D2.4. Report on Co-creation and Open Innovation Methods for social manufacturing

CBS

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Abstract	Report D2.4 Co-creation and Open Innovation Methods for Social Manufacturing presents the results of Task 2.3 Mapping and Assessment of Co-creation and Open Innovation Methods, Tools and Practices. The report delivers a knowledge base of methods, tools and approaches supported by a thorough literature review, definitions and assessment of Co-creation, Co-Production and Open Innovation tools, including the definitions of Design Thinking and generative design, as well as an initial overview of current materials lifecycle management approaches to be explored and exploited throughout iPRODUCE upcoming tasks and activities.

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Executive Summary

Report D2.4 Co-creation and Open Innovation Methods for Social Manufacturing presents the results of Task 2.3 Mapping and Assessment of Co-creation and Open Innovation Methods, Tools and Practices. The aim of this task is to create a knowledge base of practices, methods and tools to ground and provide the most relevant resources to be applied the upcoming activities in iPRODUCE. The report presents the literature review, definitions and assessment of Co-creation, Co-Production and Open Innovation tools, while including the definitions of Design Thinking and generative design, more specifically how these approaches can be explored towards open innovation and social manufacturing. Furthermore, this report gives an overview of current materials lifecycle management approaches carried out by iPRODUCE partners.

The initial chapters of the report present definitions of the key concepts of co-creation, co-production and open innovation, followed by the definition of approaches and methods, such as Design Thinking, based on a thorough literature review as well as an assessment of the most popular and useful tools among makers and related creative communities. In order to complement and improve the review, we devised a small questionnaire (in Section 10.8) with the intent to gather the practitioners' perspective of the concepts and tools encountered during the review. The questionnaire gathered responses primarily from the project partners and a few other international labs and makers that assist in framing and expanding the concepts used in the project description and their related tool list. This approach has created a wider and more consistent practice perspective of the terms, which can better assist with the project process and the cMDFs developments.

The following chapters cover the methods and tools converging the literature review with the questionnaire results. The tools are introduced and discussed, including how they have impacted projects' processes and outcomes. The discussion is complemented with an assessment of how the methods and tools are applied in regards to distinct project phases. The tools are presented with their descriptions, purposes and links to digital resources and are listed according to the assessment of their popularity, from the most to the least used and known. The report also covers the assessment of hardware and software tools used by iPRODUCE partners as well as an initial assessment of approaches towards lifecycle management from within iPRODUCE partnering labs.

The final chapters give examples of which types of tools and methods can be applied in the context of the project upcoming tasks and activities, towards optimising and devising new approaches for social manufacturing and urban production.

In summary, this report analyses over 100 co-creation and co-production tools and resources as well as communication platforms used across projects for various purposes identified thorough literature review and desk research. The tools cover all aspects of co-creation project phases: team building, research, ideation, development, assessment and evaluation and validation. The types of tools and resources are assessed on how they impact co-creation processes and they are listed in tables based on an assessment of their popularity (indicating which were the ones most used and known among makers). The final part of this report indicates how a range of these tools can be applied throughout many of the iPRODUCE activities, helping identify those most valuable for social manufacturing and how they can be adapted or further developed to support and strengthen the iPRODUCE platform towards creative approaches to local and on-demand urban production.

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1. Introduction

A wide range of co-creation/co-production and open innovation methods and tools are currently being used in collaborative design processes across the world. These methods and tools are constantly evolving and the list keeps developing keeping pace with technology advancements. This report presents an overview of the mapping and assessment of existing co-creation and co-production tools and methods available, and in which capacity they can aid iPRODUCE cMDFs and other related initiatives as a knowledge base to be explored and applied throughout the project activities.

The report initiates by presenting the literature review covering co-creation, co-production, open innovation and generative design concepts demonstrating that they are all well-acknowledged approaches to advancing open-innovation. This literature review is complemented by a chapter covering Design Thinking approach, how it is widely applied across industries and disciplines, applying co-creation resources across its process. To further map, review and assess how these tools and methods are applied, the literature review was supplemented by questionnaires and forms to create a dynamic assessment of the tools to identify which of them were most known and used across maker communities.

The following chapters present an overview of the existing co-creation and co-production tools and methods, while also providing a link to their available resources, description and purposes. There is a vast number of tools available in the market, through the literature review and questionnaire responses over 100 tools and activities were identified, assessed and listed according to their popularity and briefly described. This listing complemented the literature review helping evaluate the tools. Furthermore, these tools are discussed in regards to their impact in different processes and projects according to the literature. This breadth of resources show the wide scope and their value in running co-creation activities, leading to new formats and models towards achieving successful open innovation in industry and public settings. The tool lists were complemented by the mapping of both hardware and software tools and methods currently used by iPRODUCE partners, which are presented according to how and when they are applied.

Another chapter is dedicated to present current aspects of iPRODUCE labs' lifecycle management approaches, showing existing initiatives.

The two final chapters contextualise and discuss the resources, indicating how they can be explored within iPRODUCE upcoming tasks and activities, followed by the conclusion.

Overall, this report fulfils the overall task goals and contributes to iPRODUCE by creating a thorough knowledge base of co-creation/co-production tools and methods to be exploited throughout project activities.

2. Key Concepts

The iPRODUCE project makes use of key concepts that inform the core approach of the project. Co-creation, co-production and open-innovation are connected terms and have been defined and widely used in the literature to describe different types of user involvement in various stages of the production process (Voorberg, Bekkers, & Tummers, 2015), such as research, developing and testing ideas, validating and testing products in various contexts. More specifically the co-creation and co-production terms have been used as almost synonyms, with little differentiation between them (ibid.). Despite this interchangeable aspect, for the goal of this project we choose to align ourselves with specific definitions, however, due to the exploratory part of the research we also incorporate definitions given by the questionnaire respondents.

In order to provide a relevant set of search results, we chose the Association for Computing Machinery (ACM) digital library[1] as a key resource database due to its profile covering computing, engineering, design and science related topics, including those involved in manufacturing, machinery and production, all of which are the key aspects involved in the iPRODUCE project. Furthermore, the ACM digital library covers journals, books, magazines, conference proceedings in all iPRODUCE related fields.

From the existing literature, when doing a search for "co-creation" within the ACM digital library[2] returns 1,248 results spanning from 1984 to 2020, with a clear peak in publications containing the theme since 2007. From within the ACM Guide to Computing Literature there are 2,615 records for co-creation spanning the same timeframe. The publications vary in types, from sessions, papers, videos, etc. Within the same library, a search for "co-production" returns 346 results with the first publication from 1965 and a peak in publications from 2010 to 2019, and searching for "open-innovation returns 639 results with the first publication from 2003. Doing a search for "generative design' within the same libraries returns 263 results, spanning 1992 to 2020. When searching for "Design Thinking", it returns 1,575 results spanning 1981 to 2020 (although in the early papers from the 80s the term is not used in its methodological meaning, but just as a way to describe the thinking behind the design). The search results indicate how the terms and their applied approach have been picked up in the first two decades of the 21st century, pointing at their importance and characterizing a new paradigm in pursuing development and production.

Informed by the theoretical review, we introduce the terms and concepts behind them in a concise format, focusing on their importance related to the project and raising questions on how to best appropriate these methods and tools in the iPRODUCE cMDFs setup and practice.

2.1. Co-creation

Co-creation tools and techniques are not new; they have gained prominence in the past two decades however, their history start further in the past. Regarding co-creation definition, one problem is due to its widespread and to some extent vain use within academic and non-academic literature.

> "The term is much used as a 'buzz-word'. As a consequence, within an emerging field, such as co-creation is today, many arbitrary interpretations and hit-and-miss operationalisations of the concept will appear" (Degnegaard, 2014, p. 97).

[1] ACM is the world's largest educational and scientific computing society, delivering resources that advance computing as a science and a profession.
[2] *https://dl.acm.org/*

The definitions of co-creation are found from within psychoanalysis to marketing, design and information and communication technologies (ICT) and artificial intelligence (AI) (Degnegaard, 2014; Dengel, 2016), all agree on the meaning of the words, indicating a process that is not an individual experience, but instead defined for its collaborative aspect. This collaborative aspect also belonged to machine development in the late sixties, more precisely within Scandinavian contexts, early known as participatory design (Bodker & Pekkola, 2010). Participatory design focused on the workplace, more specifically how factory workers used machines, and adapting the machines to fit their use accordingly, and it soon became recognised as an important step when designing factory machinery (Sanders & Stappers, 2008). It quickly gained space and became known as 'an approach to systems design most suited for work settings' (Bodker & Pekkola, 2010, p. 46). As participatory design gained attraction within Scandinavia, popularising the approach of including users in the process of developing or altering products within commercial industries in the nineties, and slowly expanded its field with the arrival of digital products and their interfaces. The digital demand prompted a new set of skills, as users (and consumers) had not only to navigate digital spaces, but also directly interact with these new interfaces and devices (Knowles et al., 2019; Voorberg et al., 2015).

It can be suggested that the participatory design concept definition is intertwined with that of user-centred design, even though they might not necessarily be described or presented as connected (B.-N.Sanders, 2002a; Battarbee, Cabrera, Mattelmäki, & Rizzo, 2008; Gasson, 2003; Norman, 1988). In user-centred design, the focus is on 'the thing being designed (e.g.., the object, communication, space, interface, service, etc.), looking for ways to ensure that it meets the needs of the user' (B.-N.Sanders, 2002b, p. 1). In user-centred design, the approach is still to design for the user and not necessarily with users. This approach, which became widespread within the design field and across various industries, got another push as systems and services evolved to become a compilation of physical and digital counterparts, with interfaces that had to match, inform and complement each other across contexts and experiences. These new contexts were identified the birth of the *experience economy*, to indicate that the interactions between users and interfaces had to fulfil more functions than just utilitarian ones (Pine & Gilmore, 1998). This shift prompted private and public initiatives to look more closely at product and service development, demanding the uncovering of various aspects related to use and the interactions with products and services, bringing together what users say and do, to what they make, thus tools and methods had to be developed to fulfil these new demands (B.-N.Sanders, 2002b). The concept of co-design (Battarbee et al., 2008; Sanders & Stappers, 2008) follows and with it the co-creation approach, where users become a valuable resource towards product and service innovation (Voorberg et al., 2015). The developed tools slowly permeated the private sector, and due to their success, have caught up within the public sector in recent years, with the second decade of the 21st century seeing their prominence in public tenders. In 2016, the European Commission (EC) defined co-creation as 'the process of creating new public policies and services with people and not for them' (European Commission, 2016). More recently co-creation has been further defined as the 'creation, development and deployment of ideas and solutions emerging from a collaborative process among a group of key project theme's stakeholders' (Angelidou, Karachaliou, Froes, & Wippoo, 2020, p. 2).

Co-creation as a collaborative process, promotes the development of ideas and solutions to be deployed in the context where they have emerged (Puerari et al., 2018; Sanders & Stappers, 2008). The approach involves various phases that can be carried out in short or long formats. For example, there are projects that will make use of co-creation tools throughout the whole process, which can last from one week to a few years, while others might only use during specific phases of product development. One key aspect of the co-creation approach is bridging disciplines and competences.

By gathering a diverse expertise, projects gain a wide perspective during their product development, early uncovering challenges, assets and opportunities within the product or service being created.

From the questionnaire, 22 respondents agreed with the co-creation definition suggested:

'Co-creation is defined as any project/product/service emerging from a collaborative development with a group of different stakeholders (citizens, designers, companies, makers, etc.)'.

While two respondents offered the following definitions:

a. Co-creation is a process (or organization methodology) for creating new products or services by involving different stakeholders in collaborative development
b. Co-creation is not only a formal consultation in which professionals give users the opportunity to express their views on a limited number of alternatives, but "a more creative and interactive process that challenges the opinions of all parties and seeks to combine the professional experience and diverse actors in new ways", where the design of the process goes through different iterative cycles of learning and requires the participation of users

While both responses align with the suggested definition, response b expands it in line with Design Thinking and human-centred design processes, which will be described later in this report.

2.2. Co-production

Co-production has been identified in the late seventies as the need to involve citizens in the production of public services (Alford, 2014; Percy, 1978). More recently, the term co-production has been used towards defining a process where various stakeholders engage in conceptualising and testing solutions before they are implemented, or 'an arrangement where citizens produce their own services at least in part' (Brandsen & Pestoff, 2006, p. 6). Co-creation and co-production terms have been similarly defined, with the terms being used as synonyms or the choice of using one over the other being apparently random (Voorberg et al., 2015). Recently, the co-production term has had a wide concentration of use within design, engineering, however it also has been broadly used within urban development and governance topics. From the existing literature, co-production appears to have been more broadly used within public services (Alford, 2014; Brandsen & Pestoff, 2006; Khan et al., 2017), which agrees with its early definition.

Looking at both co-creation and co-production terms, they indicate and highlight the shared character of a creation and production process. Their definitions present the importance of a holistic approach when developing public or commercial products and services and the value of interdisciplinary expertise among the participating stakeholders. Recent scholars have also highlighted the importance of co-production in shared platforms thanks to its impact in community building and creating a common value. This connection may also lead to a higher commitment and help with the sustainability of the platform (Primlani, Salunke, D, Sutar, & Sharma, 2017), similar to that described in the co-creation literature.

Therefore, we see co-production and co-creation terms directly intertwined, and for the purpose of this project, we will not differentiate between the two, as both indicate the inclusive aspect of involving stakeholders throughout to process to be carried out by the iPRODUCE cMDFs.

2.3. Open Innovation (OI)

Another concept that directly relates to those of co-creation and co-production is the one of open innovation, connecting internal research to outside ideas (Chesbrough, 2003; Helfat, 2011). Open innovation principles cover 'integrated collaboration, co-created shared value, cultivated innovation ecosystems, unleashed exponential technologies, and extraordinarily rapid adoption' (Curley & Salmelin, 2008)(Figure 1). Most importantly, it indicates that products and services ideas are to be co-created with groups that do not necessarily work in the company or organisation that will develop or provide them. Therefore, open innovation contrasts with closed innovation, by outsourcing and expanding the reach of where ideas might come from (ibid). The process of innovation includes three phases, idea generation, idea development, and the diffusion of developed concepts, which very much align with those described in design processes. Design processes tend to break these phases into sub-phases, creating a more detailed description of the process.

A key implication of open innovation deals with companies having to increase their '"metabolic rate" at which they access, digest, and utilize knowledge. Companies cannot treat their knowledge as static; they must treat it as fundamentally dynamic' (Helfat, 2011, p. 57). Technology advancements are crucial to pushing this shift in pace and require services to maintain a continuous adaptive process, to keep up with emerging demands and needs. Therefore, OI is a valuable aspect within local production and 'Do it yourself' (DIY) initiatives, and is a core structure of the iPRODUCE project DNA.

For the purpose of this report, we have mapped a number of co-creation/coproduction and open innovation tools and resources, which will be presented and described in chapter 4.

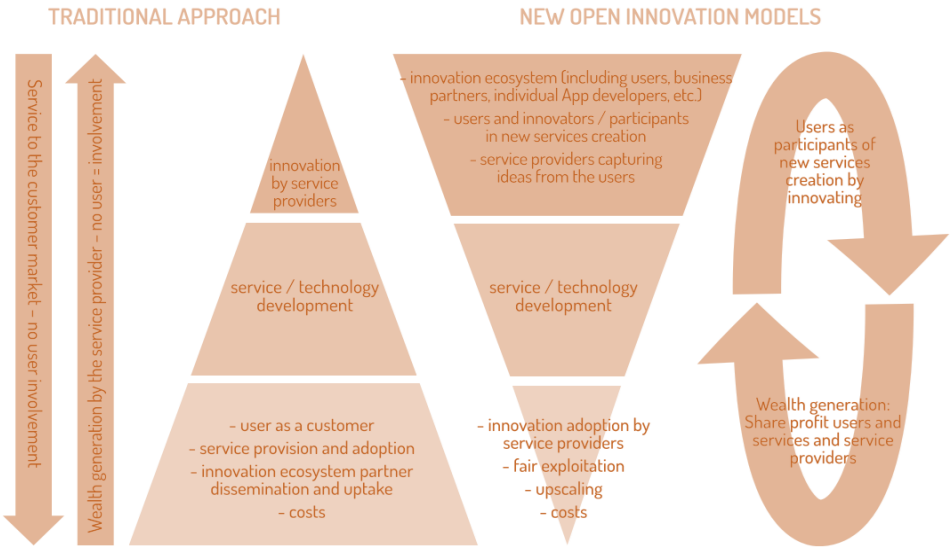

Figure 1. Open innovation model, traditional versus new approaches. Source EU Open Innovation Strategy and Policy Group, 2013

2.3.1. Social Innovation

Although not directly described in this project task, the concept of social innovation also belongs in the realm of open innovation. Social innovation has been described as:

> "…the creation of long-lasting outcomes that aim to address societal needs by fundamentally changing the relation- ships, positions and rules between the involved stakeholders, through an open process of participation, exchange and collaboration with relevant stakeholders,

> including end- users, thereby crossing organizational boundaries and jurisdictions"(Voorberg et al., 2015).

Aligning with this definition, we can bring another aspect within the open innovation process, more specifically the challenge to an existing hierarchy that is required to bring a fruitful outcome of the interdisciplinary stakeholder involvement.

Social innovation as a collaborative concept implies a social change in some form focusing on sustainable and shared outcomes (Ziegler, 2017). The makers' movement, hackerspaces, fablabs and other community driven initiatives have been described as social innovation (Tracey & Stott, 2017). Through developing new formats and processes of exchange through open innovation approaches, new business models emerge and create opportunities that affect social constructs, thus leveraging societal change. Moreover, facilitating citizen engagement in social manufacturing offers the development of untapped opportunities, empowering local communities to spearhead new businesses and services that benefit both markets and social integration.

2.4. Generative Design

Generative design is an explorative design process, and its core theory deals with providing the thinking or rationale behind achieving a potential outcome. In other words, generative design covers establishing a set of goal and constrains to the system and let it create its own combinations to fulfil the defined goals (Matejka et al., 2018).

A simple example deals with how generative models have been widely used within 3D printing, basically providing the capability of generating new 'products' similar to the initial models (Tutum, Chockchowwat, Vouga, & Miikkulainen, 2018). Due to its holding metaphor and definition, generative design has been widely used from 3D printing, as in the recent example, to video games and participatory design sessions (Chen et al., 2018; Dearden, Finlay, Allgar, & McManus, 2002; Kazi, Grossman, Cheong, Hashemi, & Fitzmaurice, 2017; Salge, Green, Canaan, & Togelius, 2018). The strength of applying generative design within manufacturing and production development can be highlighted through its aptitude to help engineers, designers and makers assess the best outcomes, analyse them towards feeding new parameters in forthcoming iterations. Furthermore, generative design helps address manufacturability limitations leading to the development of improved products (English, 2020). From an algorithm perspective, generative design feeds directly into machine learning (ML), called Deep Learning (DL) and its applications are vast within various areas, including that of 2D and 3D designs, including those of generative design results analysis, such as Generative Adversarial Networks (GANs)(Newton, 2019).

Therefore, generative design offers a wide range of possibilities within social manufacturing. In the case of the iPRODUCE project, generative design could be explored through providing product parameters and goals in different systems across the cMDFs and analysing the results to evaluate which outcomes were most successful. The learnings from such experiment could then feed back into the various systems across the iPRODUCE collaborating labs for a new round of product results. This approach could expand the generative design approach and be described as a form of machine crowdsourcing. Questions that arise deal with how to best define the criteria for analysis and how to facilitate this exchange within the iPRODUCE platform.

The tools presented in chapter 4 support all the concepts introduced here, but for the purpose of alignment to the questionnaire used, we present them as co-creation tools.

3. Co-creation and Design Thinking Methods and Approaches

In this chapter, we present the Design Thinking approach and which tools and resources are currently available towards this approach.

3.1. Design Thinking

As previously described within co-creation, co-production and open innovation, design processes converge all these concepts into a full structured process. The design process is iterative and includes a set of phases in developing products and services that define the Design Thinking approach (T. Brown, 2008; T. Brown & Katz, 2009; Buxton, 2007; Chou, 2018; Dörner, 1999; Liedtka, 2018; Stickdorn & Schneider, 2012; Thompson, Goldwasser, Stanford, Syverson, & Haley, 2017). In short, Design Thinking can be defined as the ability to think as a designer (T. Brown, 2008), so applying design processes and methodologies with a human-centred focus. As defined by Brown and Wyatt 'Design Thinking incorporates constituent or consumer insights in depth and rapid prototyping, all aimed at getting beyond the assumptions that block effective solutions' (T. Brown & Wyatt, 2010, p. 2).

Design thinking became very popular in the 21st century and it has been used as a methodology for innovation for various tools. From Blockchain and other related solutions (Schönhals, Hepp, & Gipp, 2018) to education and ways of teaching to industry to public services (Denning, 2013; Farnsworth, Lawler Kennedy, & Kumar, 2016; Hennigan, 2019; Murauer, 2018; Sari & Tedjasaputra, 2018; Thompson et al., 2017; Walker, Nolen, Du, & Davis, 2019). Although Design Thinking is regarded as a 'newer' approach, some scholars point out that its history links back to the 60s, not directly to participatory design but the works from within engineering and computer fields (Thompson et al., 2017).

The terms of co-creation and Design Thinking tend to be mashed up and used in various settings, with some fields describing their methods as a co-creation methodology. For example, in projects where users are involved in interviews and workshops, they are described as applying a co-creation methodological approach (Knowles et al., 2019).

As described by Brown (2008, 2009, p.87), the Design Thinking process requires the skills of Empathy, Integrative Thinking, Optimism, Experimentalism and Collaboration.

a. Empathy. Deals with observing, listening, respecting and engaging with others. It is the first step to avoid misjudgements that might jeopardise the process.
b. Integrative thinking. Create connections and the ability to expand the thinking beyond the obvious. Create bridges of thoughts that should expand ideas.
c. Optimism. To believe in the process and that the outcome will show higher value than whatever exists in the market.
d. Experimentalism. Explore ideas and limitations through questioning, creating new perspectives to be explored and considered.
e. Collaboration. Facilitating the interdisciplinary aspect to create a valuable knowledge exchange towards more holistic solutions.

Recently, the design council in the UK has suggested the framework for innovation and Design Thinking supported by the their 'double diamond', dividing the phases into discover, define, develop and deliver (Design Council, 2019). More specifically, these phases cover the research, concept definition and development and bringing the product to market. To carry out these phases, despite distinct, they feed off and keep a direct connection with each other, being dynamic and constantly reiterated.

More recently, other researchers and designers have suggested a triple diamond model for Design Thinking process (Gray, 2019) as shown in Figure 2.

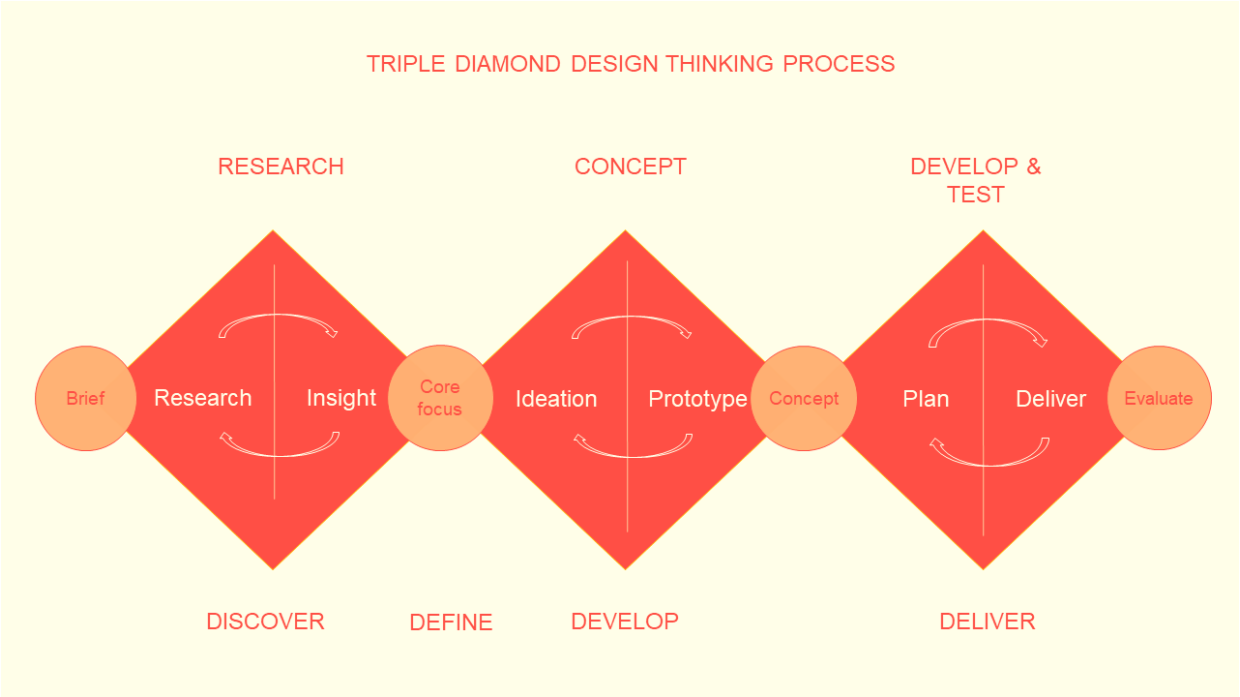

Figure 2: Triple diamond Design Thinking process adapted from Gray, 2019

When aligning co-creation and co-production tools and methods with the diagram in Figure 2, we can highlight how these tools can be applied in all the phases towards various desired outcomes:

a. Research. Includes user research, both market and audience research towards uncovering existing behaviours and needs.
b. Insight. Evolving from the research findings, choosing with the various stakeholders and users which aspects to focus.
c. Ideation/Prototype. Co-create solutions and concepts addressing the selected aspect of focus. Co-create prototypes to be tried out and evaluated together with the internal and external stakeholders. During this phase and depending on prototyping tests' results, the concept can still change a lot or even be fully dismissed sending the team back to the ideation board.
d. Plan/Deliver. Co-define the product/service process, uncovering problems and opportunities that might promote/interfere with the product/service adoption as well as define a product/service plan milestones and timeline. This process should also include validation tests, which might lead to small tweaks in the product. This also entails a second round of evaluation and benchmarking to better define the marketing strategy and product positioning.

Most importantly, the final product/service can be linked back to the research findings and insights and it should demonstrate how it addresses them. If this method is to be applied throughout the project, it is important that the cMDFs become well acquainted with the approach, possibly also helping advance it through social manufacturing experiences and learnings.

The Design Thinking process and the various co-creation/co-production tools used to apply the process can also be considered as iterative, as they keep evolving and being developed as new needs emerge and the method is contextualised accordingly.

4. Methods and Tools

This chapter presents an overview of the mapping and assessment of methods and tools with a strong application in Design Thinking and co-creation/co-production projects and approaches, creating an informed knowledge base for iPRODUCE upcoming activities and tasks.

The mapping and assessment of co-creation/co-production methods and tools are divided into 3 sets:

- Online resources - covering online sites and platforms.
- Co-creation/co-production resources – covering various activities, models and services.
- Communication resources – communication platforms and services.

These resources are presented and described in the following sub-chapters, covering how they have impacted diverse processes, moreover, they are clustered according to their purpose and use.

4.1. Overview and assessment of methods and tools

There is a large number of different co-creation/co-production tools used towards applying Design Thinking processes. According to the literature review, these tools are used towards distinct phases in the process, more specifically the tools' purpose and use is linked to research, team building, ideation and development, assessment and validation phases. The literature review and desktop research revealed how the various tools have had a strong impact in various projects through facilitating a holistic approach of product and service development, while also providing faster and tested means for bringing the product to market and process replication.

After the thorough literature review and the desk research investigating current co-creation tools in the market, the tools were added to a questionnaire (*appendix 10.8*), which was initially sent out to the project partners. The online questionnaire assessed the extent to which these tools are known and which of them are most used among the involved maker communities. The questionnaire was open and shared beyond the iPRODUCE partners to gather a broader international perspective. Among the countries represented beyond Europe, Brazil and Japan were present in the results (Figure 3). From the literature review and questionnaire responses, even though they did not reach a large number of respondents outside the project partners[3], it became clear that some of these resources are well known to research and maker communities, while others are known but not necessarily very used.

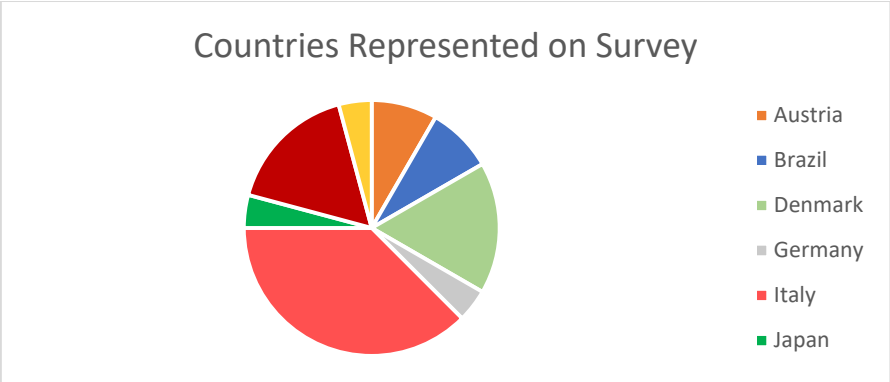

Figure 3: Countries represented on the online questionnaire

[3] The questionnaire was not among the task objectives, however we feel that it positively supplemented the literature review.

The literature review and questionnaire responses show how these tools have been applied and we have clustered them in the following categories of use and application:

1. Research **(R)**: Covering different approaches to identify citizens and stakeholders' perceptions, habits, preferences, needs, etc. Research tools and resources can be used at different times in the projects. In a Design Thinking approach, projects should use research as a starting point for understanding current issues and opportunities instead of starting with a solution to be developed. This aspect is connected to the Discover Phase from the Triple Diamond (Figure 2).

2. Team-building **(TB)**: Creating a team is a key aspect in co-creation. To obtain a higher engagement together, participants need to feel involved and belonging to the group. These tools and activities focus on creating a space with a common language and a feeling of trust and equality, which are key aspects to achieve a positive collaboration towards a shared outcome. Team Building should be seeing as a preparation to engage in the Design Thinking process, as well as used throughout as a way to create cohesion and better cooperation and exchange among the teams working in the projects.

3. Ideation **(I)**: Tools and resources that help participants develop ideas and gain perspectives to create novel concepts solving or addressing insights uncovered through the research tools. This aspect is connected to the Define and Develop Phases from the Triple Diamond (Figure 2).

4. Development **(D)**: Tools catered to help develop the ideas into more tangible concepts and scenarios that can be initially prototyped, both in low of high definition. This aspect is connected to the Develop Phase from the Triple Diamond (Figure 2).

5. Assessment/Evaluation **(AE)**: These tools facilitate an understanding about the concepts feasibility, impact, value and positioning compared to related cases/projects on the market as well as the project budget and timeline. This aspect is connected to the Develop and Deliver Phases from the Triple Diamond (Figure 2).

6. Validation **(V)**: Validation tools are applied as a way to test if the ideas and solutions fulfil their goals, and how they are adopted and appropriated by users. They can also be used to benchmark the service or product. This aspect is connected to the Deliver Phase from the Triple Diamond (Figure 2).

4.1.1. Mapping and assessment of online resources for social manufacturing (forums, wikis, bulletin boards, etc.)

Many of the resources used by makers across the world are found online, most of which provide dynamic and up to date content. The content varies from projects and programming examples, tutorials, educational materials, videos and more. Many of these resources function as network groups, having members and creating resourceful and interdisciplinary communities where participants exchange tools, manuals, projects and templates to be widely explored across their network. These resources are presented in Table 1 ranked based on the assessment of usage and awareness (from most to least used and known according to the questionnaire responses). In the vast majority, the descriptions originate from the sites themselves to keep the accuracy of how the platforms describe their roles. In Figure 4 and Table 1, the resources are the sum of both the ones presented on the questionnaire and those suggested by the respondents.

The results show that there is a broad knowledge of these resources among the maker community. The online platforms dealing with physical computing, programming and project tutorials are the most used and widespread among makers. According to the literature review and supported by the

questionnaire response, they are perceived as reliable resources and communities when developing projects. This result does not come as a surprise, considering the collaborative aspect of maker communities however, it does highlight the lack of an existing centralised resource. In order to create a platform to support local manufacturing, it is vital to further assess the quality of the tutorials and examples in these platforms, how and if aspects of data collection, intellectual property (IP) and ethics are taken in consideration, informing best practices to be incorporated into the iPRODUCE platform.

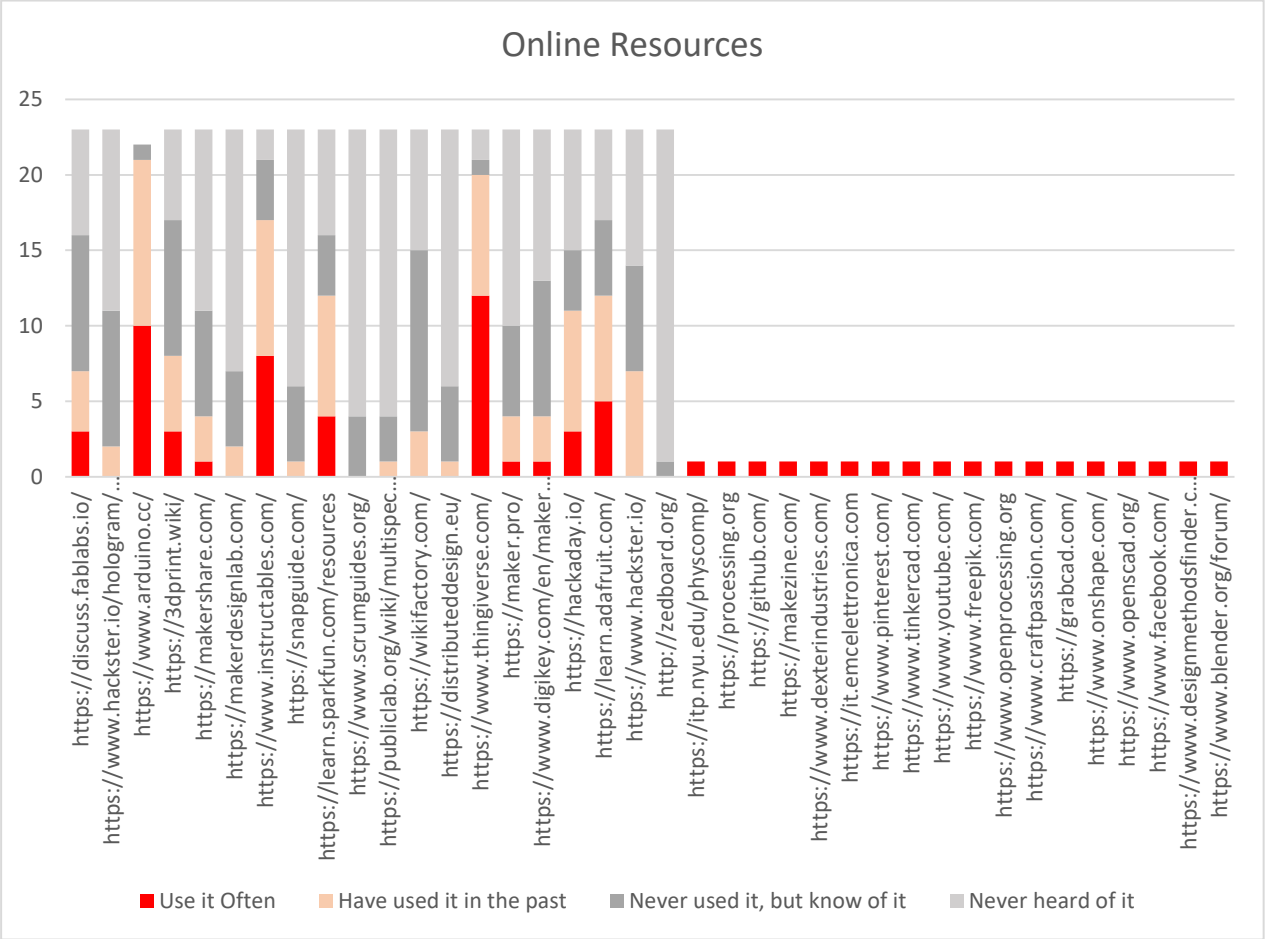

Figure 4: Online resources questionnaire results

In Table 1, the third column (Purpose) indicates the purpose (when in the process the resource has been used):

- Research **(R)**,
- Team-building **(TB)**
- Ideation **(I)**
- Development **(D)**
- Assessment/Evaluation **(AE)**
- Validation **(V)**

Table 1: Online resources list and description

Online resources for social manufacturing			
Platform Name	**Link**	**Purpose**	**Description (how they are used)**
Thingverse	*https://www.thingiverse.com/*	R, I, D	Platform offering instructions and models for various DIY projects.
Arduino	*https://www.arduino.cc/*	D, AE, V	Open-source hardware and software ecosystem offering a range of software tools, hardware platforms and documentation enabling users of all types to be creative with technology. Arduino is a popular tool for IoT product development as well as one of the most successful tools for STEM/STEAM education. Designers, engineers, students, developers and makers around the world use Arduino to innovate in music, games, toys, smart homes, farming, autonomous vehicles, and more.
Instructables	*https://www.instructables.com/*	R, I, D	Instructables is a community platform for people who like to make things. Their tutorials include circuits, workshops, craft, cooking, living, outside and educational materials for teachers.
Ada Fruit	*https://learn.adafruit.com/*	R, I, D	Online platform for learning electronics and making designed products for makers of all ages and skill levels.
Sparkfun	*https://learn.sparkfun.com/resources*	R, I, D	SparkFun is a another maker platform with open course components and online tutorials helping users create from a smart weather station, to exploring the frontier of machine learning, as well as building a robot for school or prototyping a range of products. The platform is designed to broaden access to innovative technology and make the path to a finished project shorter.
Hackday	*https://hackaday.io/*	R, I, D	Collaborative hardware development community based platform.
Hackster	*https://www.hackster.io/hologram/discussion*	R, I, D	Community platform of developers working from machine learning and edge computing to IoT security and automation.
Fablabs	*https://discuss.fablabs.io/*	R, I, D, AE	Fab Labs discussion platform. Fablabs.io is the online social network of the international Fab Lab community.

Online resources for social manufacturing			
Platform Name	**Link**	**Purpose**	**Description (how they are used)**
3DPrint	*https://3dprint.wiki/*	R, I, D	Platform offering online Q&A catalogue for 3D printing.
Makershare	*https://makershare.com/*	R, I, D	Makershare platform is a joint venture between Make: and Engineering.com to connect and elevate those who create and problem solve through projects.
Maker platforms	*https://www.digikey.com/en/maker/platforms*	R, I, D	Another product to market support platform, helping makers understand the phases that occur from concept through production. The main objective of the site is to walk makers through the design-chain "Roadmap" that offers an aggregated community of tools, ideas, solutions, and information that properly meet the needs of the marketplace every step of the way.
Maker	*https://maker.pro/*	R, I, D	Platform helping makers to design and collaborate with one another, with the goal to take their product to market. Offers both public and private project settings to support proprietary information.
Wiki factory	*https://wikifactory.com/*	R, I, D	Social platform for collaborative product development. Designed for open source communities, designers and product companies.
Maker Design Lab	*https://makerdesignlab.com/*	R, I, D	Platform offering laser cutter project cases and ideas.
Snapguide	*https://snapguide.com/*	D	Platform offering the possibility to create and share step-by-step "how to guides." The service provides easy to understand instructions for a wide array of topics including cooking, gardening, crafts, repairs, do-it-yourself projects, fashion tips, entertaining and more. Users are invited to create their own guides using the iPhone app. Snap pictures and videos of your project, add captions, and share their guide with the Snapguide community.
Multispectral Imaging tool	*https://publiclab.org/wiki/multispectral-imaging*	D	Open source community platform to modify consumer cameras to capture near infrared imagery for a range of purposes.
Distributed Design	*https://distributeddesign.eu/*	AE, V	A platform membership of 12 partners, supported by the European

Online resources for social manufacturing			
Platform Name	**Link**	**Purpose**	**Description (how they are used)**
			Union through the Creative Europe fund and an Advisory Board made up of experts related to Distributed Design. The platform fosters the role of emerging Makers and Designers as part of this new digitized world. It celebrates, supports and inspires these professionals from across Europe and provides opportunities to support the mobility and circulation of their work to connect them with new digital markets.
Scrum	*https://www.scrumguides.org/*	D	Website where the Scrum framework is introduced and explained. The platform offers instructions towards developing, delivering, and sustaining complex products. The site offers roles, events, artefacts, and the rules that bind them together into the framework.
Zedboard	*http://zedboard.org/*	D	Platform offering development kits for a wide range of applications and levels of complexity. Documentation, reference designs and training material for kits aimed at entry-level designers to those developing highly complex designs like embedded vision, test and measurement and Industrial IoT.
Physical Computing at ITP	*https://itp.nyu.edu/physcomp/*	R, I, D	Interactive Telecommunication Programme Physical Computing class syllabus and examples.
Processing	*https://processing.org*	R, D	Platform introducing Processing programming language with examples and tutorials.
Github	*https://github.com/*	D, AE	Membership development platform offering support and advice from open source to business, members can host and review code, manage projects, and build software alongside 50 million developers.
Makezine	*https://makezine.com/*	R, I, D	Maker community magazine website offering various projects and tutorials.
Dexter Industries	*https://www.dexterindustries.com/*	R, I, D	A website that offers tutorials to design, build and support educational robot platforms.

Online resources for social manufacturing			
Platform Name	**Link**	**Purpose**	**Description (how they are used)**
Emcelettronica	*https://it.emcelettronica.com*	R, I, D	Platform offering projects and tutorials on various maker topics in Italian.
Pinterest	*https://www.pinterest.com/*	I	Image sharing and social media service platform designed to enable saving and discovery of information on the World Wide Web using images and, on a smaller scale, GIFs and videos, in the form of pin boards.
Tinkercad	*https://www.tinkercad.com/*	R, D	Platform offering an online collection of software tools that help people all over the world think, create and make. Offers introduction to Autodesk, the leader in 3D design, engineering and entertainment software.
YouTube	*https://www.youtube.com/*	R, D	Online video-sharing platform.
Freepik	*https://www.freepik.com/*	D	A website offering free graphic resources.
Open Processing	*https://www.openprocessing.org*	I, D	Community platform of coders, designers, artists and educators experimenting on algorithmic design.
CraftPassion	*https://www.craftpassion.com/*	R, I, D	Website offering hundreds of free patterns & tutorials covering sewing, crochet, knitting, beading, paper crafts and more. The site also offers many tutorials on how to recycle unwanted materials into a useful handmade. All patterns and tutorials in Craft Passion come in full details with step-by-step photos, easy to follow.
Grabcad	*https://grabcad.com/*	D, AE	Free cloud-based collaboration platform that helps engineering teams manage, view and share CAD files.
Onshape	*https://www.onshape.com/*	D, AE	Product development platform that unites 3D CAD, data management & analytics. Onshape helps businesses modernize their product design process.
Openscad	*https://www.openscad.org/*	D	Product development platform that unites 3D CAD, data management & analytics.

Online resources for social manufacturing			
Platform Name	**Link**	**Purpose**	**Description (how they are used)**
Facebook groups	*https://www.facebook.com/*	R, D, AE	Maker dedicated groups on the social network platform.
Design Methods Finder	*https://www.designmethodsfinder.com/*	R, I, D	Website compiling many tools and templates to apply design methods.
Blender	*https://www.blender.org/forum/*	D, AE	Developers' Discussion forum platform.

4.1.2. Mapping, assessment and impact of co-creation/co-production tools and activities

A number of co-creation tools are well known in design, engineering, business fields and more. Various scholars and practitioners have presented and discussed them widely in the last three decades as applied techniques in various fields. Brainstorming techniques (Gregersen, 2018; Kent, 2017; Ritter & Mostert, 2018), roleplaying (Elmore, n.d.; Svanæs & Seland, 2004), sketching and prototyping (T. Brown & Katz, 2009; Buxton, 2007; Houde & Hill, 1997; Lilley, Moreno, & Lofthouse, 2011; Lim & Stolterman, 2008; Mazé & Bueno, 2002; Osterwalder, Pigneur, Clark, & Smith, 2010; Polaine, Løvlie, & Reason, 2013; Sugimoto et al., 2005; Svanæs & Seland, 2004), and storyboards (Buchenau & Suri, 2000; Nedeltcheva & Shoikova, 2017; Rajanen & Rajanen, 2019; Sari & Tedjasaputra, 2017, 2018; Zaman et al., 2015) have all been widely discussed and used in various fields with proven impact in developing new products and services. Other techniques, such as creating personas, which has been defined as creating "hypothetical individuals that take on the characteristics of real users" (Kolko, 2011), have also been incorporated into co-creation and design practice. Video prototyping (Bardram, Bossen, Lykke-Olesen, Nielsen, & Madsen, 2002; Halskov & Nielsen, 2006) is also a very useful and cheap technique to recreate the product interaction and use it for testing and validation early in the process, as it both contextualises and creates a perception of 'reality' that can be explored with users, delivering a high impact in regards to concept assessment and feedback..

Other tools, such as blueprinting, which emerges from architecture and engineering, has been adapted for the development of services due to its plural and comprehensive capability (Forlizzi, Zimmerman, & Dow, 2011; Little, 2010; Polaine et al., 2013). Journey maps, experience and community mapping also complement the blueprints, as they demonstrate the product journey from the user perspective creating a full overview of the user experience, impacting how the product and services are deployed and delivered. (Coghlan & Brydon-Miller, 2014; Dove, Reinach, & Kwan, 2016; Fu, He, & Chao, 2018). The business model canvas (BMC) (Osterwalder et al., 2010; Pigneur, 2013) has also been widely used since its adaptable structure can fit various cases and allows it to be a key tool in the business development of products and services.

More recently, design sprints have also become popular as a way to develop and test ideas in a short and compressed format, however collecting enough material to validate and push a concept further or dispose of it, going back to ideation.(Nedeltcheva & Shoikova, 2017; Sari & Tedjasaputra, 2017, 2018; Thompson et al., 2017). Design sprints' impact deals with fast feedback based on a low-cost investment, which facilitates the exploration of various concepts and help with faster product to market delivery.

Some other tools, such as 'a day in the life' (also known as mobile probes), 'shadowing', 'proto safari', 'pictogram interview', 'guided tour' have all emerged from within the ethnography and anthropology fields and have been embraced within Design Thinking practice. Their impact lies in identifying, mapping and analysing people's behaviours and needs that could support and define the opportunity to develop new products and services (B. A. T. Brown, Sellen, & O'Hara, 2000; Cameron & Hunt, 2018; Everett & Barrett, 2012; Hulkko, Mattelmäki, Virtanen, & Keinonen, 2004; Jewitt & Mackley, 2018; Pink et al., 2015; Read, 2019; Spinney, 2011).

Many other tools have emerged from pedagogy and learning while others have been developed (sometimes ad-hoc) by practioners from various fields[4]. More recently, through the EU funded project

[4] Some of the resources initially researched were IDEO, Google, universities and institutions teaching related topics, Royal College of the Arts (RCA-UK), Interactive Telecommunication Program, New York University (ITP,

Cities-4-People, some of these tools were compiled into one platform, the co-creation navigator[5], where further descriptions and templates can be found. Another platform offering a compilation of design methods and tools is the Design Methods Finder website (*https://www.designmethodsfinder.com/*).

The questionnaire responses (N=25, Figure 5) have been compiled and assessed according to their popularity and can be found in Table 2, we have also provided an online resource to make the information more dynamic. This aspect raises the opportunity to explore them towards adapting and integrating them into forthcoming local production events and activities within WP3, WP4 (more specifically Task 4.5), WP5 (T5.1, T5.2, T5.3, and T5.6), WP6 (T6.1, T6.2, T6.3, T6.4), WP7 (T7.1, T7.2), creating another round of assessment regarding which tools are better fit to open and social manufacturing. The ones that are deployed during the project and proved most valuable to this field should be incorporated into the iPRODUCE platform. Many of the co-creation tools templates can be found through the links provided and some have been attached in the appendix.

In Table 2, the third column (When) indicates when in the process the resource has been used:

- Research **(R)**,
- Team-building **(TB)**
- Ideation **(I)**
- Development **(D)**
- Assessment/Evaluation **(AE)**
- Validation **(V)**

The resources are listed based on the assessment of their popularity in use, which are the ones most used and known among the iPRODUCE partners and external respondents. The tables follow this structure, starting from the most used and known to the least.

NYU), D-school, Stanford; Chaos Pilot, Denmark, Politecnico di Milano (Italy), KEIO Media Design (Tokyo, Japan); MIT (Boston).

[5] Co-creation Navigator (*https://ccn.waag.org/navigator/*), developed in connection with the Cities-4-People project.

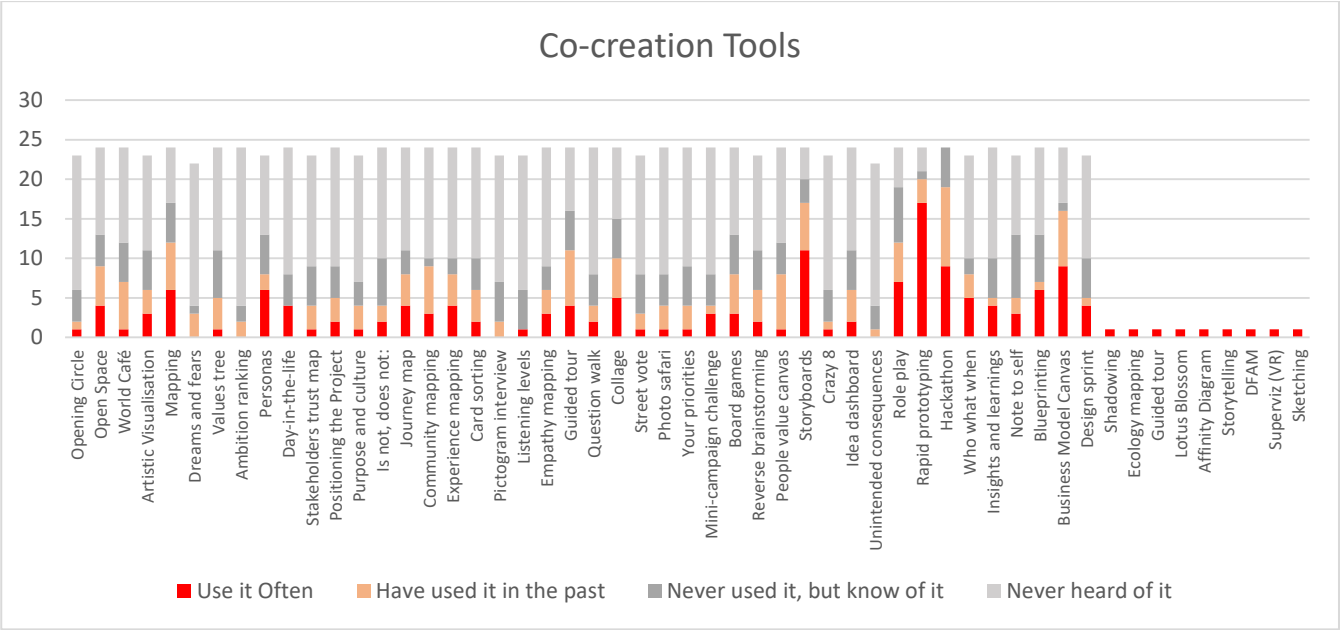

Figure 5: Co-creation tools questionnaire results[6]

[6] Vertical axis indicate number of replies

Table 2: Co-creation methods & tools list and description

Co-creation methods & tools			
Name	**Link**	**Purpose**	**Description (how they are used)**
Rapid prototyping/Low-fi prototyping	*https://theblog.adobe.com/prototyping-difference-low-fidelity-high-fidelity-prototypes-use/*	I, D, AE	A fast way to make something abstract into tangible using average office supplies, off-the-shelf microcontrollers, or other available resources to recreate a minimised version of an idea/concept.
Sketching	*https://sketch.io/sketchpad/* *https://en.wikipedia.org/wiki/Sketch_(drawing)*	I, D	An activity where participants draw an idea to help communicate and have a shared visual input to discuss/present.
Storyboards	*https://en.wikipedia.org/wiki/Storyboard* *How to template on appendix 5*	I, AE, V	Create a linear narrative through drawing and telling a story of your product/service scenario in use.
Hackathon	*https://en.wikipedia.org/wiki/Hackathon* *How to template on appendix 2*	R, I, D, AE	Hackathon (also known as a hack day, hackfest or codefest) is a design sprint-like event in where coders, designers, project managers, researchers and other subject-matter-experts collaborate intensively on software projects.
Business Model Canvas	*https://www.businessmodelsinc.com/about-bmi/tools/business-model-canvas/* *template on appendix 6*	D, AE	A tool that identifies different aspects of a business propositions towards assessing value and other key aspects to develop and deploy products/services to market.
Role play	*https://en.wikipedia.org/wiki/Role-playing* *How-to template on appendix 4*	I, D	An activity where participants recreate through acting out/playing a part of the context/scenario where the experience takes place. The guidelines are modelled on realistic aspects to provide an experience close to reality

Co-creation methods & tools			
Name	**Link**	**Purpose**	**Description (how they are used)**
			(Elmore, n.d.).
Mapping/Brainstorming	*https://en.wikipedia.org/wiki/Brainstorming* *How to template on appendix 1*	I, D	An activity where one or more people collect information from the participants in an open and dynamic way, and write it on a flipchart or whiteboard to create a type of 'map' the group can logically follow.
Personas	*https://www.interaction-design.org/literature/article/personas-why-and-how-you-should-use-them* *https://en.wikipedia.org/wiki/Persona_(user_experience)* How to template on Appendix 3	D, AE, V	Personas are (fictional) descriptions of a possible user or stakeholder based on a compilation of variables acquired through research. The personas can be applied in different circumstances and will help bring different perspectives based on the case/project.
Blueprinting	*https://www.nngroup.com/articles/service-blueprints-definition/*	D, AE	A tool to strategize the service around the product offer with clear tasks and product/service flow. A detailed guideline for a project replication.
Open Space	*https://en.wikipedia.org/wiki/Open_Space_Technology*	TB	An activity where participants co-design the activities and agenda for the given session or workshop.
Collage	*https://arl.human.cornell.edu/PAGES_Delft/Collage_deeper.pdf*	I	A low-fidelity creative method to promote a tangible demonstration of an idea or concept and create a shared visual to communicate it to the other participants.
Who what when	*https://ccn.waag.org/navigator/tool/who-what-when*	D	An activity where the participants collectively decide and delegate the tasks and timeline.
Day-in-the-life	*https://toolkits.dss.cloud/design/method-card/day-in-the-life/*	R	An activity focusing on collecting insights from users' daily routines, habits, behaviours, etc. To collect the information a diary, journal pictures or video can be used.

Co-creation methods & tools			
Name	**Link**	**Purpose**	**Description (how they are used)**
Journey map	*https://servicedesigntools.org/tools/journey-map*	R, D, AE	An activity where one draws or writes the steps composing the customer/product journey to identify the steps required to deliver the optimal product/service. The final map also aids in identifying aspects that might be lacking in the plan.
Experience mapping	*https://www.nngroup.com/articles/ux-mapping-cheat-sheet/* *https://servicedesigntools.org/tools/empathy-map*	R, D, AE	A task where participants draw or write the steps composing the customer/product journey experience to create a full overview of highs and lows involved in product/service delivery.
Insights and learnings	*https://sightsinplus.com/insight/learning/the-difference-between-insights-learning/*	D	A final activity to compile the outcomes of the workshop or session.
Design Sprint	*https://designsprintkit.withgoogle.com/assets/tools/Product%20Sprint%20Deck%20-%203-Day%20Template.pdf*	I, D, AE, V	A time-limited, five-phase process following a design Thinking approach focusing on fast research, ideation and testing towards evaluating and minimising the risk of introducing a new product or service into the market.
Artistic Visualisation		I	This method entails presenting an image or drawing to introduce the workshop/meeting topic to inspire or provoke.
Community Mapping	*https://ucanr.edu/sites/CA4-HA/files/206668.pdf*	R, D, AE	An exercise where participants identify the community stakeholders and create a map indicating how they relate and intersect with each other.
Empathy mapping	*https://www.nngroup.com/articles/empathy-mapping/*	D, AE	A tool to gain perspectives from project participants, stakeholders or users. It can create a collective perception on a product or service interactions.
Mini-campaign challenge	*https://ccn.waag.org/navigator/tool/mi*	I, D, AE	An exercise where participants create a short ‘fake’

Co-creation methods & tools			
Name	**Link**	**Purpose**	**Description (how they are used)**
	ni-campaign-challenge		campaign to dive further into the possible product/service proposition. Another way to explore and further develop ideas and concepts.
Board games	*https://ccn.waag.org/navigator/tool/board-games*	TB, I, D	An activity where participants develop a board game with rules and goals based on a project topic.
Note to self	*https://ccn.waag.org/navigator/tool/note-to-self*	D	An activity where each participant writes down a note to him/herself to follow up regarding the project or the teamwork.
People value canvas	*https://waag.org/en/project/people-value-canvas* *How to template on appendix 7*	D, AE	The People Value Canvas tool supports designers and stakeholders to gain insight into what people consider valuable in a structured way. This process aids stakeholders and users identify key aspects of a service/product concepts and their value proposition.
World Café	*http://www.theworldcafe.com/key-concepts-resources/world-cafe-method/*	TB, D	In this activity, groups of 3-5 people gather around tables to discuss a common topic for a short time (10-15'). After the first round, a 'host' stays at the table, while the others move to another table. The host summarises what has been discussed at that table and the 'new' table participants share their previous conversations. This format allows for the threads of the various conversations to be linked together.
Values tree	*https://en.wikipedia.org/wiki/Value_tree_analysis*	TB	In this activity, all the participants create a tree or diagram with the key values to be kept during the whole project process. This diagram should be visible and used as a fresh reminder whenever needed.

Co-creation methods & tools			
Name	**Link**	**Purpose**	**Description (how they are used)**
Card sorting	*https://en.wikipedia.org/wiki/Card_sorting*	TB, I	Using image cards (DIXIT style - *https://www.pinterest.dk/evamelinda11/dixit-cards/*), participants have to select cards related to a defined topic and explain the reason behind their choice. This activity can help teams identify aspects related to a project topic; images can help elaborate on themes that might have been overlooked otherwise.
Reverse brainstorming	*https://www.mindtools.com/pages/article/newCT_96.htm*	I	Reverse brainstorming is an activity focusing on developing bad solutions to the issue or problem giving perspectives on what the concept should avoid.
Idea dashboard	*https://dschool.stanford.edu/resources/idea-dashboard*	I, D	A way to create a visual overview of the co-created ideas and what they address. This activity facilitates the clustering and specific aspects that might need to be incorporated into the product/service.
Dreams and fears (also known as hopes and fears)	*https://www.ibm.com/design/thinking/page/toolkit/activity/hopes-and-fears*	TB	This activity offers the opportunity for the project participants to shed their 'dreams' and 'fears' related to the project.
Stakeholders trust map	*https://ccn.waag.org/navigator/tool/stakeholders-trust-map*	TB	Create a map showing how the stakeholders relate to each other and to the product/service regarding trust/reliability.
Positioning the Project	*https://en.wikipedia.org/wiki/Positioning_(marketing)*	D, AE	This activity covers benchmarking a concept in relation to existing products/services.

Co-creation methods & tools			
Name	**Link**	**Purpose**	**Description (how they are used)**
Purpose and culture	*https://ccn.waag.org/navigator/tool/purpose-and-culture*	TB	Organisational tool helping teams define their purpose and culture and how these aspects play out in carrying out the project.
Photo safari	*https://innovationenglish.sites.ku.dk/metode/photo-safari/*	R	In this exercise, participants take pictures of chosen aspects of their routine to share back with the researchers/other participants.
Your priorities (online tool)	*https://www.yrpri.org/domain/3*	AE, V	Online participatory social network, launched in 2008. The community has over 11.000 registered users, with more than 6.000 ideas generated and over 10.000 arguments for and against ideas submitted.
Ambition ranking	*https://ccn.waag.org/navigator/tool/ambition-ranking*	TB, D	In this activity, participants list and order project ideas and ambitions towards creating a common ground across the team.
Is – is not – does – does not	*https://martinfowler.com/articles/lean-inception/product-is-isnot.html*	TB, I	*Is – Is not – Does – Does not* is an exercise helping define and assess both product/services capabilities and goals.
Pictogram interview	*https://ccn.waag.org/drupal/sites/default/files/2018-03/WaagPictoInterview.pdf*	R	Using the same visual cards (DIXIT or similar), however this time for interview purposes, open discussion with images that bring out some different possibilities and scenarios to be further researched.
Question walk	*http://sru.soc.surrey.ac.uk/SRU67.pdf*	R	An observation walk to identify aspects of the environment that might have become ignored through routine. The objective is to look at specific topics and raise a number of previously unasked questions.

Co-creation methods & tools			
Name	**Link**	**Purpose**	**Description (how they are used)**
Street vote	*https://ccn.waag.org/navigator/tool/street-vote*	D, AE	This activity helps connect with citizens/users/target audience in an easy, low-cost, and data-driven way by making quick and low-fi interviews or interventions in the public space.
Opening Circle	*https://facilitation.aspirationtech.org/index.php/Facilitation:Opening_Circle*	TB	In this activity, participants sit in a circle facing each other, where everyone can engage with each other. Adding a prop to the circle helps in indicating a shared leadership approach.
Listening levels	*https://ccn.waag.org/navigator/tool/listening-levels*	R	This exercise focus on listening to interviews to divides them into three parts to help the data clustering and analysis.
Crazy 8	*https://designsprintkit.withgoogle.com/methodology/phase3-sketch/crazy-eights*	I, D	An activity where participants create eight distinct ideas in eight minutes. Very used as a way to kickstart an idea generation session.
Unintended consequences/ Dormant opportunities	*https://en.wikipedia.org/wiki/Unintended_consequences*	D, AE	In this activity, participants develop scenarios to explore ways how a product, technology or service can be appropriated towards an unplanned use. This activity can also be used with blueprints to uncover possible opportunities within services.
Shadowing	*https://www.interaction-design.org/literature/article/shadowing-in-user-research-do-you-see-what-they-see*	R	A research exercise where one follows users with their consent to observe and identify behaviours related to their routine. This activity can also feed into concept scenarios, where teams can identify how the service or product fits in the observed flow.
Ecology mapping (also called Ecosystem Map)	*https://servicedesigntools.org/tools/ecosystem-map*	D, AE, V	An exercise to map and correlate the different communities, products and services related to your project. The final visual map serves as a good overview of the project context.
Guided tour	*https://think.design/user-design-research/guided-tour/*	R	An exercise where we ask research subjects to present their life and routine through their own words.

Co-creation methods & tools			
Name	**Link**	**Purpose**	**Description (how they are used)**
Lotus Blossom	*http://creatingminds.org/tools/lotus_blossom.htm*	I	A visual brainstorming tool.
Affinity Diagram	*https://en.wikipedia.org/wiki/Affinity_diagram*	R, I	The affinity diagram is a way to organise and cluster large amounts of research data to facilitate its analysis.
Storytelling/video prototyping	*https://toolkits.dss.cloud/design/method-card/video-prototyping/*	R, I, D, AE	This activity focus on creating narratives where the product or service is described within a context, its use and its purpose. It facilitates the sharing of an idea and it becomes easier to be understood by the other participants. It can be drawn or made as a video.
Superviz	*https://www.superviz.com/*	D	A VR tool that can be used for collaborative work and conferences towards products and project development.
Ergocreo	*https://ergocreo.io*	D, AE	A co-design platform for rapid prototyping challenges.

4.1.3. Mapping and assessment of Communication Tools

Various communication tools are used to exchange information and work in teams locally or across countries. These tools can also be applied as managerial or research tools, depending on the project need.

For example, making an analysis and assessment of the tools base on the questionnaire results, Skype and Slack are the most popular communication tools, followed by Skype for business and Zoom. The tools offer instant messaging, voice over IP (VoIP), video calls and have been widely used in industry settings, where team managers and members exchange information, keep each other updated in project processes, and hold project meetings. Other tools, such as Skype, Zoom, Gotomeeting, etc. are widely used for meetings and research[7]. A question that might emerge is if these tools, which have been used for research and meetings, can also been effective in co-creation activities. If so, it would be valuable to evaluate, which of the tools are better suited for these types of activities and what characteristics might facilitate these process. For example, Zoom offers the possibility of breakout rooms that equals to working in smaller groups and this aspect might promote a similar type of interaction to that of working in the same place. Depending on the pandemic consequences, these communication tools might also be explored through some of the project activities, providing yet another core and valuable resource towards a cross-cultural and cross-location social manufacturing collaboration.

In Table 3, the third column (When) indicates when in the process the resource has been used:

- Research **(R)**,
- Team-building **(TB)**
- Ideation **(I)**
- Development **(D)**
- Assessment/Evaluation **(AE)**
- Validation **(V)**

The resources are listed based on the assessment of their popularity in use, which are the ones most used and known among the iPRODUCE partners and external respondents. The tables follow this structure, starting from the most used and known to the least. The overall results from the questionnaire (Figure 6) and the list of the tools (Table 3) can be found in the following.

[7] Some of the responses were collected before the pandemic and they might have changed meanwhile.

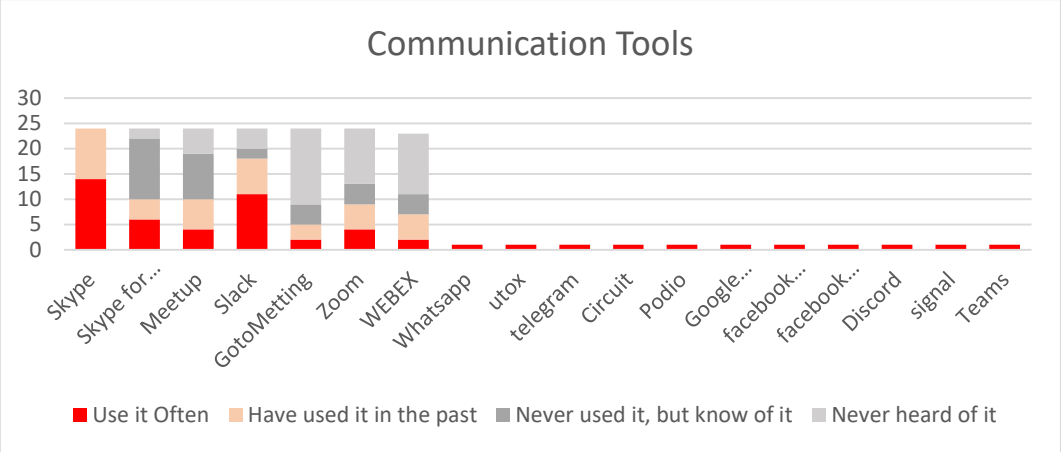

Figure 6: Communication tools questionnaire results

Table 3: Communication tools list and description

Communication Tools			
Name	**Link**	**Purpose**	**Description (how they are used)**
Skype & Skype for Business	*https://www.skype.com/en/*	R, TM, I, D, AE, V	Microsoft tool. Includes chat, video conferencing, etc. Instant Messaging and VoIP.
Slack	*https://slack.com/*	TM, I, D	Business Communication Platform. Offer groups and topics. Also VoIP.
Meetup	*https://www.meetup.com/*	R, TM, I, D, V	Service hosting in-person events for groups and individuals having similar interests.
Zoom	*https://zoom.us/*	TM, I, D, AE	Video conferencing service communication platform.
GotoMetting	*https://www.gotomeeting.com/*	TM, I, D, AE	Video conferencing service communication platform.
WEBEX	*https://www.webex.com/*	TM, I, D, AE	Video conferencing service communication platform.
Whatsapp	*https://www.whatsapp.com/*	TB, D	Encrypted personal & group Communication instant messaging & VoIP platform, owned by Facebook.
Utox,	*https://utox.org/*	TB, D	Open source peer to peer instant messaging platform.
Telegram	*https://telegram.org/*	TB, D	Instant messaging and voice over IP service platform.
Circuit	https://unify.com/en/solutions/team-collaboration/circuit	TB, D, AE	Cloud-based digital workspace.
Podio	*https://podio.com/site/en*	TB, D, AE	Cloud-based digital workspace.
Google Hangouts	*https://hangouts.google.com/*	TB, D, AE	Video conferencing service communication platform by Google.
Facebook messenger	*https://www.messenger.com/*	TB, D, AE	Instant messaging and voice over IP service from Facebook.
Facebook workplace	*https://www.facebook.com/workplace*	TB, D, AE	Business platform offering channels, instant message, etc.
Discord	*https://discord.com/*	R, TB, I	Business Communication Platform. Offer groups and topics. Also VoIP.
Signal	*https://signal.org/en/*	TB, D, AE	Encrypted messaging service.

4.1.4. Co-creation/co-production methods and tools in iPRODUCE

The tools presented in chapter 4 are to be explored in the project context, where we can create a new setting and overview of which of them are most valuable for social manufacturing purposes. This initial listing should be integrated within the iPRODUCE platform, as a way to facilitate the access the distribution of the tools. In this way, both the iPRODUCE partners and other makers can have a one-stop shop for a variety of tools and resources. As new resources and tools are constantly developed, this listing should also be updated throughout the project to keep being a dynamic database.

Even though the listings indicate the most popular tools and resources, thus indicating the most used and applied tools, the project partners should engage in the opportunity to explore the knowledge base herein presented as a way to expand their toolboxes, creating new standards for social manufacturing to be offered in the iPRODUCE platform.

5. iPRODUCE partners' methods and tools overview and assessment

In order to better assess and match available tools and resources to the needs of the project and its various goals and activities, it is necessary to understand our consortium's current 'arsenal' and how it is used. Therefore, in addition to the open questionnaire, another set of tables were dedicated towards gathering more detailed information from the iPRODUCE partners. This spreadsheet was shared from within the iPRODUCE cloud-based platform, so all partners had access to it. From the iPRODUCE project partners' responses, we gathered which tools are used, and assessed how and when they are applied in their current production processes, while also gathering information regarding hardware and other tools they have at hand when developing products. Overall, these tools are frequently used for various projects and they relate to both software required for interacting with hardware production, involving modelling, data analysis, product simulation, testing, etc. Many of the tools are used across projects and in different phases aided of hardware equipment and materials, such as microcontrollers, sensors, gears, etc. Furthermore, these tools are used also towards physical prototypes and final products, as well as towards analysing and testing the products. The spreadsheet covered Co-Creation and Co-Production tools (Table 4), Open-Innovation Tools (Table 5), Co-Creation and Co-Production methods (table 6) and Open-Innovation Methods (Table 7). For the purpose of the project, it is highly valuable to create a common understanding of these tools and methods, and only by sharing their knowledge and use of them, we can create a platform that agrees with this understanding, proving a common shared language across makers.

From the iPRODUCE partners' overall results, it becomes clear that all the partners that have production facilities and are well versed in 3D modelling and printing, prototyping, development and testing. However only few are often experimenting with augmented reality (AR), virtual reality (VR) or generative design. This brings a great opportunity to interchange expertise and create a diverse exchange among these partners, which can then be embedded into the iPRODUCE platform.

Table 4. Co-Creation/Co-Production Tools– Hardware & Software used by iPRODUCE partners

Co-CREATION/Co-PRODUCTION TOOLS – HARDWARE & SOFTWARE		
LIST	**PURPOSE**	**FREQUENCY**
Fusion360	Share designs between parties	Daily to Weekly
Microcontrollers: ESP32/ESP8266, Arduino, Raspberry Pi Arduino Nano/Uno	IoT / Prototyping	Weekly
Soldering Stations/Oscilloscopes	Prototyping/Manufacturing/Repair Jobs	Weekly
FDM 3D Printer	Modelling	Weekly
Soldering Station	Electronic Circuit Prototyping	Weekly
Multimeters and Power Supplies	Troubleshooting Electronics	Weekly
Engraving and Drilling tools	Crafting, Prototyping/small batch productions	Weekly
FDM Printers	Prototyping	Weekly
Laser Engraver/Cutter	Prototyping	Weekly
Cnc Milling machine	Prototyping	Monthly
Airtable	Idea tracking, visualisation	Weekly or more often.
Sewing machines	Prototyping/Repair Jobs/Design	Weekly or more
CNC-Router	Prototyping/small batch productions	Weekly or more
CAD/CAM/FEA software	Design, simulation and manufacturing	Daily
3D printing preparation software	Prepare for 3D printing (support and slicing)	Daily
CNC machining (5-axis milling/hybrid, turning, WEDM)	Production	Weekly
Laser cutting/marking (for metal and non-metal materials)	Production	Weekly
SLM 3D printers	Production	Weekly
MJF and SLA 3D printer	Production	Weekly
CMM, 3D scanner, computed tomography	Inspection and reverse engineering	Weekly

Mechanical test bench	Testing	Monthly
Vibration test chamber with temperature control	Testing	Monthly
HPC cluster, AI, Deep Learning, VM	Computing	Daily
Gitlab	Co-development tracking for source code	Daily
Electronic dev&test equipment (oscilloscopes, multimeters, spectrum analyzer, NX5, emscan, oven&pick-and-place, ecc...)	Electronics prototyping, testing and pre-compliance analysis	Daily
Industry 4.0 test and production equipment (robots, cobots, automates, sensors, vision systems, adaptative prehensors, RFID, Augmented and mixed reality equipment, ...	"ready to play" equipment to build process demonstrators or PoC	Weekly
Rhino 6 (with Grasshopper)	Generative design	Spontaneous
Autodesk (Fusion 360, Recap, EAGLE, other)	generative design, 3D scan, circuit board	Spontaneous
Solid Edge	CAD SW (additive manufacturing)	Continuously
AWS	Integration of own SW tools	Continuously
3D Laser Scanner BLK360	Point Cloud for fabric model	Project dependent
Laser Cutter & 3D Drucker Ultimaker	Prototyping	Project dependent, weekly
AR / VR equipment	Trainings, UI	Regularly
Microcontrollers: ESP32/ESP8266, Arduino, Raspberry Pi Arduino Nano/Uno	IoT / Prototyping	Weekly

Table 5: Open Innovation Tools – Hardware & Software used by iPRODUCE partners

OPEN INNOVATION TOOLS – HARDWARE & SOFTWARE		
LIST	**PURPOSE**	**FREQUENCY**
Coding tools/IDEs	Arduino IDE, Visual Studio Code, etc.	All frequently/multiple times per week.
Git, Wikis,	Learning, exchange	All frequently/multiple times per week.
Instant Messaging tools (IM)	Discuss	All frequently/multiple times per week.
Self-developed project management system	Keep track of project status	1. Daily
Self-developed cloud	Sharing	Daily
Slack	Communication	Daily

Table 6: Co-Creation/Co-Production Methods used by iPRODUCE partners

CO-CREATION/CO-PRODUCTION METHODS		
LIST	**PURPOSE**	**FREQUENCY**
Sketching Group (C-Sketch)	Ideation Phase	Group training processes
Affinity Diagram	Interpretation Phase	At some point in the decision-making process
Customer Journey Map	Discovery and Interpretation Phase	At some point in the decision-making process
Paper prototyping	Ideation and Prototyping Phase	Initial phases of ideation or prototyping of a project
Brainstorming	Developing ideas	Daily
Business Model Canvas	Lean startup template for developing new or documenting existing business models	Daily
Jam Sessions	Cooperative exploration of new/interesting topics/fields	When necessary, 2-3 per month

Bastelabend (open house)	Networking/Member acquisition/community building	4 per week
Hackathons	Prototyping	>1 per year or project dependent
Workshops	Education/Networking/Training	Weekly
Excelcar project structuring process	Intern process and methodology to build a project from between several partners (define requirements and goals, build consortium, structure the budget, define Intellectual property issues, ...)	Weekly or monthly
Double diamond method (from idea to Proof of concept definition)	Define the best user-oriented demonstrator to be built to "convince" future users of the innovation concept and implementation interest	Monthly (depending on project profiles)
Multidisciplinary Meetings and Brainstorming	Discuss ideas from different perspectives	Weekly
Genetic algorithms	Optimization of material and ergonomic forms	Project dependent
Design Thinking	Ideation	Spontaneous
Sketching Group (C-Sketch)	Ideation Phase	Group training processes
Affinity Diagram	Interpretation Phase	At some point in the decision making process
Customer Journey Map	Discovery and Interpretation Phase	At some point in the decision making process
Paper prototyping	Ideation and Prototyping Phase	Initial phases of ideation or prototyping of a project

Table 7: Open Innovation Methods used by iPRODUCE partners

OPEN INNOVATION METHODS		
LIST	**PURPOSE**	**FREQUENCY**
Facility tour	Explain technologies and capabilities, present new approach to innovation	Weekly
Open Innovation Competition	Involvement of students in open innovation challenges using the facility resources	Yearly

6. Lifecycle management, recycling, repurposing and reusing assessment overview

Another objective within Task 2.3 was to do a first assessment of lifecycle management of materials. To assess if makerspaces and fablabs already have specific approaches in regards to lifecycle management, recycling, repurposing and reusing approaches, another spreadsheet was shared among iPRODUCE partners to cover existing methods dealing with material waste. From the information provided, it becomes visible that there is not a structured way across all labs to recycle or reuse, but instead, each apply different approaches managing differently the lifecycle of employed materials and components. Table 8 shows a summary of approaches currently used across iPRODUCE labs to address material waste.

Although material lifecycle management is not necessarily in the same scope as co-creation tools, some of tools herein presented can be applied in *Task 5.5 Lifecycle Management, Recycling, Repurposing and Reusing* towards ideating and developing new ideas towards optimising current recycling and repurposing processes and how to best integrate them into the iPRODUCE platform.

Overall, currently there is no uniform approach to lifecycle management of materials among iPRODUCE partners. Recycling, repurposing and reusing approaches appear to be dependent to local recycling companies and systems, whereas labs exchanges or even community interest have not been accounted for as possible sustainable opportunities, which can still be explored. In order to create a circular approach to social manufacturing, lifecycle material management needs to be included in upcoming business models to exploit opportunities that might strengthen the recycle, repurpose and reuse of materials across the iPRODUCE platform. This aspect will be considered in the WP7 activities related to business model developments towards optimal cMDFs solutions.

Table 8: Lifecycle Management summary

LIFECYCLE MANAGEMENT		
LIST	**APROACH**	**METHODS**
RECYCLE	Recycle the rest of the materials no longer in use and also other small pieces or leftover material.	Use a specialised company to pick up the rest of the materials once every two months in special container. Paints, wood, plastics, sprays and materials are all separated.
	Recycle plastic waste from 3D printing and working on making new filaments from it in the near future.	Collection/Re-extrusion
	Recycle the material waste that cannot be reused and also all the end-life prototypes.	Use a specialised recycling company to collect all the parts and materials, which have been previously identified, separated and stacked (metal, plastics, cardboards).
	Recycle Plastic and paper, metal chips	A specialised company.
	Recycle wood, Metal, large plastic pieces	Separate all materials and dispose them into dedicated recycling garbage stations.
REUSE	Reuse as much as possible just because of the sustainability and economical focus.	No methods. Just imagination. Just few members in the group and this is a work philosophy.
	Scavenge old battery packs an reconfigure good cells to new packs Retrofit (industrial) machines and tools to be used by the community (Routers, Lathes, Handtools...)".	Collection, disassembly, measurement, spot-welding new packs.
	Stock and reuse the raw material we do not use, for other tests or prototypes.	The concerned parts / materials are identified and go back to the "raw material" stock; the process is manually managed.
	Metal and plastic powder, deionized water.	Sieving and de-humidification, filtering.

REPURPOSE	Build workbenches and storage space from donated furniture (closets, rolling file cabinets).	Sawing, gluing, screwing.
	Part of the equipment is refurbished / updated industrial equipment given by large companies (e.g. robots from PSA)	There is no defined method, more a goal, and capacity in reuse depends on the new usage and old equipment status, depending on opportunities, evaluated and checked case per case.

7. Summary and relevance of methods and tools for iProduce

The tools, methods and lifecycle management approaches presented in Chapter 2, Chapter 3 and Chapter 4 are to be explored in the project context, where we can create an overview of which of them are most valuable for social manufacturing purposes. Many of the project activities entail workshops and events with users and other stakeholders, where a number of tools and resources can be applied. This report provides a thorough knowledge based to be explored throughout the project. All tools and methods have been assessed and presented in the tables according to their popularity in use, from the most used and known to the least used and known.

The partners are to choose and apply some of these tools in their activities throughout WP3, WP4, WP5, WP6, WP7, WP8 and WP9. For example:

WP3. T3.3 - *Teambuilding (TB), Ideation (I) and Development (D)* tools and activities can be used towards setting up the cMDFs' network in *T3.3 Setup the Network of local cMDFs*.

WP4: T4.5 - A number of selected tools based on the project development will compose the 'Toolkit in Co-creation' in *T4.5 iPRODUCE Training Toolkit on Co-creation*.

WP5: T5.1, 5.3, T5.5 and T5.6 – This initial list from Task 2.3 will be advanced and refined in *T5.1 Assistive and Collaborative Designing Methods and Tools* based on the iPRODUCE partners' learnings feeding new methods towards social manufacturing. Some of the existing VR/AR collaborative tools in the list can be explored and analysed towards *T5.3 Collaborative VR/AR-based Real-time Social Manufacturing Space*. Lifecycle management will also be advanced in *Task 5.5. Lifecycle Management, Recycling, Repurposing and Reusing* through ideas towards optimising waste lifecycle. One example could be to create a local image database with measurements, which could be accessed across the platform facilitating the exchange or even creating a new local marketplace. Many of the *Ideation (I), Development (D) and Assessment and Evaluation (AE)* tools and resources can be used in the *T5.6 Collaborative Testing and Training* sessions.

WP6: T6.1, T6.3, T6.4 – In WP6 there are many sessions and workshops where Team Building (TB), Ideation (I), Development (D) and Assessment and Evaluation (AE) tools can be used across the events. For example, in both *T6.1 Ecosystem Establishment and Engagement* and *T6.3 Ambassador Programme for Early Adopters* as the tasks intend to create a network composed of various stakeholders, activities such as *Community Mapping* and *People Value Canvas* can be of before and during the sessions to be organised. *Hackathons* are also a clear resource for the *T6.4 Open Competitions on Consumer Products Innovation Challenges*.

WP7: T7.2 – In *T7.2 Business models and case development for iPRODUCE cMDFs* the *Business Model Canvas tool* will be deployed to both map the existing business models in place across iPRODUCE partners, as well as to devise new models aligning with the platform services and opportunities.

WP9: T9.2 – In *T9.2 Validation of the Digital Platform and Co-creation Tools* iPRODUCE partners can apply *Assessment and Evaluation (AE)* tools to facilitate the heuristic process of evaluation and validation of the service.

8. Conclusion

Within existing literature, co-creation and co-production definitions are used almost as synonyms. Co-creation tends to be more broadly used across all disciplines, while co-production has larger prominence from within public initiatives descriptions. Both indicate a process that it is not an individual experience, but a collaborative one. Open innovation is therefore directly linked to co-creation and co-production perspectives, as it has been defined as a process that includes bringing external ideas to devise the development of an internal research/product. By engaging in a collaborative process, open innovation relies on co-creation and co-production tools and methods. The concept of Design Thinking, which has been popularised across industries in the first two decades of the 21st century, is also presented as a product and service development methodology alongside co-creation and co-production approaches.

Overall, this report offers a knowledge base that can be integrated within the iPRODUCE platform, as a way to facilitate the access to and selection of the various tools. In this way, both the iPRODUCE partners and other makers can have a one-stop shop for a variety of tools and resources. As new resources and tools are constantly developed, this listing should also be updated throughout the project to keep a dynamic database.

Some further considerations that arise related to the iPRODUCE platform and the co-creation/co-production tools and methods deal with:

a. How we can best integrate some of these tools in the platform – as a database or as a general listing?
b. How to provide a best-practice sharing procedure to the learnings acquired from applying the tools (easy input, voting system, organisation through popularity, etc.)?
c. How to best co-create new tools to support upcoming developments?

All of these points can offer a wider application of the iPRODUCE platform and it can help develop more informed and well-equipped communities focused on local and social manufacturing.

Furthermore, the compiled resources presented are to be explored within iPRODUCE activities, demonstrating their value and how they can best be exploited towards social manufacturing and incorporated in the iPRODUCE platform for creative approaches to local and on-demand urban production.

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10. Appendix

10.1. Appendix 1: Brainstorming Techniques

Basic brainstorming is not complex—though there are important techniques for ensuring success. Here, briefly, is how basic brainstorming works:

1. Get a group of people together to address a problem, challenge, or opportunity

2. Ask your group to generate as many ideas as possible—no matter how "off the wall" they may seem. During this period, no criticism is allowed.

3. Review the ideas, select the most interesting, and then lead a discussion about how to combine, improve, and/or implement the ideas.

While this process may be simple in theory. Nevertheless, it is not always easy to generate new ideas out of nowhere. In addition, that is why so many interesting and inspirational brainstorming techniques have been developed.

Discover which techniques are the best fit for your next brainstorming session.

Analytic Brainstorming

When brainstorming focuses on problem solving, it can be useful to analyse the problem with tools that lead to creative solutions. Analytic brainstorming is relatively easy for most people because it draws on idea generation skills they have already built in school and in the workplace. No one gets embarrassed when asked to analyse a situation!

1. Mind Mapping

Mind mapping is a visual tool for enhancing the brainstorming process. In essence, you are drawing a picture of the relationships among and between ideas.

Start by writing down your goal or challenge and ask participants to think of related issues. Layer by layer; add content to your map so that you can visually see how, for example, a problem with the telephone system is contributing to issues with quarterly income. Because it has become so popular, it is easy to find mind mapping software online. The reality, though, is that a large piece of paper and a few markers can also do the job.

2. Reverse Brainstorming

Ordinary brainstorming asks participants to solve problems. Reverse brainstorming asks participants to come up with great ways to cause a problem. Start with the problem and ask, "How could we cause this?" Once you have a list of great ways to create problems, you are ready to start solving them!

3. Gap Filling

Start with a statement of where you are. Then write a statement of where you would like to be. How can you fill in the gap to get to your goal? Your participants will respond with a wide range of answers from the general to the particular. Collect them all, and then organize them to develop a vision for action.

4. Drivers Analysis

Work with your group to discover the drivers behind the problem you are addressing. What is driving client loyalty down? What is driving the competition? What is driving a trend toward lower productivity? As you uncover the drivers, you begin to catch a glimpse of possible solutions.

5. SWOT Analysis

SWOT Analysis identifies organization strengths, weaknesses, opportunities and threats. Usually, it is used to decide whether a potential project or venture is worth undertaking. In brainstorming, it is used to stimulate collaborative analysis. What are our real strengths? Do we have weaknesses that we rarely discuss? New ideas can come out of this tried-and-true technique.

6. The Five Whys

Another tool often used outside of brainstorming, the Five Whys can also be effective for getting thought processes moving forward. Simply start with a problem you are addressing and ask, “Why is this happening?” Once you have some answers, ask “why does this happen?” Continue the process five times (or more), digging deeper each time until you have come to the root of the issue. Dig into the details of this process:

7. Starbursting

Create a six-pointed star. At the centre of the star, write the challenge or opportunity you are facing. At each point of the star, write one of the following words: who, what, where, when, why, and how. Use these words to generate questions. Who are our happiest clients? What do our clients say they want? Use the questions to generate discussion.

Quiet Brainstorming

In some situations, individuals are so cramped for time that a brainstorming session would be impossible to schedule. In other situations, team members are unwilling to speak up in a group or to express ideas that others might not approve of. When that is the case, you might be well served with brainstorming techniques that allow participants to generate ideas without meeting or without the need for public participation.

8. Brain-Netting (Online Brainstorming)

Perhaps not surprisingly, brain netting involves brainstorming on the Internet. This requires someone to set up a system where individuals can share their ideas privately, but then collaborate publicly. There are software companies that specialize in just such types of systems, like Slack or Google Docs.

Once ideas have been generated, it may be a good idea to come together in person, but it is also possible that online idea generation and discussion will be successful on its own. This is an especially helpful approach for remote teams to use, though any team can make use of it. Learn more about this brainstorming technique:

9. Brainwriting (or Slip Writing)

The brain writing process involves having each participant anonymously write down ideas on index cards. The ideas can then be randomly shared with other participants who add to or comment on the ideas. Alternatively, the ideas can be collected and sifted by the management team. This approach is also called “Crawford Slip Writing,” as the basic concept was invented in the 1920’s by a professor named Crawford.

10. Collaborative Brainwriting

Write your question or concern on a large piece of paper and post it in a public place. Ask team members to write or post their ideas when they are able, over the course of a week. Collate ideas on your own or with your group's involvement.

Role Play Brainstorming

What do customers/clients/managers really want? What are the challenges we face internally or externally? Very often, internal and external clients best answer those questions. Role-play allows your team to “become” their own clients, which often provides surprisingly potent insights into

challenges and solutions. Another plus of role-play is that, in some cases, it lowers participants' inhibitions. Variants of role-play include Rolestorming, Reverse Thinking, and Figure Storming.

11. Role Storming

Ask your participants to imagine themselves in the role of a person whose experience relates to your brainstorming goal (a client, upper management, a service provider). Act out a scene, with participants pretending to take the other's point of view. Why might they be dissatisfied? What would it take them to feel better about their experience or outcomes?

12. Reverse Thinking

This creative approach asks, "What would someone else do in our situation?" Then imagine doing the opposite. Would it work? Why or why not? Does the "usual" approach really work well, or are there better options?

13. Figure Storming

Choose a figure from history or fiction with whom everyone is familiar—Teddy Roosevelt, for example, or Mother Theresa. What would that individual do to manage the challenge or opportunity you are discussing? How might that figure's approach work well or poorly?

Brainstorming with Support

For groups that are not very creative or communicative or are likely to be stuck once the most obvious ideas have been suggested, help is in order. You can provide that help up front by setting up the brainstorming process to include everyone in a structured, supportive manner. A few techniques for this type of brainstorming include Step Ladder Brainstorming, Round Robin Brainstorming, Rapid Ideation, and Trigger Storming.

14. Step Ladder Brainstorming

Start by sharing the brainstorming challenge with everyone in the room. Then send everyone out of the room to think about the challenge—except two people.

Allow the two people in the room to come up with ideas for a short period, and then allow just one more person to enter the room. Ask the new person to share their ideas with the first two before discussing the ideas already generated.

After a few minutes ask another person to come in, and then another. In the end, everyone will be back in the room—and everyone will have had a chance to share his or her ideas with colleagues.

15. Round Robin Brainstorming

A "round robin" is a game in which everyone gets a chance to take part. That means everyone:

1. Must share an idea and
2. Wait until everyone else has shared before suggesting a second idea or reviewing ideas

This is a great way to encourage shy (or uninterested) individuals to speak up while keeping dominant personalities from taking over the brainstorming session.

16. Rapid Ideation

This simple technique can be surprising fruitful. Ask the individuals in your group to write down as many ideas as they can in a given period. Then either have them share the ideas aloud or collect responses. Often, you will find certain ideas popping up repeatedly. In some cases, these are the obvious ideas. However, in some cases, they may provide some revelations.

17. Trigger Storming

This variant on the round robin approach starts with a “trigger” to help people come up with thoughts and ideas. Possible triggers include open-ended sentences or provocative statements. For example, “Client issues always seem to come up when ____” or “The best way to solve client problems is to pass the problem along to someone else.”

Radically Creative Brainstorming

If your team seems to be stuck on conventional answers to brainstorming challenges, you may need to stir the pot to help them generate creative ideas by using techniques that need out-of-the-box thinking. These may include the Charrette approach and "what if" challenges.

18. Charrette

Imagine a brainstorming session in which 35 people from six different departments are all struggling to come up with viable ideas. The process is time consuming, boring, and—all too often—unfruitful. The Charrette method breaks up the problem into smaller chunks, with small groups discussing each element of the problem for a set period. Once each group has discussed one issue, their ideas are passed on to the next group who builds on them. By the end of the Charrette, each idea may have been discussed five or six times—and the ideas discussed have been refined.

19. "What If" Brainstorming

What if this problem came up 100 years ago? How would it be solved? What if Superman were facing this problem? How would he manage it? What if the problem were 50 times worse—or much less serious than it really is? What would we do? These are all different types of “what if” scenarios that can spur radically creative thinking—or at least get people laughing and working together!

Conclusion

Brainstorming is a terrific technique for idea generation, coming up with alternatives and possibilities, discovering fatal flaws, and developing creative approaches. However, it is only as good as its participants and facilitator. The better you are at selecting participants, setting the stage, and encouraging discussion, the better your outcomes are likely to be.

10.2. Appendix 2: Hackathon Guide[8]

What is a hackathon?

- *Hacking is creative problem solving. (It does not have to involve technology.)*
- *A hackathon is any event of any duration where people come together to solve problems. Most hackathons have a parallel track for workshops.*

Participants typically form groups of about 2-5 individuals, take out their laptops (if the event is technology themed), and dive into problems. Training workshops are a great parallel track especially for newcomers but also for all participants.

Positive energy

Hackathons have gotten a bad rap because of some that have an unhealthy, competitive structure, and for setting unrealistic expectations. Do not run a hackathon like that and you will be on the right track. Here are the goals I keep in mind:

- *Strengthen the community at which the hackathon is aimed.*

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- *Be welcoming to newcomers to the community.*
- *Provide an opportunity for participants to learn something new.*
- *Provide a space and a time for participants to make headway on problems they are interested.*

Do not expect to have actually solved a problem by the end of the hackathon. Real life problems are hard! Think of the hackathon as a pit stop on a long journey to solve problems or as a training session to prepare participants for solving problems.

Since you are not going to solve a problem, do not put unrealistic (and unhealthy) pressure on your participants. Do not stay up all night, do not pump participants with caffeine, and do not make winners and losers. Just do not. Participants should come energized and be greeted with positive energy.

Wait — maybe a hackathon is not the right thing

The notes below are mostly logistical and assume a technology-centric approach.

Welcoming newcomers

The hardest thing about running a successful hackathon is being welcoming to newcomers and helping them get involved in an activity.

Newcomers often suffer from "imposter syndrome", the feeling that they do not belong because they do not have skills, are not smart enough, etc. They are wrong, of course, but until they feel like they belong, they will not be able to have a fulfilling experience. It is the hackathon organizer's job to help them realize they have something to contribute.

First time hackathon participants are often overwhelmed when it comes time to finding a project to work on. They may not yet know how to relate their own skills to the sorts of projects being worked on. Knowing how to be useful is a skill in itself. You will need to guide them to a project and through a process for them to realize how they can contribute. If you have too many lost participants and not enough help in getting them started on a project, they will leave — try to avoid that.

The hackathon organizer must make sure that everyone has something to do. One way to do this is to have a list of project leaders ahead of time: people you know are coming with particular projects to which you can guide other participants. In addition, you can work to make sure your hacking projects are ready to accept newcomers. You can also hold non-project activities — workshops, described below — which are easier for newcomers to join.

You could also consider pairing newcomers with mentors or holding a pre-event session just for newcomers, as Wikimedia recently did.

Hacking

The hacking track is for participants to dive into problems. Often groups of 2-5 individuals form around a project, such as building a new data visualization, writing a document, or collaboratively investigating a problem. Participants take out their laptops, connect to power and Wi-Fi, and get working.

Hacking begins with project introductions. Participants that bring projects to the event have an opportunity to briefly (1 minute max) explain what they are working on at the very start of the event so that other participants can join that project. At the end of the event, a wrap-up session gives each project a chance to demonstrate some accomplishments.

Cultivating Good Projects

Not every project makes a good hackathon project. It is extremely important to maximize the following qualities in the projects at your event:

- *Clearly articulated. Projects should have a clear question or problem they are trying to solve plus a reasonably specific proposed solution.*

- *Attainable. Most projects will accomplish about 25% of what they think they can accomplish in the limited time they have. Manage each project's goals so participants are able to feel accomplished at the end of the session, not interrupted.*

- *Easy to onboard newcomers. Projects should have ready-to-go tasks for newcomers with a variety of skills and at a variety of skill levels. For coding projects, these tasks cannot require an intimate understanding of the code base, and make sure the build environment can be spun up in less than 20 minutes. Make a list of tasks or create GitHub issues ahead of time!*

- *Led by a stakeholder. A stakeholder (or "subject matter expert") guides a project to real-world relevance. Projects without a stakeholder can "solve" a problem that does not exist. Ideally, the leader (or one of the leaders) is a stakeholder, or a good proxy for a stakeholder. Additionally, it is never enough for a project leader to be just an ideas' person. Beware when the leader is a stakeholder but cannot foresee how he or she might be implementing along with the rest of the team.*

- *Organized. For projects with four or more members, especially newcomers, the project leader's role should be to coordinate, ensuring each team member has something to work on and helping to welcome new team members.*

Treat these bullets like a checklist. Projects that think about themselves in terms of these qualities tend to be happier and more productive.

If you know what projects are going to be worked on at the event, the earlier you can get those projects thinking about this the better. Meet with project leads and talk about these components of their project ahead of time if possible. As an organizer, having this information about projects can also help you route participants to projects they may want to work on.

At Themed Hackathons

A themed hackathon is one in which the projects are confined to a particular problem: such as food sustainability or returning citizens. Themed hackathons are able to attract subject matter experts (something that open-ended hackathons like Open Data Day DC are not good at), and projects typically revolve around problems that the subject matter experts bring to the table.

When themed hackathons are also technology hackathons, there is a common problem: Subject matter experts can readily identify problems in their field but cannot always turn those problems into workable technology projects. Other participants may be ready to apply their skills but not know anything about the hackathon's theme. Bridging that gap requires careful planning ahead of time.

What often results is a division of the room into three groups:

1. *Subject matter experts and other participants successfully working together.*

2. *Subject matter experts working with other subject matter experts on problem investigation but not implementation.*

3. *Other participants struggling to find something relevant to work on / implementing a solution of minimal value to solving the theme's actual problems.*

#1 is great. #2 is fine if the group is happy. Nevertheless, #3 is bad: participants without subject matter guidance will feel lost. To avoid this, make sure you have enough workable projects for everyone ahead of the event. Work with the subject matter experts before the event to turn their problems into projects. See the section Cultivating Good Projects above to ensure there is a coherent question, that the necessary resources exist (e.g. datasets), and that the skills needed for the project match the skills expected to be brought by other participants (and in sufficient quantity).

Additionally, a subject matter expert may propose many ideas but he or she can only effectively participate in a single project during the event, so ensure that there is at least one subject matter expert + workable project for about every four non-expert participants.

Placing Newcomers into New Projects

Onboarding participants onto existing projects can be very difficult. It is one of the hardest parts of hacking. So have ideas for new projects that are especially easy for participants to get started with if they cannot join an existing project. Having project ideas ready is especially important if you do not expect many participants to bring projects! In addition, always be open to project ideas from participants. A project of one, meaning someone working alone, is okay too!

Other Tips

Do not allow anyone to pitch an idea they will not be working on at the event, unless there really are not enough ideas to go around. Otherwise, this is a waste of everyone's valuable time.

Once hacking has begun, do not interrupt the hackers except to ensure that the hacking is going smoothly, to check that everyone has something to do, and to keep people on the overall schedule. Mid-day activities such as lunchtime speakers and video calls with people off-site are incredibly distracting for participants who are now eager to get working on a problem.

Training

A successful hackathon might be just hacking, just training, or both hacking and training.

If you have a significant number of newcomers, having training workshops is a great way to give them something to do that they will be more comfortable with than diving into hacking. You can run workshops to introduce participants to the subject of the hackathon or to particular technical skills useful for the hackathon. Workshops can also be places to discuss issues in the field related to the hackathon. Workshops should be interactive as much as possible

Choose your workshop leaders carefully. Ideally, the leaders have run the same workshop before so they are well rehearsed. They should also be as diverse as the attendees you would like to see present at the event (gender, race, age, etc.). Read the Hopper Conference Diversity Guide's tips on selecting speakers.

Run the workshops in a second room if possible. 45-90 minute workshops are a good length. If you have more than one workshop, leave 15-30 minutes free between workshops to allow for the first leader to close up and the second leader to set up.

Venue & date

Basic requirements

Find a venue to host your event and reserve the date. This is the only thing you need to do significantly in advance of the event. The earlier you can reserve space the better.

Find a venue that can provide:

- *Proper seating (see below)*
- *One power strip per table*
- *Wi-Fi (is it fast and reliable? can it connect all of your participants? does it block any ports?)*
- *Projector*
- *A microphone, at least in large rooms*
- *Accessible entrances and wheelchair-friendly seating space (and if there is a stage, check if it is accessible, if applicable)*
- *Gender-neutral, single-occupancy, accessible bathrooms*

(If you are running a large event, also read all of the accessibility concerns listed here.)

Seating

Seating requirements are different for hacking and workshops. For hacking, you will want a banquet-style setup with large circular tables that seat about 10 people each. Rooms in banquet-setup hold the fewest number of people compared to other table/chair arrangements, so consider those when computing capacity. For workshops, you will want classroom-style seating, i.e. rectangular tables with chairs on one side.

When

Choose the date of your event carefully. Avoid the summer, holidays, and other major events in your field. Weekends are hard for people who are attending in their professional capacity. Weeknights are hard for parents.

Ask your venue about permissible start and end times. Set times for when you will arrive/leave and for when participants will arrive/leave. Plan at least 30 minutes before and after the event for you to set up and tear-down/clean up.

Make sure you can get in and that your participants can get in. If the building's front door is locked, make sure you have a key and that you have someone posted at the door to let in participants (you may need a team of people to rotate at the front door throughout the day).

Check whether the venue permits you to have food in the room.

If holding the event outside of business hours, check that the venue will have air conditioning/heating.

Budgeting your venue

Professional venues charge quite a bit of money, so you will need to find something that fits your budget. Hopefully you can find some free space with good Wi-Fi (your local library, a friend's company, etc.).

Sponsorship

For large events, you will probably need sponsors to help you cover the costs.

Sponsors will give you something — cash, space, food, t-shirts — with the expectation that they get something out of their support for your event. They might be recruiting/hiring and are looking to scout out your attendees, or they might be marketing a product that they want to promote.

Think about what you are willing to give sponsors in return for their support. You will certainly thank your sponsors, by name, during your opening and closing session and you will probably want to tweet your thanks too. Beyond that, do you want to give them a time at a podium to speak to your attendees? Alternatively, a table in the back to show off their stuff? It is up to you, and you have to strike the right balance between bringing in enough sponsorships with not interfering with the goals of your event.

Figure out your budget — your venue and food costs, especially — first, so you know how much in sponsorships you need. Then get started on securing sponsors early.

Food

Ideally, you should provide coffee and light fare for breakfast and beverages throughout the day (especially water). Food is surprisingly expensive though, so do what you can.

What to buy

If you provide any food, you really must supply vegetarian and dairy-free options because these dietary restrictions are very common. Going vegetarian is not a bad idea. After that, consider other restrictions your participants may have (vegan, kosher, gluten-free) and do your best.

Be responsible with your food. Think like a parent. Order food that is relatively healthy. Avoid heavy foods that make people sleepy (like bread) or ineffective (like alcohol). Caffeine and sugar are fine (energy is important), but have real nourishment too.

Budgeting and logistics

If you are ordering food, you will probably place the order at least three days ahead of the event.

Code of conduct

Technology events have a history of not always being welcoming to women and minorities. We need to change that. You can be a part of that change by adopting a code of conduct for the event. A code of conduct is not just about enforcing rules. It sets community norms and sends a signal to would-be participants that you are trying to create a welcoming environment. Moreover, of course, if there is a problem at your event having a code of conduct ahead of time will help you resolve the issue.

Look for codes of conduct used at events you admire, or copy from Code for DC's code of conduct or Tech Lady Hackathon + Training Day's code of conduct.

Happy hours

A pre-event happy hour the night before helps participants to get to know each other in a relaxing setting. A post-event happy hour the evening after the hackathon wraps up gives participants a chance to socialize now that they know each other.

For large events, pick a bar ahead of time and make sure it is ok for you to bring a large group. You may want to reserve a section of the bar (they may ask for a payment ahead of time or a guaranteed minimum spend that they will charge you after if your people do not order enough).

If you are serving alcohol, keep in mind: not everyone drinks (those under 21, pregnant women, and many other people for a variety of reasons); alcohol can lead to an unsafe or uncomfortable environment; those that drink will need public transportation to get home. Thus, provide non-alcoholic drinks; supervise the environment to ensure it remains professional and comfortable for all; be near public transit.

Registration

Set up an Eventbrite registration form.

Registration Limit

Determine your maximum capacity. For an event with parallel tracks, bear in mind that participants will all gather in one room at the start of the event, so your maximum capacity is a little larger than the capacity of your main room (some people can squeeze/stand at the beginning).

For a free event, about 65% of those who register will actually show up. This number is very consistently seen across events. So cap registration at 150% of your actual maximum capacity.

Gather info

Use the registration form to gather information about participants:

- *Name (and possibly other information as required by venue security)*
- *Email address*
- *Job title*
- *Are they new to hackathons?*
- *What kind of hacker are they? Examples: Developer. Designer. Data Scientist. Domain Expert. Government Staff. Communicator. Project Manager. Advocate.*
- *What are they interested in hacking on? (Free form question)*
- *Are they interested in any of the workshops?*
- *How they heard about the event*
- *Special needs/requests*

The more information you can gather ahead of time the better planning you can do. You can start to think about who will be working on what as soon as registrations start coming. Literally, try to imagine how each registered participant will keep occupied at the event based on whatever information you know about him or her.

Ten days before

Find project leaders

Look at who is coming and if you know some of those people are coming with particular projects, identify project leaders. You may also want to meet with them at this time to:

- *Guide them on how to make progress on their projects*
- *Identify how they can take on newcomers; what tasks are doable for newcomers*

- *Identify what kind of help their project needs*

See the section Cultivating Good Projects above.

Find helpers

If you are running interactive workshops where the participants are following along on their laptops and expect many participants to attend, you may want to have workshop helpers around to help participants that are stuck. Plan for at least one helper for every 10-20 participants.

Also, find helpers to run a registration table and the building's front door if it is locked, you can also consider identifying volunteers to take point on photography, managing social media, and documenting what happens at the event for storytelling afterward.

Email attendees

You may want to email the registered attendees at this point with as much of the logistics information, as you know, so that they can plan ahead. See "The day before" below for what to include in the email.

Three days before

Set up group communication

Set up a way for your participants to communicate digitally and stay in touch after the event. Some options are:

- *A chat room, like Slack*
- *A social media channel, like a hashtag on Twitter or a Facebook group*
- *A shared document space, like Google Docs or Dropbox Paper*
- *An email list, like a Google Group*

Think about how you will tell your story

Part of your event's lasting impact is in how people will remember it:

- *Choose a hashtag.*
- *Set up a Gdoc or other public shared document space (see above) for projects to record progress and post links.*
- *Think about how to take photos of your hackathon that tell its story.*

Acquire supplies

You should bring to the event:

- *Paper, markers, and tape to write and post signs with*
- *Name tag stickers and markers for people to write their names on their name tag*
- *Note cards, pens, paper and other supplies to facilitate project planning*
- *Plastic cups, paper plates, and disposable utensils if you are providing food*

Also...

- *Place any food catering orders*
- *Email any journalists you know who may be interested in the event*
- *Charge your camera so you are ready to take photos*
- *Some venues require a list of participants for security. If you need to submit a list, make sure you alphabetize it! Security will probably print whatever you have as-is and things get complicated quickly when the list is not in order.*

Email attendees again

You may want to email the registered attendees at this point, again, with as much of the logistics information as you know, so that they can plan ahead. See "The day before" below for what to include in the email.

The day before

Walk-through

Do a walk-through of your venue. Ensure you have:

- *Banquet tables for hacking, rectangular tables for workshops*
- *Enough chairs (count them!)*
- *One power strip per table*
- *Working Wi-Fi*
- *Working projector and VGA dongle (maybe even test your computer)*
- *A microphone, at least in large rooms*

If you have two parallel tracks:

- *Go over the list above once for the hacking room and again for the training room*
- *Ensure you have enough space to hold everyone in one room because participants will gather in one room first for the welcoming session*

Email blast

Send out a logistics email to registered participants. Include:

- *Your contact information, including your cell phone number so participants can call/text you if they cannot find the venue*
- *Any pre-event and post-event happy hour information: location, date, and time*
- *Start and end dates and times of the event*
- *Location of the event (address and building name), exact location of entrance, directions, and map*
- *Reminder to bring ID if the venue has a security check-in*
- *Reminder to bring a laptop and charger*

- *What food/beverages will be provided and when (breakfast, lunch, dinner?), and what restrictions will be accommodated (vegetarian, etc.)*
- *Schedule of workshops, if applicable*
- *Your code of conduct (or a link)*
- *If there are any disability accessibility issues with the venue, include that*
- *Any read-ahead materials to prepare them for the topic of the event*
- *Names of the organizers and acknowledgement/thanks to sponsors*

Handouts

Print handouts for participants that include:

- *Wi-Fi info (SSID and password)*
- *The event's hashtag and URL*
- *The schedule (start time, lunch, end time, and workshop schedule if applicable)*
- *A list of breakout rooms*
- *Recommend nearby locations for lunch/dinner (and include a map if possible)*
- *A short URL (e.g. bitly) to the Gdrive or hackpad page*

Print one copy per table (i.e. one copy for every ~5-10 participants).

Also

- *Prepare slides for the welcoming session (if you want)*
- *Charge your phone. It is going to be a long day tomorrow.*

Hackathon schedule

When you arrive early

- *Make sure things are OK: tables/chairs are there, the projector works, restrooms are in working order*
- *Post signs from the main entrance of the building to where participants should go first*
- *Post signs to restrooms and any other rooms participants may need to go to*
- *Lay out the name badges. If they are printed with names, lay them out alphabetically and if there are a lot group them by part of the alphabet and post signs.*

Welcoming session

Start with a brief session welcoming everyone and laying out the day:

- *Introduce the organizers*
- *Thank the venue and sponsors (do not forget anyone — this is why they sponsored you)*
- *Explain the history and purpose of the event*

- *Mention the code of conduct (again, the point is often to set norms, not merely to enforce rules)*
- *Ask who has not been to a hackathon before, or to your particular event before; give an applause*
- *Explain logistics: the online doc, the schedule of workshops, lunch, end time*
- *Encourage people to take and share session notes and to record progress on projects (see the notes above on telling the hackathon's story)*

In a small event (up to about 30 people), you can have all of the participants introduce themselves.

Anyone who has brought a project to work on should then introduce the project to everyone. This is sometimes called "project pitches." Keep each pitch short: the leader's name and affiliation, a problem statement, the solution, and the skills/help needed. Project leaders tend to talk for as long as they can, so you may need to cut them off after one minute to be respectful of the audience's time. Encourage leaders to think of this not as recruiting but as boasting how awesome their day is going to be.

During the day

Have someone managing the hacking room. Go around checking that every project is going smoothly. See if anyone needs anything or cannot find something to work on. Keep people on the overall schedule. Alert everyone when it is time for lunch and one hour before the wrap-up session. Leading up to wrap-up, make sure each project is prepared to explain what they did. Get them to record their progress on the online doc.

Have someone managing workshops. Make sure workshops stay on schedule, that participants understand the leader, can hear the leader from the back of the room, etc. Be around to ensure that the workshop leader does not have any technology problems. An organizer should be on hand at the workshops at all times.

Wrap-up

The wrap-up session gives everyone a chance to hear what everyone else worked on during the day. For a small group, ask volunteers to report what they accomplished or what they learned (especially for workshop participants). Give folks rounds of applause.

In large groups, have each project report on its accomplishments. If possible, let them show their work on the projector. However, keep things quick. By this point, projects may have a lot to say. Keep each project to 1 or 2 minutes, and if they are going to show something on the projector make sure it is ready before the wrap-up session begins.

Finally:

- *Thank the venue and sponsors*
- *Thank the attendees and co-organizers*
- *If there is a post-event, direct people to it or ask a volunteer to lead people over*

Teardown

Finally once all of the participants are gone, make sure the venue is returned to its original state:

- *Clean up*
- *Remove signs*
- *Check for lost items*

Post-mortem

After the event:

- *Write down everything that went right so you can repeat it next time*
- *Write down everything that went wrong so you can avoid it next time*
- *Compute how much the event cost in total and per participant, just to know*
- *Survey the attendees about what they liked and did not like*
- *Blog about the event*

10.3. Appendix 3: Persona Guide

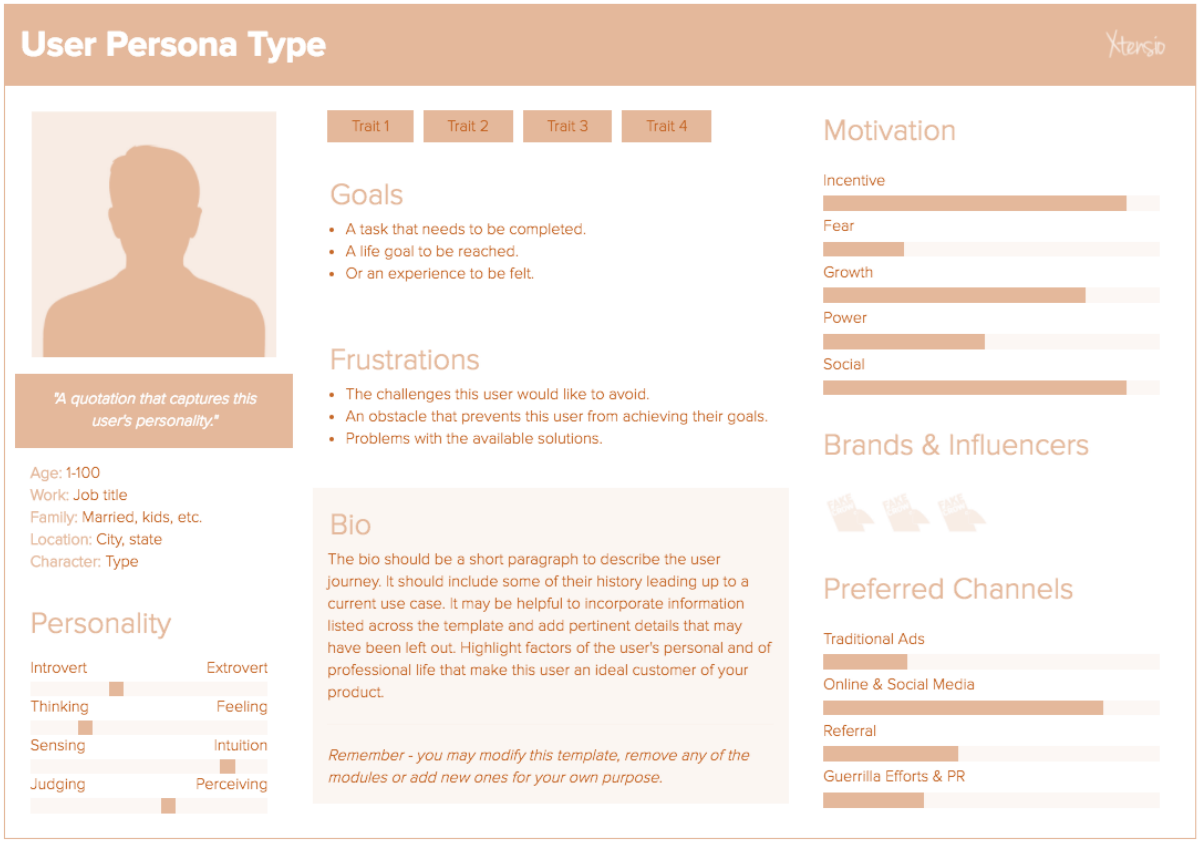


Figure 7: Template from https://library.xtensio.com/user-persona-template-and-examples

10.4. Appendix 4: Role Playing

Using Role-Playing[9]

Define Objectives

The details of what you need to do depend entirely on why you want to include role-playing in the workshop.

- What topics do you want the exercise to cover?
- How much time do you and your class have to work on it?
- What do you expect of your participants: research, reports, presentations?
- Do you want the participants role-playing separately or together?
- Do you want to include a challenge or conflict element?

Choose Context & Roles

In order to prepare for the exercise:

- Decide on a problem related to the chosen topic(s) and a setting for the characters. It is a good idea to make the setting realistic, but not necessarily real. Consider choosing and adapting material that others have prepared.
- If the characters(s) used in the exercise are people, let the participants co-define his or her goals and what happens if the character does not achieve them.
- Work out together each characters' background information on the problem or, better yet, directions on how to collect it through research. If possible, prepare maps and data for your participants to interpret as part of their background information rather than the conclusions upon which they would ordinarily base their decisions (especially if the characters are scientists).

Introducing the Exercise

- Engage the participants in the scenario by describing the setting and the problem.
- Provide them with the information you have already prepared about their character(s): the goals and background information. It needs to be clear to the participant how committed a character is to his/her goals and why.
- Determine how many of your participants have done role-playing before and explain how it will work for this exercise.
- Outline your expectations of them as you would for any assignment and stress what you expect them to learn in this lesson.
- If there is an inquiry element, suggest a general strategy for research/problem solving.

Participant Preparation/Research

Even if there is no advance research assigned, participants will need a few moments to look over their characters and get into their roles for the exercise. There may also be additional questions:

[9] Adapted from https://serc.carleton.edu/introgeo/roleplaying/howto.html

- Why they are doing this in character? Why did you decide to make this a role-playing exercise?
- Participants may have reservations about the character that they have been assigned or about their motives. It is good for the instructor to find out about these before the actual role-play. It can be very difficult for a participant to begin researching an issue from a perspective very different from their own because even apparently objective data tends to be reinterpreted as support for pre-existing world-views.
- Similar websites representing the very common viewpoint of the worker, property owner, or industrialist whose future may be in conflict with environmental interests are hard to find. One site, Debate Central, has constructed arguments for characters promoting property rights and wary of government intervention. Their topic coverage is still limited, however. A poorer alternative is to send participants to the websites of companies involved in an issue to read their PR material.
- Often, the best resource for understanding people is other people. Model UN encourages participants to call the embassy of the country they are to represent for advice. The same can be done with the PR divisions of mining firms and unions, environmental and taxpayer protection groups, etc.
- If there is an inquiry component (i.e. participant-led research), the participants may need help coming up with a research plan and finding resources.

The Role-Play

Depending on the assignment, participants could be writing papers or participating in a Model-UN-style summit. For a presentation or interaction, props can liven up the event, but are not worth a lot of effort as they are usually not important to the educational goals of the project.

- Potential Challenges with Interactive Exercises

Concluding Discussion

Like any inquiry-based exercise, role-playing needs to be followed by a debriefing for the participants to define what they have learned and to reinforce it. This can be handled in reflective essays, or a concluding paragraph at the end of an individual written assignment, or in a class discussion. The instructor can take this opportunity to ask the participants if they learned the lessons defined before the role-play began.

Assessment

Generally, grades are given for written projects associated with the role-play, but presentations and even involvement in interactive exercises can be graded. Special considerations for grading in role-playing exercises include:

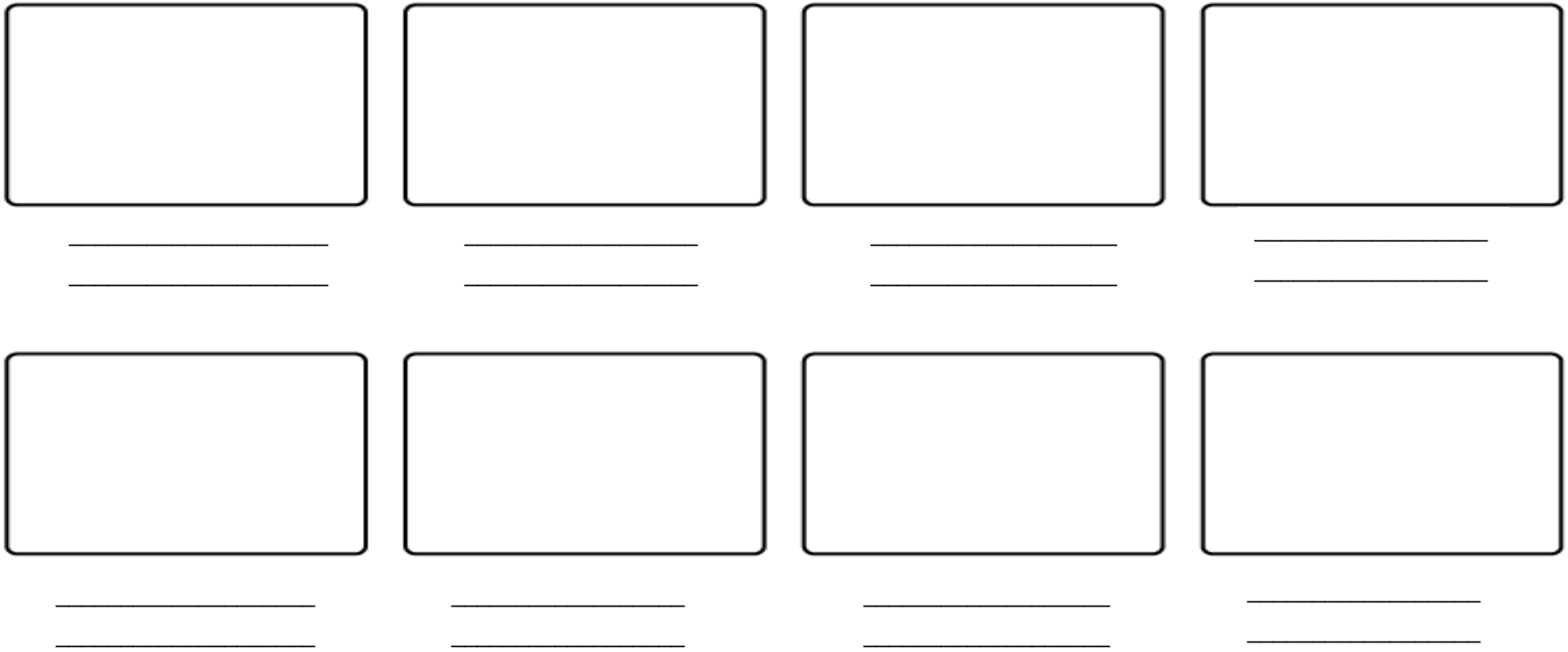
- Playing in-character
- Working to further the character's goals
- Making statements that reflect the character's perspective
- In an interactive exercise, being constructive and courteous
- For many assignments, being able to step back and look at the character's situation and statements from the participant's own perspective or from another character's perspective.

10.5. Appendix 5: Storyboarding template

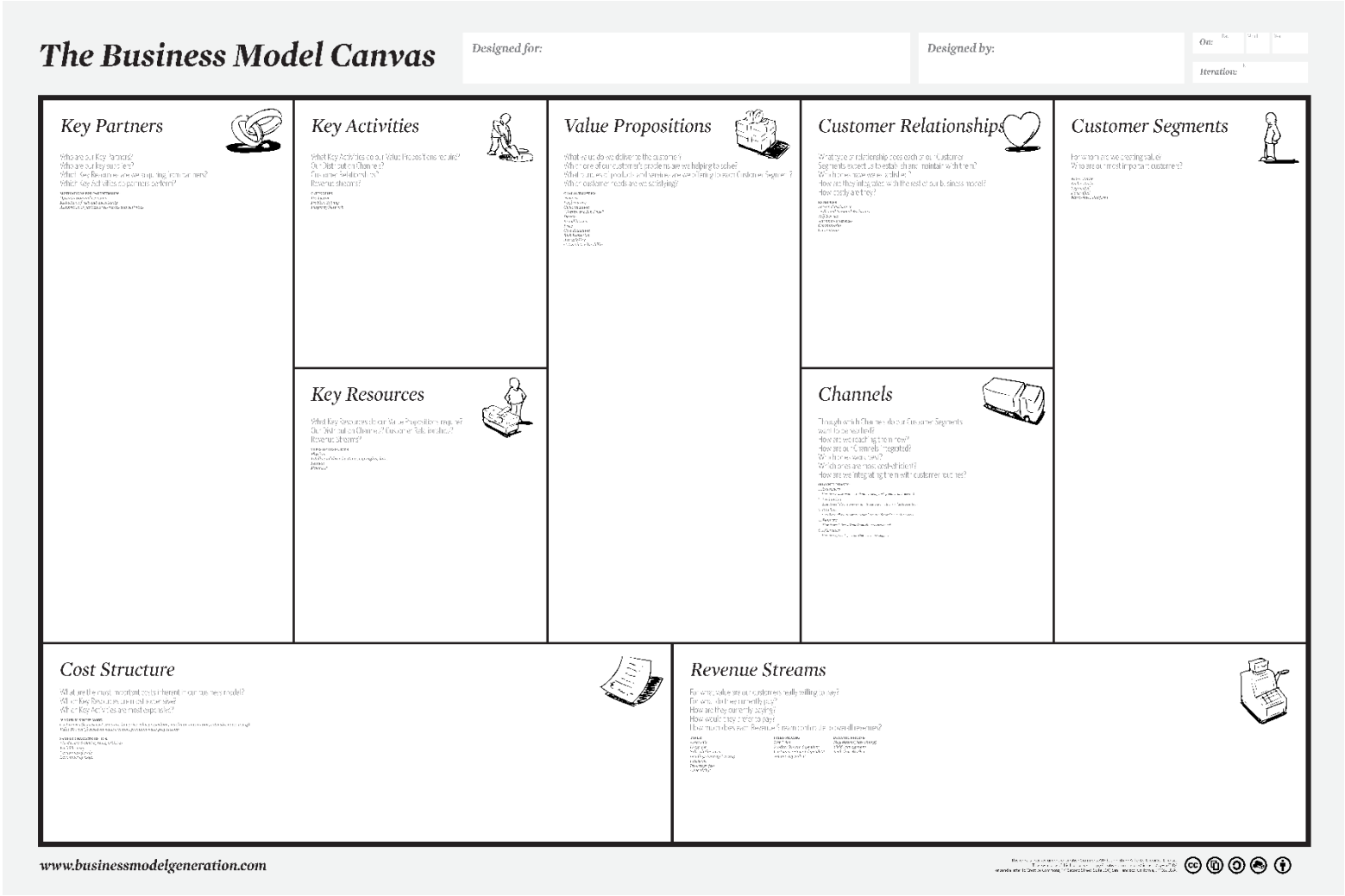
Project Name: _____

Date: _____

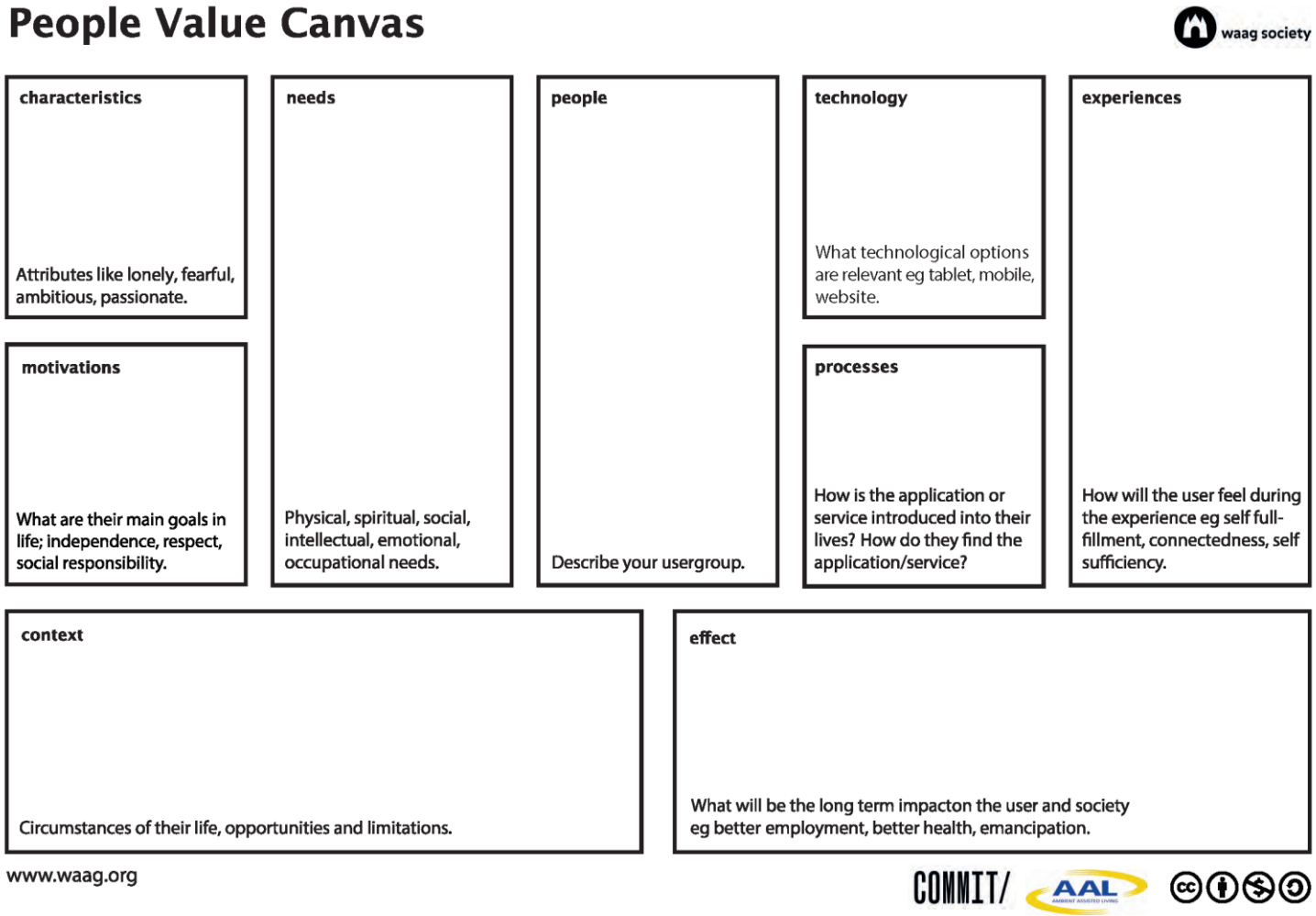
By: _____



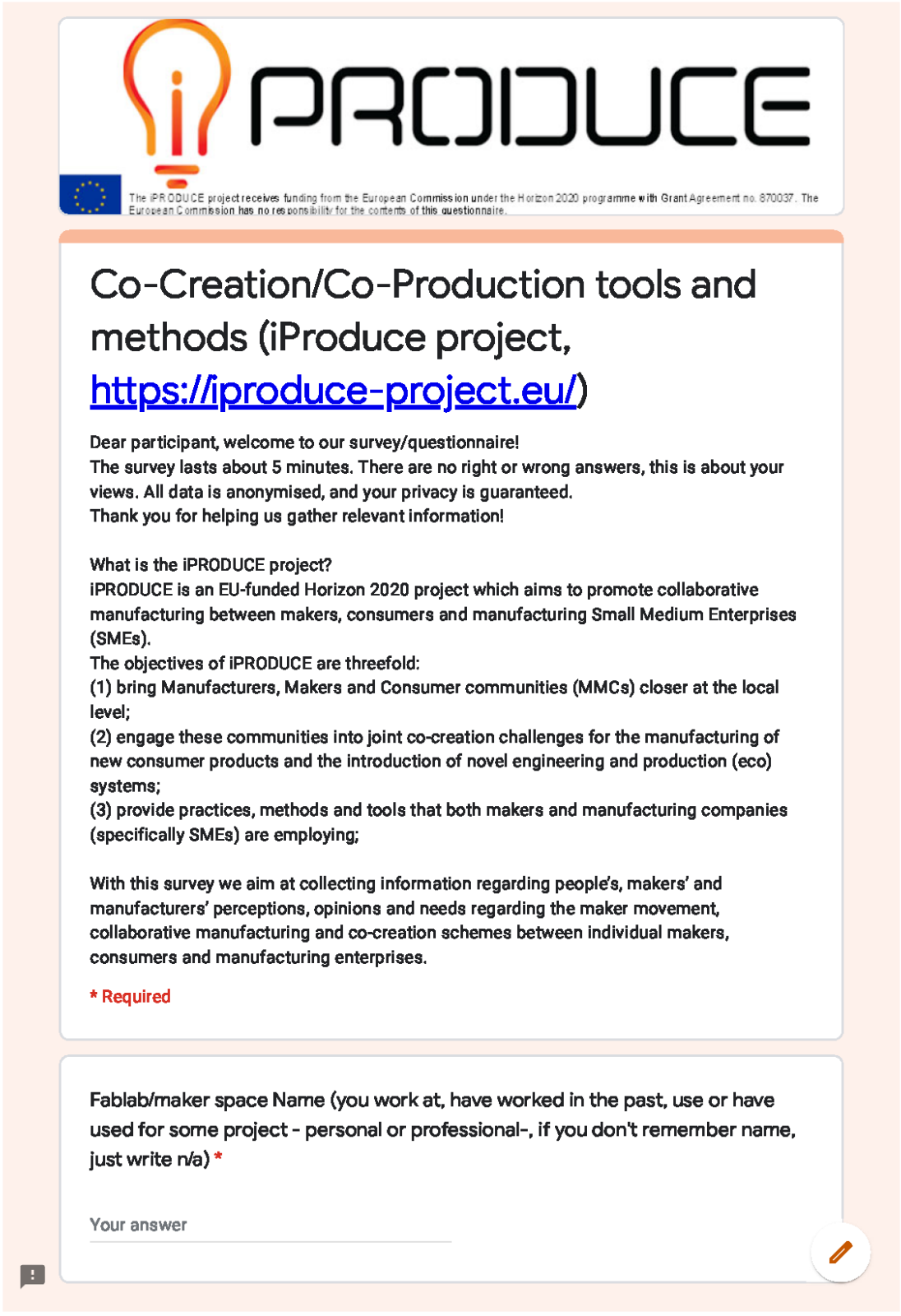
10.6. Appendix 6: Business model canvas template



10.7. Appendix 7: People Value canvas template



10.8. Online questionnaire



PRODUCE

The iPRODUCE project receives funding from the European Commission under the Horizon 2020 programme with Grant Agreement no. 870037. The European Commission has no responsibility for the contents of this questionnaire.

Co-Creation/Co-Production tools and methods (iProduce project, https://iproduce-project.eu/)

Dear participant, welcome to our survey/questionnaire!
The survey lasts about 5 minutes. There are no right or wrong answers, this is about your views. All data is anonymised, and your privacy is guaranteed.
Thank you for helping us gather relevant information!

What is the iPRODUCE project?
iPRODUCE is an EU-funded Horizon 2020 project which aims to promote collaborative manufacturing between makers, consumers and manufacturing Small Medium Enterprises (SMEs).
The objectives of iPRODUCE are threefold:
(1) bring Manufacturers, Makers and Consumer communities (MMCs) closer at the local level;
(2) engage these communities into joint co-creation challenges for the manufacturing of new consumer products and the introduction of novel engineering and production (eco) systems;
(3) provide practices, methods and tools that both makers and manufacturing companies (specifically SMEs) are employing;

With this survey we aim at collecting information regarding people's, makers' and manufacturers' perceptions, opinions and needs regarding the maker movement, collaborative manufacturing and co-creation schemes between individual makers, consumers and manufacturing enterprises.

* Required

Fablab/maker space Name (you work at, have worked in the past, use or have used for some project - personal or professional-, if you don't remember name, just write n/a) *

Your answer

Country *

Your answer

URL *

Your answer

Staff number (average) (if you work at a lab/makerspace)

Your answer

Do you agree with the definition of Co-creation: Co-creation is defined as any project/product/service emerging from a collaborative development with a group of different stakeholders (citizens, designers, companies, makers, etc.)?

- ◯ Yes
- ◯ No

If no, please state your definition below

Your answer

Online resources for social manufacturing (forums, wikis, etc) *

	Use it often	Have used it in the past	Never used it, but know of it	Never heard of it
https://discuss.fablabs.io/	○	○	○	○
https://www.hackster.io/hologram/discussion	○	○	○	○
https://www.arduino.cc/	○	○	○	○
https://3dprint.wiki/	○	○	○	○
https://makershare.com/	○	○	○	○
https://makerdesignlab.com/	○	○	○	○
https://www.instructables.com/	○	○	○	○
https://snapguide.com/	○	○	○	○
https://learn.sparkfun.com/resources	○	○	○	○
https://www.scrumguides.org/	○	○	○	○
https://publiclab.org/wiki/multispectral-imaging	○	○	○	○
https://wikifactory.com/	○	○	○	○
https://distributeddesign.eu/	○	○	○	○
https://www.thingiverse.com/	○	○	○	○
https://maker.pro/	○	○	○	○
https://www.digikey.com/en/maker/platforms	○	○	○	○

https://hackaday.io/	○	○	○	○
https://learn.adafruit.com/	○	○	○	○
https://www.hackster.io/	○	○	○	○
http://zedboard.org/	○	○	○	○

Please list any other online tools you may use

Your answer

Co-creation tools and activities *

	Use it often	Have used it in the past	Never used it but know of it	Never heard of it	Other
Opening Circle	○	○	○	○	○
Open Space	○	○	○	○	○
World Café	○	○	○	○	○
Artistic Visualisation	○	○	○	○	○
Mapping	○	○	○	○	○
Dreams and fears	○	○	○	○	○
Values tree	○	○	○	○	○
Ambition ranking	○	○	○	○	○
Personas	○	○	○	○	○
Day-in-the-life	○	○	○	○	○
Stakeholders trust map	○	○	○	○	○
Positioning the Project	○	○	○	○	○
Purpose and culture	○	○	○	○	○
Good&co	○	○	○	○	○
Is – is not – does – does not:	○	○	○	○	○
Journey map	○	○	○	○	○

Community mapping	○	○	○	○	○
Experience mapping	○	○	○	○	○
Card sorting	○	○	○	○	○
Pictogram interview	○	○	○	○	○
Listening levels	○	○	○	○	○
Empathy mapping	○	○	○	○	○
Guided tour	○	○	○	○	○
Question walk	○	○	○	○	○
Collage	○	○	○	○	○
Street vote	○	○	○	○	○
Photo safari	○	○	○	○	○
Your priorities	○	○	○	○	○
Mini-campaign challenge	○	○	○	○	○
Board games	○	○	○	○	○
Reverse brainstorming	○	○	○	○	○
People value canvas	○	○	○	○	○
Storyboards	○	○	○	○	○
Crazy 8	○	○	○	○	○
Idea dashboard	○	○	○	○	○

Unintended consequences	○	○	○	○	○
Role play	○	○	○	○	○
Rapid prototyping	○	○	○	○	○
Hackathon	○	○	○	○	○
Who what when	○	○	○	○	○
Insights and learnings	○	○	○	○	○
Note to self	○	○	○	○	○
Blueprinting	○	○	○	○	○
Business Model Canvas	○	○	○	○	○
Design spring	○	○	○	○	○

Please list any other tools/methods you may use.

Your answer

What about communication tools? *

	Use it often	Have used it in the past	Never used it, but know of it	Never heard of it
Skype	○	○	○	○
Skype for business	○	○	○	○
Meetup	○	○	○	○
Slack	○	○	○	○
GotoMetting	○	○	○	○
Zoom	○	○	○	○
WEBEX	○	○	○	○

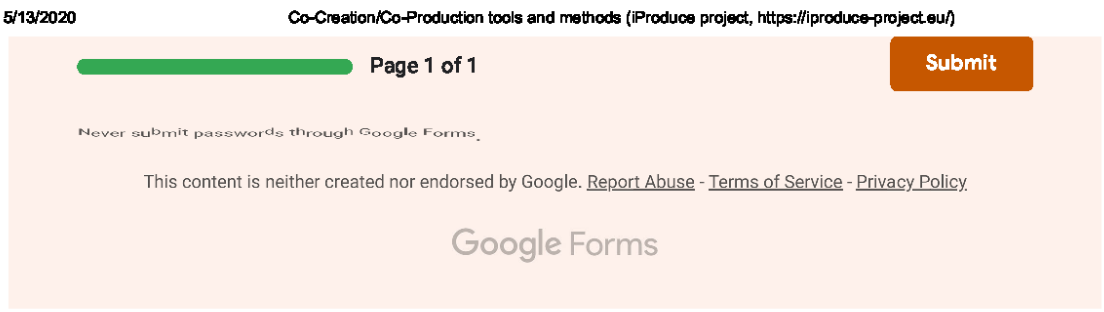
Please list any other communication tools you may use

Your answer

THANK YOU

Thank you for taking part in this survey and contributing to our understanding of what people think about makerspaces and collaborative manufacturing between individual makers and manufacturer enterprises. Your input will help us a great deal to identify key elements and perceptions that should be considered during the implementation of our project.
Do you have any questions or comments? You can contact us at info@iproduce-project.eu.

Informed consent
This privacy policy details information collection practices related to your personal data and other related information and the limited manner in which the iPRODUCE project will use and disclose the information provided to us when you responded the survey.
By participating in the survey, you voluntarily consent to the collection and use of your information by iPRODUCE as set forth in this privacy policy. If you have any questions concerning this privacy policy or our data collection practises you may contact us at info@iproduce-project.eu. We reserve the right to change this privacy policy at any time and inform all participants about the updates.
The collected data will be only used for the purpose of the iPRODUCE project, funded under the European Union Horizon 2020 programme. The lawfulness of the processing of personal data is determined pursuant to Article 6 of the EU's General Data Protection Regulation (GDPR). With respect to personal data, the processing of personal data is based on consent.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Co-Creation/Co-Production tools and methods (iProduce project, https://iproduce-project.eu/)
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