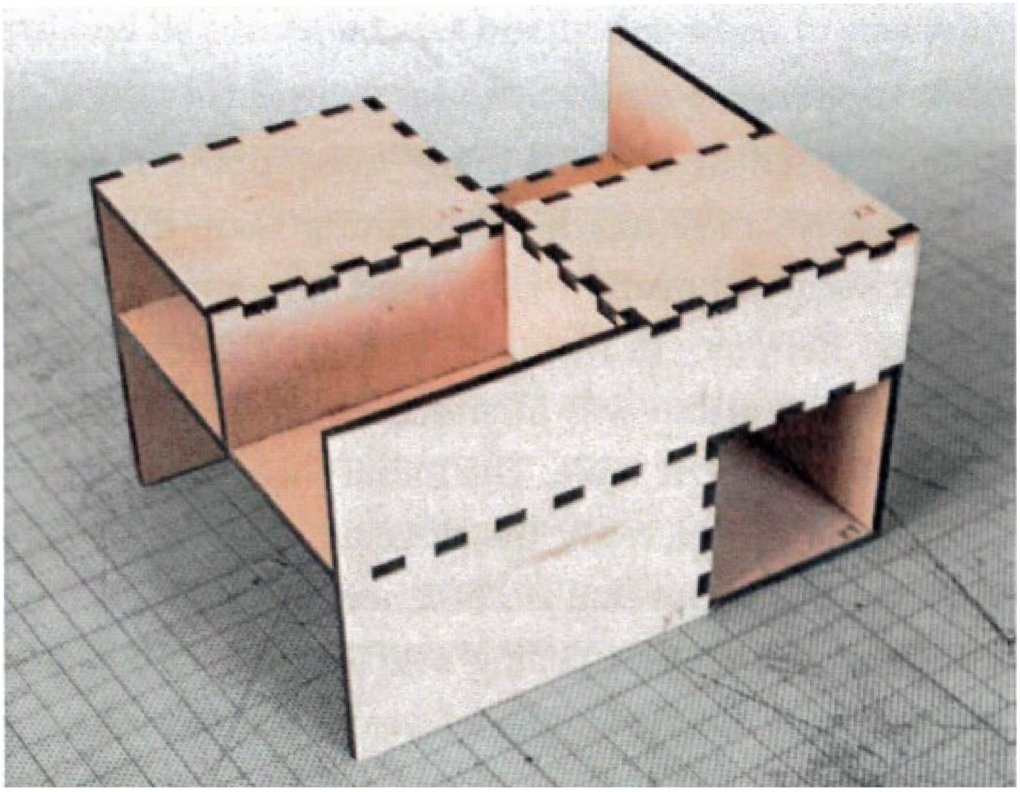
PROJECT 7

MUZIMÖ

A multifunctional piece of furniture that translates carpenters' compounds into modern times

Challenge

The SME Charly Walter Styleconception GmbH is operating in the field of creative projects and design. It is a company which features many overlapping interests with the FabLab that they are regularly cooperating with, the Spielraum Innsbruck. For their Innovation Challenge, the goal was to develop a multi-functional piece of furniture with five different pieces of functionality. This furniture was intended to serve as a table, chair, sofa, room decoration or bar table.



Description of activities

The initial focus was on the traditional wood compound, especially the dovetail, as a means to realise the first prototype. The dovetail is not a new invention, but can be translated into modern times, utilising new technologies. The SME had the concept and idea for a number of years, but lacked the know-how, time and technical possibilities to implement such a product or prototype, until cooperating and implementing it with the FabLab. Initially and during the Kick-off Meeting, the focus of this project was heavily surrounded by the wood connection and finding and implementing the best possible solution. This proved to be quite a simple aspect of the project, through the know-how and effort of the FabLab and SME. Soon, the focus shifted towards digitising the workflow of creating such furniture. With the usage of algorithm and scripting software, the process of building prototypes like these can be shaped much faster and more efficient. Previously, if some units of measure had to be changed in the digital design of the prototype, it would require changing a large number of values accordingly, resulting in considerable amounts of overhead. With the algorithm and scripts, changes such as altering the material thickness and tine length can now be made to the digital 3D model in a more convenient and time-efficient way.

Outcomes

To summarise, the focus of the Innovation Challenge shifted towards a different goal throughout the course, namely to developing a digital workflow for producing prototypes like these. In the future, changes in terms of size or any other details can be made rather time-efficiently with the use of the innovative digital workflow established in this Innovation Challenge. In the graphic below, a small-scale prototype of the MuZiMò can be seen.

SME

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PROJECT 8

SERVICE TUBE – LEDOVATION-MULTIMATTER

Diverse materials for professional planning

Challenge

Ledovation GmbH is a young start-up in the field of gastronomy, with a focus on the hotel industry. The SME works on digital solutions for better communication between guest and service staff, realising this with their innovative product. It blends the concept of light advertisement with service optimisation. By touching the product on the table, a restaurant or hotel guest can signal a wish and a member of the service staff is immediately alerted through their smartwatch or a tablet, in addition to seeing a different-coloured Light-emitting Diode (LED)s on the tables which require attention.

Description of activities

The company has been working with the FabLab from the beginning, building and testing the first prototypes together. However, certain features were still missing, which were to be addressed in this Innovation Challenge. The milestones were as followed:

- A robust charging station and increased efficiency through optimisation processes on the CNC milling machine. Additionally, material tests, including various adhesives and their properties are to be tested, in order to discover a new special plastic milling cutter to decrease the production time.
- The development of a table fixing/ anti-theft device to reach a new target group, such as bars. Includes the prototype design of a base plate or a closure, which can be flexibly mounted on different table backgrounds or materials, utilising either glue, clamps or screws. The requirements are: do not change the existing geometry of the product, manufacture with a company-specific production process and easy to use and handle.
- The development of an economical packaging design, as well as optimisation of the storage of the charging stations. Additionally, visualisation of the newly developed product components and project documentation.

Outcomes

To summarise, the goal of this Innovation Challenge was to improve upon an already existing prototype with the milestones as stated above. The SME and Spielraum Innsbruck managed to accomplish their goals in developing robust charging stations, finding an innovative solution to possible theft and designing the packaging for their shipping and distribution.

SME

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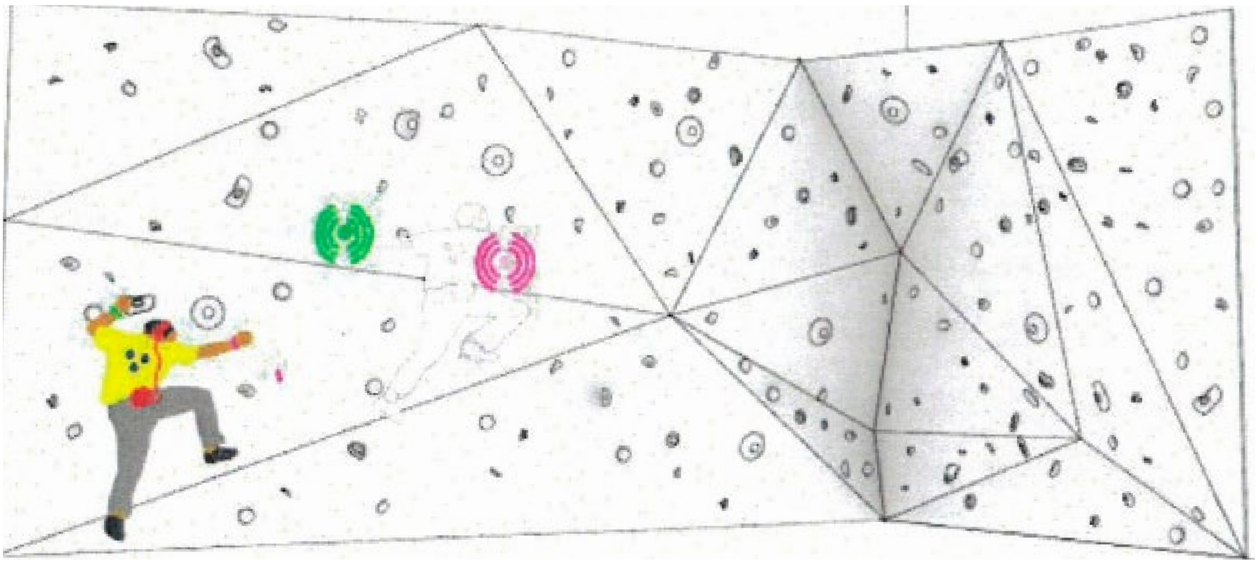
PROJECT 9

HOLD ON AND MOVE FURTHER

Challenge

Naturfreunde is not a traditional SME, but rather an association or club. However, for the sake of continuity and simpleness, it will be referred to as an SME from this point going forward. The SME is active in a number of domains such as alpine sports, nature activities, but in the context of this Innovation Challenge, the area of climbing and bouldering was the focal point. The goal of this project was to develop an acoustic and/or visual guidance system for bouldering.



Description of activities

Innovative holds and grips were to be designed and implemented, as well as functional guidance system, which supports the climber. The climber should receive information on the usage of the correct hold, the position of the next hold and tactile guidance to do so. The FabLab Spielraum Innsbruck managed to involve the Management Center Innsbruck (MCI), a university with a faculty in the fields of mechatronics and electronics. With this partner, a vast amount of know-how in these fields was added, as well as additional ideas for the first prototype. The SME had the expertise in the fields of climbing, the FabLab delivered know-how in prototyping and material aspects, while the university provided technical knowledge regarding the electronics.

Outcomes

This Innovation Challenge had to start over a number of times, as certain limitations became evident with initial technological ideas. Ultimately however, the correct technologies were discovered and implemented into a functional prototype, building the foundation for further work in this project.

SME

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PROJECT 10

DIGITAL EMBOSSING TOOLS FOR MEDALS AND MINTS

Challenge

Pichl Medaillen GmbH is a traditional SME and manufactures and mints trophies and medals. Being a family business and having worked in a similar fashion for a number of years, opportunities for innovation arose in the mind of the company. Therefore, the SME decided to enter a cooperation with the Werkstdtte Wattens and discover new ideas and concepts. The SME wanted to digitise some of their internal processes and replace certain areas of occupation with digital manufacturing technologies.

Description of activities

The goals and milestones were strongly research-based in the beginning, involving finding the best solutions to 3D scanning the objects, as well as possibly discovering a viable approach to printing or casting certain medals. Another aspect was the digitalisation of certain medal stencils. The result was that the scans were feasible for some models, while lacking precision and details in others. In the final section of this cooperation, the FabLab and SME used the CNC milling machine to create some models and comparing them to the original designs.

Outcomes

The results were satisfactory and the process and know-how was implemented into the daily operations of the company. In summary, the cooperation was successful, as both sides gained and transferred valuable knowledge, while the SME could dis-cover innovative workflows and digitise their operations. In the image a 3D scan of a medal can be seen.

SME

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FABLAB

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PROJECT 11

HOTEL LAUTSPRECHER

Challenge

Strofeld Manufaktur is another Tyrolean Start-up, which has previously worked with the Spielraum Innsbruck, but never to such an extent. They are focused in the area of loudspeakers and their first series of products involved suitcases. After a discussion with a hotel owner, the SME discovered the opportunity to enter the market of hotel loudspeakers.

Description of activities

However, they soon discovered that the technical implementation would require external know-how, which resulted in this cooperation. The aim of the project was to develop a functional prototype, with a high-quality sound and attractive appearance. The FabLab provided input in terms of design, material knowledge and prototyping, while the SME delivered the technical expertise in the field of music and loudspeakers.

Outcomes

Together, a final prototype was designed and implemented, resulting in a successful cooperation and project. Important factors were an attractive and meaningful exterior, while accommodating all technical parts in the relatively small body of around 15cm x 15cm x 30cm. Additionally, the production process was to be optimised, to allow a simple and fast manufacturing of future loudspeakers. In the graphic below, the final prototype can be seen.

SME

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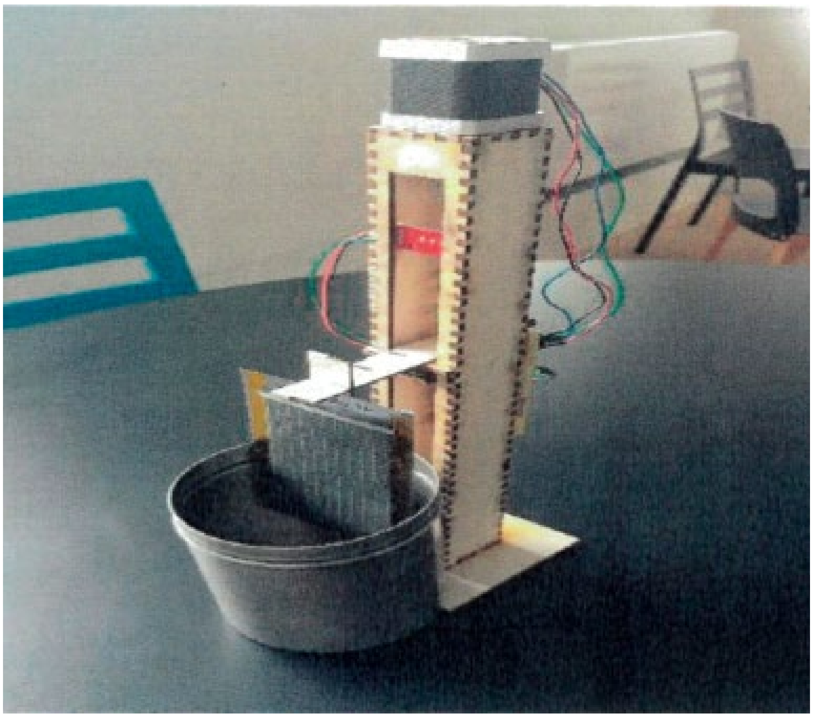
PROJECT 12

PRINTCONPV

gedruckte Anschlüsse für biegsame Photovoltaikmodule

Challenge

Sunplugged GmbH is an SME which has been cooperating with the staff from the Werkstätte Wattens for roughly ten years. The company specialises in photovoltaics and is currently working on a flexible module. Standard photovoltaic modules are based on junction boxes, cables and conventional connectors, which become expensive when attempting to leave the mass production. The SME requires individually adaptable solutions for contacting and encapsulating of its monolithically interconnected thin-film solar cells.



Description of activities

The SME has been operating in this field for a number of years and can utilise the machinery and additional know-how from the FabLab to develop their prototype. In the Kick-off Meeting, three major milestones were established. These were:

- A 3D printed housing for functional prototypes with a cable connection, featuring no weather resistance.
- A 3D printed junction box with a plug system and a two-part assembly, including weather resistance.
- A demo series of junction boxes.

Outcomes

The cooperation resulted in the first milestones being reached, with the demo series as a goal set in the foreseeable future. In first phase, the prototype was designed and implemented, with a successful contacting as a result. Secondly, manufacturing processes were digitised and transferred from manual into automatic workflows. Finally, the SME and Werkstätte Wattens built a Dip-Coater, which can submerge the solar modules into the liquid, laminating or coating the prototype in one of the final steps.

SME

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FABLAB

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werkstaette-wattens.at/de

PROJECT 13

VR GLOVE TESTING

Challenge

Innerspace GmbH is an SME active in the domain of VR training. They are focused on providing other companies with VR applications, mirroring training environments for new staff or tasks. Therefore, the usability of these applications is one of the most important aspects of their product.

Description of activities

VR applications are usually operated by the user with controllers, however special VR gloves provide an interesting alternative, as they perhaps could help the user to immerse themselves even further into the training environment. This hypothesis lead to the cooperation between Innerspace and the DigitalLab at the FH Kufstein. The goal of the SME was to develop a small VR room with the gloves as a testing environment, as well as performing usability tests with contrasting the traditional controllers to the VR gloves. The task of the SME was to create requirements, similar to those in their daily operations, and evaluating the usability test results.

Outcomes

If the VR gloves did provide a better usability and immersion for the user, the SME could consider adopting them into their products and services. In the image, a user can be seen, working with the ManusVR gloves and the VR headset, seeing his own arms and fingers instead of a controller within the VR application.

SME

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FABLAB

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fh-kufstein.ac.at

PROJECT 14

#PEPPERMILL

Challenge

Company Fill Arte aims at expanding its range of products by developing high-quality, wooden kitchen utensils. In particular, it plans to develop prototypes for pepper mills using 3D printing.

Description of activities

In collaboration with Fill Arte, the desired aspect of a pepper mill was determined, for which Fill Arte can use its existing skills in combination with new production techniques. In the course of the workshop, Fill Arte stated its desire to focus on amateur cooks (private customers), and several prototypes were developed accordingly during the creative workshop. The prototypes were then refined so that they could become part of a future series. Finally, three very different prototypes were chosen and produced using 3D printing in the NOI makerspace. These models were produced by Fill Arte in its own woodworking shop and presented to several potential customers. A business model for the company was developed and the next steps for the distribution of the product were defined.

Outcomes

Thanks to the project, the company could learn rapid prototyping skills. As part of the project, the company developed a pepper mill, which was designed in 3D and produced using 3D printing. The skills acquired in the field of 3D printing will be useful also for future projects. In addition, the collaboration between the company and the makerspace of NOI Techpark has been strengthened. By the end of the project, the company succeeded in developing a presentable product and intends to start marketing it in autumn/winter 2019.

Level of innovation reached

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Equipment

- CNC milling
- 3D printing
- Lathe

Service

- Rapid Prototyping Support
- Design Issues
- Prototyping

SME

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FABLAB

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makerspace.noi.bz.it

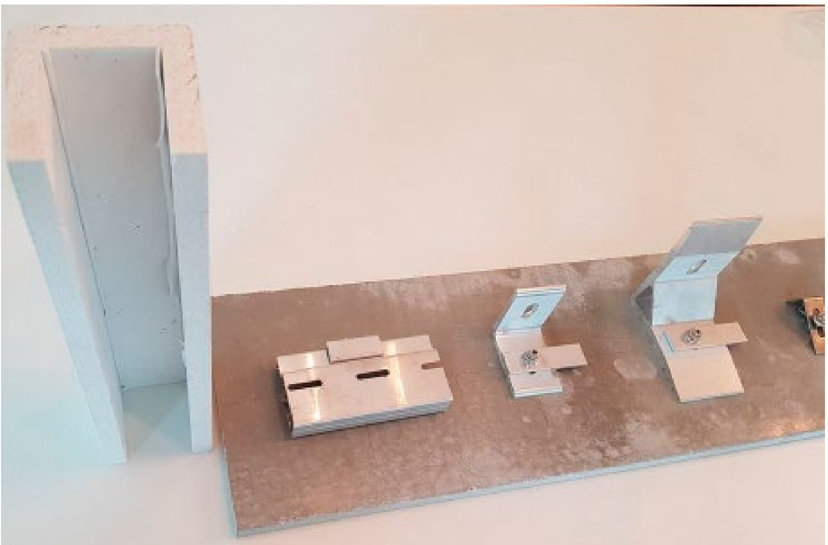
PROJECT 15

FINS FIXING

fastening system for stamped facade elements (profiles)

Challenge

The challenge lied in designing a robust solution for fastening stamped elements (profiles), both vertical and horizontal. This solution will serve as a future standard. Ideally, the substructure should remain invisible. It should be pre-assembled in the factory, and individual elements should be easy to replace.



Description of activities

During a first operational meeting Rieder Smart Elements s.r.l., Do!Lab Saalfelden and Salzburg Research identified the most important requisites of a concealed/invisible system for fastening C-section stamped facade elements (ribs, profiles, fins). Ribs of this type are often used as louvres on facades, to provide shade from the sun and visual privacy in case of large glass facades, and also to create innovative decorative solutions.
Different fastening systems were designed and tested during the project. Following in-depth discussions, some of the solutions were dismissed be-

cause they turned out to be too visible and also too difficult to implement. A workshop held in December 2018 focused on a thorough analysis of requirements and possible solutions. The two best solutions for the construction of a first prototype were selected. Both solutions use a profile with hooks. Construction of the metal prototype was preceded by a 3D simulation and 3D model.
The prototype built by the Lab showed that these relatively sophisticated fasteners hold the element rather firmly. The prototype can be further improved by extending the length of the fasteners, or by using fasteners made of a different, more resistant material.

Outcomes

Thanks to cooperation with Do!Lab Saalfelden, SME Rieder was able to come closer to its goal of developing an innovative, functional, easy-to-use, concealed fastening system. According to the SME, cooperation among the parties involved would have been a simple, fast and cost-effective way to achieve good results. All the necessary modifications could have been implemented as the project evolved, saving on costs.
The fact that the SME will be able in the future to offer profiles to be used with the new sub-structure is an important added value and paves the way for many new opportunities. There is currently considerable demand for this type of fastening system. The next step will consist in checking the static load-bearing capacity in order to guarantee that the elements do not fail when exposed to external stress (snow, own weight, wind, etc.). These assessments will be made by an engineering firm. Then, Rieder's manufacturing and R&D departments will work on a new series of prototypes. These departments control and manage technical and static tests during the testing phase. Load tests, oscillating movement tests and resistance tests of fire-prevention systems are just some of the tests carried out in cooperation with independent laboratories.

Level of innovation reached

●○○○

Equipment

- CNC milling machine
- 3D printing

Service

- Design Issues
- Technical exploration
- Prototyping

SME

Rieder Smart Elements GmbH
rieder.cc

FABLAB

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5760 Saalfelden am Steinernen Meer - AT
dolab.at

PROJECT 16

HEATED FITNESS ROLLER

Challenge

The goal of the project was to develop an innovative heated fitness roller which uses heat therapy to relax the muscles. The challenge lied in miniaturizing an adjustable heating system and finding the most suitable material which could be inserted seamlessly into a fitness roller.

Description of activities

During the first workshop SWAIG, Happylab and Salzburg Research established the requisites of a heated fitness roller. Then the parties worked on a number of issues concerning the fitness roller (medical product, heaters, accumulator performance, heat control, finishes, cover, and hygienic aspects). As the project evolved, information was collected and solutions to individual issues were identified. During the following phases, different materials were tested and used to make different prototypes. The parties also tested a number of heating systems and seamless covers for the fitness roller. The first SWAIG prototypes were distributed to some target users (e.g. athletes) as well as to physiotherapy clinics. The feedback received resulted in the improvement of the heated fitness roller and in the development of a prototype ready for production. Other workshops on secondary issues - such as business models, crowdfunding, etc. - proved useful for a young SME like SWAIG, helping it deal with the issues of funding or the distribution of the new product, and also helped it plan the next phases.

Outcomes

The result is a rigid foam roller, approx. 30x15 cm, which combines the advantages of a traditional fitness roller with the benefits of massage and heat therapy. This device can be used for the simple treatment of muscle contractures, to relieve pain and inflammatory diseases, prevent injuries and also enhance warm-up exercises and improve regeneration after sports activities. The final prototype of the heated fitness roller is hollow. The cavity houses the electronic controls for the heater. The entire surface of the fitness roller is heated using the same technology used in the automotive industry to heat car seats. The adjustable heating system creates a pleasant feeling of warmth. The power supply socket is located on the side cap of the roller. To prevent contact points on the roller, an industrial tube made of elastic rubber was used. The tube is washable, hygienically safe and moisture resistant. In the future, SWAIG would like to improve the fitness roller and equip it with wireless controls. The aim is to receive the CE certification and have the Lab start production of a small batch (100 pieces) by the end of 2019. Thanks to the expertise of the parties involved, the Labs4SMEs project gave a young entrepreneur the opportunity to rapidly implement his project in cooperation with the Happylab Salzburg and Salzburg Research Labs. The intense exchange of know-how between the SME and Happylab Salzburg, especially with reference to the choice of materials, proved to be extremely useful. SWAIG has developed a tried-and-tested product that can be used by athletes and active people, but also by professional physiotherapists.

Level of innovation reached

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Equipment

- CNC milling machine
- Laser cutting (CO_2)
- Electrotechnics/ electronics

Service

- Technical exploration
- Design Issues
- Prototyping

SME

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FABLAB

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PROJECT 17

VEGAN LEATHER SMART DOG HARNESS

Challenge

The challenge lied in designing and manufacturing a dog harness, adaptable to the size of the dog, made of vegan leather and equipped with built-in sensors to monitor the dog's wellbeing and training activities. The harness also had to be subjected to testing (design/functional prototype).

Description of activities

At the beginning of the project, requirements and materials to be used were identified (design, weight, tear resistance, washability, use of vegan leather on dogs, etc.), with the final aim of producing a functional prototype. Different vegan leather dog harnesses capable of evenly distributing the pulling force around the dog's chest and shoulders were tested.
BUTTERBROT, Happylab Salzburg and Salzburg Research had a number of meetings focussing on a motion sensor and its ideal position on the harness, in direct contact with the dog's body. The final choice, which was technically feasible and suitable for the harness, was a 65x75mm add-on pouch produced by the Lab. To protect the sensor from the weather, humidity, changes in temperature, pressure and strain, the first prototype of the sensor bag was developed with the Fusion 360 CAD software and then produced with a 3D printer.
Then, a sensor was used to test the digital components that captured motion data on a 'test dog'. In addition, a pedometer was added, in order to record the movements of the dog, encourage physical activity and improve acceptance of the prototype. As a consequence, dog owners should feel more motivated to take their dogs for a walk, thus increasing the amount of physical activity dogs get.

Outcomes

Cooperation and interaction among the parties involved at all times proved to be stimulating, interesting and inspiring, as they made construction of a functional prototype possible. Various meetings and workshops also contributed to a better understanding of problems and weaknesses, so that solutions could be identified.
The add-on pouch in the chest area of the harness adds smart functions to the harness, delivering added value to the dog owner. BUTTERBROT is currently moving production of its existing products and of the vegan leather harness abroad, so for the time being the idea of the integrated sensor is on hold. However, the add-on pouch is a novelty that will be integrated into production of the harness, allowing for possible adaptations in the future.

Level of innovation reached

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Equipment

- 3D printing
- Laser cutting (CO_2)
- Electrotechnics/electronics

Service

- Design Issues
- Technical exploration
- Prototyping

SME

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FABLAB

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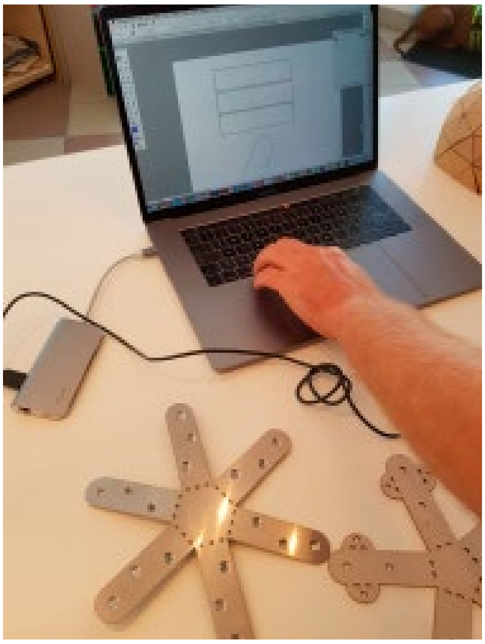
happylab.at

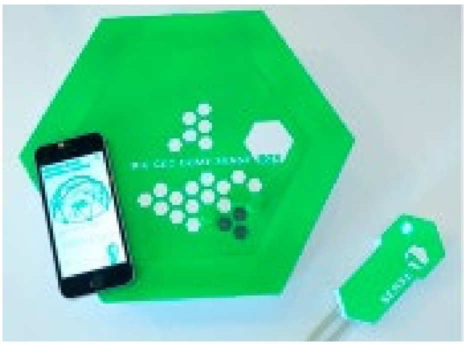
PROJECT 18

SMART BIOGEODOME

Challenge

The goal of the project was to develop a new concept or 'box assembly' for a customized, easy-to-build greenhouse adaptable to different conditions (foundation, inclination, height, weather conditions). In addition, the project also aimed at developing a low-cost, smart remote system for observing and monitoring the plants that grow inside the greenhouse.





Description of activities

At the beginning of the project, the planned location and requirements for the new greenhouse were determined in accordance with the geodesic dome principle. Based on this principle, the parties jointly designed, tested and selected a first layout of the Dome, its substrate, position on a steep slope and connecting elements (dome connectors). The first prototypes of the dome connectors were in metal, cut with a laser cutting machine and milled. These

elements were custom developed so they could be connected to the structural elements of the Dome.
In autumn 2018 the greenhouse was built at the Vogelsang mountain farm in the shape of a spherical truss. In total, construction of the prototype and of the Smart BioGeoDome required 65 uprights and 26 connectors, which made it possible to save 260 bolts.
The winter season served as a test period to check stability of the Dome, which was exposed to numerous storms and high amounts of snowfall. During this period, different digital control and remote monitoring systems were developed and tested, together with a sensor box for the optimal management of temperature, ventilation, irrigation and lighting.

Outcomes

Successful cooperation between the Vogelsang mountain farm, located in Leogang and owned by Ms. Petra Buhl, and the Do!Lab Saalfelden open laboratory resulted in the implementation of this innovative project. The solution - the new Smart BioGeoDome box - was jointly developed by the Do!Lab laboratory and the Vogelsang mountain farm, and both can now use the outcomes of the project. The Lab manages the technical aspects (dome connectors), and the SME uses the greenhouse to expand its range of services. With the Smart BioGeoDome, food products can be grown in a sustainable way throughout the year without requiring the physical presence of anybody. This is thanks to specific technical solutions and monitoring sensors. Both partners are very happy of the prototype and results of the functional tests carried out on the dome connectors, as all requirements have been met. The IT evolution of the remote monitoring system (Sensor Box) was supported by the local Makerspaces network.
In the future the Dome should available in the form of a self-assembly box, so that it can be built even by hobbyists using very simple tools. In addition, this venture can also be crowdfunded.

Level of innovation reached

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Equipment

- 3D printing
- Laser cutting (CO_2)
- Electrotechnics/ electronics

Service

- Design Issues
- Technical exploration
- Prototyping

SME

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FABLAB

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PROJECT 19

3D AVATAR

Challenge

To develop an acquisition booth where to quickly create a file for generating a 3D avatar in real time: a modern mini lab that can produce a miniature figure very quickly using easily movable equipment.

Description of activities

The project aimed at developing a scanning system for the acquisition of printable 3D models of human faces to make miniature figures. This project represents the evolution of traditional 2D photography. Starting from existing technologies, mainly 3D scanning and digital photogrammetry for generating digital 2D images, the parties involved examined the competitive environment to identify products already on the market as a starting point for a feasibility study. Taking into account the specific skills of the SME in the field of photography, and also considering the costs required for setting up an acquisition booth, the parties decided to opt for photogrammetry. Existing body scanning technologies and products already on the market were analysed and compared in order to identify the minimum requisites from the hardware and software points of view and estimate costs.

Outcomes

Cooperation focused on designing a system for acquiring and processing images in order to obtain a suitable format for 3D printing. The initial idea of scanning people using old photo booths was immediately considered very interesting but also very ambitious because it requires the setting up of a computer network and a very complex, expensive image processing system. The photogrammetry technology requires long image processing times as it generates a preview in 15 or 20 minutes at least. At the moment this processing time is considered too long for occasional users or passers-by. The final, sustainable idea, which is innovative and feasible, is the creation of a network of operators, for example photo studios using the same photogrammetry system (each one its own) but common resources (for instance the server) for image processing, post-processing and final printing of the miniature figures. The system uses a relative small number of cameras (at least 4 or 6) compared to other system that require up to 20 times as many. Therefore it is relatively low-cost.

Level of innovation reached

●○○○

Equipment

- 3D scanner
- 3D printer

Service

- Technological scouting
- Prototyping
- Design/Engineering

SME

Agenzia Fotografica Mauro di Massimo Semeraro
Via del Molino
a Vento, 4/c
34137 Triest - IT
fotomauro.com

FABLAB

Fablab Innova Fvg
Piazza Italia, 19
35085 Maniago - IT
fablabinnovafvg.it

PROJECT 20

MEDICAL CAD 3D

3D modelling and fabrication for diagnosis purposes in medicine and surgery and for the development of custom-made, patient-specific orthopaedic aids

Challenge

This project aimed at developing orthopaedic aids tailored to the specific physical characteristics and conditions of individual patients. The orthopaedic aids are designed from CT or X-ray images and are printed using 3D technology.

Description of activities

Cooperation occurred in two phases: during the first phase the FabLab trained the SME owner in the use of 2D and 3D modelling software (Artcam and Powershape) necessary for modelling the orthopaedic aids. The SME owner received 40-hour software training and learned the necessary skills for designing the orthopaedic aids starting from CT and X-ray images. The second phase focused on printing various, more or less rigid materials using different technologies (FDM, Polyjet). The technological scenario was analysed in order to identify the different materials that could be used, which were later tested to determine the ideal printing parameters. Of these materials, Polycaprolactone (PCL) has thermoplastic characteristics at low temperature and is suitable for contact with the skin. Polycaprolactone can be used to print in 3D orthopaedic aids that are rigid at ambient temperature but become mouldable already at less than 60°C.

Outcomes

At the end of the project, a prototype was built that has satisfactory characteristics, also from the point of view of the time required for production. Using Polycaprolactone (PCL) it is possible to print in 3D a number of standard-shaped orthopaedic aids that can be immersed in hot water and adapted to the specific anatomy of each patient; once they cool down, they become rigid again. If this characteristic was not present, the orthopaedic aid would need several hours to be moulded into the right shape. However, in many cases patients may need an orthopaedic aid very quickly (for example in the case of a fracture, whereby orthopaedic aids could be used instead of plasters). With this project the SME owner learned to use the 2D and 3D modelling software selected among those applications that more than others can generate complex surfaces and textures. A further advantage lies in the specific ability by the SME owner to shape the orthopaedic aids starting from CT or X-ray images.

Level of innovation reached

●●○○

Equipment

- 3D printer

Service

- Technological scouting
- Design/Engineering
- Training

SME

3D Printer Surgery di Carlo Campana
Via Vittorio de Sica 2/2
34079 Staranzano - IT
3dprintersurgery.com

FABLAB

Fablab Innova Fvg
Piazza Italia, 19
35085 Maniago - IT
fablabinnovafvg.it

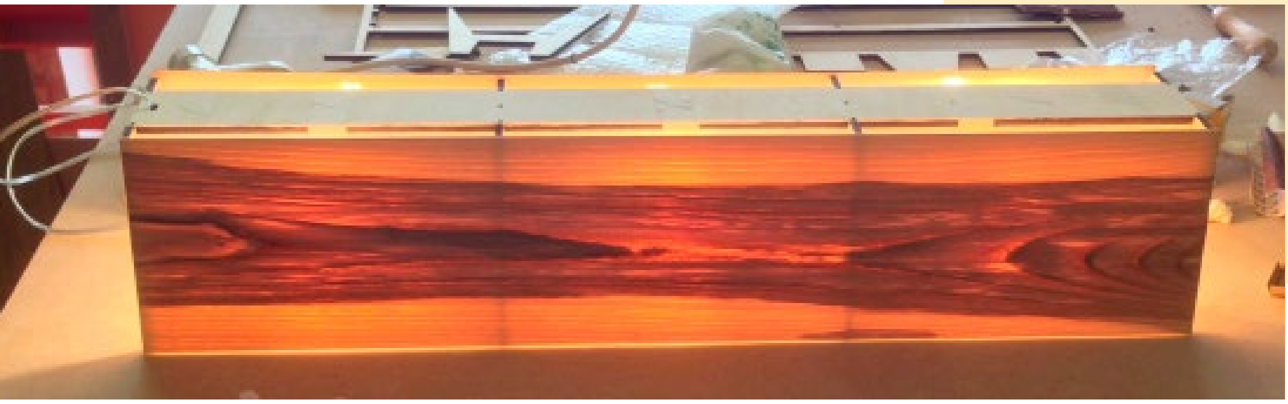
PROJECT 21

TRASPARENZE

Using innovative techniques to create products that combine different materials

Challenge

Using laser cutting and CNC milling technologies the project aimed at developing a lamp prototype that consists of thin sheets of wood and other materials (such as plexiglass) that add sturdiness while keeping the lamp transparent.



Description of activities

The project involved two distinct but interconnected phases. At the beginning the FabLab trained the SME owner on parametric 3D modelling for digital fabrication using FreeCAD. After setting up the project correctly from a parametric point of view, FabLab experts and the SME owner rapidly tested different prototyping and micro digital production methods, leading to a final drafting of the project and prototype. The second part of the project was implemented at FabLab Castelfranco Veneto, where consultancy aimed at enabling the use of laser cutting and CNC milling was provided. At the end of the process the SME produced the parts designed with FreeCAD using laser cutting and CNC milling technologies, testing different materials and techniques.

Outcomes

The tangible outcome of the project is the prototype of a lamp having the characteristics required from the beginning. Thanks to this experience the SME acquired skills that can be used with future projects not necessarily in the lighting field. The SME owner was introduced to digital fabrication and reached a certain level of confidence in digitising production of artisan creations and using laser cutting and CNC milling for production purposes. Indeed, this is one of the innovative aspects of the project: a transition from totally artisan production, with long manufacturing times and a very low repeatability rate, to digital design and fabrication, with drastically shorter times and a very high repeatability rate.

Level of innovation reached

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Equipment

- Milling cutter
- Laser cutting
- Woodworking tools

Service

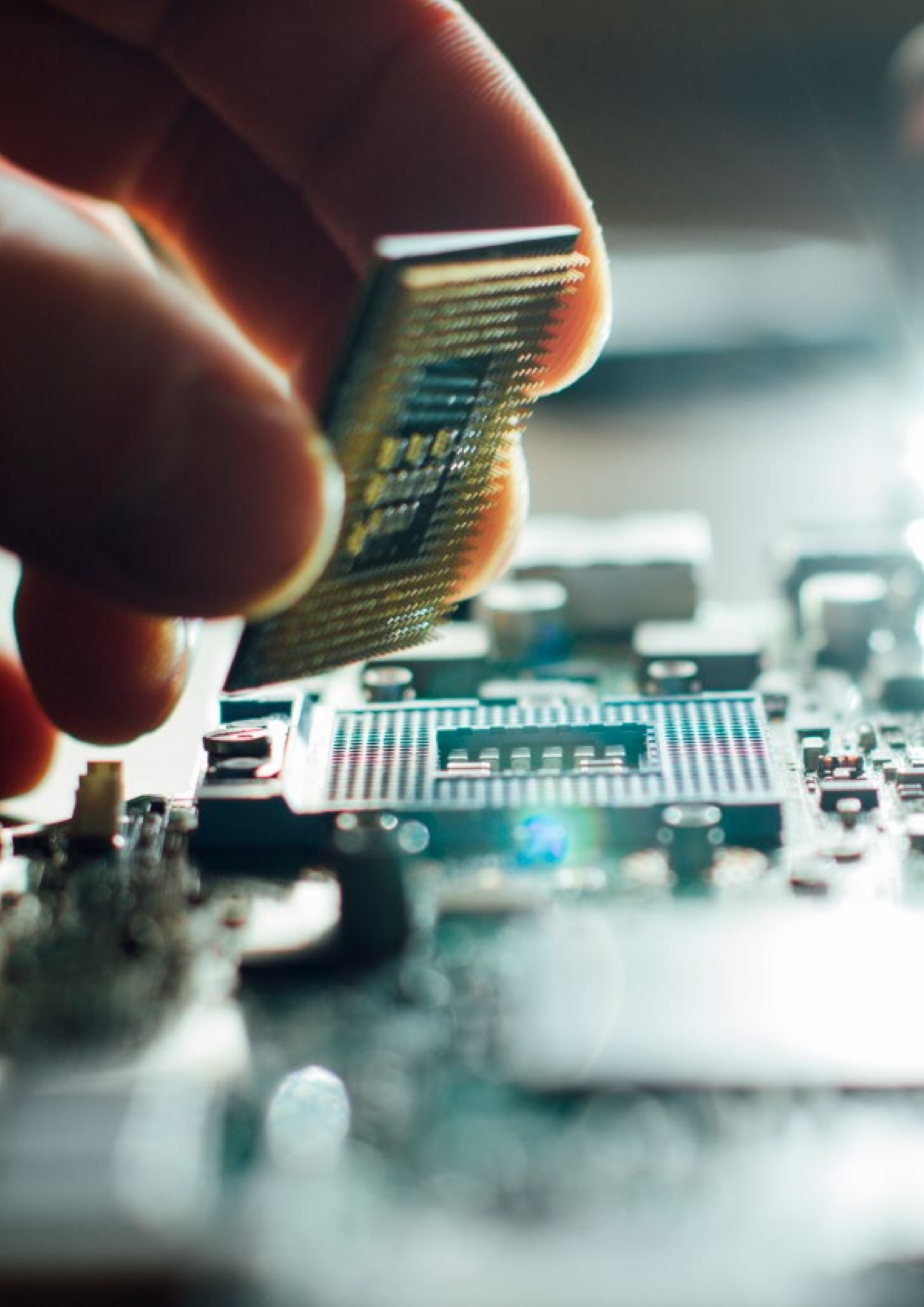
- Technological scouting
- Design/Engineering
- Training

SME

EX RAW di Michele la Rosa
Via Aleardi 2
34134 Triest - IT

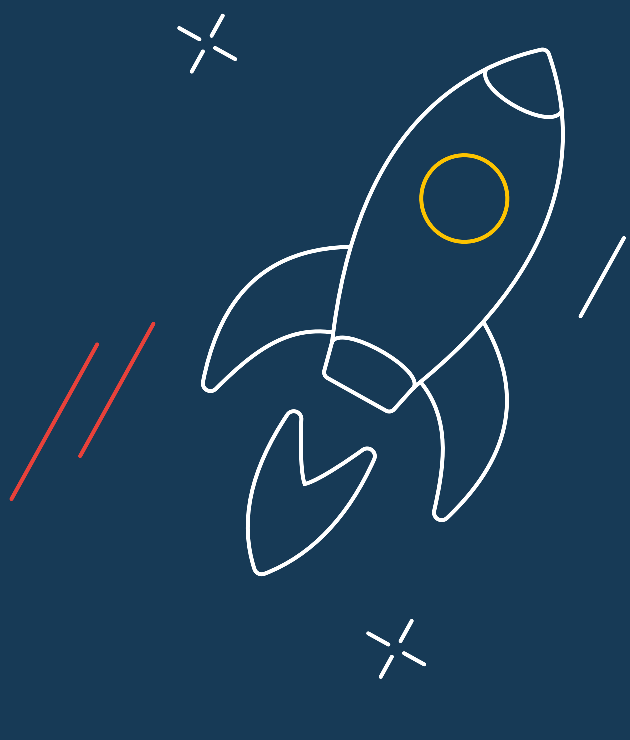
FABLAB

FabLab Castelfranco Veneto
Via Sile 24
31033 Castelfranco Veneto - IT
fablabcfv.org



4

FUTURE PERSPECTIVES



FUTURE PERSPECTIVES

(by S. Aceto, C. Salatin – ECIPA Scarl)

This section will share perspectives and recommendations arising from a comparison between the empirical **experience** of the project and **other experiences** described in studies and researches, and will identify new challenges and issues.

Though a complex combination of mapping activities, networking among stakeholders, communication and indirect funding of cooperation activities between the SMEs and Laboratories, the Labs.4.sme[4] project identified some perspectives that can successfully accompany digital transformation processes and also stimulate and develop product and process innovation within SMEs.

In 2003 N. Gershenfeld[5] (current Director of the MIT's Center for Bits and Atoms) helped create the **first 'FabLab'**, i.e. a model lab offering guided digital fabrication tools that empower individuals to create objects with a level of precision previously only available to large multinational technological groups or large manufacturing companies. People with no technological expertise, 'geeks' and technophiles, engineers and creative craftspeople, artisans and large companies can use FabLabs to learn, share, cooperate, produce and develop prototypes of (almost) anything.
In substance, all FabLabs anywhere in the world are meant to provide similar types of equipment (for example digitalization and 3D printing tools, equipment for cutting and engraving a variety of materials, electronics, software development, IOT, physical computing), and thus contribute to speeding up the process for reproducing projects and sharing developments.

As remarked by Cindy Kohtala[6], FabLabs and Makerspaces play a key role in **transmitting the value of digital fabrication**. The most exemplary FabLabs, with the involvement of the most appropriate stakeholders, have shown that open design and digitalization processes can indeed support a sustainable approach. FabLab business services are expanding, yet much remains to be done. The innovation potential of FabLabs for SMEs is high, but we cannot speak yet of 'digital production business' or, in some cases, 'tech shops'.

The challenge for the Labs.4.sme project lied in **showing the added value** that cooperation between Austrian Laboratories for digital innovation, Italian FabLabs and Micro and Small Enterprises can bring within a process of digital transformation, mainly working at a Technology Readiness Level TRL[7] 2 shifting to TRL[8] 4 .

The project experimentation phase identified FabLabs as the **ideal partners** for those companies - mainly small - that need to tackle the first steps of a digital development and transformation strategy; during the monitoring interviews with the protagonists of the pilot projects (Innovation Challenges) it emerged that helpfulness, expertise, flexibility and trust were crucial for achieving the pre-set goals, together with response times in case of need.

If on the one hand the ExploreInnoSpaces platform[9] created by the project can support the FabLabs wishing to communicate their services to companies and describe their past projects, on the other in the medium term it is also necessary to work on three aspects, namely:

1. strengthen the network of experts – ecosystem - that can become complementary to the work of a maker (turning a FabLab into a digital transformation Hub for SMEs)

2. expand the network of laboratories at a cross-regional level, develop the digital infrastructure (Exploreinnospaces platform) and offer new opportunities for meetings. Several contacts have been initiated to include Laboratories from Slovenia and the provinces of the Veneto region not yet included in the programme (Padua, Rovigo, Venice, Verona).

3. entrepreneurial skills useful for the definition of business models that can enable the FabLabs to be economically sustainable (and independent).

A thorough analysis of the aggregated data of the Lab - SME[10] cooperation cases has identified some aspects that have an impact on it: geographical position of the FabLab; level of trust established or already existing; involvement of external facilitators; role of the Lab in the community/hub of reference; involvement of third parties (e.g. suppliers); use of project management tools. A key point identified by the analysis, which has not been included as a factor that requires observation, is the initiation of cooperation and the factors that can either facilitate or hinder it.

The analysis has also made it possible to identify the **necessary or recommended steps** to encourage further cooperation with the stakeholders involved[11].

Necessary

- Cooperation must generate a prototype
- Intermediate and semi-finished products (including software codes) must be documented and stored/saved as a reference for future projects
- Verify IPR and patent procedures

Recommended

- Identify whether the SME's goal is to sell the final product or develop a different version of the product
- Publication of results can generate visibility and therefore help establish new partnerships
- Production of small runs
- Prototype testing
- Plan additional processes and costs for product packaging and shipping
- Train SME colleagues/employees in order to foster the use of digital technologies

A further consideration regards the return on investment in digital technologies by SMEs and workers. Aggregate data from the OECD countries[12] show that training in digital technologies can lead to better employment opportunities for highly specialized workers, although some empirical researches[13] show a positive correlation only in the case of investments in digital technologies based on machinery (e.g. robots, 3D printing, IoT). The main consequence, which was also highlighted by other studies[14] and should be considered during cooperation activities between the Labs and SMEs, is the need for complementary regional policies focusing on the labour market and lifelong training, which should support digitalization and benefit from it in different economic areas (job creation, improved productivity).

In addition, the cross-regional cooperation fostered by the Labs4sme project has raised **new questions** and **challenges**, but also **new opportunities** for **cooperation** and **expansion** to other areas of the Exploreinnospaces platform.

How do the affordances[15] associated to the economic, regional, institutional, organizational and digital infrastructure interact with each other and determine the way innovation and entrepreneurial initiatives take place in different contexts?
To what extent does digitalization (including platforms like Exploreinnospaces) compensate for the reduction of spatial and institutional resources to facilitate interaction among SMEs that are geographically and institutionally diverse?
What is the role of institutional facilitators (e.g. employers' associations) and knowledge brokers (e.g. Competence Centers, Digital Innovation Hubs) in promoting initiatives to internationalize SME knowledge and innovation?
How and on what conditions do digital technology offerings stimulate/facilitate the development of regional innovation and cross-regional business ecosystems?
Some of these questions could be answered with the validation of the Cooperation Model presented in the publication by other SMEs and stakeholders at the end of the Labs4sme project.

THE AUTHORS

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1 Nambisan, Satish & Wright, Mike & Feldman, Maryann. (2019). The digital transformation of innovation and entrepreneurship: Progress, challenges and key themes. Research Policy. 10.1016/j.respol.2019.03.018.

2 B60 blog (UK leading technology consultancy), (2018). https://blog.b60apps.co.uk/digital-transformation-vs-innovation-which-one-is-better

3 We subsume different types of Labs under the term „Digital Innovation Labs" (or Labs for short) in this paper. We include more production oriented Labs, aka Fab Labs as well as Labs that focus more on the innovation process or digital technologies. A common aspect of all relevant labs is their focus towards the creation of new and innovative products and services as well as the general availability for small and medium sized enterprises (SME).

4 http://www.labs4smes.eu/

5 http://ng.cba.mit.edu/neil/bio/

6 Making "Making" critical: How sustainability is constituted in Fab Lab ideology (2016 – The Design journal).

7 https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

8 The Technology Readiness Leve' (TRL), which can be translated as Technological Maturity Level, is a method for estimating the maturity of a given technology. TRLs are based on a scale from 1 to 9, with 1 being the least mature technology (basic principles observed) and 9 the most mature one (actual system proven in operational environment)

9 https://www.exploreinnospaces.eu

10 Paul, C., 2019. Master's Thesis submitted at Fachhochschule Kufstein Tirol Bildungs GmbH – Web Communication and Information Systems

11 Paul, C., 2019. Ibidem.

12 OECD (2019), OECD Employment Outlook 2019: The Future of Work, OECD Publishing, Paris, https://doi.org/10.1787/9ee00155-en.

13 Balsmeier, B., Woerter, M., 2019. Is this time different? How digitization influences job creation and destruction. Res. Policy.

14 Forman, C., Zeebroeck, N.V., 2019. Digital technology adoption and knowledge flows within firms: Can the Internet overcome geographic and technological distance? Res. Policy

15 Potenziale d'azione o possibilità offerte da un oggetto (es. Tecnologia digitale) in relazione a un utente specifico (o, un contesto di utilizzo) - Majchrzak, A., Markus, M.L., 2013. Technology affordances and constraints in management information systems (MIS). In: Kessler, E. (Ed.), Encyclopedia of Management Theory. Sage Publications.

The project has been realized with support of the European regional development fund Interreg V-A Italia – Austria 2014-2020.