# iPRODUCE Social Manufacturing Vision and Reference Model 2

CERTH

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| **Abstract** | This deliverable reports the results of the activities carried out by M18 in Task 2.5 of WP2 of the iPRODUCE project. In this deliverable, it is presented an overview of the main EU survey findings. It also provides an overview of the proposed social manufacturing framework. It includes the structure that local cMDFs and ecosystems can adapt to. Finally, it presents the interconnection between the software components in relation to the user perspective is illustrated. |

| DELIVERABLE HISTORY | | | |
|---|---|---|---|
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| 01/04/2021 | V0.1 | CERTH | First version (ToC) |
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| 02/07/2021 | V0.4 | CERTH | Final version for submission |

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|---|---|---|
| PU | Public | X |
| PP | Restricted to other programme participants (including the EC services) | |
| RE | Restricted to a group specified by the consortium (including the EC services) | |
| CO | Confidential, only for the members of the consortium (including the EC) | |

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# List of Abbreviations & Definitions

| Abbreviation | Definition |
|---|---|
| API | Application Programming Interface |
| AR / VR | Augmented Reality / Virtual Reality |
| cMDFs | collaborative Manufacturing Demonstration Facilities |
| DIY | Do – It - Yourself |
| CNC | Computer Numerical Control |
| DIH | Digital Innovation Hub |
| EC | European Commission |
| IPR | Intellectual Property Rights |
| MSB | Makerspace Bonn |
| OpIS | Open Innovation Space |
| SME | Small And Medium – Sized Enterprises |
| SMF | Social Manufacturing Framework |
| UC | Use Case |
| SLA | Stereolithography |
| FFF | Fused Filament Fabrication |
| PCB | Printed Hybrid Circuit Board |
| FDM | Fused Deposition Modelling |
| SLM | Selective Laser Melting |
| PETG | Polyethylene Terephthalate Glycol |
| PLA | Polylactic Acid |

# Executive Summary

This document is a deliverable of the iPRODUCE project, which was funded by the European Commission's Directorate-General for Research and Innovation (DG RTD), as part of the Horizon 2020 Research and innovation programme (H2020). The document summarizes the outcomes of the activities carried out by M18 within the context of WP2 (Business Challenge Definition for Social Manufacturing in Consumer Goods Sectors), particularly in the Task 2.5 "Social Manufacturing Reference Model and Framework Evolution".

Within the scope of the submitted D2.6, D2.7, and the work carried by M18, is a living update document under iPRODUCE vision on how social manufacturing can work in the consumer sector at pan European level.

Initially, a review of the main EU survey conducted in the context of the D2.2 related to stakeholders' requirements, barriers, and willingness to join the iPRODUCE platform was investigated and presented in order to define and justify their shared needs and requirements.

Additionally, D2.7 identifies the federated structure of the cMDFs, their local ecosystems and their applied governance principles.

Finally, in this D2.7, a holistic user's flow overview while using the OpIS digital platform is presented, after an analysis of the pilot use cases. In particular, regarding the architecture, OpIS design has been identified all the interconnections between the software components in relation to the user's perspective in order to fulfil the gaps and the missing functionalities.

The D2.8 will be the last updated version of D2.7 in M36, where the developed software building blog of OpIS platform will demonstrate their operational performance through a social manufacturing framework.

# Table of contents

# List of Figures



# List of Tables

# 1. Introduction

iPRODUCE is a revolutionary Social Manufacturing platform that supports user-driven open-innovation and co-creation by enabling multi-stakeholder interactions and collaborations. This platform is an open digital innovation space (OpIS) that allows for the secure and interoperable sharing of data and domain-specific intelligence to support co-creation projects. The OpIS is utilised by a set of innovation digital tools that support matchmaking, secure interactions, generative product design, process orchestration, co-creation up to agile prototyping, usability evaluations and lifecycle management. Under the concept of collaborative manufacturing demonstration facilities, the iPRODUCE platform is deployed in local "ecosystems" (made of SME association, manufacturing and specialised SMEs, FabLabs, Makerspaces, and so on) cMDFs. The platform facilitates information and resource sharing across cMDFs, allowing for the formation of a federation of cMDFs. In order to adapt organizational structures, shape social manufacturing processes and scale collaborative production activities, the cMDFs and the iPRODUCE platform are equipped with unique co-creation methodologies, training toolkits and sharing – economy business models.

The purpose and scope of this deliverable 2.7 (hence referred to as D2.7) is to elaborate and incorporate the outcomes of T2.1 "Business Challenge Definition for Social Manufacturing in Consumer Goods Sectors" as supplied by D2.2, as well as to introduce the OpIS User Flow. As regards the first action, all the results and conclusions of the pan-European level surveys will be reported and regarding the second action, the interconnection of the OpIS components from the user's perspective will be provided.

This second version in the form of a position paper provides:

- An analytic evaluation of the stakeholders' perceptions and needs in order to fine-tune the OpIS functionalities: This evaluation defines and explains the stakeholders' perceptions, intentions, requirements, drivers and barriers, as well as their active participation in user motivation and social manufacturing based on the pan-European analysis;
- A description of the proposed structure of the local cMDFs and ecosystems and their governance principles: The horizontal issues including regulations, intellectual property management, data management and ethics and occupational health & safety issues will be introduced;
- The cMDF social manufacturing concept: The user roles and the product specifications of each use case are analysed in order to provide a comprehensible input regarding the social manufacturing concept under the umbrella of each cMDF;
- A holistic view of the OpIS User Flow: The interconnection between the OpIS components is analysed in order to provide a more detailed explanation of the user's navigation inside the iPRODUCE platform.

# 2. Social Manufacturing Framework Overview

Within the framework of Social Manufacturing, the six cMDFs of iPRODUCE project will demonstrate the systemic innovations of Open Innovation Space (OpIS) under an open innovation environment for co-creation and co-design activities, reinforcing the Do-It-Yourself (DIY) movement.

Based on the selected information for social manufacturing framework, with regards to the needs and requirements, described in deliverable D2.6, the structure and the federation of the local cMDFs and ecosystems is defined, by employing governance principles in order to ensure that the intellectual property protection issues, regulation, data management etc. are efficiently and effectively enforced.

Additionally, the architecture and the holistic view of OpIS platform is described extensively by giving the opportunity to makers to deal with a long-range of products, large-scale production and create a vast customer base. These innovative approaches and methods can lead to a large-scale experimentation in the elaboration of tools, services or techniques in a pan-European level, and can reveal a wide range of new business opportunities.

## 2.1. Evaluation of the stakeholders perceptions and needs to fine-tune the OpIS functionalities

In this section, a thorough analysis of the perception, intentions, requirements, drivers and barriers of the projects involved as well as their active participation in user innovation and social production. In particular, the purpose of this section is to highlight the most fundamental details regarding the development and design of the iPRODUCE social manufacturing platform. In addition, technical specifications relevant to the development and the optimization of specific components are analysed in order to address functionality and integrity of the results. At last, it is crucial to mention that the functional requirements of the platform are explicitly handled in iPRODUCE T2.5, whilst the platform development software engineering process is fully described in T4.1.

### Easy-To-Use and User-Welcoming Tools

On the one hand, the majority claims that manufacturing space can make a great difference. The respondents on the other hand indicated a lack of knowledge on the actual extent and action of the manufacturing areas. Regarding the local contribution of makerspaces and Fablabs, empowering consumers and encouraging inclusiveness are essential factors that need to be addressed, so that favourable attitudes and desirability to join these efforts arises. The study recommends that more exposure is needed on the presence, the vision and the work of manufacturers. In this context, components should be focused on enabling users to learn about the notion of social collaboration and cMDFs, as well as to participate directly in digital processes for co-creation and co-production.

The findings from the survey indicate easy to use digital cooperation tools as the most essential elements of a digital platform. Furthermore, an online cartography exercise at the manufacturers' and Fablabs' sites and their production equipment would certainly be of added value based on the demands highlighted by the respondents' surveys, particularly to manufacturers and customers.

Furthermore, some poll respondents deemed more measures are needed to include groups who, for example women, elderly, poor social status or persons with disabilities, are underrepresented (as proven also by present research) in the maker movement. The findings highlight the relevance of a courteous and supportive culture, unequivocal task/interest sexualisation and the need for more feminine role models in society. While the machine-maker movement has distinct cultural aspects, all of these are built on the ideals of diversity empowerment and unrestricted access.

In general, an inclusive digital area accompanied by an intuitive and user-friendly interface needs to be developed on the basis of appropriate design and language, while accepting, for instance, the various approaches to gender or different cultural and language contexts. All platform users should be given the tools to engage and collaborate with others online, without any discrimination, promoting this way, their technological skills growth and boosting their confidence.

The **Marketplace** acts as a gateway for the public, allowing cMDFs to include their customers in a modern digital co-production process, to promote their products, to enable users to innovate and present their ideas for new products and to find both the expertise and capacity to manufacture them. It is important for makerspaces and Fablabs to be able to easily register their location and their manufacturing equipment through the **Marketplace** to the iPRODUCE platform.

The **AR/VR toolkit** and the **Generative Design Platform** should support the digital co-creation and co-production processes. The functionalities of these tools are designed to be user-friendly and easy to use. In addition, features such as voice over internet protocol communication have been integrated, in the case of the AR/VR toolkit for example, to facilitate the interaction between users in order to cooperate on product design.

## Training for Social Manufacturing

The vast majority of the survey population sample has shown a significant readiness to share information and receive access to specific training and mentorship. It is obvious that a social manufacturing training assistance tool would be a major advantage in a digital platform, especially for producers and consumers.

Among other things, users of the platform would hope to improve their knowledge and ability in using cMDF equipment. Interactive virtual seminars giving technical (design, manufacture, crafts, CAD etc.) or soft (creativity methods) skill instructions would enable the general public to participate more. Training may be aimed at supporting an enterprise, a creative endeavour that is already ongoing, or even at learning skills for eventual use. Pair-to-pair online learning could act as a virtual supplementary way of supporting direct knowledge exchange and mentoring. This would allow current technicians and specialists to periodically serve as mentors and consultants in platform-developed initiatives rather than as teachers.

The study explored the link between the educational level and prior project knowledge of the participants. It indicates that the most essential element in achieving greater levels of past project experience is higher education (doctoral degree). This modification is a result of the pilot data, which revealed that primary education among individuals who claimed to have been involved with the movement was the most frequent. The primary goal is enhancing digital modelling and production while making digital tools and ideas readily available and exchanged, under a manufacturer or Fablab.

Age seems to have an influence in both pilot and EU surveys on the opinions and motivation of producers to participate. An even greater desire to take part in a pilot-level survey seems to be more

closely connected to educational achievement. It should be noted that both elderly customers and professionals with higher education adopt a more favourable position regarding their engagement in collaborative production. In direct contrast to the pilot results, research at EU level also reveals that expertise in engineering, IT is also a positive factor in increased manufacturing preparedness.

The **Digital Fablab Kit (Training Support Tool and Process Automation Tool)** aims to the digitalization of workshop results, tutorials and methods, user manuals and hands-on best practices for machinery and machinery-exchange knowledge. In this context, multimedia integration should also be considered for the development of these tools, including audio, video, text, image, 3D animation, etc.

In addition, through the **Marketplace** the user has the ability to share information and instructions to his team through a chat functionality provided on the team page.

## Participation in Makerspaces and Professional networking

The study's insights confirm the desire of manufacturers and customers not only to present their ideas for new goods but also to obtain knowledge and production skills to implement them. Matchmaking services in this context are deemed to be necessary and really in line with the stated objectives of building a professional network of people.

Low income is mostly associated with an increase in wishing to join a manufacturing field in the example of manufacturers. It is important to note that at the same time it is linked to an important feeling of belonging to a sociodemographic group that is more willing to work with producers and customers. Thus, as far as gender is concerned, the intention to engage in the first-round research in manufacturer's spaces is negatively affected by female consumers, but the desire to enter producers is only negatively affected by female manufacturers in the EU analysis.

The analysis of current roles and relationships can simultaneously generate new synergies and identify new financing prospects. There are several elements that might contribute in establishing a professional network or to produce a project (e.g., location, industry, language, material, machine skills, technology, design tools etc.). The study has shown that skills, activity and location are some of the most important elements for establishing matchmaking for manufacturers and consumers. The main events of matchmaking for manufacturing SMEs and industrial actors should include every kind of product and technology. Services and certification also play a major role in this latter situation. Thus, the platform should allow users to search for profiles with certain talents and abilities that support the development of agile networks and to offer tailored suggestions. Thus, users may reply collaboratively on the basis of corresponding competencies to new or current business possibilities. Such a feature might be beneficial for people who want to establish new partnerships or to develop joint businesses with complimentary profiles between diverse parties.

In conceptual terms, users should be able to build a profile, by registering on their iPRODUCE platform, providing their credentials (locations, industry, language, materials, skills, technology, etc.). This information may be included into the planned iPRODUCE **Matchmaking and Agile Network Creation Tool**, which should function complimentary to encourage the development and joint development of collaborative networks.

Also, new synergies are insured by the **IPR Authoring tool**, which increases the confidence for new synergies to be conducted. A contract is offered by an issuer to contract holders and therefore, the

collaboration among users could be reinforced through the aforementioned **IPR Authoring tool**, to ratify their cooperation.

## Team building and Communities

The findings of the survey show that people with common interests interact, exchange knowledge and expand their networks, which are key drivers for social production involvement. Those drivers may be materialised in the framework of a digital platform to enable users to build organisations and communities that meet their unique requirements. In particular, users will be able to communicate their knowledge directly and obtain help on specific difficulties if needed by creating online communities of similar interest (i.e. 3D printing, AR/VR etc.).

However, communities should not be established only in the technical sectors but also in other users' requirements. The capacity to build online communities is therefore projected to significantly enhance social manufacturing involvement and engagement. The results of the EU-level survey have shown that the use of digital collaboration tools can act as facilitators to manage collaborative network activities for the general public, while targeted e-mail-based communication can improve the efficiency of collaborative network growth for makers, SMEs and industry stakeholders.

The EU survey revealed that personal improvement concerns are the main reasons why companies are willing to participate. In general, in order for individuals to improve their opinions, moral pleasure is absolutely required to witness a concept being transformed into a product, even a financial reward. New technological abilities are viewed as vital. The provision of a helpful service in your community is a key element in enabling you to participate in such initiatives simultaneously. In order to enhance producers' passion for social production, exchanges of knowledge and skills, networking and profit as innovators are key factors. In parallel, reductions are the major drivers for manufacturers to increase their impression of manufacturing spaces and fablabs. As far as obstacles are concerned, the results indicate that worries regarding the absence of creative places, knowledge and financing possibilities affect the views of all stakeholder groups. The lack of financial opportunities is a significant obstacle particularly in the scenarios of customers and companies that have shown good views in the producing areas. Lack of the required capability for operations and management issues are the most important obstacles for customers. The lack of health and safety standards and clarity with respect to culpability in the case of an accident should be seen as major obstacles to the same stakeholder group. This shows that a broad public is not welcome inside industrial facilities because of the absence of safety standards. It is, nevertheless, advisable to focus on changing these situations so that good impressions can be increased. Finally, problems related to the transmission of sensitive information between manufacturers and varied purposes only become major obstacles when manufacturers are ready to participate.

Both the **Marketplace** and the **Matchmaking and Agile Network creation tools** can support the creation of teams and communities. It might be also linked with the **mobile application,** which will help individuals and teams to obtain valuable feedback and solicit input about new or existing ideas, while also providing the ability to publish surveys and collect user's reactions through the integrated survey functionality.

# 3. Collaborative Manufacturing Demonstration Facilities

## 3.1. Structure of the local cMDF and ecosystems

Collective Manufacturing Demonstration Facilities (cMDFs) are composed of a set of geographical proximate firms in vertical and horizontal relationships. In addition, they involve a localized enterprise support infrastructure centered around a common vision for business expansion, based on competition and co-operation in a specific market. Furthermore, they serve as small clusters with open to the public manufacturing and production capabilities. Within the confines of the iPRODUCE initiative, cMDFs are required to take hold of a common pool of work procedures, activity plans and branding. Information regarding the cMDF-registered users can be found in the various profiles provided by the components of the project (e.g. Marketplace Profile).

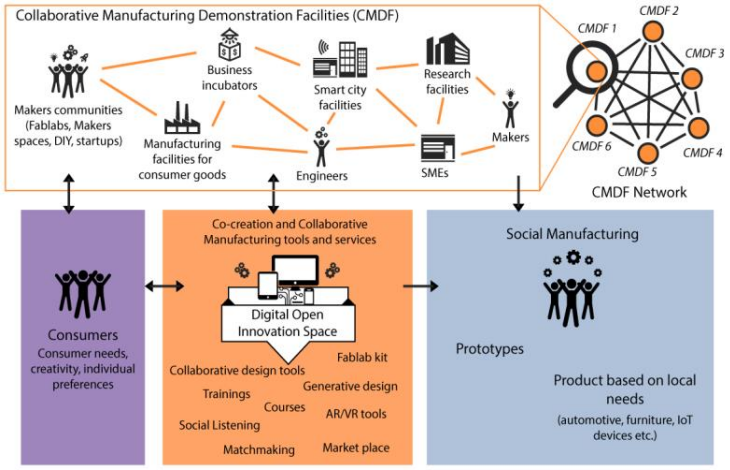


Figure 1: CMDFs

Moving on, crucial local partnerships are also of common interest between cMDFs, especially with them being focused on an infrastructure capable to support collaboration according to the iPRODUCE architecture, through facilities aimed at user engagement, co-creation, validation and training.

Based on an MDF's definition, a local cMDF refers formally **to a set of different entities aimed at supporting collaborative manufacturing by implementing all the required actions to involve users in the process.**

Finally, the existence of a local cMDF in collaboration with the Manufacturers-Makers-Consumers (MMC) communities ensures the local knowledge fields and needs are covered. Thus, a cMDF acts as an alliance of companies focused on supporting activities for mutual benefit centered around productive innovation and facilities.

Six cMDFs have been initially set up in iPRODUCE (ES, GR, FR, D, IT, DK as covered in D2.5 and D3.4.

iPRODUCE's social manufacturing solution is built upon the notion of local "ecosystems", including SME associations, specialists, Fablabs and Makers' facilities. In conjunction with the use of collaborative MDFs or cMDFs, the interconnection and enrichment of existing manufacturing facilities is succeded.

Key components of the survivability of such ecosystems include geographical proximity, as all members are required to physically meet and interact with the cMDF leading to the mobilization of the creative endeavours of prosumers/consumers. Moving on, an additional set of constraints is the identification of relevant partners who provide benefits to the ecosystem while also being in the position to create a diverse set among them.

The IIRA model as mentioned in D2.6, two viewpoints could be identified that help in structuring a local cMDF. On one hand, the business viewpoint is focused on the concerns of the specifications provided by the stakeholders such as their commercial vision, values and objectives. On the other hand, the usage viewpoint addresses the concerns of expected system usage. The cMDFs are going to use the components provided by the iPRODUCE project in order to communicate and collaborate, leading to the enhancement of the structures involved.

According to their different roles and amounts of interaction within the cMDF, the surrounding: entities and actors can be characterized according to their **level of involvement** as:

1. **Founding Members**: Partners involved in the initial stages of iPRODUCE.
2. **Core Group:** Entities with complementary profiles which act mainly as part of the management/governance of the cMDF. Permission to join is granted by the Founding Members.
3. **Local Individual Contributors:** Umbrella term for entities with technical profiles, who act as mediators between their know-how and the cMDF's needs.
4. **Users:** Actors who interact with the cMDF mainly through their engagement with activities, services and bulletins. They can be either participants in the cMDF's activities or clients who their involvement is based on making use of the cMDF in exchange for a product or a service.

Tasks T2.4, T6.1 and T3.3 are centred on this. In **Annex1: Local cMDF Ecosystems**, a summary of each cMDF's specified ecosystem structure is provided. In addition the set of actors, centered on the different roles and levels of interactions, structured in iPRODUCE are the subject of T2.5 and T3.2.

## 3.2. Federation of iPRODUCE cMDFs and their governance principles

### 3.2.1. Offerings of federation

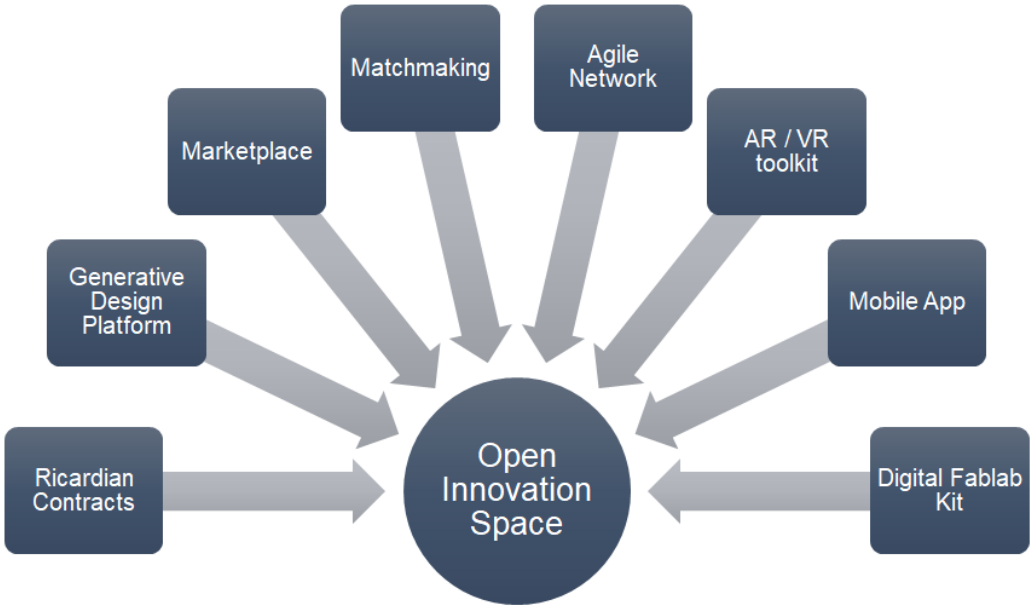


Figure 2: iPRODUCE Open Innovation Space Digital Offering

The iPRODUCE Federation method will serve two purposes: (a) operational optimization by enabling knowledge extraction and sharing, as well as resource and production facility sharing; and (b) marketing and business by accessing a much larger community of customers.

The tools developed within iPRODUCE, are aligned, in every stage of design and development, with the above purposes.

As a result of their synergetic effect, the Federation will greatly boost the efficiency of the offerings. We identified a scale of distinct levels of collaboration (in ascending order of integration) that will contribute to these synergies after analysing the existing Networks (D7.1 and D3.4):

- Share dissemination
- Share ecosystem (a cMDF involves members of its own ecosystem when petitions are made to other cMDF).
- Priority outsourcing: A cMDF becomes the main reference provider of other cMDFs..
- Shared jobs: Under a contract or similar that delivers both responsibilities and benefits.
- Free and transparent access to all cMDF resources from other cMDFs

Besides the synergetic effort in the cMDF co-creation services, the networked operation will allow for extended offerings on:

- Open innovation services.
- Training on co-creation methodologies for product design, IPR management on collaborative production engineering, etc.
- Support on product engineering, and conceptualising strategies.
- Distributed co-creation and manufacturing based on the platform and network, with standardised security and knowledge sharing mechanisms.

Both these integration levels and extended offerings are intrinsically taken into account by the Open Space, toolkits and components:

- The Agile Network, Matchmaking tool/Marketplace and the Ricardian Contract will deal with the integration needs, from more “soft” to “hard” integration.
- The Digital Fablab Kit and the AR/VR Toolkit, as well as other outcomes of the project, such as the Training Toolkit on Co-creation and the Generative Design Platform -used as training tool or ideation support tool- will be the grounds for the extended offerings.

### 3.2.2. Governance principles

The iPRODUCE platform will involve all members of the network, starting with local cMDFs connected to each other, across Europe. It is implemented in many industries and geographical situations. Local contributors such as manufacturers, engineers etc. can be part of the network by adhering to local cMDFs or by registering via the Marketplace component to offer their services, according to the local cMDF levels of involvement. In summary, a local cMDF network is a set of cMDFs linked to each other. The concept of collaborative networks leads to a more detailed and scholarly definition.

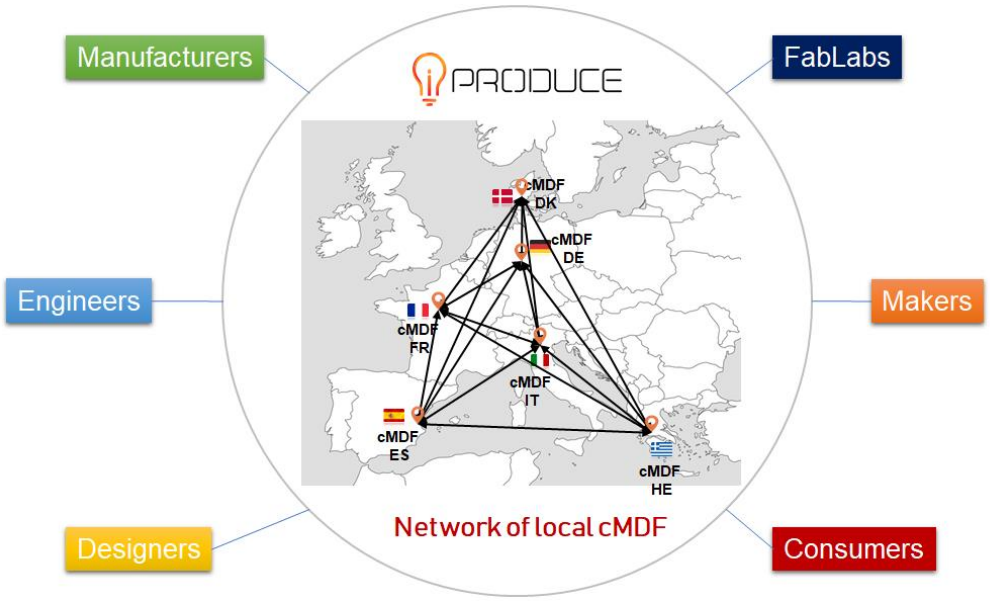


Figure 3 cMDFs and local contributors Network

The main pillars of iPRODUCE project are to support customer-driven production and enrich the new business model under the sharing-economy paradigm. The first key factor is supported by AR/VR toolkit and Generative Design Tool. These tools give the customer the ability to design and suggest modifications to the manufactures. The other factor is enhanced by the Marketplace component which constituted by the interconnected cMDFs all over the Europe which consist a coherent ecosystem which scope is to collaborate and share resources among all stakeholders to achieve common goals. The governance mechanisms have to be developed over time to ensure the stable growth and the positive outcomes of the ecosystem. The governance mechanisms for digital platform ecosystems need to reflect on the lawful interactions of stakeholders: owners of the platforms, companies using the platform, or developers, users and regulators.

Their governance as a single cMDF structure or as a network structure must be compatible, and the OpIS digital platform must cope with it. The iPRODUCE OpIS will address aspects common across other environments such as user management, automation, communication, transaction management etc. and aspects as security, privacy and robust IPR protection.

The OpIS governance elements would cover the following areas, effective at the time of deployment (technical details about the technologies used to ensure the governance principles described in Deliverable 4.3):

- User-oriented policies that govern interactions and business relationships
    - A text area describing the terms and conditions for each component where the user has to read it in order to accept it or decline it.
    - In each component of the iPRODUCE there is a text area mention the terms of use.
    - The registration of the users take place in the Marketplace component.
    - The authentication of the users take place at each component separately (Single-Factor Authentication)
    - Collaboration agreements with the insurance of IPR authoring tool.

- Platform policies that define the rules, trust policies, communication rules and terms of doing business on the platform based on IPR management strategies (during iPRODUCE, the specific directions for IPR and knowledge management are detailed in the project's consortium agreement, which defines the rights and responsibilities accordingly)
- Data management policies that define the way data is managed, processed/used, stored and exchanged between partners
    - Data handling: Back-end systems of the components directly store their corresponding data to the OpIS Data Repository (MongoDB). Connections to different components (API calls) will use HTTPS with basic authentication.
    - Confidentiality of data: Consideration of regulations associated with personal data and corporate data. Data encryption (AES256 encryption) for the data exchange scenarios will be applied.

The iPRODUCE platform will use the Self-Governance Model, one of the three main platform governance mechanisms outlined in D2.6. Because the platform notion is not subject to any regulatory restraints other than those that already regulate the exchange of ideas and commerce. This paradigm enables the cMDF governance to follow a minimum intervention principle: platform decisions are made with minimal external oversight. Platform instances (cMDFs) and platform owners' voluntary agreements are unlikely to have an impact on cMDF operation. However, the following governance issues for the iPRODUCE platform will need to be addressed in the post-project period:

- Maintenance of the platform instances;
- Implementation and deployment of new services;
- Decisions on technology provisions

# 4. iPRODUCE's CMDFs Social Manufacturing concept

This section gathers all the Use Case scenarios from the 6 pilots of the iPRODUCE project and translates them into a valid user workflow inside the OpIS digital platform. Each pilot focuses on a specific theme (mobility, electronics, furniture, collaborative learning, health) and brings together different entities – such as FabLabs, companies or research centers. Hence, these entities know their customers, their habits and their needs. Each pilot developed their use cases and their interconnection with the OpIS platform, in order to best meet the needs of their local ecosystem. In this section, an analysis of the uses cases regarding their connection with the OpIS platform digital components is given.

More specifically, a short description, the possible user roles and the specifications of the products and services of each use case are presented, as well as an overview of the user's flow inside the OpIS platform is introduced. This analysis of the use case scenarios aims to enrich and enhance the functionalities of the platform so that the needs of the iPRODUCE project are covered. Through discussions with the stakeholders – and based on their experiences – the different pilots were able to determine how to best use the available software components and shape the platform's functionalities.

## 4.1. CMDFs Use Cases Scenarios

### 4.1.1. Spanish cMDF

The Spanish cMDF's mission is first to provide a physical space for MMC's communities to stimulate, promote and develop innovative customer-driven product ideas in a collaborative way. It will also act to transform ideas into real furniture products in order to be commercialized. The pilot objectives are to enable collaborative engineering between the furniture manufacturing companies, the cMDF and the FabLab jointly with the community of experts/makers, allowing them to develop customer-driven products with complex specifications that the furniture producer cannot tackle on his own. In the following tables a short description of each use case, the involved users for each use case, the parts of which the products are composed, the material of the parts and the specifications are presented.

Table 1: Description of the Spanish Use Cases

| Use Case | Description |
|---|---|
| Intelligent Headboard | This use case originates from the innovative idea of furniture manufacturing company that want to address a need brought by its target consumers.<br><br>The headboard is designed from scratch and has to accommodate 5 systems which need to be integrated in the headboard design, according to the functional requirements specified by the manufacturer. A lightning system responsible to give light in the headboard, regulating intensity and color according the user selection. A sound system responsible to play music in the headboard according the user selection. An environmental conditions system responsible to measure inside and outside weather conditions. A messaging system responsible to show in a screen integrated in the headboard customized messages, and finally an aromatherapy system responsible to offer the user different fragrances inside the headboard. All these systems will work together offering a unique experience to the user. |
| Smart Adjustable Gamer Chair | This use case originates from the innovative idea of gamer. Similar to the case above, the gamer chair is an innovative chair that combines state of the art technology to offer |

| | |
|---|---|
| | gamers a unique experience while playing video games. |
| 3D printed Components for Assembling Customized Furniture | This use case comes from a Maker entrepreneur whose idea is about the manufacturing of 3D printed components for assembling customized furniture. These pieces are intended to replace broken pieces of furniture, making furniture last longer, thus reducing the environmental impact. |

Table 2: Possible user roles for the Spanish Use Cases

| Use Case | Roles |
|---|---|
| Intelligent headboard | User 1 has the role of the Furniture Manufacturer - LAGRAMA |
| | User 2 has the role of cMDF (OCÉANO NARANJA and AIDIMME) |
| | User 3 has the role of Consumers |
| Smart Adjustable Gamer Chair | User 1 has the role of the Gamer |
| | User 2 has the role of Furniture Manufacturer - LAGRAMA |
| | User 3 has the role of consumers |
| 3D printed Components for assembling customized furniture | User 1 has the role of the Maker entrepreneur (any Maker) |
| | User 2 has the role of cMDF (OCÉANO NARANJA and AIDIMME) |
| | User 3 has the role of Manufacturer (any Manufacturer) / Makers' community. |
| | User 4 has the role of Manufacturer to industrialize the prototype (any Manufacturer). This user could be even User 3 perhaps |

Table 3: Product parts and materials of the Spanish Use Cases

| Use Case | Parts and Materials |
|---|---|
| Intelligent headboard | Headboard made of wood |
| | 1 LED strip, 1 Raspberry PI, 5 power supplies 5DCV, 1tactile screen, 2 speakers, 1 environmental sensors, 1 Wi-Fi router, 3 relays, 3 diffusors, multiple electrical wires, communication wires, multiple wire connectors |
| | Plywood board, metal frame, fabric or leather |
| Smart Adjustable Gamer Chair | Chair |
| | Sensors |
| | Wood |
| | Metal frame, fabric or leather |
| 3D printed Components for assembling customized furniture | Wood |
| | Plastics |
| | PLA filaments |

Table 4: Product specifications of the Spanish Use Cases

| Use Case | Specifications |
|---|---|
| Intelligent headboard | • CNC-cutter. working area 3000x2000x100mm<br>• CNC milling machine 1000x2000x300mm<br>• Laser cutter: working area 900x600mm.<br>• Laser cutter working area 1200x900mm<br>• 3D-printer. working area 250x250x200mm |

| | |
|---|---|
| | • Power Tools and other tools (TBD) |
| | AC Plugs: 5 plugs (220 AC) need to be available in the headboard to connect power supplies |
| | Diffusers: all of them (3) need to be accessible to refill it |
| | Environmental sensor: the sensor requires open space to let enter the air |
| | Speakers: the speakers require open space to let exit the music sounds |
| | Tactile screen: the screen need to be accessible to be manipulated by the user |
| | Wires: integrated inside the headboard |
| Smart Adjustable Gamer Chair | • CNC-cutter. working area 3000x2000x100mm<br>• CNC milling machine 1000x2000x300mm<br>• Laser cutter: working area 900x600mm.<br>• Laser cutter working area 1200x900mm<br>• 3D-printer. working area 250x250x200mm<br>• Power Tools and other tools (TBD) |
| 3D printed Components for assembling customized furniture | • CNC-cutter. working area 3000x2000x100mm<br>• CNC milling machine 1000x2000x300mm<br>• Laser cutter: working area 900x600mm.<br>• Laser cutter working area 1200x900mm<br>• 3D-printer. working area 250x250x200mm<br>• Power Tools and other tools (TBD) |

### 4.1.2. German cMDF

The German cMDF envisions multiple purposes. First it aims at understanding and determining the relationship between SMEs and MakerSpaces. Then it aims to establish a concise list of services that are of interest and could be beneficial for SMEs. After this, mechanisms to facilitate initial equipment usage for new machine users and corresponding processes and tools to support iterative prototyping with electronics will be developed. The objective of the German pilot is to enhance the co-creation capacity of manufacturing SMEs for consumer product innovation, introduce SMEs to the Maker scene and capitalize the FabLab mentality and working processes to stakeholders in the area. In the following tables, we provide a short description of each use case, the involved users for each use case, the parts of which the products are composed of, the material of the parts and the specifications respectively.

Table 5: Description of the German use cases

| Use Case | Description |
|---|---|
| UC_1 (CoCreation –Introduction for SME's) | The use case is about providing consultancy services to companies, mainly SMEs, who want to renew their innovation approach. Their goal is to get from idea to prototype in less time and to make sure that product development is more user-centered, effective and modern. The company does not currently follow a defined process or methodology for innovating. Their products are based on innovation created by the owner (or a small group of experts) and are rarely updated.<br>Within this use case, the company is using OpIS to search for consultancy for learning about innovation processes. They find trainings about ideation or prototyping methodologies, which are offered by the German cMDF. The company may also decide to engage into a consulting process to co-create on the company's products. The training lets the employees get a first grasp on the taught methods and the connected mindset. And the consulting process can accompany their first implementation steps, in order to be able to apply what has been taught. Concrete consulting processes are offered, such as |

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|---|---|
| | the live prototyping service or the nerd testing service. The German cMDF would further support the company's innovation process in a concrete innovation project if desired. |
| UC_2 (Machinery Training) | Every time when MSB received a new machine, many people need to learn about the operation and security mechanisms of this machine as well as its capabilities for projects. Currently this educational task can be an unpopular task because of its repetitiveness. Within this use case, MSB will use the iProduce training support tool to establish virtual tutorials and sample projects to teach and train inexperienced makers about machinery, material and processing steps in a fun and immersive way – also to reduce the time spent on explaining repetitive information. They provide sample projects as well as learning material for inexperienced users.<br>The created training material can be shared with other maker spaces who own the same machine and are struggling with the same educational challenges. |
| UC_3 Guided Product Development as a Service (GPDaaS | MSB will offer Guided Product Development as a Service (GPDaaS) for start-ups. MSB experts will challenge the start-up to carve out the unique selling point of their product idea. Furthermore, MSB experts will support and consult with regard to cost calculation, ramp-up and production. If needed, consulting regarding certification, etc. can be given by subject matter experts internally or externally (matchmaking). |
| UC_4 (New Skilling/MSB IoT Education Kit) | SMEs often have good niche products, but struggle with connecting these to the internet. The German cMDF helps SMEs to get their devices connected to the internet and cloud. We "new skill" SMEs and offer cookbooks, recipes and workshops, supporting the SMEs with their coding and electronics challenges. Furthermore, an IoT education kit (hardware and software) will be developed and made available to SMEs.<br><br>The MSB IoT Education Kit is an electronics development kit, based on a microcontroller with internet connectivity, as well as a server side backend (cloud/dedicated) which is easily programmable. The kit can be used commercially.<br>If needed, a second phase can follow the prototyping with the MSB IoT Education Kit, in which a custom electronics product (PCB) is designed and built in MSB |

Table 6: Possible user roles for the German use cases

| Use Case | Roles |
|---|---|
| UC_1 (CoCreation –Introduction for SME's) | User 1 has the role of a customer (SME) |
| | User 2 has the role of the consultant (FIT and MSB) |
| UC_2 (Machinery Training) | User 1 has the role of a machine owning maker space (MSB) |
| | User 2 has the role of a customer (Guest of MSB) |
| | User 3 has the role of a different maker space that owns the same machine (Other maker space from the iProduce consortium) |
| UC_3 GuidedProduct Development as a Service (GPDaaS) | User 1: Startup seeking for consulting<br>User 2: MSB Makers who act as mentors<br>User 3: External Subject Matter Expert |
| UC_4 (New Skilling/MSB IoT Education Kit | User 1: SME with product idea<br>User 2: MSB Members<br>User 3: Expert (External/MSB) |

Table 7: Product parts and materials of the German use cases

| Use Case | Parts and Materials |
|---|---|
| UC_1 (Co-Creation – | N/A |

| | |
|---|---|
| Introduction for SME's) | |
| UC_2 (Machinery Training) | N/A |
| UC_3 Guided Product Development as a Service (GPDaaS | N/A (Whiteboard consulting) |
| UC_4 (New Skilling/MSB IoT Education Kit | MakerSpace Bonn IoT Education Kit. (Cloud-Connectible IoT development kit) |

### 4.1.3. French cMDF

The French cMDF focuses on 2 main purposes: Firstly, it will work on making the FabLabs equipment, tools and machines more accessible to potential user or products developers by creation virtual and digital trainings, tutorial and courses. By doing so, the public user will become more familiar with prototyping and CNC machines, including their respective software. Secondly, the French cMDF will aim at supporting entrepreneurs' and SMEs' projects, especially in the mobility and electro-mobility sectors, by introducing and encouraging them to involve social and collaborative manufacturing in their product design and development processes. The objective of the French pilot is to demonstrate the use of co-creation and co-design in the mobility, automotive and robotics sectors, and its extension to other sectors in which Excelcar and Materalia have already worked with (agriculture, health and maritime). In the following tables, we present a short description of each use case, the involved users for each use case, the parts of which the products are composed, the material of the parts and the specifications.

Table 8: Description of the French use cases

| Use Case | Description |
|---|---|
| FR_UC_1 | The FabLabs want to facilitate access to their machines and their methods.<br>Today, workshops and courses are mainly face-to-face with a member of the FabLab in charge of transmitting their knowledge and training in the use of the machines.<br>At the end of the iPRODUCE project, we want to have facilitated the access to the FabLab to any person; a consumer who wants to learn how to modify his products, a beginner maker who wants to learn more, a project leader or industrialist who wants to be able to make a first prototype alone.<br>For this purpose, virtual training modules/tutorials will be designed and made available. |
| FR_UC_2 | Entrepreneurs and SMEs want to develop urban solutions for soft or electric mobility adapted to the needs of users. By using the iPRODUCE project and the installed ecosystem, entrepreneurs will be able to:<br>• Design their systems with groups of potential users<br>• Prototyping the system with shared machines<br>• Experimenting with the system with consumers in urban areas<br>• Produce the first series of the system<br>With iPRODUCE, entrepreneurs and SMEs will be able to:<br>• Have a market place where it will be easier to identify partners.<br>• Have IPR and contractualization management tools to reduce exchanges and therefore the time of contractualization between partners.<br>• Have design support tools to accelerate product development.<br>• Access visualization tools that facilitate collaborative work with partners and the promotion of the system<br>• Benefit from pedagogical resources and methodologies to introduce entrepreneurs to rapid prototyping and innovation techniques. |

| | |
|---|---|
| | • Connect the project leader with a community equipped / having the skills to prototype his idea.<br>Connect the project leader with a community of end users. |

### 4.1.4. Italian cMDF

The Italian cMDF's purpose is to serve as a partner for companies and professionals, mainly, in the design and realization of Internet of Things, mechatronics and microelectronics appliances. Competences span from mechanical and electronic design, electronics through cybersecurity, metallic and polymeric 3D printing and measurement services to quality control. The objective of this pilot is to enable collaborative engineering between the microelectronics/mechatronics manufacturing companies, the cMDF and the FabLabs/Makerspaces, involving the community of experts (professionals)/makers, local start-ups and SMEs to address the development/enhancement. The Italian cMDF is mainly related to the industrial and manufacturing sector and is centered on the Manufacturing Facility ProM, a lab built up by the partner Trentino Sviluppo within the ERDF programme of the local government of the Trentino Province; nevertheless the cMDF will involve also other non-industrial facilities (makerspaces and fablabs), covering three regions of Italy: Trentino, South Tyrol and Puglia. In the following tables, we present a short description of each use case, the involved users for each use case, the parts of which the products are composed, the material of the parts and the specifications respectively.

Table 9: Description of the Italian use cases

| Use Case | Description |
|---|---|
| Customer-Driven Robo-Shaker for industrial application (IT_UC_1) | This use case concerns a user (e.g. a client manufacturing company or a professional who acts on behalf of the company) that needs to sell a new product to the hobbyist large scale distribution or its selling channels. The client company needs a simple and customized mechatronic appliance to automate, for instance, the back and forth move of a fan or of a rocking chair or whichever consumer good may need an oscillating movement.<br><br>The Use-case relates to the collaborative development of the mechatronic component which efficiently transforms a slow-rotational movement in input (for instance from an electric motor) in an output linear movement.<br><br>The involved users can be a professional trained person (e.g. a technician like an engineer), as well a manufacturing company that wants to create a new B2B/B2C product.<br><br>The Use case, through a networking collaborative workshop and an open-source call, will involve technicians (professional world), students (academy world), SME's (industrial world), maker (fablab/makers world) that will communicate and collaborate through the OpiS features and the cMDF network. |
| Customer-Driven Watering System (IT_UC_2) | The use case concerns a user (e.g. a client manufacturing company or a professional who acts on behalf of the company) that wants to develop a networked IoT system (made up of a centralised intelligence and a remote network of transducers/actuators) that serves to keep the right soil humidity in apartment plant pots using automation control algorithms.<br><br>The use-case relates to the collaborative development of the component of the IoT system which is to be installed into the plant pot (that is a remote object made of a case, an electronic control unit, sensors/transducers, actuators and transmission/antenna). The system must transmit data to the centralised control system and water the plant when necessary: it periodically monitors when a pot is too dry and then, if needed, delivers a certain amount of water to the pot. The watering system needs to be connected to up to |

| | |
|---|---|
| | 16 pots and can keep a different level of humidity in each pot.<br><br>The involved users can be a professional trained person (e.g. a technician like an engineer), as well a manufacturing company that wants to create a new B2B/B2C product.<br><br>The Use case – through a networking collaborative workshop and an open-source call – will involve technicians (professional world), students (academy world), SME's (industrial world), maker (fablab/makers world) that will implement the use case by means of OpiS features and cMDF network. |

Table 10: Possible user roles for the Italian use cases

| Use Case | Roles |
|---|---|
| Customer-Driven Robo-Shaker for industrial application (IT_UC_1) | User 1 has the role of the professional/manufacturing SME (SME to be identified in the collaborative workshops/call for SME) – the "Client" (who defines the requirements) |
| | User 2 has the role of the designer/manufacturer (ProM, the "CMDF" master) |
| | User 3 has the role of the ancillary manufacturer/designer (the local cMDF sub-nodes that make part of the work under the ProM technical lead) |
| Customer-Driven Watering System (IT_UC_2) | User 1 has the role of the professional/manufacturing SME (SME to be identified in the collaborative workshops/call for SME) – the "Client" (who defines the requirements) |
| | User 2 has the role of the designer/manufacturer (ProM, the "CMDF" master) |
| | User 3 has the role of the ancillary manufacturer/designer (the local cMDF sub-nodes that make part of the work under the ProM technical lead) |

Table 11: Product parts and materials of the Italian use cases

| Use Case | Parts and Materials |
|---|---|
| Customer-Driven Robo-Shaker for industrial application (IT_UC_1) | Robo-shaker case: plexiglass, aluminum with polimeric (3D printed) joints |
| | Internal mechanical components: polymeric (3D printed) gears and shafts |
| | Motion: bipolar stepper motor |
| | Control: pcb with electronics driver and customizable user interface (push-button) |
| | Optional: wifi interface for remote control |
| Customer-Driven Watering System (IT_UC_2) | Watering component case (IoT object installed into the pot): polymeric case, with modern style design (a beautiful object that is part of the apartment décor). |
| | Watering component subsystems: sensors (e.g.: humidity), electronic control unit, antenna, actuators (for triggering watering), battery. |
| | Anchorage: the case must include an anchoring system for the stable installation in the pot |
| | Low-power and low-voltage mini diaphragm pump |
| | Case resistance to powder and water |

Table 12: Product specifications of the Italian use cases

| Use Case | Specifications |
|---|---|
| Customer-Driven Robo-Shaker for industrial application (IT_UC_1) | Size (up to 500x500x300 mm) |
| | Shape: parallelepiped |
| | Colour: not specified |
| | Noise: < 50 dB |
| | Power consumption: 50W @ 24 V |
| Customer-Driven | size (up to 200x200x600 mm) |

| | |
|---|---|
| Watering System (IT_UC_2) | Shape: to be defined with designers |
| | Transmission Protocol: IEEE 802.15.4 Zigbee |
| | Battery: Li-ion (3.7 V) |
| | Energy consumption: a few $10^{-3}$ Joule |
| | Case: IP67 |

### 4.1.5. Danish cMDF

The Danish cMDF focuses on democratizing 'making' by expanding the knowledge and expertise related to the possibilities of local production through partnerships with distinct sets of stakeholders, including educational institutions (schools and universities), SMEs and businesses. Among the activities of the cMDF, a mobile lab unit containing a set of machines has been created and equipped to provide a mobile production facility that can be deployed to various locations, linked to specific 'maker'/on site production workshops and activities. The objective of this pilot is to deploy the Mobile BetaFactory Unit in real Use Case scenarios in at least 10 Danish cities to evaluate the requirements for a sustainable long-lasting business case. The results will help to best scale up the open innovation concept and understand consumer market. They will also be used to better cater to actual needs, as well as to understand how future trends could impact the concept. In the following tables, we present a short description of each use case, the involved users for each use case, the parts of which the products are composed, the material of the parts and the specifications respectively

Table 13: Description of the Danish use cases

| Use Case | Description |
|---|---|
| Co – creation in Schools | Through co–creation workshops with local school groups and associations, it will be determined how to best engage primary and secondary Danish students to learn and experiment with digital fabrication and other sets of tools towards creating and developing furniture solutions to their school spaces.<br>The BetaFectory Mobile Unit, which comprises a 40" side-opened shipping container, that can be deployed anywhere. The container will be equipped with digital manufacturing equipment for processing of standard plywood sheet, size 1250x2500mm. It will contain ventilation systems to remove process air and wood dust. The container will need to be equipped with a material storage section. The BetaFactory Mobile Unit will facilitate this interaction in the school context, through bringing the tools to the school spaces. The workshops will be run by BetaFactory design and engineering team with support from the CBS team, to co – create and co – develop with students and school staff new solutions to transform various spaces at the schools.<br>There are agreements with 3 schools in 3 distinct cities in Denmark. The final workshops and construction will happen from M20-M24, when the mobile unit will be dispatched to these locations and stay on site for one week. |
| Distributed Design Market | By using a Mobile BetaFactory Unit, the project can be manufactured on site using CNC-technology. The client can be fully be immersed in the collaborative co-creation process as it happens, and ideas can be thought out and tested on site<br>The main goal is to apply the iPRODUCE fabrication platform, from where individuals and businesses can browse through (distributed CAD) designs, select the one they prefer, and then 'print'/produce the object in site. It is preferable to showcase the opportunities with local digital fabrication and 'open-source' parametric distributed designs. There will be a collaboration with a design market to get a quick reach in certain cities and sites. This approach will facilitate the recycling and upcycling of materials available on site, while also facilitating adjustments and production, without adding to transport costs.<br>There are agreements with a municipality for a city-museum collaboration in Elsinore and |

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|---|---|
| | also there is an agreement with a development company to co-create a local recycling station – this station will need to be built using at least 25% of discarded construction/renovation materials. |
| Temporary Architecture | By applying our Mobile Production Unit in conjunction with the iPRODUCE platform to this use case, with assistance from our design and engineering team, we will create designs that will be parametric and more sustainable.<br>• Co-creation workshops with the stakeholders to identify current needs and co-create solutions<br>• Hands-on learning with design thinking concepts and fabrication<br>• Co-create a new space for a festival/event (eg. Benches, seating, signage, visual installations, separations walls)<br>• Modular, adaptive and parametric designs<br>• AR viewer - used for presentations on venue<br>• Change the way temporary design is applied.<br>A collaboration has started with the KHR architecture firm for building one-to-one scale prototypes for co-creating adaptive architecture solutions for an upcoming large residence building project. |

Table 14: Possible user roles for the Danish use cases

| Use Case | Roles |
|---|---|
| Co – creation in Schools | User 1 has the role of the service provider, designer and manufacturer (BetaFactory)<br>User 2 has the role of consumer (School) |
| Distributed Design Market | User 1 has the role of the service provider/designer/manufacturer (BetaFactory)<br>User 2 has the role of consumer (company/municipality/museum) |
| Temporary Architecture | User 1 has the role of the service provider – machines and space (BetaFactory)<br>User 2 has the role of consumer, designer producer (Architect and Architecture studio) |

Table 15: Product parts and materials of the Danish use cases

| Use Case | Parts and Materials |
|---|---|
| Co – creation in Schools | TBD:<br>1. Upcycle of existing furniture/materials<br>2. Wood<br>3. tbd |
| Distributed Design Market | TBD:<br>1. Wood<br>2. Discarded construction/renovation materials (tbd) |
| Temporary Architecture | TBD:<br>1. walls: wood<br>2. junctions |

Table 16: Product specifications of the Danish use cases

| Use Case | Specifications |
|---|---|
| Co – creation in Schools | Size: L12,5m x B2,5m x H2,762 |
| | Weight: 10 tons |
| | Includes:<br>a. CNC-cutter. working area 2500x1300x180mm<br>b. Laser cutter: working area 900x600mm.<br>c. 3D-printer. working area 250x210x210mm |

| | |
|---|---|
| | d. Power Tools and other tools (TBD) |
| Distributed Design Market | Size: L12,5m x B2,5m x H2,762 |
| | Weight: 10 tons |
| | Includes:<br>a. CNC-cutter. working area 2500x1300x180mm<br>b. Laser cutter: working area 900x600mm.<br>c. 3D-printer. working area 250x210x210mm<br>d. Power Tools and other tools (TBD) |
| Temporary Architecture | Size: L12,5m x B2,5m x H2,762 |
| | Weight: 10 tons |
| | Includes:<br>a. CNC-cutter. working area 2500x1300x180mm<br>b. Laser cutter: working area 900x600mm.<br>c. 3D-printer. working area 250x210x210mm<br>d. Power Tools and other tools (TBD) |

### 4.1.6. Greek cMDF

The Greek cMDF's mission is to bridge the gap between SME's and Makerspaces. Aidplex – CERTH, with expertise in medical and 3D printing sector respectively, are going to help companies and customers to achieve a better treatment experience. The pilot objectives are to leverage expert opinion and experimental feedback to feed the design process supported by community makers and result in innovative medical equipment that outperforms current solutions in terms of comfort and efficiency, offering patients a chance to increase their quality of life. In the following tables are presented a short description of each use case, the involved users for each use case, the parts of which the products are composed, the material of the parts and the specifications respectively.

Table 17: Description of the Greek use cases

| Use Case | Description |
|---|---|
| IoT-based orthopedic back brace | The orthopaedic back brace solution is designed by AidPlex with the aim of higher comfort levels and retrofitting the resulted design with IoT sensors, for scoliosis, kyphosis, or similar spinal deformities. The overarching goal is to finetune the design of a back brace by examining aspects like weight distribution, modularity, size adaptability and overall comfort, whilst IoT sensors will help patients self-assess and adapt their back braces leading to higher degrees of adherence and outcome.<br>With the IoT system, the doctor and the patient will be informed when the right time for a new brace has come, due to child's growth, achieving the best possible fit of the medical device. The IoT component of the solution will also support gamified processes which stand to help patients follow through treatment and exercises more diligently achieving better results and subsequently increase their quality of life. |
| Splints for fractures | AidPlex, Doctors and patients are going to design new sizes & designs for children, in order to provide with the best possible treatment experience. In addition, the patient can select not only the possible size but, the color of the splint and the type of the strap. AidPlex's team design its products based on patients' needs during the healing procedure. The main features of splint are: waterproof, lightweight and skin friendly. First of all, patients can easily bathe themselves without the use of plastic covers around their broken bones. In addition, we offer a 6 times lighter solution, giving to patients a more useful splint in a very difficult period of their life. AidPlex's splint has a lot of holes, therefore patients' skin can breathe normally and eliminate the chance of skin irritation problems. Finally, it is ideal for children. Sometimes Doctors may prescribe drugs to |

| | |
|---|---|
| | children in order to be easy to easily splint their broken bone. Our quick and easy-to-apply solution helps on the one hand healthcare professionals do their job easier and on the other hand, avoiding drug delivery to children. |
| Splints for pets | AidPlex and Vets are going to design new designs for pets, in order to provide the best possible treatment experience. In addition, the owners can select not only the possible size but, the colour of the splint and the type of the strap. AidPlex's team design its products based on patients' needs during the healing procedure. The aim features of the splint are: Waterproof, Lightweight and Skin Friendly. First of all, patients can bathe themselves easily without the use of plastic covers around their broken bones. Furthermore, we offer a 6 times lighter solution, giving to patients a more useful splint in a very difficult period of their life. AidPlex's splint has a lot of holes, therefore patients' skin can breathe normally and eliminate the chance of skin irritation problems. Finally, it is deal for pets! Sometimes, pets pee their splint and then there is a need for change of the splint. Our waterproof & quick and easy-to-apply solution helps professionals do their job easier. |
| Customized face shields | Customized protective face shields can be designed and fabricated for both adults and kids in the fight against COVID-19. The face shield is one of several projects being run by the COVID-19 Response Greece action. This project aims to make the design of protective gear open source and available to everyone that has relevant production facilities, under the license terms of Creative Commons (4.0 International License) Attribution-Non-Commercial, offering high levels of protection. |
| 3D printed smart luminous artifacts | During the coronavirus disease (COVID-19) pandemic, Additive Manufacturing Unit (AMU) of Centre for Research and Technology Hellas (CERTH) encourages students to fabricate 3D printed prototypes based on customized and personalized solutions, using Additive Manufacturing technologies. Students can co-create with AMU experts, 3D Printed Smart Luminous Artifacts based on their favorite historical and mythological figures. The goal of this project is to encourage student's psychology and creativity, and at the same time can be utilized for educational purposes and medical purposes.<br>The 3D Printed Smart Luminous Artifacts are composed of three printed parts using three different 3D printing technologies:<br>1. The 3D printed transparent artifact, fabricated via Stereolithography (SLA)<br>2. The 3D printed electronics housing with adjusted LED stripes, fabricated via Fused Filament Fabrication (FFF)<br>3. The printed hybrid circuit board (PCB), fabricated via Inkjet technology<br>The 3D printed artifact fits with the electronics housing and the PCB is places inside the housing. The PCB consists of a microprocessor with MCU & WIFI & BLUETOOTH Module, a rechargeable battery with 12 hours autonomy, a low energy RGB LED and a USB Port for Power Supply. The 3D printed smart luminous artifact is controlled by a user-friendly specialized mobile application, the AMU4you that is semi-programmable. The student can select the preferred color (white, green, blue, magenta, cyan, red, yellow, orange), brightness and blinking pattern (normal, blink, fast blink) based on the selected mood or activity that would like to follow (e.g., studying or sleeping) and use it as an RGB controllable table lamp. |
| 3D printed (bio) scaffolds | Additive Manufacturing Unit (AMU) of Centre for Research and Technology Hellas (CERTH) encourages researchers to design and fabricate customized scaffolds with optimal lattice structures using Additive Manufacturing technologies for bio-applications, such as organoids or implants in order to better understand neurological or other disorders/ diseases (e.g., Parkinson's, Alzheimer's disease, etc.) and screen potential treatments.<br>The 3D Printed Scaffolds can be manufactured by utilizing different 3D printing technologies, such as:<br>a) Fused Deposition Modelling (FDM) technology |

| | |
|---|---|
| | b) Stereolithography (SLA)<br>c) Selective Laser Melting (SLM)<br>d) 3D Bio-printing |

Table 18: Possible user roles of the Greek use cases

| Use Case | Roles |
|---|---|
| IoT-based orthopedic back brace | User 1 has the role of the designer/manufacturer (AidPlex) |
| | User 2 has the role of consumer (Patient) |
| | User 3 has the role of the manufacturer (CERTH) |
| Splints for fractures | User 1 has the role of the designer/manufacturer (AidPlex) |
| | User 2 has the role of consumer (Patient) |
| | User 3 has the role of the manufacturer (CERTH) |
| Splints for pets | User 1 has the role of the designer/manufacturer (AidPlex) |
| | User 2 has the role of the consumer (Patient owner) |
| | User 3 has the role of the manufacturer (CERTH) |
| Customized face shields | User 1 has the role of the designer/manufacturer (AidPlex) |
| | User 2 has the role of consumer (COVID-19 Response Greece) |
| | User 3 has the role of the manufacturer (CERTH) |
| 3D printed smart luminous artifacts | User 1 has the role of the designer/manufacturer (CERTH) |
| | User 2 has the role of consumer (students) |
| 3D printed (bio) scaffolds | User 1 has the role of the designer/manufacturer (CERTH) |
| | User 2 has the role of consumer (biologists, doctors, surgeons, orthopedists, pharmaceutical companies, medical centers) |

Table 19: Product parts and materials of the Greek use cases

| Use Case | Parts and Materials |
|---|---|
| IoT-based orthopedic back brace | Back brace: Polymer material |
| | Straps: Velcro straps, fiber, woven tape, hook tape |
| | Sensors |
| | Sheet: PE foam |
| Splints for fractures | Splint: polymer |
| | Straps: Velcro straps, fiber, woven tape, hook tape |
| Splints for pets | Splint: polymer |
| | Straps: Velcro straps, fiber, woven tape, hook tape |
| Customized face shields | Face shield: polymer material (PETG) |
| | forehead band: polymer material (PLA) |
| | elastic strip: fabric, polyester, nylon |
| 3D printed smart luminous artifacts | 3D printed Artifact: Optical transparent photopolymer resin |
| | 3D printed electronics housing: polymer (PLA) filament |
| | PCB (Printed Circuit Board): Plastic substrates, silver nanoparticle ink and solder paste for the circuitry |
| 3D printed (bio) scaffolds | Fused Deposition Modelling (FDM): polymer (PLA) filament |
| | Stereolithography (SLA): ceramic (Silica SiO2) resin |
| | Selective Laser Melting (SLM): metallic (Co-Alloys, Ni-Alloys, Cu-Alloys) powders |
| | 3D Bio-printing: bio-materials |

Table 20: Product specifications of the Greek use cases

| Use Case | Specifications |
|---|---|
| IoT-based orthopedic back brace | size (up to 500x500x500mm) |
| | Shape (based on doctors' feedback) |
| | Colour (blue, red, light green, black, orange) |
| | Selected engraved logo/name |
| | Type of straps (Velcro straps 5cm or 2.5cm) |
| Splints for fractures | size (up to 500x500x500mm) |
| | Shape (based on doctors' feedback) |
| | Colour (blue, red, light green, black, orange) |
| | type of straps (Velcro straps 5cm or 2.5cm, or elastic bandage) |
| Splints for pets | size (up to 500x500x500mm) |
| | shape (based on vet's feedback) |
| | Colour (blue, red, light green, black, orange) |
| | type of straps (Velcro straps 5cm or 2.5cm, or elastic bandage) |
| Customized face shields | size (up to 500x500x500mm) |
| | shape (based on doctors' feedback) |
| | colour (blue, red, light green, black, orange) |
| | type of strip (elastic strip 2cm) |
| 3D printed smart luminous artifacts | Customized 3D printed figure of artifact |
| | size of artifact (up to 140x140x160mm) |
| | size of electronics housing (based on artifact's dimensions) (up to 140x140x50mm) |
| | colour of electronics housing: blue, red, light green, magenta, orange, white, cyan, yellow |
| | Selected engraved logo/name |
| 3D printed (bio) scaffolds | size:<br>a) FDM: up to 180x180x180mm<br>b) SLA: up to 145x145x175mm<br>c) SLM: up to 100x110x110<br>d) Bio-printing: up to 130x90x60mm |
| | lattice structure (complex geometries) |
| | colour based on technology: white, transparent, metallic |

## 4.2. Holistic View of the OpIS User Flow

This section provides a holistic overview of the user's flow inside the OpIS Platform based on the the Use Cases of the 6 pilots of the iPRODUCE project. The OpIS platform takes into account the shared needs and requirements of the pilots to provide a unified framework.

The OpIS platform is a set of digital components developed by different partners of the iPRODUCE project. These digital components work together in order the support the social manufacturing activities and collaborative design processes of the users.

The following components make up the OpIS platform and enable the user interaction:

- OpIS data Repository
- IPR Authoring Tookit
- Marketplace
- VR/AR Toolkit
- Generative Design Platform

- Matchmaking and Agile Network Creation Tool
- Mobile App
- Agile Data Analytics
- Digital Fablab Kit

A detailed technical analysis of these tools can be found in the related deliverables. Here, we provide a more holistic view related to the use of the tools by the possible stakeholders in order to engage within a social manufacturing framework. Specifically, in the next sections we describe the user's flow related to the following processes inside the platform:

- Registering user accounts and new products
- Collaborating and Co-designing products with other users
- Visualizing products in 3D
- Purchasing products
- Receiving support through the Digital Fablab Kit

To better understand these processes we use possible user roles and products based on the previously presented use cases.

### 4.2.1. User Registration

The user registration process is essential for all the Use Cases of the 6 pilots of the IPRODUCE project. The Marketplace constitutes the starting point of a user in the OpIS platform. As in any platform concerned the social manufacturing, the first step is the registration on the platform. From the Marketplace Home screen a user is able to register a new account in the OpIS platform or login using his/her credentials (Figure 4).

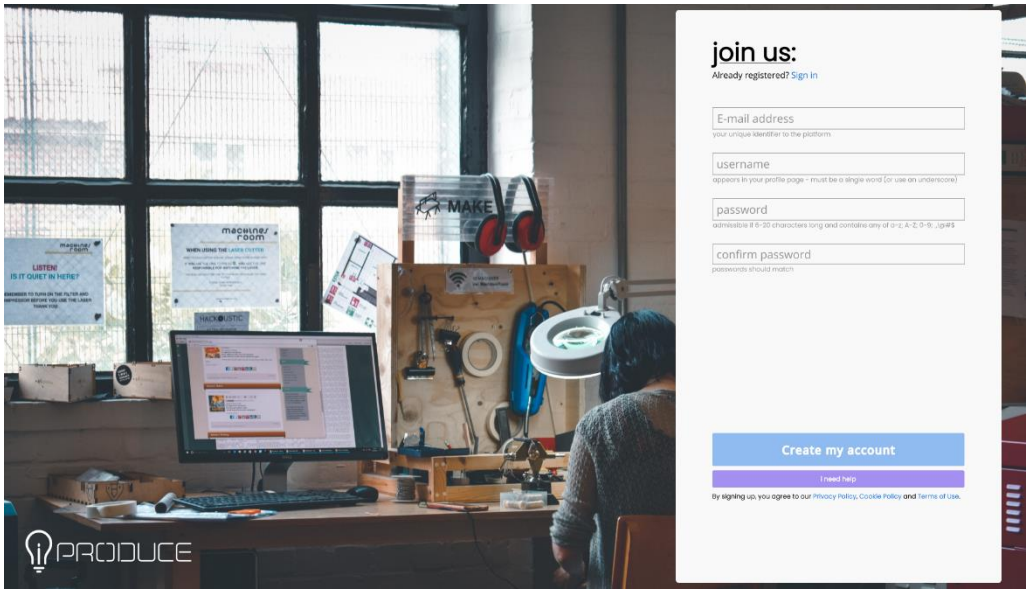


Figure 4: User Login/Registration through the Marketplace component

When a user logs in to the marketplace, through the dashboard a list of actions are available.. The user has the ability to select and view a specific product. A description of the product, an image and

the attached files are displayed (Figure 5). On that screen, from the right side-bar the AR/VR and optimizer buttons link the users to the VR/AR Toolkit and the Generative Design Platform respectively. User notifications are available at the top right user profile icon. By pressing the profile icon, a user should be able to view notifications regarding collaborations, requests and contracts. Also, by pressing the profile icon, the user will be able to process his/her profile information.

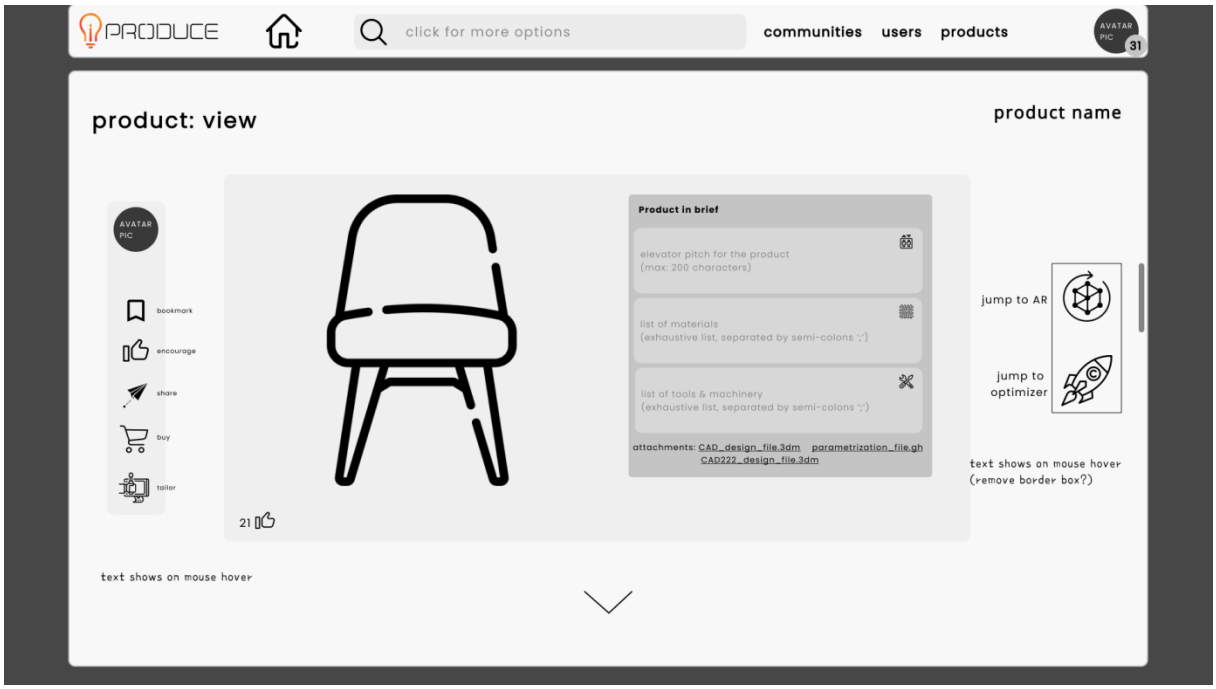


Figure 5: View Product – Overview

On the left side-bar there will be contained a buy button by pressing it the user will be able to purchase the product.

### 4.2.2. Collaborating and co-designing

In this section, based on the use cases analysed previously we present a simplified collaborative and co-design pipeline involving three different users as shown in Table 21.

Table 21: Users of Manage Teams pipeline

| Users | Role |
|---|---|
| User 1 – Manufacturer | User 1 has the role of the designer/manufacturer |
| User 2 – Consumer | User 2 has the role of consumer (Consumer) |
| User 3 – Designer/Manufacturer (Optional) | User 3 has the role of the manufacturer |

We assume User 2 is a consumer looking for a product and User 1 is a manufacturer involved in the design process of the products. User 2 navigates to the “Manage Teams” page where a list of theTeams that he is a member of is displayed (Figure 6). There, he is able to create a new team by completing the information at the “Create a new Team” tab and by sending an invitation to the desired users.

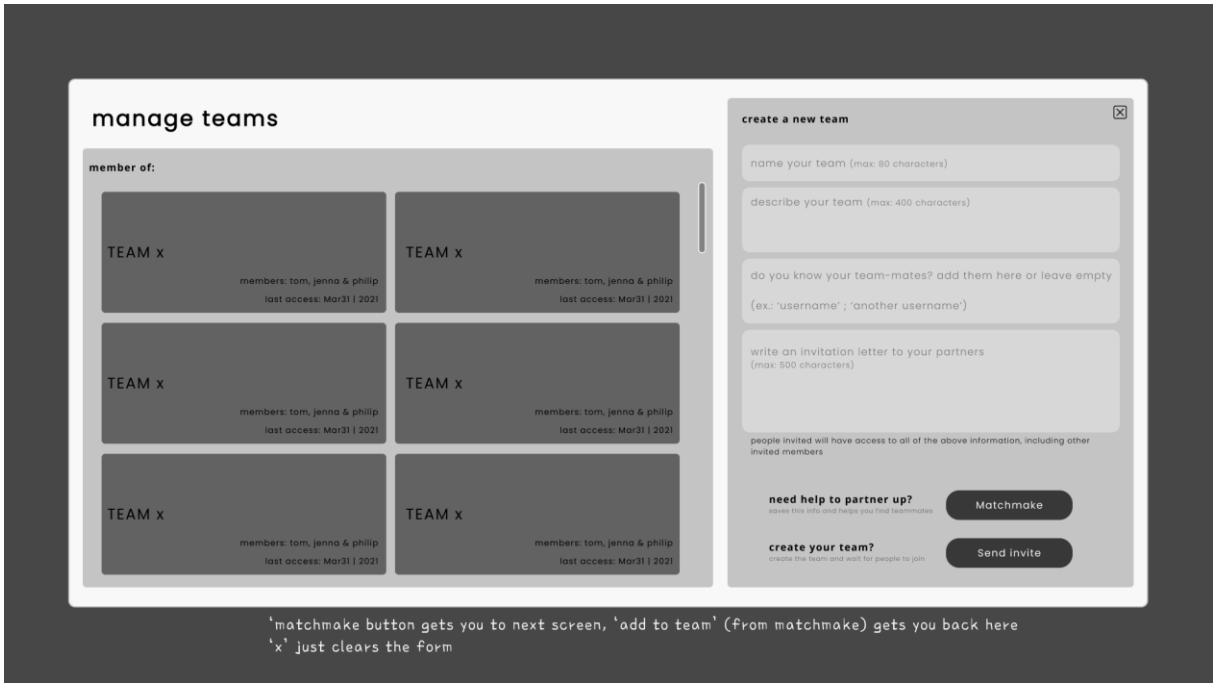


Figure 6: Create team – manage teams' page inside the Marketplace

### *4.2.2.1. Matchmaking*

User 2 uses the Matchmaking component in order to find the suitable partners by clicking the "Matchmake" button. In the specific example a list of possible candidates is returned based on the search criteria. The returned candidates will be User 1 (Mike o'Chair) and User 3 (Mike o'Chair) (Figure 7). User 2 is able to select both User 1 and User 3 for collaboration, add a message and click the "Send Invitation" button. Once User 2 sends a request for collaboration, a notification is received by Users 1 and 3.

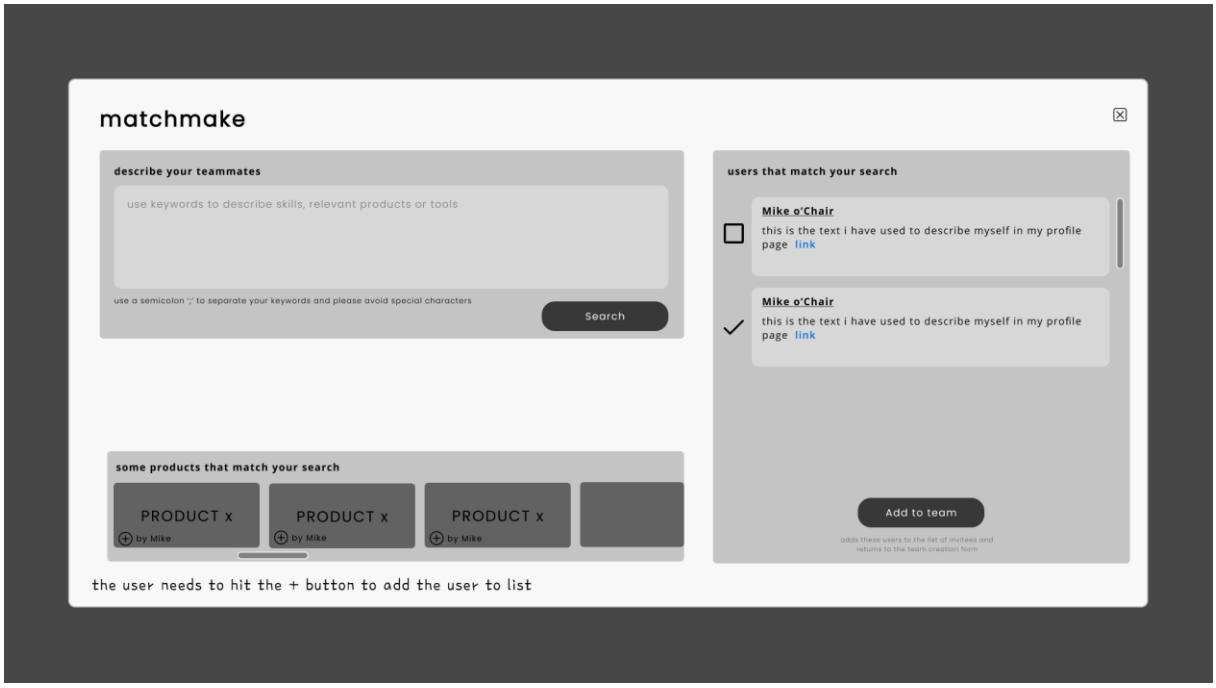


Figure 7: Create team – interface with matchmaking

### *4.2.2.2. Team Page*

When the users accept the invitations a new team is created and they all have access to team page. Inside the newly created Team Page on the Marketplace Users 1, 2, 3 have the following options:

- Add/Update a new product description (this can include text, images, 3d models etc.)
- Communicate with other teammates through text chat
- View the product's specifications

Each team user has the ability to add a new product. For example, User adds a sample product by clicking the "ADD NEW" button (Figure 9). The user has to provide information regarding the product (name, description, type, image, 3D model, etc.). When User 1 hits the "submit" button the new product is added for the team and a notification is sent to User 2 and 3. All 3 users receive a notification that a new product contract is pending. Users can view their pending contracts through the IPR Authoring Tool's web page.

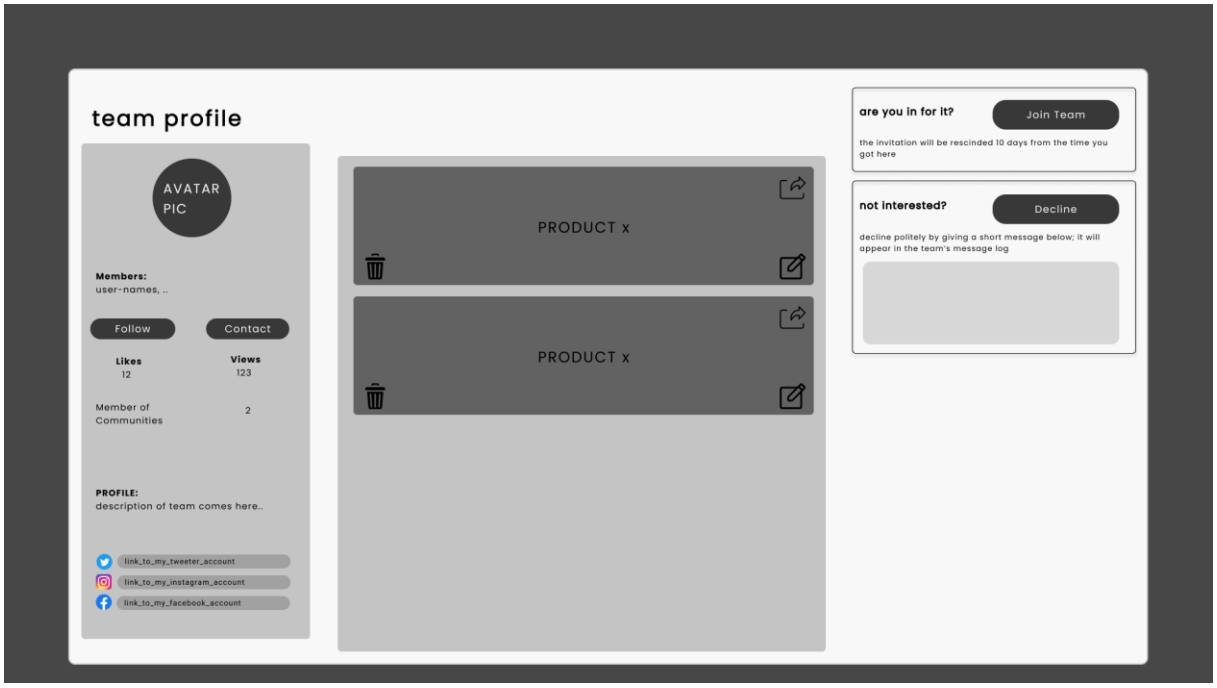


Figure 8: Join team – team preview

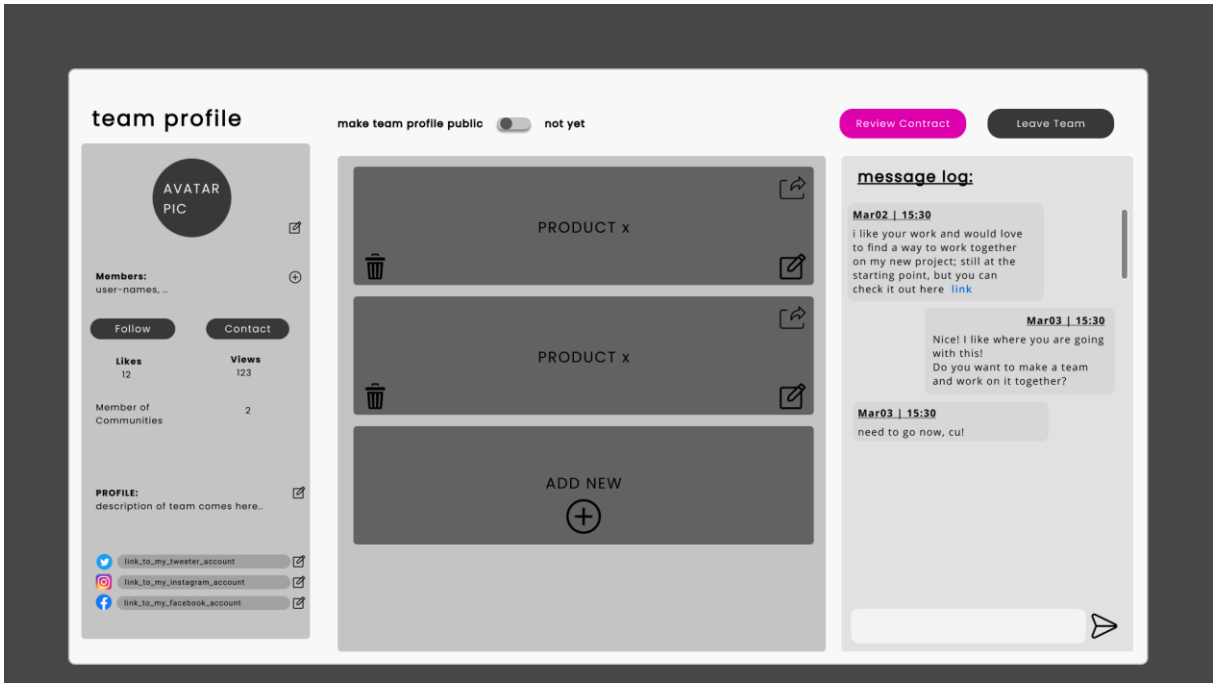


Figure 9: Join team – team page

### *4.2.2.3. IPR Authoring Toolkit*

When a new team product is added all involved users get a notification regarding a new contract that defines their collaboration. By clicking the notification the user can be linked to the IPR Authoring Toolkit's Home page (Marketplace->IPR Authoring Toolkit). On the IPR Authoring Toolkit's Home page

the user can view his pending contracts and choose to accept them. In its simplest form the contract is an NDA which states that Users 1, 2 and 3 agree to co-design a product (Figure 10). Once accepted every user can view the contract and its detailed description (Figure 11).

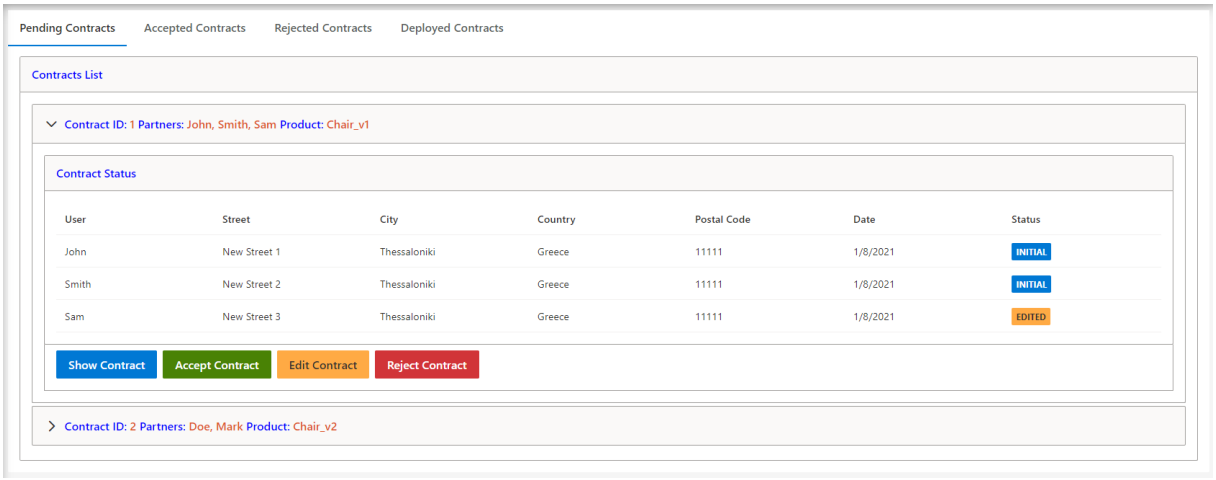


Figure 10: Pending Contracts list as shown in the IPR Authoring Toolkit's web page

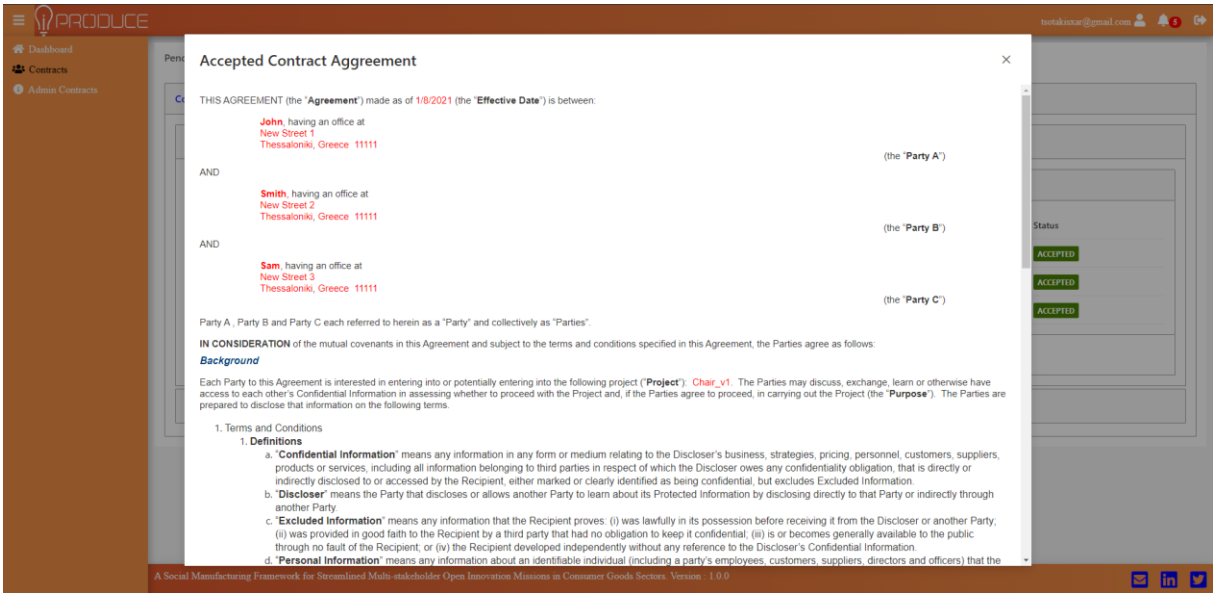


Figure 11: Accepted contract details as show in the IPR Authoring Toolkit's web page

### *4.2.2.4. Generative Design Platform*

The user can be linked to the Generative Design Platform using the "Optimizer" button from the product's page inside the team. (**Marketplace→Generative Design Platform**). A product archetype/template should be provided to the Generative Design Platform to initiate the parametric design process. These templates will be defined with the relevant cMDF.

### *4.2.2.5. VR/AR Toolkit*

A button that links the user to the VR/AR Toolkit is displayed on a Team Product tab **(Marketplace→VR/AR Toolkit)**. The button should be active only if a product has a 3D model available. In the case where User 2 wants to modify the product's appearance, (s) he can be linked to the VR/AR Toolkit by clicking the VR/AR button on the product tab. User 1 can also be linked to the VR/AR Toolkit by clicking the VR/AR button as well. Inside the VR/AR Toolkit user 2 can communicate directly with user 1and receive the same 3D visualization of the product in order make design decisions. In case User 1 and 2 decide to change the colour of a product's part to blue for example, the product will be updated for all 3 users and they will also receive a notification on the marketplace about a new product configuration.

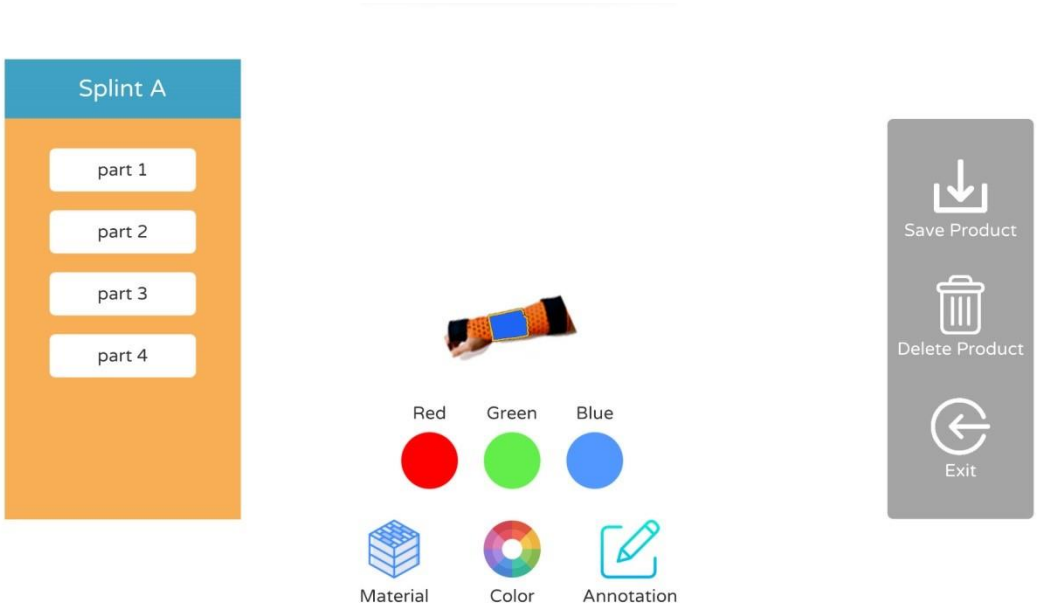


Figure 12: VR Tool, page inside the VR/AR Toolkit component

The users can also collaborate asynchronously through the VR/AR Toolkit. For example user 1 can change the material of a chair product and add a relevant text annotation. Then the other team members can see the change and the descriptive text once they enter the product's view inside the VR/AR Toolkit.

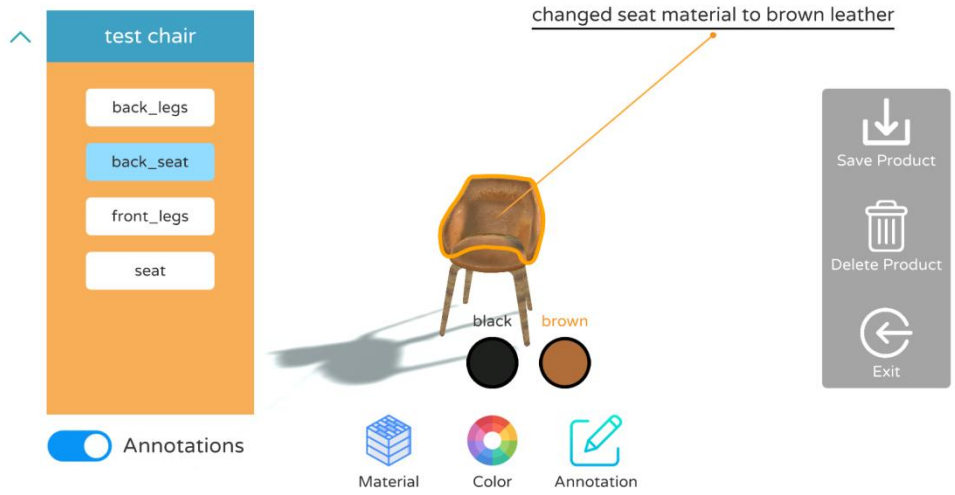


Figure 13: Text Annotation attached to a 3D model of a product as seen inside the VR/AR Toolkit component

The collaboration pipeline described above is illustrated in the sequence diagram below (Figure 18):

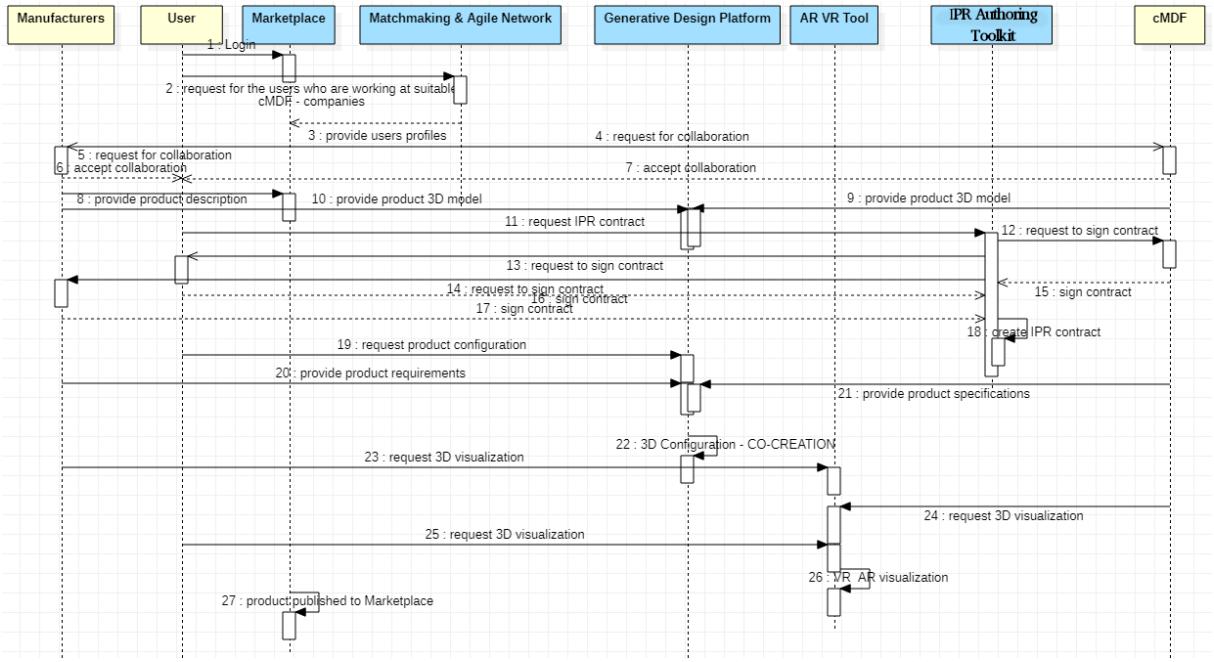


Figure 14: Holistic User Flow for Collaboration and Co-Design

### *4.2.2.6. Mobile Application*

Through the Mobile application, all involved partners (the team created by the matchmaking and agile network creation) are able to communicate and provide feedback (e.g., through a survey). The app allows users to create and publish surveys to collect feedback related to products and services from other registered users to the OpIS platform.

### 4.2.3. Data Visualization

Using the Agile data analytics and visualization suite each user is able to receive valuable visualized data. Every platform component (Marketplace, AR/VR Toolkit, Generative Design Platform, IPR Authoring Toolkit, Mobile applications, Matchmaking) provides data to the visualization suite for analysis. All the data used by the suite will be managed by the Data Ingestion and storage that will interact with the OpIS Data Repository to extend the functionalities of OpIS platform and retrieve valuable data to analyse the user behaviour, preferences about products available on the Marketplace and possible relations between the user interest on different products.

### 4.2.4. Purchasing a Product

A user should be able to purchase a product using the OpIS platform. From the products description page inside the Marketplace the ability to purchase a product by clicking “Buy” button is provided. For example in the Danish use case, a user will be able to purchase a tall desk that is already on the marketplace. If the product has a 3D model description he can preview the product in VR/AR using the “VR/AR” button (Marketplace->VR/AR toolkit) on the product tab and then add it to his/her cart (Cart button). When the purchase is confirmed a new contract is created on the IPR Authoring Toolkit detailing the purchase (Marketplace->IPR Authoring Toolkit). Once User 2 and the Back brace provider sign the contract through the IPR Authoring Toolkit page the purchase is validated and complete.

This pipeline is also depicted in the figure below:

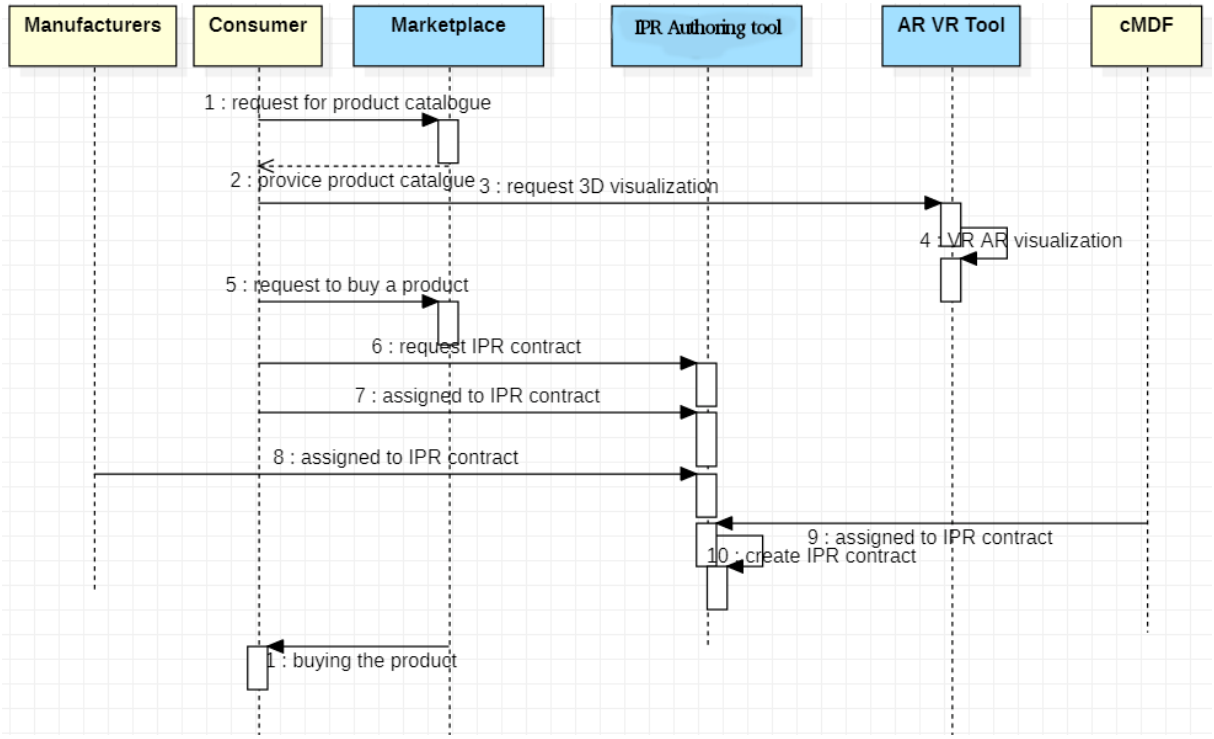


Figure 15: Purchasing a Product pipeline

### 4.2.5. User's flow using the Digital Fablab Kit

The Digital Fablab kit consists of the Training Support Tool and the Process Automation Tool components. The Training Support Tool of the Digital Fablab Kit can be used to provide instructions and training for the use of a particular machine which is accessible in a maker space. This way it can help inexperienced users to get familiar with previously unknown equipment.

In addition the Training Support Tool of the Digital FabLab Kit can help the workshop conductor to reduce the time spent for the instruction of new makers which are not familiar with the use of a new machine or material. The knowledge about material and machinery should be digitized as virtual sample projects or as learning materials as much as possible. This can greatly reduce the time spent on explaining repetitive information.

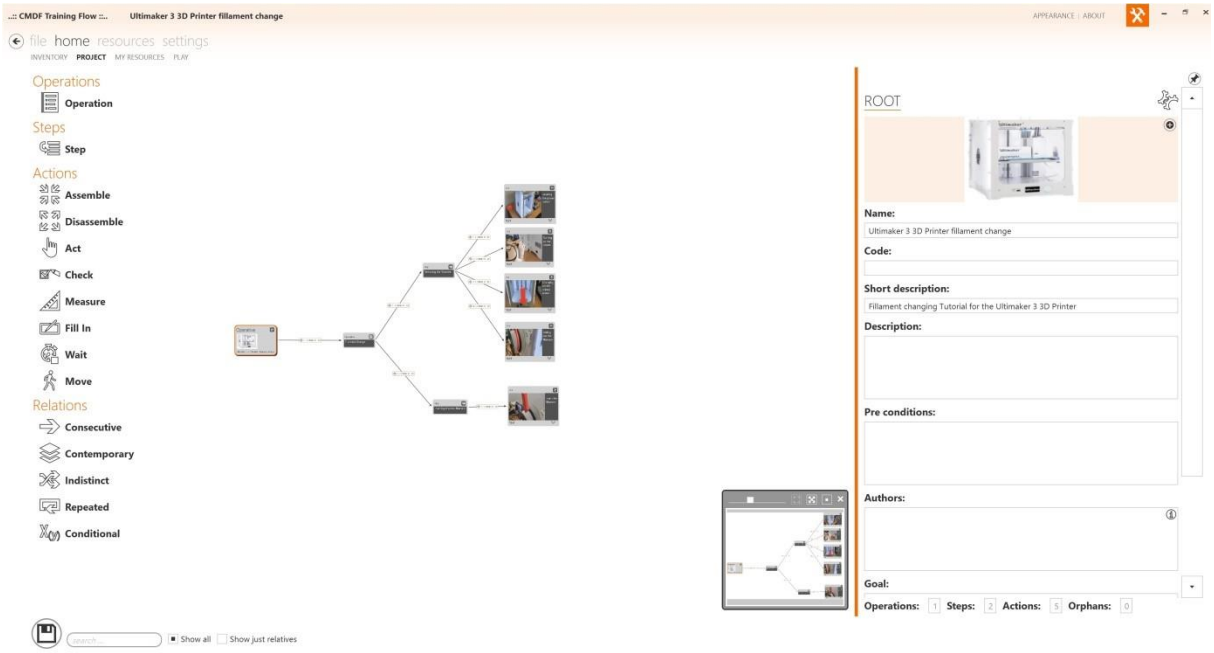


Figure 16: A training procedure as seen inside the the cMDF Training Flow application

After the inexperienced user gets familiar with a new machine using the Training Support Tool of the Fablab Kit, the workshop conductor will need to provide only instructions for sophisticated aspects which cannot be easily digitalised.

The Training Support Tool is used by Workshop Conductors to create training material, e.g., AR Training procedures, training videos or digital twin tutorials. The central component is the cMDF Training platform which consists of the cMDF Training Flow and View applications.

Through the cMDF Training Flow application an experienced user can create AR training scenarios by breaking down into simple steps and digitizing standard operative procedures (Figure 16).

Inexperienced users can then receive training enhanced with Augmented Reality using the cMDF Training View mobile application (Figure 17).

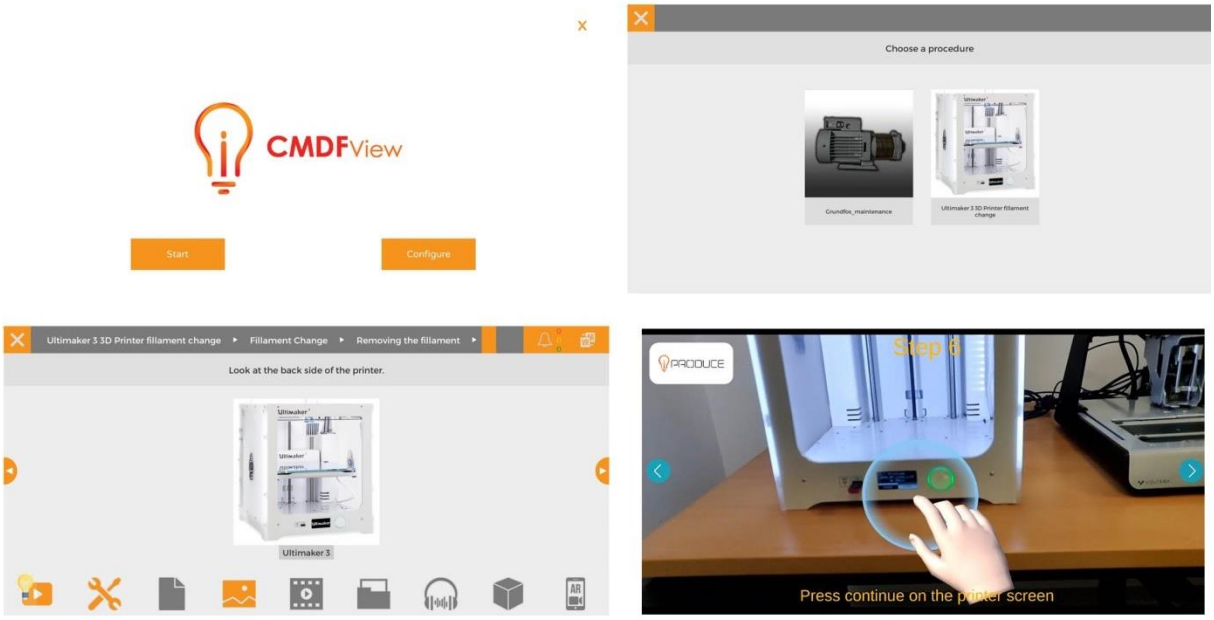


Figure 17: Viewing an AR Training procedure through the cMDF Training View application

# 5. Conclusions

This document D2.7 constitutes a report in which the objectives of the Task 2.5 are addressed so that the iPRODUCE social manufacturing concept will be enriched. Firstly, the analysis of the results based on the pan – European surveys identifies (i) the stakeholders' perceptions, intentions, requirements, drivers and barriers and (ii) how the stakeholders will have an active participation during a co-creation process under the iPRODUCE social manufacturing platform. This evaluation helps to understand in a better way the needs of each stakeholder, so that the business use case scenarios and the technical implementations will be based on these outcomes in order to improve the user experience. Furthermore, identifying the structure of local cMDFs and ecosystems, as well as presenting their governance principles, provides solutions for all the horizontal challenges, such as legislation, intellectual property management, data management and ethics and occupational health and safety. It is important to be mentioned that an important factor in the analysis of the local cMDFs' structure is the presentation of the user roles and the product specification of each use case which are covered in section 4.1. Based on this record, the business use case scenarios are enriched as result the development phase of the OpIS tools will be more distinct. Finally, in the last section, the OpIS user flow is configured by providing an analytical description of the user experience and navigation inside the OpIS platform so that the real interconnection of the individual components which are presented in the D4.1 (Marketplace, Matchmaking and Agile Network Creation Tool, Agile Analytics and Visualization Suite, AR/VR tool, IPR Authoring Toolkit, etc.) will be clearer.

Further improvement and enrichment of this second version will be follow by month 36, D2.8 "iPRODUCE Social Manufacturing Vision and Reference Model III", where the enhancement of the maker and Do-It-Yourself (DIY) and co-creation activities and collaboration for manufacturing consumer good will be included by providing the final developed software blog of the OpIS platform which will present the operational performance through this social manufacturing framework.

# PRODUCE

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