# OPEN_NEXT

## Deliverable 5.2

## First release of prototyping improvement logic (PIL)

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# OPEN_NEXT – Transforming collaborative product creation

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| 11 | MAKER | MAK | DK |
| 12 | AGILE HEAP EV | FLB | DE |
| 13 | SONO MOTORS GMBH | SOM | DE |
| 14 | OPNTEC GMBH | OPT | DE |
| 15 | STYKKA APS | STY | DK |
| 16 | TILL WOLFER | XYZC | DE |
| 17 | FICTION FACTORY | FIF | NL |
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## Abstract

As places of intersection between society and technology with great experience in community management and co-development practices, makerspaces can have a huge impact on open source (product) development projects (OSD) in the context of company-community collaboration (C3). As a source of an open source mind-set and as prototyping facilities, they can decrease the distance between the design process and communities of concern, e.g. by actively engaging them in the ideation and decision-making activities.

In order to train makerspaces to become OSD labs that are able to initiate, support and manage OSD projects with SMEs, a suitable qualification strategy is needed. This is summed up as a methodology for OSD sprints, the so-called ‘prototyping improvement logic’ (PIL), which guides especially makerspaces through a standardised learning process. The first release of the PIL contains the basics to provide a common understanding of the OSD context as well as a conceptual model incl. a gender & diversity plan. Furthermore, an engagement plan is introduced as basis for the makerspace's service pitch for winning new SMEs.

Keywords: *open source hardware, development, makerspace, prototyping, methodology, company community collaboration, diversity, gender, engagement, co-design*

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# List of abbreviations and terms

| | |
|---|---|
| ASD | Agile Systems Design |
| C3 | Company-community collaboration |
| CAD | Computer-aided design |
| CAx | Computer-aided x |
| CIR | Continuous idea repository |
| DIN | Deutsches Institut für Normung e. V. |
| DIY | Do it yourself |
| EC | European Commission |
| EU | European Union |
| Gender | The term ‘gender’ in this document is used in a summative format and refers to the entire spectrum of gender identities that are not exclusively masculine or feminine – identities that are outside the gender binary as well as LGBTQ and other gender identities. |
| FoA | Fields of Action |
| ICT | Information Communication Technology |
| iPeM | Integrated Product Engineering Model |
| IPR | Intellectual property rights |
| MS | Milestone |
| NDA | Non-disclosure agreement |
| NPD | New product development |
| OS | Open source |
| OSH | Open source hardware |
| OSD | Open source (product) development |
| PIL | Prototyping improvement logic |
| PM | Project management |
| PSS | Product-Service-System |
| PST | Problem-solving team |
| QFD | Quality Function Deployment |
| RRI | Responsible research & innovation |
| SME | Small and Medium-sized Enterprise |
| TRL | Technology readiness level |
| WP | Work package |

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# 1 Introduction

Together with three makerspaces, six Small and Medium-sized Enterprises (SMEs), the research partners of OPEN_NEXT are going through an open source (product) development (OSD) journey. During this time, data, insights and feedback were collected for sprints in the context of consumer open source hardware (OSH) products. This resulted in the interim outcome, the first of two releases of the OPEN_NEXT prototyping improvement logic (PIL) - a methodology for OSD sprints. This PIL contains the basics that provide a common understanding of the OSD context and the conceptual model as a basis for the following first draft of the implementation of the qualification strategy for makerspaces to become OSD Labs.

## 1.1 Motivation

To establish open innovation in the context of open source hardware (OSH) of consumer products through a strong company-community collaboration (C3), the combination with makerspaces as the heart of prototyping as well as the cooperation with makers and citizens offers the perfect basis for a real co-design. The qualification of makerspaces to become open source (product) development laboratories or in short OSD Labs opens up great potential for this cooperation and the development of needs-based and demand-oriented hardware solutions including relevant services. Together with a moderated, transparent and open development process the aim is not only to increase the benefit of the subsequent product, but also to improve its acceptability and sustainability.

## 1.2 Preliminary considerations & the vision of an industry-changing PIL

In the development of consumer products, an open source (OS) approach, in contrast to classic product development, focuses on and promotes the participation of every interested individual with the help of a strong company-community collaboration (C3). Both the content development process and the outcome of that process are open and transparent. The active involvement of relevant stakeholders and affected individuals and groups move away from the company-customer paradigm, where the company creates products and the customers use them, to a mind-set that sees product development as more of a collaborative effort. Successful execution of open source projects is heavily reliant on whether or not these stakeholders are able to collaborate and align their objectives and activities (Mitchell et al. 1997).

When the community and the company share the common objective of pushing the ball forward and chasing new opportunities, people can advance their own interests while contributing to the common good and the SME benefits from workers who come from outside its own workforce. This also enables new ways to seek out talent beyond the company’s walls. C3 means fostering and relying on a community of engaged users, citizens and organisations, seeing them as potential partners rather than mere customers, and thinking about new ways to harness the talent and ingenuity of people who aren’t on the payroll. Thus, the C3 approach goes far beyond the state of the art in customer-innovation. Certainly, there are limits to this principle, as community management, for example, is a huge challenge. SMEs will have to find a comfortable balance between the traditional workforce model and new models. However in the long run, incorporating the open source mind-set deeper

into the company DNA will potentially be an added value for companies, their employees, and their communities.

In the case of physical consumer products, which is the main focus of the C3 journey in OPEN_NEXT, open source innovation is termed as open source (product) development (OSD). Thereby OSD includes products and product-related services following a Product-Service-System (PSS) approach (Exner and Stark 2015). OSD entails significant challenges to coordination, cooperation and communication in a diverse transdisciplinary development environment.

Since the rise of solutions and tools for distributed development (e.g. Wikifactory[1], GitHub[2], Thingiverse[3]), virtual teams who are working in a group with a focus on a common task at different locations can significantly influence the PSS development (Heimburg and Radisch 2001). The available technology makes it easier than ever to communicate and collaborate with people anywhere, any time. In combination with the transparent and open development process it is possible to exploit great potentials and generate positive influence in the consumer product market like more usable products, which can lead to wider adoption and more accelerated adoption rates, cost savings (Booher and Minninger 2003), and safer systems (Leveson and Turner 1993).

However, there is a particular challenge to involve local stakeholders and citizens in the development. Yet, due to the increasing importance of co-creation and two-way communication, the need to select stakeholders who are able to seamlessly collaborate with one other rose (Kazadi et al. 2016). In addition, due to a change towards more agile development processes, stakeholder involvement has become significantly more complex and for many SMEs stakeholder involvement is still a non-routine situation, where extra support might be needed. Working and communicating with multiple stakeholders (with different backgrounds and goals) can cause issues in the project due to the large cognitive distance between their mental models (Badke-Schaub et al. 2011). Additionally not just the technical competencies play an important role but also motivations, social capabilities and goals of the different stakeholders affect the project (Kazadi et al. 2016). This is where the makerspaces come in as a source of the OS mind-set and as a prototyping facility in the heart of the cities and society. For C3 they can initiate, support and guide the OSD projects through improving the connection between the company and their community and decreasing the distance between the product development process and the involved people i.e. by including them in the ideation and prototyping activities.

High staff turnover, little or no standardisation and weak project structuring are still the biggest challenges for OSH communities when it comes to creating awareness, making decisions and sharing knowledge. That is why the objective of the work package (WP) 5: *Prototyping makerspace-based demonstration facilities*[4] is to develop a qualification strategy for makerspaces to enable

[1] https://wikifactory.com/

[2] https://github.com/

[3] https://www.thingiverse.com/

[4] In the further course of this deliverable, only the short form WP5 will be used.

them to run community-based innovation projects with SMEs. In other words, to enable the transformation of makerspaces into so-called OSD Labs. This includes besides the possibility to build and validate PSS prototypes up to Technology readiness level (TRL) 6 in the real system environment with the target user group, also a focus on creating a collaborative business model around an existing or newly established community. The PSS prototypes can be seen as a flexible vehicle of exploration for all the relevant stakeholders and disciplines to communicate across their boundaries and up the PSS value chain (Exner and Stark 2015; Kim 2020). It is central to the user-centred design approach to understand products not only as what physically exists, but to explicitly embed them in practices and to help shape these. Of course, the technical documentation required to manufacture the product (drawings, parts lists, assembly instructions, original file formats, all under an appropriate licence) also plays a relevant role and should be made publicly available (ideally from an early stage in the development in preliminary state as per the idea of "release early"). Because (partly) distributed development processes as well as agile approaches increase the complexity of the development process, methodological support throughout the entire product development process is required. For this, the makerspaces must be equipped with methods, tools and guidelines, among other things.

All of this is summed up as a methodology for OSD sprints, which is called ‘prototyping improvement logic’ (PIL) that guides the stakeholders, especially OSD Labs, through a standardised learning process. The PIL has two objectives: one the one hand to profile and train makerspaces and related groups in OSD projects with SMEs and on the other hand to develop a communication strategy for promoting C3 and OSD collaboration with the purpose of engaging a broader group of potential SME and makerspace stakeholders (see Figure 1). Based on two iteration cycles (Pilot study September 2020 to June 2021; Demonstrator September 2021 to May 2022), the PIL is built, tested and refined through the experience of the work with three makerspaces and six SMEs during the first round and four makerspaces and 12 new SMEs in the second.

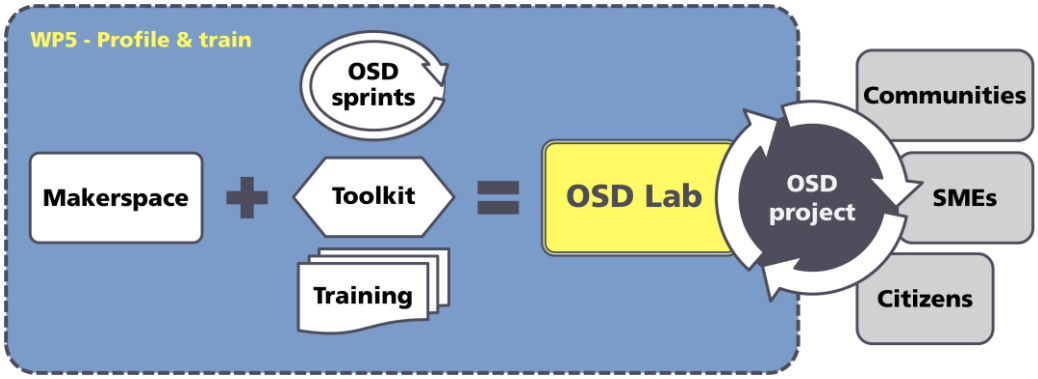


*Figure 1 :Transforming makerspaces to OSD Labs*

Leaving behind the idea of outsourcing as a means of increasing work performance at the lowest cost and replacing it with a new ideal: OSD with C3. OPEN_NEXT aims to show how OSD can facilitate a new corporate culture and a new way of developing and designing consumer products collaboratively to increase productivity outside the traditional office, quality of work and customer satisfaction.

## 1.3 Structure & relationship to other deliverables

The first version of the PIL, which is presented in this deliverable, is aimed in particular at the project partners in OPEN_NEXT. On the one hand, it is intended to provide the research partners in particular with a common, deeper understanding of the role of makerspaces. On the other hand, the product development process-related elaborations are addressed among other things to the practice partners (makerspaces and SMEs). As shown in Figure 2, this deliverable is divided into the sections (1) introduction, (2) fundamentals worth knowing, (3) the elaboration of the PIL within the conceptual model as well as an (4) outlook on the next steps and the second release of the PIL in June 2022.

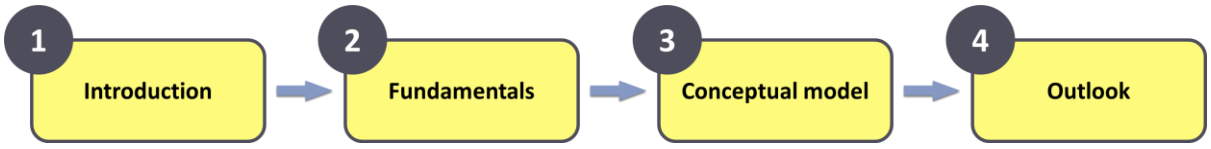


*Figure 2: Structure of this deliverable*

In deviation from the project proposal, the order of the subtasks was reweighted and prioritised according to the scope of the project. As a result, the Gender & diversity plan comes first, as it concerns all persons, groups and organisations involved. This is followed by the Engagement plan, which is particularly relevant for the practice partners. Both plans strongly influence the subsequent elaboration of the further elements of the methodology for OSD sprints and the tools to profile and train, which are mainly aimed at the makerspaces.

As seen in Figure 3, this deliverable builds on extensive groundwork. While *D4.1: First release of the open source business model development framework* supports the OSD journey of SMEs and makerspaces, *D5.1: Open source sociotechnical design components* provides the socio-technical basis and the description of the development phases in the OPENNEXT focus. These two pieces of work have been combined and extended, resulting in *D1.3: OSD framework*, which sets out the basis for the first release of the PIL. As the project progresses, *D4.2: Second release of the open source business model development framework*, *D5.3: First release of OSD Lab report*, *D6.1: Service pitch* and the case studies analysis in *D4.4: OSD impact assessment* will build on this. Especially the service pitch to recruit new project partners will benefit from the insights in the communication strategy. The second release of the PIL then combines the data from the implementation with the SMEs and makerspaces, the lessons learned and best practices in *D5.4: Second release of prototyping improvement logic (PIL)*.

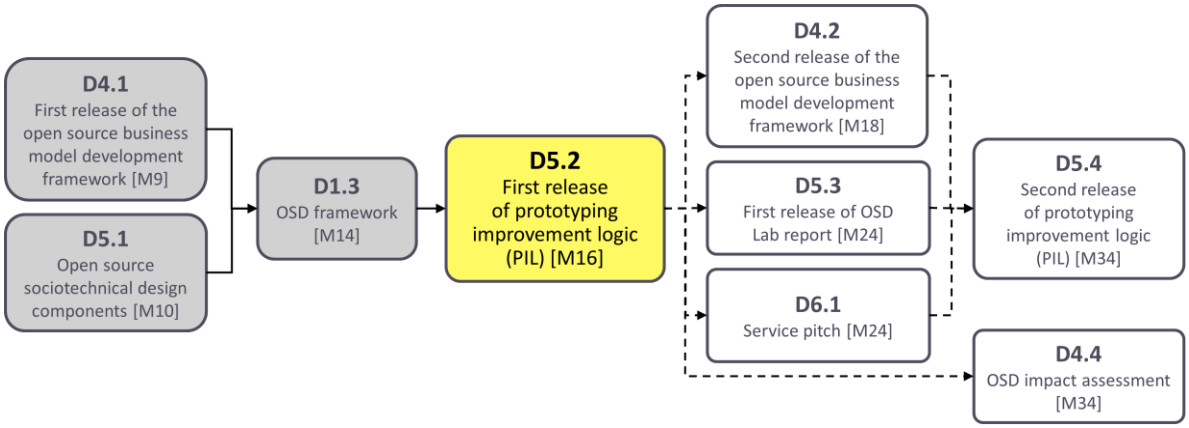


*Figure 3: Relationship to other deliverables in OPEN_NEXT*

# 2 Fundamentals – What do you need to know?

The "prototyping improvement logic" or in short PIL is the title for a methodology for OSD sprints. This chapter provides an overview of the basics worth knowing to explain what a methodology is, what OSD sprints are supposed to be and what is meant by a makerspace and a community.

In this project makerspaces act as experts in the field of engaging people and working in diverse collaborative settings. The makerspace partners in OPEN_NEXT are highly motivated to take the new path towards OSD and C3 and thus to advance a new kind of collaborative development and design of consumer goods. In doing so, they are pioneering work in this field to increase productivity, the quality of work as well as customer and citizen satisfaction. Their expertise serves as a basis for the Engagement plan and the training materials for OSD Labs developed during OPEN_NEXT. Therefore, an interview guide with 15 items (see Annex) was developed to cover the following item sets:

(1) Ways of working and project understanding,
(2) Self-image and makerspace culture,
(3) Communities and collaboration,
(4) Success criteria and risk factors, and
(5) Conflict in makerspaces-SME collaboration.

In contrast to the paired interviews (makerspace and SME together) in *D5.1: Open source sociotechnical design components*, three new, more in-depth interviews with the makerspace partners (duration: 1.5-2h per interview) were conducted to get to know their motivations and perspectives better. These were conducted via video and phone calls, recorded, transcribed and clustered. After evaluation, these has resulted in the partially deductively formed categories. Based on the insights gained, the individual elements of the PIL were elaborated and will be continuously expanded, validated and refined in the course of OPEN_NEXT to enable adequate planning of the demonstrator phase.

## 2.1 What are the makerspaces?

In the sense of a differentiated use of terms, some working definitions regarding the roles in makerspaces from WP5 perspective will be shared here first, before the topic of communities will be looked at in more detail in the Engagement plan which includes resources to recourse to the qualitative interviews with the partner makerspaces (see chapter 3.2).

According to Rosa et al. who provided an overview of the Maker Movement in the European Union:

> *"The [makerspace] concept started to be commonly used by practitioners to refer to any generic space (often also including FabLabs and Hackerspaces) that promoted active participation, knowledge sharing, and collaboration among individuals through open exploration and creative use of technology (i.e. through tinkering and making). In this sense, makerspaces do not comply with a pre-defined structure and indeed do not need to include a pre-defined set of personal fabrication tools (or by that matter, any of them to be considered a makerspace). The focus is on having a publicly-accessible creative space that explores the maker mind-set and tinkering-practices." (Rosa et al. 2017)*

For easier distinction in the context of OSD, **makerspaces** are understood as places where people from different disciplines work together collaboratively to produce new products and services, while sharing ideas, equipment and knowledge. Their representatives are considered to be the **operators or employees** of the makerspace. **Members** are all those people or representatives of organizations who contractually belong to a membership-based makerspace, regardless of whether they use the workshop or are merely interested in the network. **Makers**, on the other hand, are all those people who actively make things around makerspaces, from hobbyist tinkerers to small business owners. Therefore, the roles can overlap, but they do not have to.

## 2.2 What are the communities?

Variety of collaborations take place in makerspaces. For the OPEN_NEXT project - especially with regard to the Engagement plan (see chapter 3.2), the acquisition of partners for the demonstrator phase and the training materials - the interviews focused on collaboration between makerspaces and SMEs on the one hand and collaboration between makerspaces and their communities on the other hand. Here, the relationships between makerspaces and communities were highlighted, a classification of different communities was undertaken, and everyday practices in collaboration projects of makerspaces were explored. It is not always easy to identify roles, actors, and relationships, especially within makerspaces, but this is necessary for both theory building and practical support for prototypes and later demonstrators.

Collaborations play out in makerspaces at all levels. Those groups from which people come together to collaborate, sometimes spontaneously, sometimes purposefully organized, are vaguely referred to as "communities" regardless of their backgrounds and motivations. The term "community" is thus an "umbrella term" under which a number of different notions are subsumed that need to be differentiated in the context of OPEN_NEXT. Moreover, members are sometimes granted far-reaching powers in the makerspace and their activities are often equated with those of the makerspace by the operators in the narrative, in the sense of "what happens in the makerspace is part of the makerspace". This participatory basic attitude, which can be seen as typical for the Maker culture (Walter-Herrmann 2013), requires a precise determination of actors and roles in makerspaces in order to be able to develop supportive tools and instructions for C3 that are suitable for the target group and involve makerspaces.

## 2.3 What is an OSD sprint?

In recent years, the term 'sprint' has become increasingly popular in various fields and is used for many different methods, processes and frameworks. In the following, the relevant sprints for OPEN_NEXT and their differences and relations to each other will be briefly explained. A distinction is made between sprints from agile development approaches, 'Design sprint' and the newly introduced term 'OSD sprint'.

In agile product development or project management approaches which originally come from software development, the project or project phase is divided into short, iterative development cycles so-called sprints (Wagenaar et al. 2015). These **Agile sprints** are short, repeatable and timeboxed phases that usually last two to four weeks. At the beginning of a sprint, the functionalities are determined based on concrete requirements with the team, the product owner and, if necessary, other project managers to fill the sprint backlog. This working method allows teams to work largely independently to complete product features of a product and not be confronted with new requirements during the sprint. This enables the team to plan a single sprint at a time and adapt future sprints based on the outcome of the sprints already completed. During the sprint retrospective at the end of each agile sprint, the previously defined requirements are checked. If they are fulfilled, the product increment (e.g. draft, prototype or working version of the final project deliverable) can be released. If not, the further processing of open requirements is determined in the planning meeting of the next sprint. Well-known agile approaches are, for example, Scrum and Kanban (Anderson 2010).

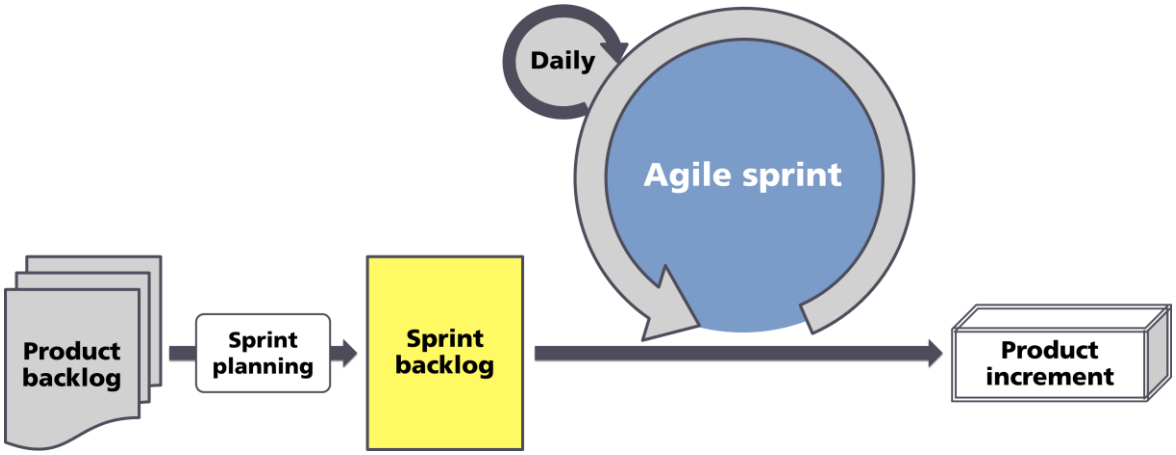


*Figure 4: Schematic representation of an Agile Sprint*

While an Agile sprint is about the actual development of a product, the **Design Sprint**[5] is one step further in the innovation process and fills the backlog of the next agile sprint(s). The Design sprint is a process developed by Google Ventures through which an idea is developed, converted into a prototype and qualitatively tested with the target group within just a week (Knapp et al. 2016). The process is based on a Design Thinking mind-set (Brown and Kātz 2009; Plattner et al. 2011) and provides a precise sequence of activities and methods to be used for each day as seen in Figure 5. A way to

[5] www.gv.com/sprint/

solve design problems quickly. Design sprints can be conducted, for example, at the beginning of a project to establish a product profile (Albers et al. 2018) and create a shared vision. They are also suitable when the problem-solving team has encountered obstacles or to make decisions regarding the further development of features, for example. Due to the possibility of conducting Design sprints on-site in the makerspace as well as (partly) remotely[6], it can be used excellently as a collaboration tool between the decision-makers in the company and the makerspace as well as the respective problem-solving team. Modified versions of the design sprint can be, for example, a strategy, idea, development or documentation sprint.

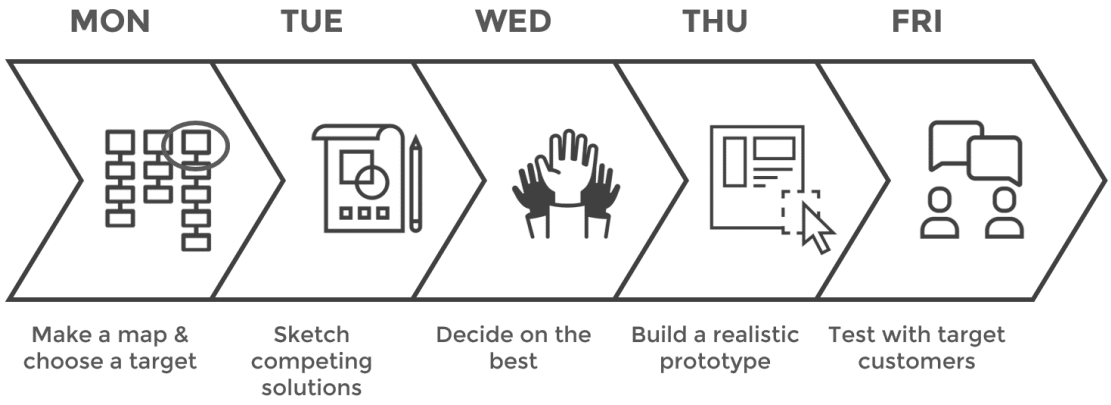


*Figure 5: 5-day Design sprint process by Google Ventures (UXM 2018)*

Both the working method of Agile sprints and the Design sprint process are part of the **OSD sprint**. In this way, the basic ideas and approaches of Integrated Product Development (Ehrlenspiel and Meerkamm 2017) and Design Thinking (DT) as well as a Rapid Prototyping mind-set (Bertsche and Bullinger 2007) of the makerspaces are implemented. The core idea is to facilitate the co-design (Steen et al. 2011) of PSS with individuals, groups, organisations and communities, which collaborate to realise the product (Ensici and Badke-Schaub 2011). This includes many stakeholders such as users, customers, suppliers, manufacturers, distributors, consumers, customers and other agencies. These consequently become key to design decisions and actively shape the development, with their own goals and concerns, making them a key component of the design process (Bayazit 2004). The OSD Sprint is structured as assistance for process management for the development of products and the product-related services. It covers the Early phase of product development (Albers et al. 2019)t from ‘Phase 1: Analysis’ up to ‘Phase 5: Realisation’ (see *D1.3: OSD framework*) with a PSS prototype at TRL6 at the end.

The OSD sprint thus focuses on a very specific part of the OSD journey as a chronological process of collaboration between community, makerspaces and companies as seen in Figure 6. Since every development project is individual and unique, the OSD sprint is not a fixed set of rules, but offers orientation in the OSH development process. At the phase level, for example, individual phases can be shortened or carried out more intensively, or even skipped, depending on prior knowledge and the status of existing materials, prototypes, information and insights. However, it should be kept in

[6] https://www.thesprintbook.com/remote

mind that a fundamental analysis of the context of the future solution and the resulting description of the problem to be solved are often more valuable than technical innovations without market demand. At the activity level, the OSD sprint is completely modular and can be adapted to the community or SME needs to suit the collaboration as best as possible. The design activities and decisions carried out in the OSD sprint rely heavily on the other stages in the product lifecycle and should not be considered isolated from them (Qureshi et al. 2014). The individual activities can be supported by different methods. These should be selected according to the larger challenge to be solved, the specific situation the team is facing in the process and their needs to carry out the activity in the best possible way.

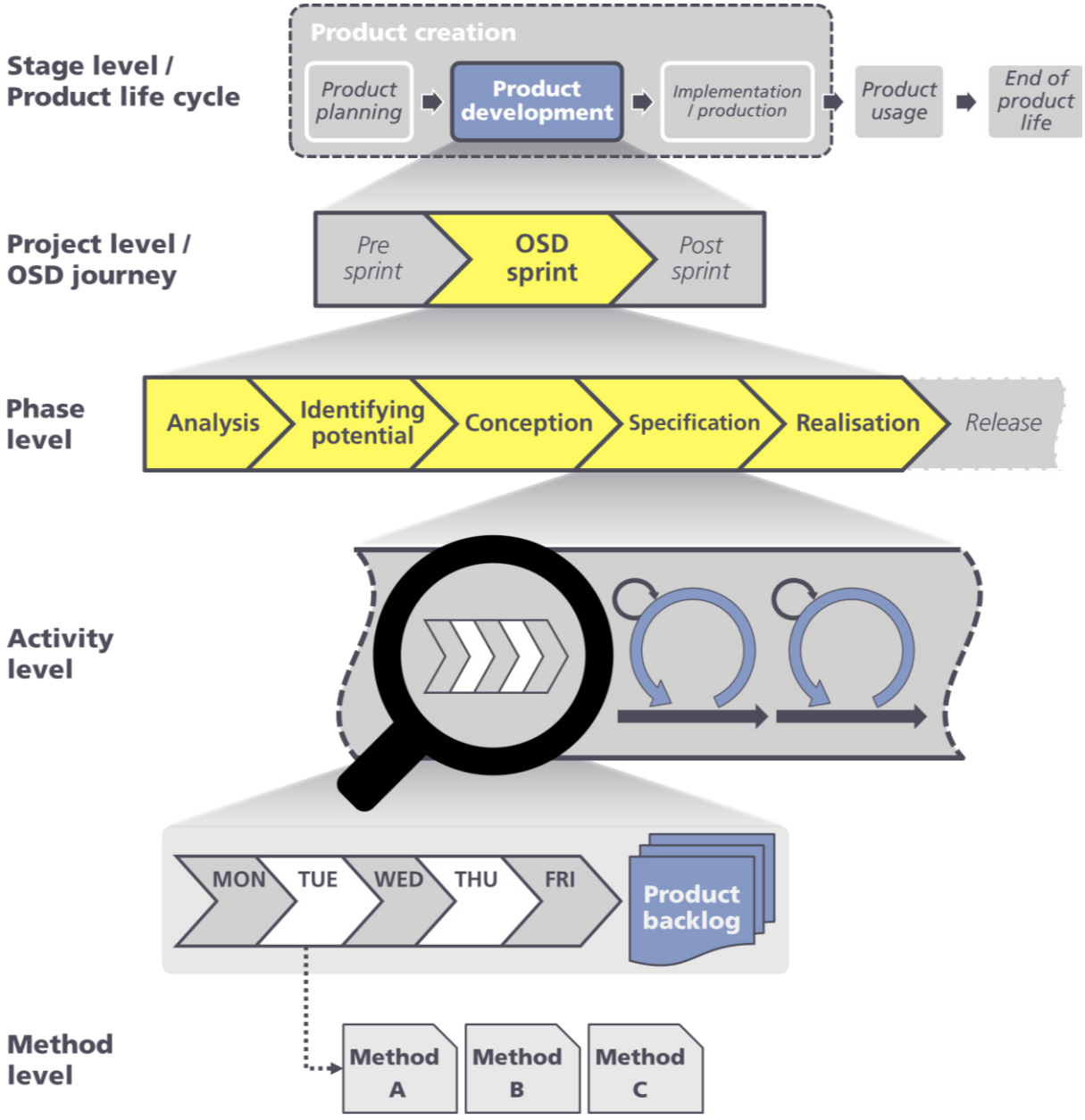


*Figure 6: Classification and relationship of the different sprint concepts*

## 2.4 What is a methodology?

Often the terms methodology, framework, process and method are rarely used with a clear distinction, making it difficult to use and validate them properly in the non-academic world. As transdisciplinary collaboration and teamwork form the basis for effective and efficient community engagement, it is fundamental that there is a common design language with clear and consistent positioning of concepts and terms (Sanders and Stappers 2008). In order to create a common understanding, the most relevant terms are explained in Table 1.

The methodology to be developed aims to structure the process and thus reduce uncertainty for the individual person taking part in the OSD journey but also the uncertainty of the other participants and partners to make teams work productively. According to Gericke et al. (2013a) a (design) methodology should be:

- *Open for all disciplines (mechanical engineering, software engineering, product design, …), enabling the creation of a transdisciplinary design methodology*
- *Open for practitioners and researchers, enabling a consolidation of existing support, best practices and new methods, tools and research results*
- *Open for active participation and feedback, enabling a dynamic evolution and continuous improvement*

For this, a (design) methodology is divided in the elements ‘methods’, ‘guidelines’, ‘process’ and ‘tools’, as shown in Figure 7. These form the central building blocks in the development of this deliverable and help to link all objects, artefacts, software and other materials created for the OSD sprint to them. The conceptual distinction and assignment of terms should help to better understand the guidance for conducting OSD sprints and should serve to improve the support provided by the OPEN_NEXT partners.

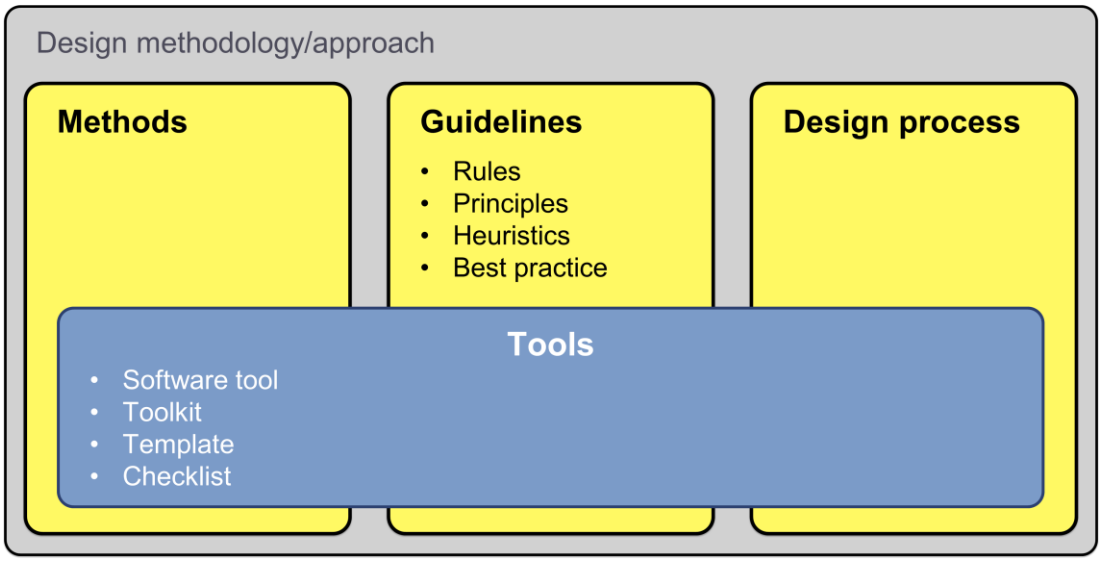


*Figure 7: Relationship between central terms of a methodology (Gericke et al. 2013a)*

*Table 1: Overview of relevant terms and their descriptions acc. to Wallisch et al. (2019)*

| Term | Conceptualization |
|---|---|
| Strategy | overlying plan of activities to achieve a long-term goal; usually valid across several operating units or for the whole company; can include philosophies, methodologies and guidelines |
| Philosophy | general overlying goal or mind-set affecting the whole design process or even the whole company; by far less specific than a strategy |
| Methodology | clearly and explicitly articulated approach to produce designs for a class of systems; specifies the activities, i.e. process steps, to be carried out, their relationship and sequencing and also the methods, the information artefacts to be produced by the activities and used as inputs to other activities, guidelines and tools to be used for particular activities as well as (tacitly or explicitly) the paradigm for thinking about the design problem and the priorities given to particular decisions or aspects of the design or ways of thinking about the design. |
| Framework | description of activities and their sequence to produce designs for a class of systems; less specific than a methodology |
| Process | a formally specified sequence of activities to be carried out in developing a particular design, or a class of designs, which will often be an application or customization of a methodology to a particular problem. Also the actual sequence of activities carried out in the development of a design, which may correspond more or less well to any formally specified process. |
| Guideline | a statement or a collection of statements (i.e. rules, principles, heuristics, best practices) of what to do when or what should be the case under particular circumstances and actions to perform; without any sequence or order |
| Model | schematic representation of a design process |
| Approach | often synonymously with design methodology but also the actual sequence of activities, methods, guidelines and tools and carried out in a specific context |
| Method | rationale procedure/specific description on how to achieve a specified result; can include specifications of how information is to be shown, what information is to be used as inputs to the method, what tools are to be used, what actions are to be performed and how, and how the task should be decomposed and how actions should be sequenced. |
| Technique | often synonymously with method, but also an alteration of a generic method for a specific context |
| Tool | an object, artefact, form, template or software that is used to perform some action (for example to produce new design information). Tools might be based on particular methods, guidelines, processes or approaches or can be generic environments that can be used in conjunction with many methods. |
| Principles | widely applicable laws, guidelines, biases and design considerations, all reflecting researchers’ and practitioners’ accumulated knowledge and experience |
| Activities | defined as actions taken by a designer or user to achieve a goal |

# 3 Conceptual model – What do we have in mind?

Based on six paired-interviews with partners of the SMEs and makerspaces as well as three more in-depth interviews with the makerspace partners, observations concerning the work of the six makerspace-SME-cooperation during the pilot study and experiences from other development projects and literature, the remainder of this deliverable focuses on the building blocks 'design process', 'methods' and 'tools' as well as on the elements 'Gender & diversity plan' and 'Engagement plan' as part of the building block 'guidelines'. The other areas of the last-mentioned block will be described in more detail in the second release of the PIL in June 2022.

## 3.1 The Gender & diversity plan

Next to the Engagement plan that outlines how to reach and communicate with the target user groups and stakeholders, the Gender & diversity plan is one of the key baselines for the OSD sprints and makerspace-SME-cooperations, with the aim to improve the quality of their work. The Gender & diversity plan shall aim for guiding the OSD sprints, setting a (different) focus and enriching the work by increasing the participation of females and diverse groups.

Often gender and diversity are neglected in activities, especially in technical applications. As stated in *D5.1: Open source sociotechnical design components*, OS development in general and Maker Communities in particular, pride themselves on being open to a diverse community and all genders.

Gender usually refers to roles, responsibilities, rights, relationships and identities of men and women that are defined or ascribed to them within a given society and context – and how these roles, responsibilities, rights and identities of men and women affect and influence each other. The term ‘gender’ in this document is used in a summative format and refers to the entire spectrum of gender identities that are not exclusively masculine or feminine – identities that are outside the gender binary as well as LGBTQ (Lesbian, Gay, Bisexual and Transgender) and other gender identities.[7]

Still, studies show that similar to other technical sectors, Maker Communities are predominantly white, male and wealthy (Sherrill 2017; Christian Voigt et al. 2017; Walter-Herrmann 2013). As outlined by Eckhardt et al. (2021) “makerspaces still attract considerably more males than females and exhibit a primarily ‘male’ culture, reflected in the interior design of places, or by the language and attitudes of their members.” The same paper outlines also a division between ‘crafting’ and ‘making’ between women and male makers: men tend to have an engineering background whilst women in maker spaces often work in design, communication or social relations area. Also, there is a lack of female role models, although maker spaces invest in attracting a diverse clientele by offering i.e. free training to all, having no or low membership fees or by reducing the complexity of machines through practical and simple procedures (ibid.). A critical view on maker spaces reveals that there is a significant lack of women in maker spaces.

[7] https://www.unfe.org/

For the Gender & diversity plan, the OPEN_NEXT project considers that - especially for creative processes like the OSD - diversity is as important as the gender aspect. Promotion of equity should not be limited to gender but should also be extended to include the diverse social groups that are relevant to the project. Therefore diversity - defined as people’s behaviour and natural resource use and management decisions are shaped by complex and interlinked cultural, social and economic structures and processes, including social groups: age, ethnicity, race, class, gender, indigenous groups, religion and caste - should be included in the plan. When we use the term ‘diversity’ in this document, we also include marginalized people or target groups with special needs.

Given this difficult situation of few women participating, only specific roles that are overtaken and few diversity in general, it is of high importance to establish a sustainable Gender & diversity plan for the activities of the OPEN_NEXT team and partners and in specifically the OSD sprints.

### 3.1.1 Aim and rationale of the Gender & diversity plan

So, what is the main aim of an OPEN_NEXT Gender & diversity plan? Basically, the Gender & diversity plan should form a sound basis for the OSD sprints in that way that it 1) fosters increasingly the awareness on gender and diversity issues around making 2) introduces and implements gender equality policies and processes in the OSD pilot study partners in order to prevent and overcome gender inequalities and biases and 3) foster diversity in the different working groups.

Analysing the different pilot study partners from a gender/diversity aspect (see chapter *4.1.4 Diversity* in *D5.1: Open source sociotechnical design components*), the starting point for the partners differ a lot. While some of them report a fairly high engagement of women and many diverse project members already, others claim the few opportunities to engage women, especially in the technical branches. Creating a framework that supports the stakeholder and in specific, the OSD Labs will therefore require to recommend tools and ideas that can be individually adapted to the diverse needs.

OPEN_NEXT is committed to contributing to the achievement of the Sustainable Development Goal 5 by the United Nations on gender equality and the empowerment of all women and girls not only for a formal reason[8]. As a project that supports innovation and OSH development, we consider it also our role to promote women's empowerment via our pilot study partners in OSH. Bundling our efforts to support women and marginalized groups in OSD makes sense from three perspectives that bring additional benefit:

- Investing in women is the right thing to do because their economic participation is still significantly limited (Sayre and Silverstein 2009), especially in OSD.
- Fostering participation of women and diverse groups also in technical areas will contribute to elaborate on the STEAM concept (science, technology, engineering, arts, mathematics).
- Supporting women is also the smart thing to do from a consumer perspective: women represent US$ 20 trillion in consumer spending and gender-diverse boards and senior management teams can lead to better business performance (ibid.).

[8] for further information see https://sdgs.un.org/goals/goal5

Addressing gender equality will not happen accidentally, and like any other business issue, a strategic and systematic approach - a Gender & diversity plan - is required. By definition, a Gender (and diversity) plan includes three components (see European Institute for Gender Equality 2019):

- Conducting impact assessment/audits of procedures & practices to identify gender bias
- Identifying & implementing innovative strategies to correct any bias
- Setting targets & monitoring progress via indicators

Our goal in providing this Gender & diversity plan is to equip the OPEN_NEXT partners with the skills and resources to accelerate strategic, sustainable and meaningful change.

### 3.1.2 The Gender & diversity plan process

Thus, on a rather practical level, we will focus our efforts on the recommended four phases (see Plotina[9]) namely (1) Assessment/analysis - Where are we now? Where do we want to be (and why)? (2) Discussion on the process - What is the best way to get there? (3) Implementation - How can we start (or keep) moving? (4) Review - How is the status and how can we improve?

**(1) Assessment/analysis**

The gender and diversity issue isn’t a new topic for OPEN_NEXT partners. Already in *D5.1: Open source sociotechnical design components* they were asked about issues around the integration of gender and diverse target groups. Several ideas and examples were already collected in the six paired interviews (19 quotes) that were used for D5.1. Consequently this material was used to develop a first understanding of the status of the pilot study participants.

Summarizing these results, we can state that SMEs and makerspaces might find that the gender and diversity aspect is difficult to integrate into existing processes of hardware development. However, gender and diversity is a topic for the Maker Community to embrace in the sense that a variety of skills and diversity is highly valued. Gender or diversity is not a driving factor in hiring, but rather the best qualification. Moreover, exactly this point seems to be difficult for many makerspaces, since that women or girls seemed to get not that attracted to technology. Often a true implementation of gender and diversity integration depends on the motivation of a single person. This might not be very surprising considering that our partners in the pilot study are SMEs and makerspaces, which are by their nature small. As agreed by all pilot partners, diversity can even bring an added value to the product development and consider this aspect when hiring personnel. However, they decide to employ the most competent person, but try to consider also age, background, disabilities, linguistic differences, socio-economic status and cultural background.

[9] https://www.plotina.eu/plotina-formative-toolkit/

**(2) Design - The OPEN_NEXT Gender & diversity plan**

Given the identified gaps, our gender action plan should foster different levels of participation at the pilot study activities:

- Increase access to OSD which are initiated and led by women and diverse people,
- Promote gender/diversity - equitable workplaces where women and diverse target groups work in leadership positions, and their workplace needs are met (improvement of work-space for women, users with special needs, ...), and
- Support OSH which develops products and services that can directly improve the lives of women and people with diverse needs (adaptation of products to women or diverse needs).

With this starting point, we constructed a first draft on the Gender & diversity plan (see Table 2), presented and for the first time discussed during the OPEN_NEXT consortium meeting in November 2020. The Gender & diversity plan is a living document that can be accessed from the internal exchange platform ‘Element’[10].

**(3) Implementation - How can we start (or keep) moving?**

At this point, several maker spaces have already started measures. I.e. Foreningen Maker[11] already has launched a project that would allow accessibility for people in the need of wheelchairs. Also the competition calls were specifically checked if they are designed in the way that it would also attract women and people with special needs. Thus the plan is not the starting point of actions, but rather serves the need of a structured and systematic approach. Once the revision has been implemented and the plan finalised (expected by January 2021), the implementation phase aims to put the Gender & diversity plan into practice and promotes women and marginalized groups in the different pilot study cooperation on the different mentioned levels.

**(4) Review - How is the status and how can we improve?**

By nature, the Gender & diversity plan and its goals will be reviewed in the middle of the OSD sprints and compared with the set measure indicators. Depending on this first review, it will be discussed within the OPEN_NEXT consortium and diverse actions will need to be taken once gaps or missing elements are identified. In case issues or problems are identified, the primarily responsible of the OSD sprints will be the responsible partner to address the issue. The consortium as a team is requested to discuss these issues during their meetings and bring it to the awareness of the partners and propose possible solutions.

[10] https://app.element.io/#/room/!TLtAxOJvCkTFIthrXi:saturn.iit.tu-berlin.de

[11] https://maker-effekt.dk/

*Table 2: First draft of the Gender & diversity plan*

| OPEN_NEXT Key areas | Objectives | Measure number & measures/activities | Feedback/ Comments |
|---|---|---|---|
| KA1 - The governance bodies, key actors and decision-makers | 1.1 Create structures and offer tools to support and promote gender and diversity equality in the project as well as in the makerspaces and SMEs | (1.1) Creating interdepartmental network structures such as for example, a virtual (online) forum to discuss gender and diversity equality issues among project members | Proposal: Include a section in our internal working space |
| | 1.2 Promote gender and diversity inclusivity with the institutional use of communication | (1.2) Providing staff members with useful tools that will help them using an inclusive language, such as guidelines and spell-checking programs (word and pictures) | Check different calls; provide guidelines; provision of good/bad examples |
| | | (1.3) Reviewing project documents from a gender and inclusiveness perspective | Include a question in reviewer template for deliverables |
| | 1.3 Ensure all stakeholders are aware and have easy access to the information about the gender and diversity equality policy and the Gender & diversity plan | (1.4) Developing a communication plan that includes all stakeholders to communicate the initiatives linked to the gender equality and diversity policy of the project | Provide guidelines; giving specific positive and negative examples |
| KA2 - Recruitment, career progression and retention | 2.1 Ensure all women and marginalized groups in the institution are empowered from a gender/diversity perspective | (2.1) Enhancing visibility of female role models (for representation, chairing meetings, keynote speaking at a conference, sharing career good practices, communicating and disseminating role models for women, etc.) and ensure a diverse representation of diverse actors within the project | |
| | 2.2 Ensure a wide pool of diverse applicants is reached in all vacant positions and pilot partner calls | (2.2) Implementing a wide communication policy for vacant positions, inside and outside the project and the pilot partners | |
| | 2.3 Ensure a gender and diversity aware internal evaluation system | (2.3) Promoting rewards and incentive systems for gender equality and diversity efforts and results | |

*Continuation of the table on the next page*

| OPEN_NEXT Key areas | Objectives | Measure number & measures/activities | Feedback/ Comments |
|---|---|---|---|
| KA3 - Work and personal life integration | 3.1 Develop a co-responsible working culture | (3.1) Understanding and developing ways to address different working hours culture adapted to needs and requirements of women and diverse living circumstances. | |
| | | (3.2) Scheduling work-meetings only within core hours and enabling online meetings. | Done in Project, but also done in the pilots? |
| | 3.2 Ensure availability of structured supports for work and personal life integration | (3.3) Implementing ICT-based systems that enhance flexibility | Done already via ZOOM, platform for resources and discussion forum |
| | 3.3 Enable individuals on parental leave to have an easier return to work | (3.4) Formal process in place for contacts and communication with women and men during parental leaves | Ensure highly transparent documentation of OSD sprints and pilots for smooth and easy integration |
| KA4 - Researchers and research: gender equality and sex and gender perspective | 4.1 Promote gender and diversity in research management | (4.1) Ensuring diverse needs of individuals in research/pilot teams are considered | Covered by internal guidelines by research partners any how already? |
| | | (4.2) Ensuring research/pilot teams are gender/diversity balanced when possible | Covered by internal guidelines by research partners any how already? |
| | 4.2 Promote the inclusion of gender and diversity dimension in research content | (4.3) Raising awareness and enhancing visibility of female researchers and marginalized groups as role models in (local) community events | |
| | | (4.4) Requiring calls for application to include gender and diversity where relevant | Done by the institutions and pilots |
| KA5 - Integration of sex and gender dimension in into ‘non-formal learning and training curricula’ | 5.1. Promote the integration of a gender and diversity dimension in non-formal learning and training curricula where applicable | (5.1) Developing initiatives to raise awareness about the importance of integrating the gender /diversity dimension in non-formal learning and training curricula. | |

## 3.2 The Engagement plan

Engagement plans can be considered a communication strategy as part of the framework of Responsible Research and Innovation (RRI) as an answer to the field of tension in between innovation and technology consequences (Stilgoe et al. 2013). In the more narrow sense of the OPEN_NEXT project, the Engagement plan is meant to assist the makerspaces with their task of winning new partners for collaboration for the demonstrator phase. However, ideas of public engagement in a RRI sense also play a role in the latter when it comes to engaging with i.e. communities of concern. Furthermore the concept of open source hardware already includes the idea of integrating numerous participants and perspectives as promoted by RRI.

Collaboration is based on communication. Effective communication, however, needs to be oriented towards the mind-set of the specific target groups. In the case of OSD collaboration, this is especially important since communication is not just about clarifying the division of labour between partners but it is also the means of engaging people who are willing to contribute to OSD and winning them as active members of a community that forms around the respective project. In order to understand what kind of communication with whom is actually needed in the process of C3 for OSD, an interview series with representatives of our partner makerspaces from Berlin, Copenhagen and Amsterdam has been conducted. The aim was to increase the effectiveness of the Engagement plan by building upon the makerspaces’ expectations, experience and common practices.

The following section presents the results of the guided interviews with the OPEN_NEXT partner makerspaces that are relevant for the Engagement plan, namely the concept of “community” and its practical forms as well as a number of items on makerspace-SME collaboration e.g. collaboration experiences, relationship of collaboration partners, motivation and incentives for collaboration, partner profiles, and fields of conflict. Subsequently, these are linked to findings from *D5.1: Open source sociotechnical design components* to derive recommendations for action for communication and engagement within OPEN_NEXT, especially with regard to the upcoming project phase.

### 3.2.1 Findings from guided interviews with the OPEN_NEXT makerspaces

Collaboration is a social act in which at least two different positions need to synthesize. Those positions can vary strongly in numerous ways. OPEN_NEXT aims at integrating three major positions: those of SMEs, makerspaces and communities. The present deliverable shall define profiles of makerspaces within a C3 context, provide a training strategy to enable makerspaces for C3 OSD projects and contribute diversity and Engagement plans for C3 in general as well as the project partners‘ *D6.1: Service pitch* in particular. All this includes communication and engagement activities for which the Engagement plan shall provide orientation. Furthermore, in the internal OPEN_NEXT practice the research perspective also needs to be integrated as a fourth perspective. Over the past months this proved difficult especially in the communication between makerspaces and research partners when it came to questions of the management of C3 projects. Therefore, the guideline interviews also included a section on the topic of project management in order to clear misunderstandings and identify sources of conflict. The results nourish a second, WP5-internal communication strategy that will be presented after discussing the engagement strategy for winning new partners for the demonstrator phase.

### 3.2.2 Interview insights part 1 - External Engagement plan

**Collaboration -with communities**

A variety of collaborations take place in makerspaces. For the OPEN_NEXT project - especially with regard to the Engagement plan, the acquisition of partners for the demonstrator phase and the training materials - the guided interviews focused on collaboration between makerspaces and SMEs on the one hand and collaboration between makerspaces and their communities on the other hand. Here, the relationships between makerspaces and communities were highlighted, a classification of different communities was undertaken, and everyday practices in collaboration projects of makerspaces were explored.

Collaborations play out in makerspaces at all levels. Those groups from which people come together to collaborate, sometimes spontaneously, sometimes purposefully organized, are vaguely referred to as "communities" regardless of their backgrounds and motivations. The term "community" is thus an "umbrella term" under which a number of different notions are subsumed that need to be differentiated in the context of OPEN_NEXT. Moreover, members are sometimes granted far-reaching powers in the makerspace and their activities are often equated with those of the makerspace itself by the operators, in the sense of "what happens in the makerspace belongs to the makerspace". This participatory attitude, which can be seen as typical for the maker culture, requires a precise determination of actors and roles in makerspaces in order to be able to develop supportive tools and instructions for C3 that are suitable for target groups like problem-solving teams and involve makerspaces.

*Relationships between makerspaces and communities*

Depending on the context, makerspaces see themselves:

(1) as places where communities can organize,
(2) as organizers of communities, or
(3) as community members themselves.

Conceived as a facility (place, equipment, infrastructure, location, social surroundings), they offer people a space in which to organize themselves as a group, for example when members of the makerspaces’ community come together on their own initiative to work together on a project or when external groups are looking for a meeting place. In the role of supporters, it is the makerspaces that bring people together, for example in meet-ups or hackathons, who want to work together on something or who are more or less loosely connected by common interests. At the same time makerspaces see themselves as part of a larger “Maker Movement” or its sub-movements, for example when makerspace representatives participate in network meetings, conferences or events (Unterfrauner et al. 2018). Makerspaces do not maintain just one or the another of those relationships but usually all at once.

These relationships of a makerspace with different communities exist in parallel and often cannot be clearly distinguished from each other. For example, it is conceivable that very active members of a makerspace, who are not actually operators, organize an event in their makerspace in which other members, and possibly also external interested parties, participate. Whether this is interpreted as

an event of the makerspace bringing its community together due to the close proximity of the organizers to the makerspace, or as an event of a community using the makerspace as a physical space, or even as an event taking place in the context of the larger network of the Maker Movement, probably depends on the specific culture of the individual makerspace on the one hand, and on the respective context in which the event is talked about on the other hand. From this perspective, the point here cannot be to distinguish three types of relationships that are detached from each other. Rather, they are different perspectives from which collaboration activities of makerspaces can be viewed.

Makerspaces do not consider their communities as a resource but as capacity. Active makerspace users are the makerspace’s main target group whom the operators and employees of the makerspace feel they represent. Members and makers are not made use of as a workforce in order to obtain industry projects. Rather makerspaces pass on projects to their users to support them, sometimes even acting as their advocates. Nevertheless, funding is a constant topic of makerspaces and industry projects can be part of the business model.

**Insight for practice:**

When we talk about collaboration projects with makerspaces, it is important to question who the drivers behind the project are and what role who from the makerspace specifically plays. This helps avoid confusion such as the claim that makerspaces should take on project management in projects where they are only represented as a place, not as staff. It is important that makerspaces also create appropriate transparency to potential partners externally.

*Types of communities*

The term “community” as it is used in the project is misleading from a sociological perspective since members of the described “communities” are in the majority rather loosely if at all socially connected to each other. The term in this context describes people who foster a shared interest in the field of making or in fields associated with it. Bearing this in mind, five types of communities can be identified that appear around makerspaces as described by the interview partners (see Figure 8):

(1) Active makerspace users
(2) Inactive makerspace users
(3) Communities of concern
(4) The OSH Community
(5) The Maker Community

The first association with the term "community" was that pool of people that the makerspaces can contact when they want to acquire participants for projects or events, i.e., those groups of people whose connecting link is the makerspace. The smaller part of this group is formed by members and makers or other project partners who are physically active in the makerspace at the time. We refer to this subgroup as the "**active makerspace users**". However, the much larger part is made up of former cooperation partners, members, and makers who are no longer actively on site, but continue to take notice of events in the makerspace and can probably be activated for renewed participation on site. We refer to this subgroup as the "**inactive makerspace users**". Put simply, these groups are

people with whom there is personal contact from the makerspace as an organization and who are on its mailing list. However, it is important to note that all those people do not join makerspace projects as a community but as individuals. Only by joining do they form a project’s community, also in the sociological sense.

Another understanding of "community" is that of "**Communities of concern**". These are people who are linked by having a common concern and thus the community forms around an urgency. A concern is distinguished from the term "interest". According to this understanding, interest means personal, individual interests. Concern, on the other hand, refers to larger social or ecological contexts. These people bring their own motivation for a topic and ideally find a safe place and professional support in the makerspace to collectively develop solutions that serve the community. The notion here is that often people have concerns but not skills to work these concerns practically and are thus excluded from the market. Connecting themselves to makerspaces communities can add technology and expertise and thereby helps lay the foundation for market access. However, those people with non-technical expertise are seen as vital for most projects in makerspaces.

Additionally the "**OSH community**" is formed by the intersection of the Community of concern and the makerspace users. It is a socially formed group of heterogeneous actors who help shape OSH products and are thus by definition the source of value creation (Aksulu and Wade 2010). Due to their loosely coupled structure and fluid boundaries, participation varies greatly over time, both in terms of quantity and content. Unlike "innovation communities", their objectives are not determined by innovation activities of companies but the voice of the community, which elicites different socio-economical dynamics and cultural engineering. The **problem-solving teams** (PST) in the development process are part of the OSH community. Beyond these explicitly named communities, maker movements must also be mentioned here, in which operators, employees, members, or users of makerspaces are equally engaged. Maker movements here means the loose networks around topics of "making" that result from participation in conferences, workshops, trade fairs, and other maker-related events. It also includes local networks of several makerspaces. Wherever makers cooperate across makerspaces and local projects, they are moving within the larger context of maker movements. We refer to this as the "**Maker Community**". What is characteristic of this community is that, despite its size, participants often encounter familiar faces depending on their own focus, and a variety of personal contacts are formed.

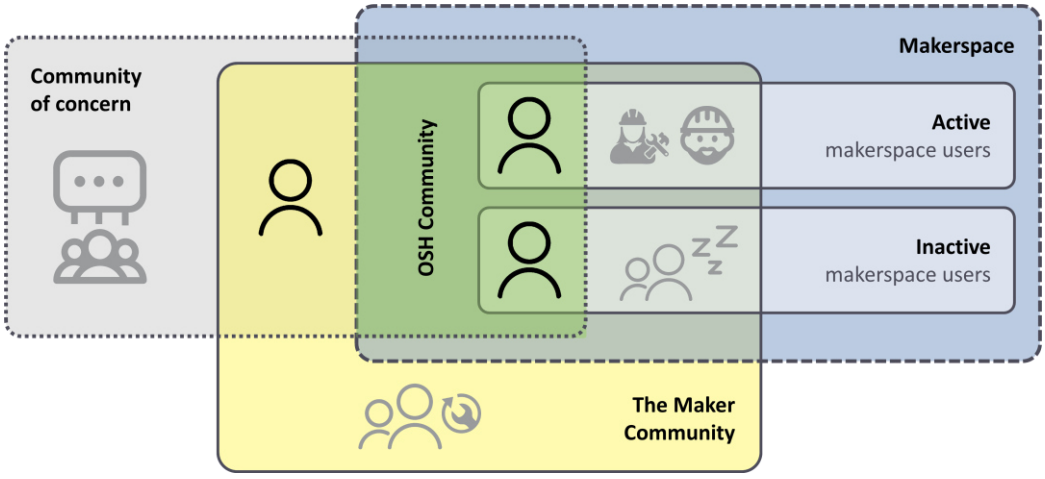


*Figure 8: Different types of communities with reference to makerspaces*

So, when makerspaces talk about "community," they are primarily referring to their target groups. Depending on the political stance, this is either, thought of from the makerspace, the pool of active and passive partners and members or, thought of locally, the larger local community, which, however, often overlaps strongly with the makerspace's active and passive community. In addition, makerspaces themselves are part of the community of the global Maker Movement.

**Insight for practice:**

We should introduce these linguistic distinctions and use them consistently ourselves to arrive at a clearer understanding in the project.

**Collaboration with SMEs**

*Makerspaces' experience of SME collaboration*

The makerspaces in the OPEN_NEXT project have experience of collaboration with companies. The types of projects that are worked on together with companies differ depending on the orientation of the makerspace. A makerspace with a large workshop area is regularly requested for the production of prototypes or individual parts for which the company lacks machines or capacity makerspaces whose active or passive community members are designers are also often contacted for prototype design or development projects. Such requests are mostly contract work from larger companies with a low level of collaboration at the hands-on work level. Real collaboration projects, which involve the joint development of solution ideas along a co-design process, in which the makerspace takes on the function of an innovation hub and for whose work a community is formed, are significantly rarer. In addition to companies, public authorities are also among clients and collaboration partners.

The distinction between commissioned work and co-design projects should not be understood in a binary way, but relative to other projects. Even contract work cannot do without communication and meetings between client and contractor to discuss requirements for the project and the product and to discuss solution options. In organisational terms, this is more of a cooperation than a collaboration. The degree of co-design involvement in a project increases with the extent of simultaneous involvement of different actors in the development process. These can be actors from the networks of the client and the makerspace, or different actors from the makerspace communities or other fields.

However, the collaboration between makerspaces and SMEs in the area of OSH development requires an active part on the part of the companies, since on the one hand they have the necessary technical expertise and on the other hand open solutions must be integrated into the corporate strategy and flanked by business models. Open source products require maintenance in the provision of data and continuous further development by the community, which must be supported for this purpose. Solutions in the sense of plug-and-play, which are commissioned and integrated into the product range as a finished prototype, are not to be expected in the OSD area.

Projects that are implemented by makerspaces together with companies or even public authorities vary in terms of the active share that the different partners have in the processing. The degree of collaboration in the project is measured by the consequence of the simultaneous involvement of

different actors during the processing. This collaborative element is elementary for enterprise-driven OSD if it is to be sustainable. Passive companies are out of place in an OSD collaboration with makerspaces.

**Insight for practice:**

When looking for partners for the demonstrator phase, the active role of the company must be taken into account as a condition for participation, even if the companies do not receive any money for it.

*Makerspaces' motivation for SME collaboration*

A large part of the motivation for makerspaces to collaborate with SMEs is the dissemination of (technical or social) solutions developed in the makerspace. The self-image of makerspaces as think tanks for innovative solutions usually ends with the prototype or an exemplary implementation. Makerspaces are not designed for mass production and commercial distribution of products or large-scale campaigns. Nevertheless, there is a desire among makerspace operators for the solutions they develop to add value socially and to spread. For this, they need partners who have the corresponding production and marketing capabilities, which in turn is the core business of classic companies or public authorities.

Collaborations with companies are also used to build up expertise, for example in relation to physical entrepreneurship. Finally, depending on the business model, makerspaces are dependent on contract work and have to position themselves in the market. Financially strong partners, a clear profile that can serve current trends, and professional working methods are a basis of existence for such makerspaces. However, it is important to note that the primary target group of makerspaces are the makers, not companies. Collaboration with businesses occurs when it benefits the members of the community or the operation of the makerspace.

There are several good reasons for makerspaces to collaborate with businesses. The insight from *D5.1 Open source sociotechnical design components* that collaboration is seen as a learning opportunity has maintained its validity even after half a year of prototype collaboration. However, financial benefits and, most importantly, the broader reach of organizations also represent important collaboration incentives.

**Insight for practice:**

For motivational reasons, it would be good for makerspaces to have partners who actually want to drive the solutions forward in the long term, and who have a large market. They must also be willing to reveal something about themselves and their way of working so that the collaboration promises a mutual learning experience.

*Possible SME Partners*

Makerspaces want partners who actually drive solutions to market. At the same time, these partners should preferably not be in competition with their own community, but this can easily happen with small companies. Makerspaces see themselves as representatives of their communities and find it difficult to work towards the competition of their members, especially since it is more difficult to recruit makerspace users for this. Large companies would not be in direct competition and at the same time had the greatest financial power. Their resources also allow them to be more open to experiments than SMEs. However, big companies do not correspond to the orientation of the OPEN_NEXT project.

The attitude of the partners is also relevant for a successful collaboration. The makerspaces strive for collaboration at eye level, in which all partners contribute equally without a hierarchical divide. A commitment to open source is also expected, in contrast to a basic attitude that involves maximizing one's own profits by simply outsourcing tasks to makers. Companies from the open hardware sector already come with a suitable mind-set for C3 in the OSD context. They are seen as good partners. The role of the makerspace here is to support these companies in making their products a success. However, these companies are usually very small, not yet established at the market, and lack resources.

What the makerspaces do expect, however, is that demonstrator partners for the second iteration of the OSD sprint in OPEN_NEXT will come primarily through personal contacts from the makerspaces' existing networks. They assume that these will be primarily small companies and start-ups that are dedicated to the topic of OSH out of their own conviction, but who also have few resources to contribute to the project with much capacity in addition to their core business. In particular, the lack of business models is lamented, which the makerspaces believe would be the most important argument for attracting well-positioned companies to collaborate that have not yet engaged with OSD.

**Insight for practice:**

There remains an unresolved contradiction that partners are expected to add capacity without counter-funding or a plan for how this can be profitable in the long run. We have to expect that makerspaces will have to take the driving role in collaboration. But that would also mean finding partners whose content is familiar to the makerspaces so they can take shares. However, this does not correspond to a sustainable strategy, since the makerspaces will also no longer receive funding for such a role after the conclusion of the OPEN_NEXT project and will then no longer be able to fill it.

*Makerspace-SME relationship when collaborating*

Collaborations between makerspaces and companies that have a high degree of collaboration are characterized by communication and working at eye level. Makerspaces and companies complement each other and the participants become a team in which everyone contributes all their competencies and skills. There are two types of collaborative projects, which differ in terms of their objectives: either as part of the product development process, at the end of which there should be a concrete, marketable product, or as a joint learning process, e.g. with regard to collaborative forms of work or the integration of new stakeholders.

From the perspective of the product development process, makerspaces and company employees are complementary. While makerspaces can strongly contribute to the early phase of product development due to the diversity within their community, i.e. idea generation and elaboration up to the first prototype, companies are specialized in driving a halfway concrete solution idea to market maturity. While especially SMEs with a small number of employees lack the diversity of perspectives, experiences and competencies to develop innovative ideas, makerspaces do not have the infrastructure and knowledge to produce products for the market, which is also not part of their business model. In the initial phase of collaborative product development, makerspaces are the drivers of the process. Where appropriate, the companies provide the impetus and contribute their expertise. Once the first prototype has been developed, the makerspaces usually withdraw from the collaboration and leave the further steps to the companies, although they nevertheless have a motivational interest in the dissemination of the solution (see section *Makerspaces' motivation for collaborating with SMEs*). This mutual dependence leads to an attitude of mutual respect without competitive pressure or strong hierarchy.

From the perspective of a shared learning process, there is no question of a focal division of labour by phase. Here it is rather a matter of working on a common question for one's own gain of knowledge. Here, the reason for the interest in the question may differ, for example, if a company wants to find out how it can act in a more socially responsible way by involving local communities, while the makerspace, which presumably has a scientific orientation, wants to observe how companies and communities can interact in order to derive theories or develop models of society. In this case, both partners are likely to be permanently and equally involved in the project and have a common interest in a setting, even if they have different emphases in their observation of the setting.

Of course, there can also be a combination of both types of projects if, for example, the socially responsible actions of the company are to be expressed by involving local communities through a product that is useful for local people. However, not every makerspace is equally suitable for both project types. Makerspaces that become primarily a large workshop and focus on actual making are more likely to engage in prototype development. Makerspaces that are connected to universities and think tanks, on the other hand, are probably more suited to supporting science-based learning experiences. However, hybrid forms do exist in practice.

The relationship between makerspace and SME in collaborative projects is thus characterized by flat hierarchy and recognition of each other's expertise. The contribution made by which partner at which point in the course of the project depends on whether the project is primarily in the area of physical prototyping or learning experience.

**Insight for practice:**

When soliciting industry partners for the demonstrator phase and generally in external project communication, the relationship between Makerspace and SME must be propagated as two parts of a whole in which collaboration can take place openly, since the partners' areas of interest are clearly delineated from each other no one need fear competition. At the same time, it must be made clear that, within the framework of a strong collaboration, a financial investment by a company in a project does not mean a distribution of roles according to the logic of customer and service provider.

*SME arguments for collaborating with makerspaces in OSD*

From the reports of the makerspaces on their collaboration experiences with companies, a number of arguments can be derived that speak in favour of C3 involving makerspaces in the context of OSD from a company perspective.

In hardware development, open source approaches generally have the advantage that a company can receive feedback on the product from many different people within a very short period of time and thus learn and can learn much more quickly in the field. In addition, joint development work with a community opens up a broader field of experimentation for the development of new ideas, even for companies with an integrated research department, where different development ideas can be worked on in parallel.

However, communities need to be guided. An appreciative, understanding and flexible approach to these groups is an important success factor. Communication at eye level is necessary to maintain the motivation of the contributors, especially when people participate voluntarily and unpaid. Such a collaborative approach is characterized by extensive communication and requires a suitable inner attitude. At the same time, this is the usual collaboration and communication mode in makerspaces. Actors from makerspaces are experienced in dealing with communities and easily find the right form of address. They can share and use this expertise in collaboration with companies. In addition, as an interface between the public and technology, makerspaces are suitable mediators between industry and society and are thus the right partners when it comes to involving society more in industrial processes.

For companies, collaboration with makerspaces is also a learning opportunity. Examples of this could be the topics of new work, corporate responsibility, sustainable product development or rapid prototyping. Impressions from the work in the makerspace open up perspectives for companies on their own business that remain invisible within the routines in the company. Not only on the product level, but also in terms of corporate culture, makerspaces can provide impetus for contemporary development. This can be particularly interesting for long-established companies from well-off regions. Young start-ups are usually in line with the trend anyway.

In collaboration with makerspaces, companies do not have to fear being booted out by their partner. Makerspaces have no monetary interest in marketing products. They are not a competitor for companies. In collaboration, there is a clear division of labour over the product development process, with the product becoming the responsibility of the company as it becomes more marketable.

But C3 does not only open up new perspectives for companies in terms of working methods and corporate culture. When collaborating with communities of concern, companies gain insights into the concerns that are so strong that a community has formed around them. Such concerns also offer starting points for new products or business models for the company. It is enough for companies to engage a little with the concerns so that they can discover their own interests within this framework.

Companies interested in RRI can learn from makerspaces how they themselves can become an incubator for citizens and their ideas, so that they can build a kind of makerspace or think tank within which business models can be developed around concerns. However, this is more likely to appeal to large companies with the appropriate financial capital, which are not part of the target group in OPEN_NEXT.

Incidentally, companies that operate on the basis of values oriented toward the common good are welcome in makerspaces and benefit particularly from the willingness of makers to participate. This also applies to the open source sector. Such business models depend on collaboration with communities in order to survive on the market. At the same time, makers prefer to participate in projects that benefit not just a single company, but the broader society, which is unquestionably the case with open source hardware development.

Another advantage in collaborating with communities, especially for SMEs, is that SMEs are at a disadvantage compared to large companies in personnel matters. They cannot afford to hire many different developers with a wide range of skills. At the same time, versatile professionals are highly competitive in the labour market and may be more likely to take jobs with well-paying large companies. Collaboration with communities can compensate for this disadvantage of diversity within the company. Makerspaces have the experience to deal with such communities.

Especially in the early phase of idea and prototype development, makerspaces and their users can contribute meaningfully to the project without creating a competitive situation, since, as mentioned above, marketing solutions is not part of the makerspace business model. However, makers should not be seen as a low-cost resource. Helping a company make more profit is usually not a sufficient incentive for makers to participate. With OSD, on the other hand, non-commercial makers are more willing to participate in projects because they are seen as adding value to the community. In business models that include OSD, SMEs may therefore be able to compensate for personnel and thus innovation disadvantages compared to large competitors within the scope of their financial possibilities. However, especially traditional companies that want to open up to the field of open source hardware development often lack experience in the field of recruiting fellow participants. Makerspaces, on the other hand, often already have a network with the appropriate skills and can fill this gap. It even happens that companies discover talent they can attract to the company while collaborating with communities. But even if these makers cannot be recruited for the company, they at least use their expertise for the company within the framework of the collaboration project.

Overall, it can be summarized that open source approaches can help companies to quickly build up competence in a field. Collaboration with communities is essential here, but requires experience in dealing with communities, which makerspaces bring. Therefore, integrating makerspaces into the collaboration makes sense. Furthermore, such collaborations hold plenty of inspiration, especially for long-established companies, with regard to a renewal of working methods and corporate culture. Furthermore, from working with communities of concern, companies can identify market gaps that are compatible with the common good, in the sense of RRI. Finally, collaborations with communities can, if necessary, compensate for personnel deficits in SMEs in the area of innovation and development.

**Insight for practice:**

These arguments should directly be used for the service pitches.

*Potential Conflicts*

For companies, it makes economic sense to externalize as many costs as possible, e.g., to involve communities in idea generation who may be willing to contribute their wealth of ideas and expertise free of charge or for a small fee as part of hackathons or other collaborative formats. On the other side of such unpaid work, however, are the makers, who are primarily engaged in ethical ventures, such as developing products that provide tangible benefits to people. If the makers are merely supposed to contribute to increasing a company's profits as a cheap resource, they generally do not give themselves up for this. Collaboration projects need an ethically motivating component in the unpaid area and respectful treatment of the makers and their intellectual property. Otherwise, makers will drop out of the collaboration.

The expertise in makerspaces is often in physical entrepreneurship. The basic principle of product development is trial-and-error. In collaboration with companies, tensions can arise because makerspaces usually have little experience in classical project management, but companies measure progress, success and professionalism along such methods. It would help if makerspaces could translate their approach into the language of classic project management to better communicate with companies.

Contract work given to individual makerspace users can also lead to conflicts due to makers' lack of experience in communicating with companies. For example, makers tend to underbid, not pricing much of the thoughtful groundwork that goes into a project, and disregarding time management. Appropriate communication with clients also requires experience, which many makers lack. All of this can result in dissatisfaction on both sides.

Companies evaluate projects based on whether they got the prototype they wanted and what hurdles arose during the project. The makerspace evaluates projects more based on what they have brought to its community, for example, in terms of experience building, skills acquisition, network expansion or even financial security. These different standards for project success can lead to disappointed expectations under certain circumstances. Clear communication of the respective expectations of the project already in the project initiation phase helps to avoid this. The OSD sprint materials help formulate the different expectations and are considered useful for that by the partners.

If companies are to participate in a collaboration that does not bring them any immediate financial benefit, as through public funding, they at least need the prospect of being able to profit from it later on. In the field of OSD, however, they usually lack business models to turn the project results into profit at a later stage. Such business models have not yet been developed in the OPEN_NEXT project either, so that they could be used as an argument. There is a clear conflict here between the profit orientation of companies as the basis of their existence and the project's expectation of makerspaces to convince companies to collaborate without financial incentives.

Most potential conflicts described therefore are about different expectations that stem from the maker logic or the company logic respectively of doing things and communicating them. It appears essential to make those differences visible in the earliest possible project phase in order to create common ground for the collaboration. Such logics, however, belong mainly to the field of implicit knowledge. The collaboration partners need assistance in making them explicit. The WP5 OSD sprint materials provide this kind of assistance. Furthermore, it seems helpful to train makerspaces and makers in project management.

**Insight for practice:**

Honest communication right from the start of the project helps to avoid potential conflicts later on. For example, makers must be described from the outset as an equal player with his own demands for degrees of freedom, ethical objectives of the project and, depending on the type of collaboration, fair payment. The interests of the makerspace for its community also need to be clearly formulated from the beginning.

It would also help if Makers and Makerspace operators knew the corporate perspective on project management in order to make their own approach understandable. Makers should receive support from the makerspace in this regard, if needed, so that their rights are protected and the makerspace's reputation as a collaboration partner is not damaged.

Furthermore, there is the challenge of missing business models for C3 in OSD in the OPEN_NEXT project, with which companies could be recruited. From its area of competence, WP5 can only offer the advantages identified above for companies with regard to collaboration with makerspaces and communities as an argumentation aid.

### 3.2.3 Interview insights part 2 - Internal Communication Strategy regarding PM

As shown above, it appears useful to train makerspaces and makers in project management. However, this turned out to be a zone of conflict within WP5 over the past months, which is why it was taken up in the guideline interviews for clearance with the aim to make underlying assumptions and reservations as well as bad communication practices visible.

Projects in makerspaces can arise from within the makerspace community itself or be accepted by the makerspace as commissioned work from external clients/partners. They can be selected for economic reasons (good payment), strategic reasons (knowledge building in certain fields), interest reasons (someone has a desire to do it), or research reasons (it fits the scientific scope of a makerspace connected to higher education). The working mode differs accordingly but we were nevertheless able to identify some general perspectives on project management that shall be displayed in the following sections.

**Project Management (PM)**

The management and processing modes of projects depend on the type of project. Projects can arise from within the Maker Community itself or be accepted by the makerspace as commissioned work from external clients/partners. They can be selected for economic reasons (e.g. good payment), strategic reasons (e.g. knowledge building in certain fields), interest reasons (e.g. someone has a desire to do it), or research reasons (e.g. it fits the scientific scope of a makerspace connected to higher education).

*Role of makerspaces in PM*

At the beginning there is the decision by whom the project should be worked on and in which form. This depends on the goal of the project. If innovation is the goal, as much of the community as possible is activated for the greatest possible creative input, and the project is planned throughout as a co-design project in multiple teams. Typically, this involves a process in the form of a series of co-design workshops where participants come together and work collaboratively. Terms such as design sprint, hackathon, and co-design workshop are used with different emphases, but overall as terms

that are not sharply delineated from one another. Here, the makerspace takes on a coordinating role and sets milestones where appropriate. The fine management, however, lies with the groups.

If the goal is a solution that requires specific know-how, the makerspace acts mainly as an intermediary to selected community members who have the necessary competencies for the project. These then implement the project largely on their own and usually also handle communication with the client. At least for a larger order volume, the makerspace usually receives a share of the money. Here, the individual makers are either responsible for the entire project management, or at least for the fine management. It happens that makerspaces take over rough coordination tasks, such as setting milestones or communicating with the client, if the member has good expertise but is inexperienced in dealing with clients.

Sometimes the formation of a community is itself a project goal, especially in rather scientific makerspace settings. In this setting, project management is usually required in order to obtain public funding and therefore carried out continuously by paid staff.

There are also plenty of projects that are acquired by individual members and worked on in the makerspace. However, for the SME-makerspace collaboration in OSD, this example will not be considered for now.

Makerspaces thus take a strong role, especially in the initial phase of projects, by deciding in which form the projects should be worked on and by whom. Once this is clarified, project management largely passes to those members of the community who are working on the project. The makerspace may still set milestones or organize the work forms and work environment.

**Insight for practice:**

If projects are to experience better project management, makerspaces would need to take on a different role, or in turn train their community to do so.

*Perception of PM as a disruptive factor*

Project work is characterized by creative design phases alternating with partial prototypes to test the feasibility of the ideas developed. We start with a great openness to possible solutions and "think up something" and then see if it works. The entire process is largely based on trial and error and appears to the makers to be largely unpredictable in its partial results. This is perceived as the nature of development projects and, in the logic of many makers, contradicts a project plan that is perceived as rigid and fixed with strict process and time specifications.

Accordingly, project plans, if they must be written, are perceived by some as a farce intended to maintain an outward appearance of control over an essentially uncontrollable process. From this perspective, writing project plans costs capacity without contributing anything to the achievement of the project goal. Rather, it is seen as a parallel narrative that runs along largely detached from the actual project processing.

Sometimes project management is even perceived as a risk factor, as it is seen with its limiting specifications in contrast to openness to diversity, which in turn is assumed to be a success factor of co-

design projects in particular. Under these presuppositions, the rejection of project management from a strategic project view is rationally justified.

Project management is thus partly understood as a plan that is written at the beginning, before the actual circumstances of the project work (dynamics in the teams) or the exact product are known, but from which it is then no longer allowed to deviate, which is why it is not possible to adapt the course of the project to actual circumstances.

**Insight for practice:**

Our communication so far assumes too much knowledge. If the makerspaces are to do project management for more than just appearances, they must first be educated about project management as a support, not a requirement. The focus must be on agile project management and each tool used must bring a tangible benefit immediately after use (e.g. better sense of control, easier to communicate, etc.).

*PM as a prerequisite for expansion*

However, from the perspective of makerspaces, there are also good reasons for clear project management, namely when working with partners with a higher degree of formalization like companies, and authorities. This is often the case in projects where assignments are brought to the makerspace from outside. Especially in actual collaboration, where work shares exist on both sides, classical project management is seen by some as a prerequisite for a common understanding of the project. Where the project is worked on unilaterally by the makerspace, but must be reported to the client, this is also the logic that the client understands from the more formalized environment.

From the experience that projects have been unsuccessful because some makers found it difficult to communicate with clients and to organize themselves, it is concluded in part that the introduction of more professional project management, possibly with a more active role of the makerspace, is necessary in order to be able to keep the project promise as a makerspace to the client. Failed projects ultimately damage the makerspace's reputation.

It is kept open to decide from project to project which role the makerspace will take, as there are also highly professional makers who may well take over the entire management and communication of a project themselves. Here, the makerspace's vast knowledge of the skills of their individual members is the basis for decision-making.

Project management is thus perceived by some as a way of professionalizing makerspaces, enabling them to open up new, commercially interesting fields of activity. But even in this context, there is no willingness to do project management for its own sake. Management tasks must contribute directly and visibly to the success of the project.

**Insight for practice:**

A compelling argument for project management over makerspaces is the economic promise of being able to better communicate with industry and public funders.

*Implicit vs. explicit PM knowledge in makerspaces*

Knowledge of classical project management is rather rare in makerspaces or in their communities. Although there is a high degree of academization among the operators and the makers, hardly any of them actively dealt with questions of professional project management during their education. Interest in this is also limited. At best, it is perceived as a possibly necessary evil. It has not arrived in practice. Project management and guidance are primarily based on experience and intuitive knowledge.

Yet these experience-driven approaches often include aspects of good project management such as a kick-off meeting, team-building processes, defining milestones, scheduling interim presentations, a documentation requirement in many co-design projects, and when organizing larger co-design projects, backward scheduling from the submission date. What often does not work well on the part of the makers is a realistic estimation of effort. Also, some of the experience gained is evaluated and systematically expanded, for example when Foreningen Maker experiments with more intensive instruction formats as part of their design camps.

In part, then, there is a lot of implicit knowledge about project management in makerspaces, but it may not be perceived as such and may not be related to it because of the limited conception of project management.

**Insight for practice:**

For the reduction of negative attitudes towards project management, makerspaces can be shown how much they already practice project management by assigning their practice to the tasks of classical project management. This will make it easier for them to communicate with SMEs. A simple set of rules for the makers in the sense of "Always add 30% to the assumed workload when planning, then no one will be disappointed in the end and you won't get into stress" could help.

### 3.2.4 Earlier findings of WP5

The guideline interviews were the second interview series conducted by WP5 to gain deeper insights following the paired interviews conducted right after the project start of which the results have been shared in *D5.1: Open source sociotechnical design components*. Those paired interviews that were led with industry and makerspace partners simultaneously already provided some inspiration for the Engagement plan that shall be brought to the mind in this section. Conclusions that have been discussed in greater detail will not be repeated here.

**Motivation for participation in C3 for OSH in the project**

The main motivation for participation of the makerspace as well as industry partners is the prospect of new possible business models and partly a sustainability orientation. Small companies in particular need external input for such changes since they lack the competencies internally. By collaborating, they expect an acceleration of their own innovation process. Small companies emphasize their need for support regarding OSH development, especially in attracting and mobilizing communities. However, there are also sustainability-oriented companies that want to promote OSH as part

of their corporate ideology. Makerspaces are looking for ways to create jobs and hope for better understanding how OSH can work. Both sides want to increase their level of professionalism by learning from each other.

This has also been stated by makerspaces during the guideline interviews. However, during the paired interviews, it was the SME partners who made statements about their needs so that it is included here as confirmation of the newest interview outcomes regarding SMEs need for support.

**Insight for practice:**

An argument for collaborating with makerspaces is that SMEs need support when opening up for new business models and innovation processes, especially when it comes to engaging communities. Makerspaces can provide this.

**OSH Collaboration**

Makerspaces see themselves as experts in participants’ motivation and ways of working, and as "Community Incubators" are experienced in co-production. Makerspaces emphasize the special way of working in OSH, compared to classical corporate processes: It is fast (no contracts need to be negotiated and signed), input is diverse and multidisciplinary. The innovation process starts the moment the idea is set into the world. Experimentation and exploration are the starting point of developments in Makerspaces. Many different implementation possibilities are worked on in parallel. That fits with OSH.

**Insight for practice:**

An argument for collaborating with makerspaces in OSH projects is makerspaces’ familiarity with the working modes of OSH development.

**Collaboration conditions**

Successful cooperation requires partners who can complement each other in terms of knowledge and skills and/or working facilities. A win-win situation should be created. Differences in cultural practices between partners require tolerance and willingness to compromise from both sides, so that a new, common working practice can emerge.

Collaboration is a consequence of equal motivation and complementary expectations. Only then collaboration requires the least possible management efforts.

Small companies value efficient ways of working. Decision-making paths in the company are short, and efficiency suits their way of working. This fits the rather agile project management in makerspaces. Although SMEs depend on external input, they are not looking for unqualified community members. Just like many makerspaces, they aim at connecting with top people.

Collaboration with companies that distribute larger core products may be mainly related to "add-ons" to the core product at the OSH level. For manufacturers of electronic hardware, OSH collaboration can be interesting in the sense of the project if it offers cloud solutions at the same time, which becomes more interesting for users the more products can be connected to it.

**Insight for practice:**

Differences in working culture should be made visible right from the start self-confidently so that all sides know where they might need to step out of their comfort zone of doing things. However, also the common ground of makerspaces and SMEs regarding quick decision-making should be emphasized for building trust.

It is important to find the right match of makerspace and company with regard to motivation, expectation, competencies, facilities, and the type of community needed for the project. This needs to be part of the clearing between the collaboration partners in the initiation phase.

Possible projects for the demonstrator phase could be add-ons for already existing larger core products or products that can be connected to cloud services of electronic hardware providers.

**Business aspects**

It makes more sense to open up projects from the beginning than to open an existing product to OS. Many aspects of already existing non-OS projects will not have been organically documented with the growth of the product. Therefore, the amount of queries from the community would be almost impossible to handle.

Collaboration costs that need to be considered must include the time it takes to get collaboration projects up and running (establishing processes) as well as the training of potential contributors (community members), if they first have to be brought up to a certain level of knowledge before they can participate. In the pilot study, some experience with 3D modelling was defined as a "minimum level of expertise" that was required to participate. When it comes to very special expertise that is required, this greatly reduces the potential community. However, the cost of teaching potential contributors can also be worthwhile, especially because SMEs, cannot match the salaries of large companies for extensively experienced workers and lack such.

**Insight for practice:**

Projects for the demonstrator phase should be new products that can be developed for OS right from the start.

When trying to win SME partners it is important to present a realistic time frame for establishing collaboration processes as part of good project management in order to allow everyone to make decisions on a realistic cost calculation.

When the community needed for the project is defined in the initiation phase, it is important to decide on the minimum level of expertise required and to decide on whether it would pay off to train participants.

### 3.2.5 Communication & engagement strategy

**External communication: What we can do externally**

The communication strategy for the engagement of additional SME partners for the demonstrator phase refers to the four fields of action (FoA) as shown in Table 3 in chronological order:

(1) Approaching
(2) Getting to know
(3) Convincing
(4) Getting started

In the context of OPEN_NEXT those have to be SMEs. However, in other contexts it indeed makes sense to approach also big companies for the sake of resources since true collaboration requires active engagement from both sides for which resources are essential. Still, it is important to note that the challenge of missing business models for C3 in OSD in the OPEN_NEXT project remains. Those are seen as essential for recruiting SMEs by the makerspaces but cannot be provided by WP5. From its area of competence, WP5 can only offer the advantages identified above for companies with regard to collaboration with makerspaces and communities as an argumentation aid.

*Table 3: First draft of the makerspaces’ Engagement plan for winning industrial partners*

| FoA | Objective | Measure |
|---|---|---|
| FoA1 Approaching | G1 Identifying promising companies to approach | M1 Check your network for partners who meet one of the following requirements<br>• SMEs that want to open up to OSH<br>• SMEs that already have a sustainability focus<br>• Long-established SMEs with an interest in adapting a modern working culture<br>• SMEs with core products for which add-ons could be developed<br>• SMEs that offers electronic hardware with a cloud solution for which further compatible products could be developed<br>• SMEs that are willing to develop new OSH products instead of turning existing products into OSH |
| FoA2 Getting to know | G2 Clear self-presentation as a collaboration partner to prevent false expectations | M2 When presenting yourself to possible collaboration partners from industry, make sure they really know what to expect when collaborating with you by explicitly stating<br>• Differences in working cultures of makerspaces and companies but also common grounds e.g. quick decision-making in SMEs and makerspaces<br>• Makers and other community members as equal players with own demands for degrees of freedom, ethical objectives and probably fair payment. They are not to be seen as cheap human resource.<br>• Own interests of the makerspace for its community<br>• Makerspaces and companies as two complementary parts of a whole without competition: Makerspaces are good in initial phases of product development, companies in preparing the product for market<br>• A relationship of equals between makerspaces & companies, not one of client and service provider, regardless of the financial invest of each |

*Continuation of the table on the next page*

| FoA | Objective | Measure |
|---|---|---|
| FoA3 Convincing | G3 Convincing SMEs to join the cause | M3 In order to convince SMEs to engage together with makerspaces in C3 for OSH development this list of arguments can be referred to:<br>• OS development offers quick feedback from many different perspectives that help a company learn fast about a new field of activity.<br>• Makerspaces open the path to broad experimentation that could not be conducted the same way by small R&D departments.<br>• OS requires collaboration with communities. SMEs that are new to the field lack experience with that, contrary to makerspaces.<br>• Working with communities required an appreciative, understanding and flexible approach to the members which might not be aligned with the usual working mode of companies but of makerspaces.<br>• As an interface between the public and technology, makerspaces can function as mediators when the public shall be involved in industrial processes.<br>• Collaboration with makerspaces offers learning opportunities to SMEs e.g. about new work, corporate responsibility, sustainable product development or rapid prototyping.<br>• Collaborating with makerspaces is safe from competition since there is a clear division of labor over the product development process, with the product becoming the responsibility of the company as it becomes more marketable.<br>• When collaborating with communities of concern, companies gain insights into the concerns that are so strong that a community has formed around them. Such concerns also offer starting points for new products or business models for the company.<br>• Companies that operate on the basis of values oriented toward the common good are welcome in makerspaces and benefit particularly from the willingness of makers to participate.<br>• SMEs are at a disadvantage compared to large companies in personnel matters. Collaboration with communities can compensate for this disadvantage of diversity within the company. Makerspaces have the experience to deal with such communities.<br>• Companies often discover talented people that they can attract to the company while collaborating with communities.<br>• In contrast to classical working modes in companies, makerspaces are familiar with the working modes of OSH development. |
| FoA4 Getting started | G4 Allowing for a smooth start of the collaboration | M4.1 In order to prevent later conflicts, it is important to explicitly identify the following points for both partners during in the initiation phase of the collaboration project:<br>• Motivation & expectation<br>• Competencies<br>• Facilities<br>• The training materials support this and should be applied. |
| | | M4.2 Furthermore the following should be defined:<br>• Type of community needed for the project<br>• Minimum level of expertise required to participate as community member as well as possibilities to train people<br>• Realistic timeframe that considers the time needed to establish collaboration processes |

**Internal communication: What we need to do internally**

Project management is recognized by makerspaces on the one hand as a necessity to be able to communicate and collaborate well with external partners. On the other hand, it is suspected of being an unhelpful burden in everyday project work. It has been shown that the scientific partners in WP5 have a different understanding of project management than the makerspace partners, thus leading to some discontent between the two parties. The actual added value of individual tasks was insufficiently explained and at the same time it was not recognized that a very static and restrictive image of project management is dominant among the makerspaces. Therefore in the upcoming months following changes need to be considered when it is about project management:

- The true day-to-day advantages of project management need to be communicated along with the tasks.
- WP5 needs to focus on agile project management since this fits the reality of makerspaces best.
- Since it is often a variety of makerspace users, not the constant makerspace operators, who coordinate the diverse projects within a makerspace, the concept of train the trainer is important in the context of project management in makerspaces.
- Makerspaces could be shown that they already practice a lot of classic project management intuitively.
- Since it is easier to pass on heuristics than methodological knowledge to makerspace users, simple sets of rules should be implemented whenever possible, e.g. "Always add 30% to the assumed workload when planning, then no one will be disappointed in the end and you won't get into stress".

On a broader project level, we need to find consensus about some terms that are being used in diverse ways so far. For the terms “Community”, “Makerspace”, “OSD Sprint” and “Methodology” we offer the working definitions of WP5 as described in chapter 2: Fundamentals as starting point for a common definition of those terms. Furthermore, when talking about makerspaces’ involvement in projects, we need to be more precise about who the actual actors in the specific contexts are since the makerspace rhetoric often does not distinguish between e.g. operators, employees, users, former users or even partners. The basic understanding of makerspaces as collective places otherwise hinders understanding of processes within makerspaces. We suggest the discussion to be held initiated by WP5 in January 2021 until the next general assembly where a final definition to be used by all partners shall be shared.

## 3.3 The development process

In addition to the building blocks of guidelines, methods and tools, the development process (also called design process) plays a key role in the concept of a methodology. Within the framework of the product development process, a multitude of different types of information must be acquired and processed by the developer through his actions, so that a later functional and manufacturable product can be created on the basis of a vague initial target system. Process models help to structure this process by making it accessible to both management in the sense of process work and the operationally active developer in the sense of knowledge work (Albers and Braun 2011). Processes are the nodes that hold everything together and ensure that tasks are completed in a systematic and organised way, so the progress can be tracked. A process can be described as a defined sequence of activities that are carried out to solve a specific problem with as few interruptions as possible. It is the basis i.a. for Information regarding the management of time and knowledge. It also has a strong influence on decision-making and the collaboration in the OSD sprint (Devine et al. 2004; Dai et al. 2020).

### 3.3.1 Structure & set-up of the development process

Gericke and Blessing (2012) compared 64 design process models from nine disciplines (mechanical engineering, industrial design, systems engineering, building design, software design, service engineering, mechatronics, product service systems and transdisciplinary approaches). They found out that design processes have similarities across disciplines: they have a core of common design stages and propose a stepwise, iterative process (Gericke and Blessing 2011). The following Table 4 contains a set of design stages of the product life cycle which can be found in the process models across the reviewed disciplines.

*Table 4: Comparison of the breakdown of the development process steps*

| **Process steps according to Gericke and Blessing (2011)** | **Process steps according to Stark (2011)** |
|---|---|
| Establishing a need | Establishing a need: initiation of the design process by a product idea, or the identification of a need or a problem (e.g. Market analysis and forecasting, identification of needs, project management, requirement specification) |
| Analysis of task | |
| Conceptual design | Define & design: design and development of the product starting from initial description of the task/product idea to development of conceptual solutions, detailing of conceptual solutions, and to refinement and finalization of the solution incl. production systems development(e.g. conceptual design, embodiment design, detailed design, production systems development) |
| Embodiment design | |
| Detailed design | |
| Implementation | Realize & implementation phase: Integration, manufacturing, assembly, systems integration, test approval, procurement and launch of the product |
| Use | Use & support: sales & distribution, installation, operation, monitoring, service and maintenance of the product |
| Closeout | End of Life (services): Recycling, disposal, update/evolution of the product |

As already described in *D5.1: Open source sociotechnical design components - Chapter 5 'Phase model: Process management for developing products and product-related services'*, the focus of the pilot study and the demonstrator in OPEN_NEXT is on product planning and product development up to TRL6. For this reason, the phase model which is based on the Agile Systems Design (ASD) approach according to Albers et al. (2019) was selected. Accordingly, the phases listed in Table 5 are considered.

*Table 5: Overview of the phases of the OSD sprint*

| Phase | Description |
|---|---|
| Phase 0: Preparation | Before the OSD development project can start, the stage for collaboration must be set. This means that all the requirements for communication and teamwork with the community are clarified on a technical level including the preparation of all tools. In addition, the recruitment of potential participants accelerated. This phase complements the process from *D5.1 ‘Open source sociotechnical design components’*. |
| Phase 1: Analysis | With ‘Phase 1: Analysis’ the OSD project finally begins. This includes further exploring the initially formulated challenge and looking at it from new perspectives in order to gain a better understanding of the underlying issues, needs and target domain.<br>Also, the analysis teams consider what the various partners already know and what needs to be discovered in the field. It also helps to examine potential markets and the competitive situation as well as to develop consistent future scenarios. Most importantly, the identification of possible reference products and reference processes plays such a significant role in order to reduce the development time and minimise risks. |
| Phase 2: Identifying potential | Now the teams identify and characterise potential stakeholders (e.g. customers, users), empathise with their situation (e.g. physical and mental limitations) and narrow down the design challenge with user stories. To summarise insights from this and previous phases the concept of a product profile is introduced. A product profile defines a demand situation in the market, emphasises the relevant use cases, characterises the future product in its main properties and considers the customer, user and provider benefits. In addition it lists opportunities as well as risks and includes the boundary conditions. That means a product profile makes the intended provider, customer and user benefits accessible for validation throughout all future phases and explicitly specifies the solution space of possible products and related services. |
| Phase 3: Conception | In the next step, the problem-solving team will finally move from the identified and well analysed problem to possible solutions. By generating ideas for PSS and testing with a small group of users using early physical prototypes, the solution space is systematically described. The best ideas are then turned into concepts by combining solution principles and focusing on details. At this stage creativity workshops play a key role in promoting inventiveness and unconventional thinking. |
| Phase 4: Specifications | Within phase 4, the knowledge gained through the phases and at the milestones continuously flows into further development. The systematic integration of users and other stakeholders in this process is used to increase the maturity of the prototypes to be able to integrate them into the concrete system environment. |
| Phase 5: Realisation | At this point, the teams will enter the critical phase. Because in the “real world”, additional influencing factors occur which have not been taken into account in the Lab. So set up a measurement and evaluation framework to gain further important insights into the sociotechnical system. The improved prototype will enable the solution to be clearly articulated and its value to be demonstrated. It will also validate the feasibility of the PSS. |

Each of these phases was described in more detail in this very deliverable. The phases are supplemented initially by the transdisciplinary design states proposed by Eisenbart et al. (2011): ‘problem statement’, ‘context analysis’, ‘need’, ‘product idea’, ‘product proposal’, ‘design object specification’, ‘requirements specification’, ‘product functionality’, ‘working structure’, ‘conceptualization’, ‘preliminary layout’, ‘layout’, and ‘production documents’ (see Figure 9). Here, a design state is defined as the incorporation of all the information about a design as it evolves, i.e. (interim) results (Dym and Brown 2012) and can be used to place activities, methods and tools in a more meaningful context (see chapter 3.4.2).

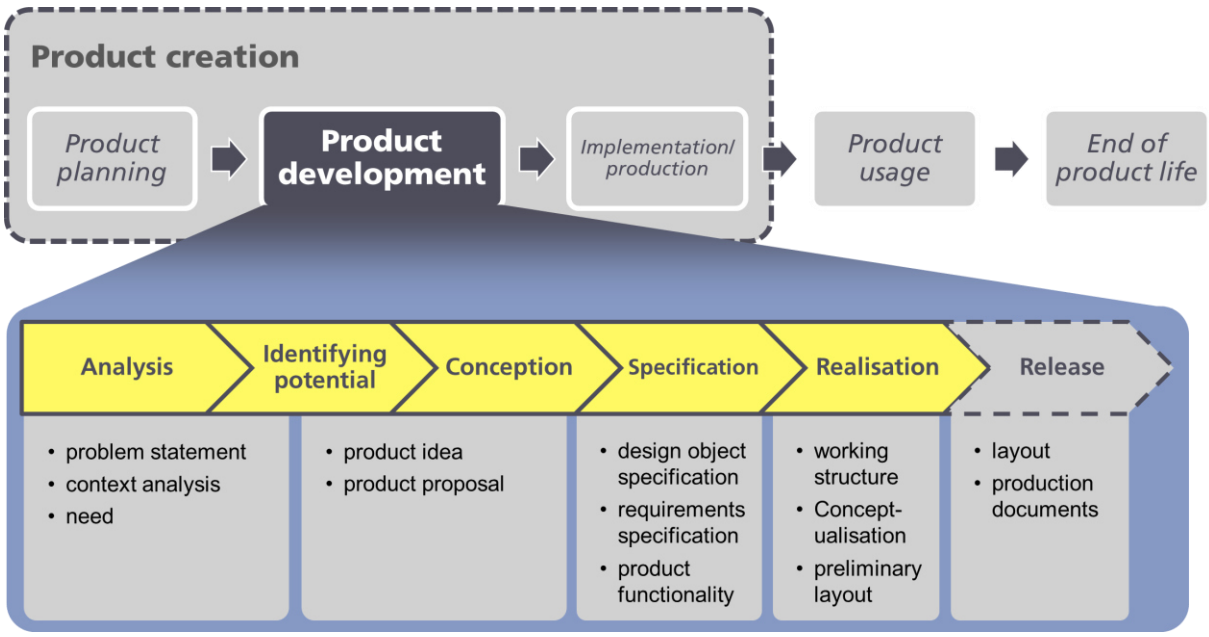


*Figure 9: Phase model of the product development in the context of product creation*

### 3.3.2 Adaptations to the OSD context

Since processes are always embedded in an environment (i.e. their context), as shown in Figure 10, these influences must be taken into account when elaborating, implementing and evaluating the development process. The environment can be described at different levels of resolution, taking into account various influencing factors (Dylla 1991), e.g. the development task, prerequisites of the problem-solving team, individual prerequisites and external conditions (Frankenberger et al. 1998; Hales and Gooch 2004; Gericke et al. 2013b). In the further course of OPEN_NEXT, the influencing factors are analysed together with the practice partners and the model of the development process is iteratively adapted.

A first draft for a specific OSD process in the context of C3 and makerspaces was presented in *D1.3: OSD framework* with a focus on the phase level as well as the activity level (cf. chapter 2.4). The development process results from the assignment of activities, some of which are repetitive, to concrete phases. The mapping of methods to support the implementation of the activities is considered in the following chapter 3.4.2. By assigning responsible parties to the activities, the triad of coordination, cooperation and communication can be shaped. The presented processes and assignment of responsibilities function as a general reference for the processes of the OSD project. For the individual project, the process must be adapted according to local conditions, resources and objectives.

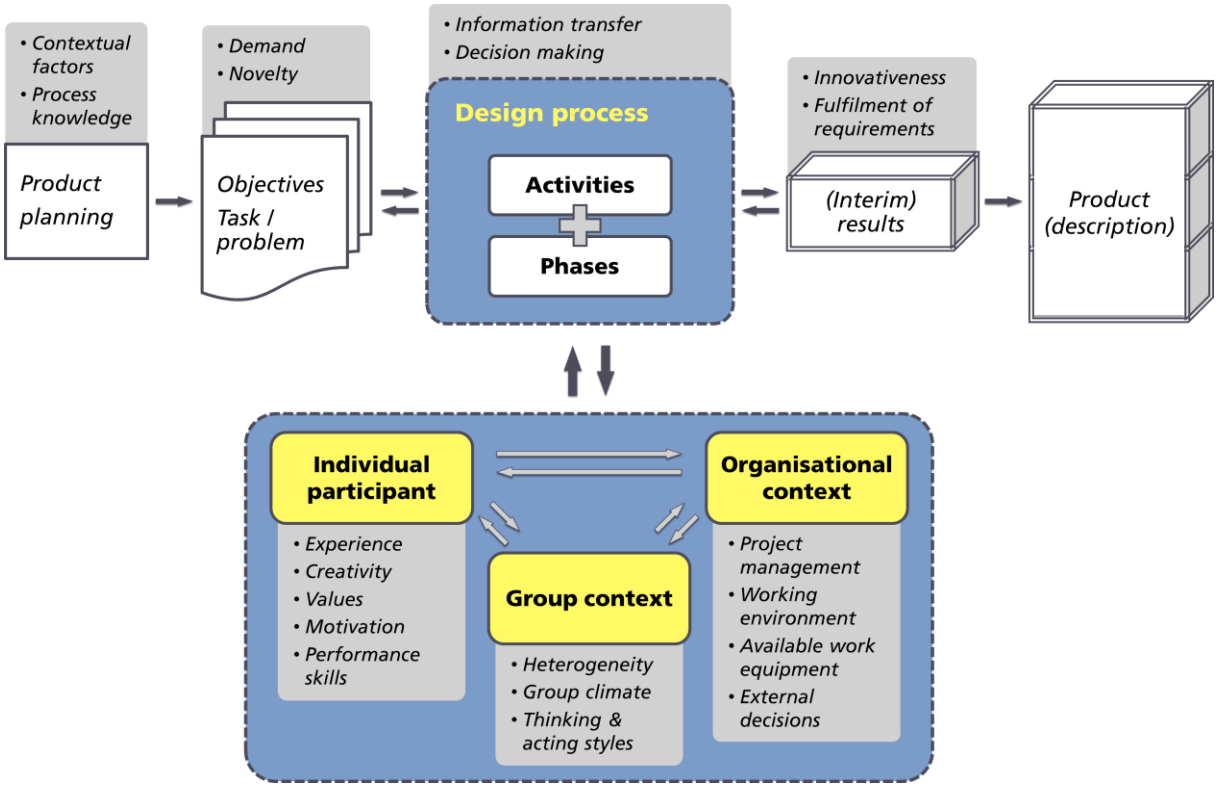


*Figure 10: Schematic diagram of the design process environment*

In the context of OSD, the community plays a prominent role and should also be taken into account accordingly when creating a development process for the specific C3. Since the OSH community is usually largely self-organised and comprises members occupying a diversity of roles, it is relevant to offer a visual overview of what is going on to all of them with their different existing knowledge. However, according to the literature, an OSH project is often dominated by a core team made up of a few people in charge of major project decisions and that is carefully managed by the project coordinator (Raasch et al. 2009). This core team can use the elaborated process description for coordination as well as communication. It needs the support to solve the bigger challenge of the project in order to steer the efforts of the problem-solving teams (PST). Because in the development of PSS, a development team working together is a decisive key to supporting innovation potential and enabling successful development processes through the integration of different areas and disciplines, which is necessary due to the increasing complexity of modern products (Exner and Stark 2015). However, there is a high turnover among other volunteer participants (Foucault et al. 2015). This constant organisational change leads to knowledge loss (Rashid et al. 2017; Herbsleb and Mockus 2003), since not all contributors are aware of the overall project status and other contributors’ activities (Treude and Storey 2010). This makes it all the more important to be able to locate the project status, the various activities and work results in the overall project. This also includes making knowledge about the process, experiences and values available for decision-making.

### 3.3.3 Iterative refinement of the development process

Processes must not be established once and then considered valid for all time. They need to be continually reviewed to identify the aspects that are not working well to use this information to implement better practices for the C3. In doing so, the process should be applied or adapted to the specific project objectives of each individual project with its unique properties. In the course of the pilot study and later of the demonstrator, the development processes, together with the different challenges and insights from the 18 cases, will be documented and analysed to identify their current processes. Through surveys on the activities carried out, observations and interviews, among other things, the projects will be evaluated in order to gain a comprehensive understanding, to get a visual representation of the individual process and to locate problems and stumbling blocks (in particular, reference should be made here to the upcoming deliverables *D4.4: OSD impact assessment*, *D5.3: First release of OSD Lab report*). In this way, experiential knowledge and lessons learned will be captured, which will be made available to existing and future project partners.

Together with the entire OPEN_NEXT project team, the OSD journeys will be discussed. Not only to understand which problems need to be fixed, but also why they arise in the first place. An improved version of the flowchart will then be created to provide a visual representation of the new planned process. By going backwards through the new process and tracing all the steps from the end result to the starting point, further potential for optimisation can be uncovered. Finally, ensure that the scope fits so that the process does not become too complex or complicated. Reference processes for specific contexts will then be derived from the totality of the combination of activities, phases and methods and enhanced with best practice examples. These will help to provide more targeted recommendations. In addition, the reference processes serve to optimise support for decision-making and, for example, time management. The improvement of the classification of methods (see to chapter 3.4) is also aimed at on the basis of the insights gained through a guided reflection process.

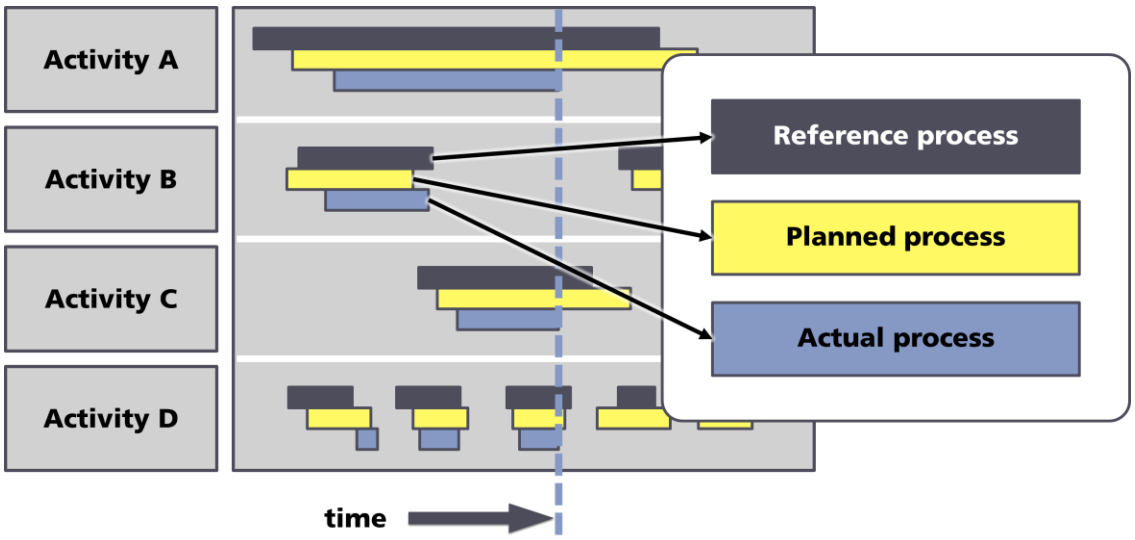


*Figure 11: Phase model with reference, planned & actual process acc. to Albers and Braun (2011)*

## 3.4 Methods & how to select them

In order to optimise the implementation of activities in the product development process, targeted methods are used which support the analysis of objectives or the selection of ideas, for example. They describe a specification/rationale procedure of how a specified result is to be achieved. Therefore, they can contain information about how the task is to be decomposed, how information is to be presented and which inputs are required. Likewise, which actions are to be carried out how, in which order and which tools are helpful to achieve the goal. At the method level (see chapter 2.4), methods can be run sequentially one after the other and certain methods can be repeated iteratively to concretise results (Albers et al. 2019).

### 3.4.1 Structure of a method

The objective of OPEN_NEXT is to support the joint product development process of makerspaces, SMEs and communities with suitable, situation-specific and needs-based methods. This includes, among other things, the provision of a collection of methods and a selection guide as part of a toolkit for independent use by the cooperation partners. The basic prerequisite for this is the comparability of different methods and the elaboration and complete description of these for their use in the context of an OSD sprint. For this reason, the schematic structure of a method according to Gericke et al. (2017) with the elements ‘Intended use’, ‘Core idea’, ‘Representation’, ‘Procedure’, ‘(Design) Method Description(s)’ and ‘Tool’ is used (see Figure 12). The description of the individual elements is shown in Table 6.

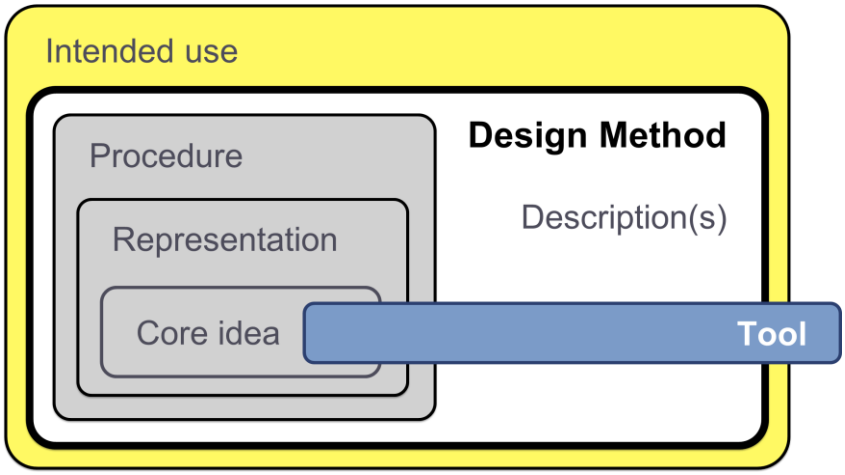


*Figure 12: Schematic structure of a method acc. to Gericke et al. (2017)*

Accordingly, each method profile should have the following points that help the team to apply the method: Brief description, alternative name of method, Input & Output, essential work steps, (supporting) tools, (needed) resources, advantages & disadvantages, field of application, similar methods, sources / literature, expert / consultant, examples of applications & best practices.

*Table 6: Description of the relevant elements of a method acc. to Gericke et al. (2017)*

| Element | Description |
|---|---|
| Intended use | A description of scope of a method, the coverage within, scope and expected benefit from using the method, informing the user about suitability of the method for a particular design task in a specific context. |
| Core idea | The basic principle, technique or theory that the method employs. |
| Representation | An object or other artefact that shows and stands for a target system, i.e. intermediate results and deliverable created by using the method. |
| Procedure | A description of the actions required to apply a method, for enabling the user of the method to do something more easily or with a sufficient guarantee of correctness, focusing on the sequence of actions and their completeness. |
| Description(s) | The description of the method provides the method user with an explanation and further information on the possible adaptation and limitations of the method elements. |
| Tool | The tool supports the user in the application of the method in order to achieve appropriate method results. |

### 3.4.2 Classification of methods for OSD sprint

Even a more or less complete collection offers no significant practical benefits without supporting the appropriate selection. In order to be able to select the appropriate method for a specific situation, it is necessary to structure the collection of methods in advance and to assign a characteristics profile and categories to the methods. For example, different classes of methods can be distinguished according to their primary purpose, e.g. methods for eliciting requirements, methods for evaluating and selecting concepts, and methods for selecting concepts. Furthermore, it must be possible to discuss the (dis)advantages of using one method instead of another in the context of the concrete cooperation to be able to make an appropriate selection. This is to avoid that the team uses methods they are already familiar with or try to avoid new ones instead of using the most appropriate ones. In order to ease the discovery of methods, it is necessary to adapt the selection assistance to the way the problem-solving teams search which means adopting an outcome-based presentation of methods to complement the existing presentation.

Instead of assigning the methods to the development phases, they are linked to the activities, which can be performed once or iteratively in the design process, objectives and generated objects, as described in the iPeM – Integrated Product Engineering Model according to Albers et al. (2016). The activities matrix as a combination of macro activities (basic activities and product development activities) and micro activities (problem solving activities), as seen in Figure 13, allows a more precise description of the situation to be methodically supported. A description of the individual macro activities is given in Table 7.

*Table 7: Product creation activities acc. to Albers and Braun; Boks; Albers et al. (2011; 2016; 2016)*

| Macro activities | | Description |
|---|---|---|
| Basic activities | Manage project | Project planning and controlling: Sum of the activities at the beginning of a product development process - including planning of the initial system of objectives and operation system – as well as their continuous controlling and regulation. |
| | Manage community | Gain an overview of internal and external people involved, information and skills. Further elements are the identification, recruitment and training of new community members as well as the care, support and development of the community. |
| | Validate & verify | Validation and verification are key activities to gain knowledge and insight: Both a continuous assurance of properties with increasing maturity of the product and a continuous target vs. actual situation comparison of process variables are carried out. |
| | Manage knowledge | Knowledge management is for gaining an overview of internal and external data, information and capabilities. Further elements are identification, acquisition and development of knowledge as well as distribution, use and maintenance of this knowledge. |
| | Manage changes | This includes the coordination of technical, economic and social changes. The inherent elements are: the examination of early detection of errors and the potential as well as the implementation of respective measures. E.g. this applies to the response to a new target vs. actual situation, which might set forth a design optimization or a new customer requirement. |
| Product development activities | Detect product profiles | Profiles are important for strategic product definition: Identification of customer, user and provider benefits as well as solution-neutral characterization of the qualities/properties of a future product or problem identification for an existing product. |
| | Detect ideas | This is about finding solutions for the holistic treatment for the (partial) problems described in the product profile. Starting from the largest possible solution space, creative ideas are developed at a comparatively high level of abstraction. |
| | Model principle solution & embodiment | This process step is about detailed elaboration of the product idea(s) under consideration of technical and economic boundary conditions as well as detailed elaboration of the physical interaction of function and embodiment (e.g. with CAx tools). |
| | Built-up prototype | This activity is necessary to perform the activity “validate and verify”. It is carried out at different maturity levels and can contain physical prototypes as well as virtual ones. |
| | Produce | This includes production system engineering: Activities that are necessary to be able to produce the product and production e.g. manufacturing activities for the realisation of the product. |
| | Market launch | This question addresses process-parallel activities that serve to market the product and includes both the implementation of a sales network and the definition of a marketing strategy including the development of a suitable product presentation. |
| | Analyse utilisation | Analysis of utilization is about the anticipation of the future user's behaviour and identification of improvement potentials with existing products. It also includes services. |
| | Analyse decommission | Analysis of decommission is about anticipating the possibilities of decommissioning or recycling at the end of the product's life. This also includes possibilities of reprocessing and is mainly carried out parallel to modelling principle and design. |

Each of these macro activities can be broken down into seven micro activities described in more detail in *D5.1: Open source sociotechnical design components* – chapter 5.4. The steps of a general problem-solving process are:

I. Analysis of the situation
II. Problem containment & formulation of the objective
III. Synthesis of alternative solutions
IV. Analysis & selection of the solutions
V. Assessment & consequences analysis
VI. Decision & implementation
VII. Recapitulate & learn

With help of a sequence of questions, for example, the teams can find their way through the matrix. In order to be able to filter out the need-based methods from the situation-specific methods of the activities matrix, they are additionally assigned to the system of objectives, which contains objectives of the design process (e.g. development time and cost reduction) and the system of objects which includes outcomes the methods help to create (e.g. physical product model, textual product descriptions or resource planning documents) as well as a resources characteristic (e.g. needed time, competencies and infrastructure) (Albers et al. 2015).

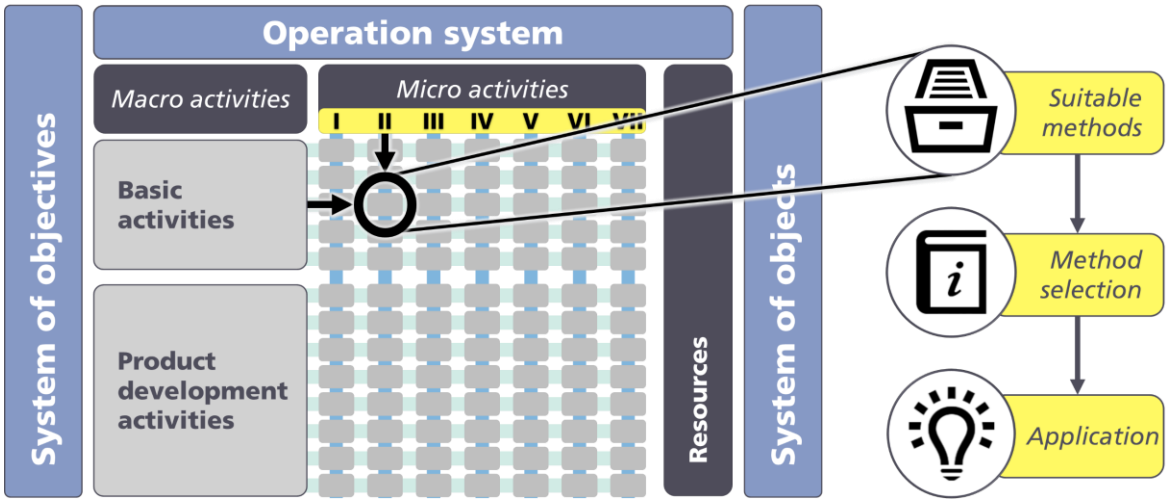


*Figure 13: Relationship between activity matrix, objectives, objects and methods selection acc. to Albers et al. (2015)*

Over the course of the development projects with the project partners in OPEN_NEXT, a number of different methods like Stakeholder analysis, Customer survey, World Café, SWOT, How Might We, Vision pitch, Lightning Decision Jam were used. However, a proper collection of methods with ready-to-use methods is currently missing, as well as the selection assistance. It should be noted that it is apparent that many development methods are only designed for use in location-bound teams (Albers et al. 2018). In order to adapt them to the conditions of distributed teams, they must be made compatible with a time and location-independent flow of information. For this purpose, in the further course of OPEN_NEXT, it must be researched which details and elements of a method are relevant for the application in the OSD sprint and how they must be prepared. Furthermore, the methods must be assigned to the activities and thus to the development process in order to be able to derive guidance for the selection of the appropriate method for a specific situation in which the teams find themselves.

## 3.5 The tools to get things done

The fourth building block of the schematic structure of a methodology (see chapter 2.4) is the tool block. This refers to all working aids that support the other building blocks of methods, guidelines and development process or the methodology as a whole.

### 3.5.1 Tools in the product development process

At the simplest level, a tool is something that helps get a task done but it is not a substitute for the person doing the task. It can be very simple, a form such as a checklist of questions to review or a customer survey, a template (e.g. Business Model Canvas (Clark et al. 2010)) or a software like a formally structured web-based support for analysis. In addition, an object or artefact can also be a tool.

In the area of methods, there are many tools such as various platforms for design methods, including textbooks (e.g. Universal Methods of Design by Hanington and Martin (2019), 101 DESIGN METHODS by Kumar (2012)), design toolkits and publications, as well as a number of web repositories and community-supported web portals such as toolkit.mozilla.org[12]; evernote.design[13] or thedesignexchange[14]. Furthermore, applications for mobile devices such as the method selection assistant “InnoFox” (Albers et al. 2015), special artefacts such as the "TRIZ contradiction Matrix" (Hua et al. 2006) or templates and guidelines such as the “House of Quality” for the Quality Function Deployment (QFD) method (Akao 1990). Regarding guidelines, rulesets and principles can provide guidance in the form of a poster in the makerspace for example. A model or prototype library may serve as a collection of best practices and heuristics presented as training content to help makers to get things down. Possible tools to support the design process are templates like the product profile and the analysis framework, a text based main guide with instructions on how to go through the process, an online database with best practices (e.g. short videos) and also an online collaboration platform. In essence, a tool is still something that can be used to perform an action to get something done.

However, the challenge for individuals and teams involved in the development process is that they often do not know where to start and where to look for help, as they are in unfamiliar territory. They want a quick, easy and accessible way to select the tools and techniques that are best suited to their situation. As part of the iterative process and the reflection process, teams also need to be guided to share positive and negative experiences, ideas and suggestions for improvement. In addition, guidance is needed on how best to combine these tools and techniques. At this point, reference is made to chapter 3.4.2, as the selection of tools can be based on the situation and needs. The tools help to implement and apply methods, which is why they should not be considered separately.

[12] https://toolkit.mozilla.org/

[13] https://www.evernote.design/

[14] https://www.thedesignexchange.org/

### 3.5.2 Classification of tools according to C3 competencies

In the context of OPEN_NEXT, however, the focus is more on the tools for profiling and training stakeholders, in particular makerspaces for OSD projects with SMEs. Thereby profiling includes the co-creation of the development process, methods (collection) and guidelines. On the other hand, tools for training are based on a qualification strategy as well as training modules and the development of related materials for C3 projects. For this reason, the core competencies cooperation, coordination and communication as basis for great collaboration will be considered in particular in the further course of the pilot study and the subsequent demonstrator.

The first, **coordination**, is understood as the linking of partial solutions. A coordinator directs the actions of the project participants to achieve the common goal. It is the coordinator's task to identify who is best suited for which tasks and to develop processes and assignments that lead to the set goals being achieved as effectively as possible. The goal of coordination is to ensure that each participant is aligned, or pulling together towards common objectives. Project stakeholders need to know what the status of the development process is and how their actions contribute to the group's goal. Here, suitable organisational and coordination tools such as (team) calendars, notification boards, to-do lists in the form of Scrum or Kanban boards (as physical tools in the makerspace or as a digital version using e.g. openproject.org[15] or trello[16]) offer transparency and the greatest possible self-organisation of the individual problem-solving teams in order to help with the project management.

The targeted use of the appropriate tools enables better stakeholder engagement and provides transparency on progress and milestones with notifications and reminders. The communication history not only promotes compliance with deadlines and agreements, but can also increase the sense of accountability. Further coordination includes tools for the administration of the occupancy plan for machines and workstations in the makerspace’s workshop (e.g. fabman.io[17]), but also the demand-oriented provision of access to (special) machines of other network partners and their skills as needed.

**Communication** describes the exchange of ideas and information (not just “facts,” but policies, prospects, rumors, feelings, failures, etc.) during cooperation and helps the people involved to develop a common understanding, communicate their goals and intentions and find consensus. One example of this is stakeholder management. The challenge is to match communication to the appropriate context, to provide the right communication mechanisms at the right time and to prioritise important communication at the right time. Considerations for enabling communication need to take into account when, how and why relevant participants, organisations or other stakeholders need to communicate with each other (e.g. different use of tools online versus on-site in the makerspace).

[15] https://www.openproject.org/

[16] https://trello.com/

[17] https://fabman.io/

Location-independent and project-internal communication can be supported by text based tools such as Email, instant messaging platforms and forums (e.g Elemet.io[18], rocket.chat[19], mattermost.org[20] or zulip[21]) and other communal online spaces as well as video and audio conferences (e.g. Jitsi[22])for example. When it comes to (partly) distributed teams, it is important that text and file-based tools enable the organisation of conversations (i.a. channels and threads help communication stay relevant and on track) as easy and efficient as possible and provide context for discussions (easily gain conversation context by scrolling through discussion and file history). This helps to give the entire team equal visibility into the project’s conversation and enables the relevant stakeholders to stay up to date with updates on the team's progress and versions of their work.

In any case, prototypes should not be forgotten as very important communication aids. Whereby different states (e.g. calculation, virtual simulation or physical prototype) and degrees of maturity are useful to share different points of view regarding the feasibility (technology perspective), viability (business perspective) and desirability aspects (customer perspective) of the developed solution (T. S. Schmidt et al. 2017).

Online training and the provision of appropriate materials are enabled by video platforms (e.g. Vimeo[23], Youtube[24]) to communicate know-how about the technological equipment for example. These can also be embedded on the project website, which is also a great tool for external communication. This is also done by using mailing lists or social media (e.g. Facebook[25], Twitter[26]), blogs (e.g. Medium[27]) and forums. Furthermore, helpful tools can of course also be completely offline (e.g. information boards at the machines, posters for working principles).

When the people involved cooperate, they each have their own (partly independent) goals, but behave in a way that does not hinder each other (For example, when one team develops the slicer software[28] for an fused filament fabrication printer and another one works on additional hardware-only add-ons such as a housing for the printer). In the area of **cooperation**, the tools used should allow them a high degree of flexibility in working independently, but should also let them know when cooperation with others is required. Building on this, tools for **collaboration** can be considered. These

[18] https://element.io/

[19] https://rocket.chat/

[20] https://mattermost.org/

[21] https://zulip.com/

[22] https://meet.jit.si/

[23] https://vimeo.com/

[24] https://www.youtube.com/

[25] https://www.facebook.com/

[26] https://twitter.com/

[27] https://medium.com/

[28] https://slic3r.org/

enable the participants to collectively create something new that could not have been created by the individual users. Helpful tools are online platforms such as Wikifactory[29], GitHub[30] or GitLab[31] for file exchange and clear version history just like dokuwiki.org or tiki.org. However, in order to involve a large variety of individuals with a wide range of skills and prior knowledge in the development process, collaboration tools are needed that are quick and easy to use. A steep learning curve reduces the barriers to co-design. A good example are applications with digital whiteboards like Miro[32], Mural[33] or Conceptboard[34]. Together with audio/video conferencing systems, these enable the design and implementation of interactive workshops, such as a remote design sprint[35].

The chosen classification of the examples of tools is only intended to provide a small insight. Most of them can be assigned to several clusters, depending on how they are used. The challenge lies in understanding where and when to use the tools, and having the necessary skills to use them well. However, how people interact with each other while working together also depends on the relationships between them, their individual skills, their perspectives of the world, their shared understanding (or lack thereof) and a variety of external influences such as overarching organisational roles and policies.

[29] https://wikifactory.com/

[30] https://github.com/

[31] https://about.gitlab.com/

[32] https://miro.com/

[33] https://www.mural.co/

[34] https://conceptboard.com/

[35] https://www.thesprintbook.com/remote)

## 3.6 Summary

The process of shared creation and co-working on a problem solution is among the necessary foundations for successful OSD. In a fruitful C3, the makerspace and SME, together with the community, have a high-level shared vision of the objectives they are trying to achieve. This means, among other things, that the collaboration creates a shared meaning about a process, a product or an event (Schrage 1990). Each collaborator, whether citizen, future customer, supplier or maker, brings different skills, world views and ideas to the collaboration to achieve the common goals. Ideally, they bring complementary skills to the OSD project that enable them to create something new and of higher quality than any of the individuals could have created independently or could have arrived on their own.

Makerspaces can meet the need of collaborators to explore their own ideas independently, but they can also actively create opportunities to come together and share ideas to merge different points of view into a single common outcome. They can provide both the physical environment for OSD and the organisational environment that people need to see what others are thinking in order to build on those ideas by applying their own unique skills. By qualifying makerspaces as OSD Labs, they are able to provide the comprehensive prototyping environment for high-performing teams that (eventually) organise themselves. Furthermore, they are able to foster collaborations to solve problems, develop new understandings and new OS products, and build a network of collaborators who feel an intense and urgent need to create something new.

To realise this vision, the PIL provides a framework for OSD through C3. In this context, the Gender & diversity plan as well as the Engagement plan form the backbone of the PIL. Based on the in-depth analysis of the role and understanding of makerspaces in a OSD project, they provide relevant guidance, not only for WP5, but for the other work packages in OPEN_NEXT as well. Thus, the gained insights and findings provide an improved understanding for the whole OPEN_NEXT project as well as a groundwork for the future *D6.1: Service pitch* of the makerspaces to advertise and attract new SME partners for new OSD projects and makerspaces to expand the OSD network. Based on the findings of this deliverable, a draft of the success factors for an OSD mind-set was derived. These are listed in Table 8. Together with the methodology model, which provides the context for the validation, and the associated elements, helpful training units, toolkits and materials can be further developed and tested with the practice partners.

As OPEN_NEXT progresses, the methods, tools and processes used are recorded and the benefits achieved are analysed to identify situations where the elements can be used effectively. It will also contextualise them in a clear framework to assess which, if any, tools and techniques can be useful. The aim is to maximise tangible results from the application of these tools and techniques for different individuals, teams and organisations. Through the exchange of project partners across geographical and thematic boundaries, a learning and exchange network can be established through which the toolkit can be continuously improved according to the needs of the users.

Based on the previous insights and experiences, a first draft for a training concept for the participants of the pilot study was built up (see chapter 4). This includes lectures on the content of the individual development phases and OSD-specific topics (e.g. OSH licences, OS business models), as

well as methods and tool recommendations including templates, and consulting workshops (e.g. expert workshops with the entire OPEN_NEXT team and business model analysis with the REMODEL toolkit[36]). This will be further developed by observing and working with partners in the pilot study as seen in Figure 14. At the end of this, with the help of a suitable reflection process, consideration is given to which elements based on the methodology model are to be adopted, adapted and implemented for the second round of practical use in the demonstrators.

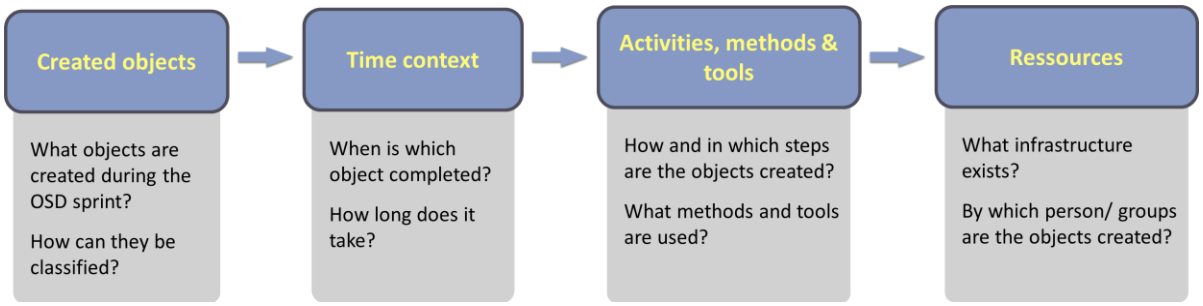


*Figure 14: Procedure for capturing the actual OSD process*

*Table 8: Overview of possible success factors for OSD in C3*

| Dimensions | Factors |
|---|---|
| Strategy | Secure management support<br>Having fundamental guidelines for OSD<br>Ensure funding for OSH initiatives<br>Having clear metrics |
| Culture | Diversity orientation<br>Foster empathy & communication at eye level<br>Ability to handle complexity and uncertainty<br>Establish collaboration and cross-functional teams<br>Clear communication of the different approaches, cultures of makerspaces and SMEs |
| Implementation | Provide necessary material<br>Innovation spaces<br>Establish flexible and responsive processes<br>Integrate OSD into new product development (NPD) and related processes<br>Apply lessons learned from past projects<br>Access to the user |
| Competencies | Provide training on OSD<br>Collaborative initiative with key partners<br>Create OS awareness<br>Enable the optimal team skills<br>Include OS principles into everyday work |

[36] https://remodel.dk/

# 4 Outlook – How to get OSD Labs started?

In the previous chapters, mainly two of the three subtasks of *WP5 - Task 5.2: Methodology for OSD sprints* from the project proposal were addressed. Firstly, subtask *5.2.3: Gender & diversity plan* was elaborated and introduced in chapter 3.1. Furthermore, subtask *5.2.2: Engagement plan* was presented in chapter 3.2. Together they bring OPEN_NEXT closer to the partial objective of developing a communication strategy for promoting C3 and OSD collaboration with the purpose of engaging a broader group of potential SME and makerspace stakeholders. In a next step, *D6.1: Service pitch* will be built on top of this, which will be used as an active promotional tool in communicating and winning additional SMEs and other potential stakeholder (groups).

However, in order to achieve the overall goal of WP5, the qualification of makerspaces to OSD Labs, the implementation part of subtask *5.2.1 tools for profiling and training stakeholders for OSD projects with SMEs* is still missing. This means that the elaborated contents of chapters 3.3, 3.4 and 3.5 have to be converted into a training concept to enable the makerspaces to initiate (e.g. networking, communicating expectations), implement (e.g. knowledge management, decision-making) and manage (e.g. time & stakeholder management) OSD projects in the C3 context. This also includes the practical application of the categories of coordination, communication and cooperation as well as collaboration, and the evaluation of these.

Together with the project partners in OPEN_NEXT, a qualification strategy for OSD Labs is being developed (see Figure 16 and Figure 15). *WP4: Following the co-creation path and developing business models* (e.g. toolset and business models) and *WP3: Supporting Production Engineering with ICT infrastructure* (e.g. instructions on how to use Wikifactory[37] as a digital collaboration platform) in particular are supporting the development of corresponding training materials (e.g. guidelines, collections of methods and tools, templates). In addition to phase kick-off presentations and milestones with predefined goals, the training also includes, for example, method workshops (e.g. creativity techniques, Scrum, Design sprint) and expert lectures (e.g. OS licences by Open Source Ecology (OSE) Germany[38], Community of concern by Waag[39]). To enable a systematic planning of the demonstrator phase, a written training concept will be elaborated together with the project partners in the next few months. This should ensure the transferability of the findings from the pilot study to other makerspaces in order to convince and enable them to initiate and conduct OSD sprints with SMEs.

Furthermore, there is demand-oriented support of the individual OSD projects by the research partners in the concrete project work. In the coming months, further workshops and training materials will be developed in line with the course of the pilot study so that the individual product development projects of the makerspaces and SMEs reach TRL6 in summer 2021. Subsequently, the processes will be reflected, refined and supplemented with best practices and lessons learned.

[37] https://wikifactory.com/

[38] https://opensourceecology.de/?ln=en

[39] https://waag.org/

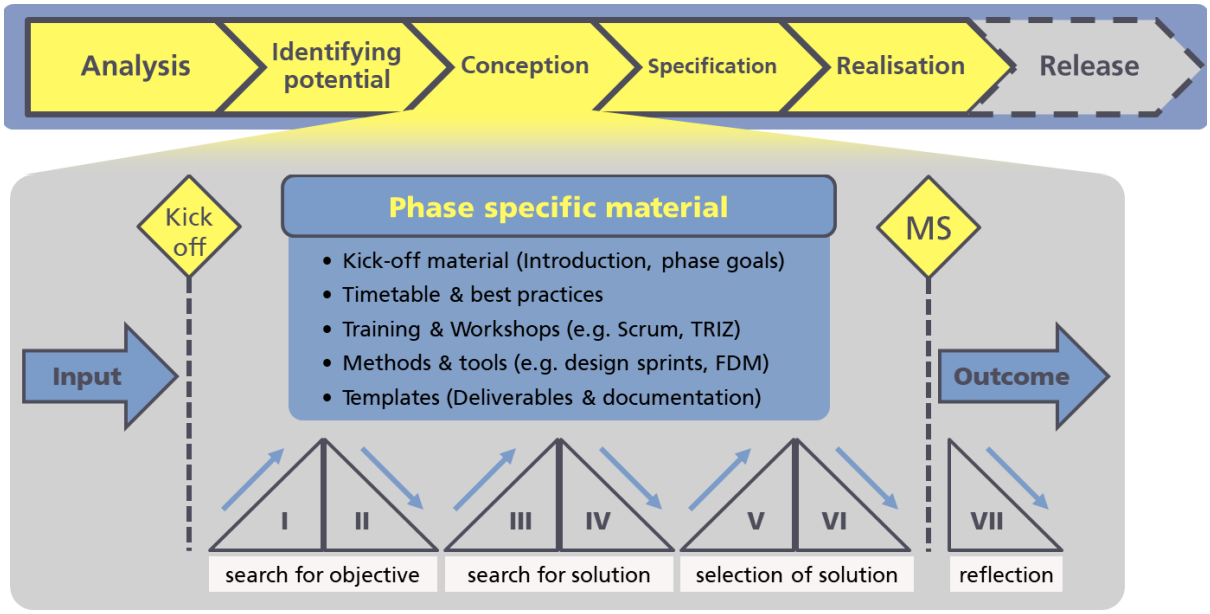


*Figure 15: Training materials in the context of the OSD sprint phases*

For *D5.4: Second release of the Prototyping Improvement Logic (PIL)* in June 2022, the focus will be on further developing and implementing the training concept for OSD Labs. This will address makerspaces even more than the present version. Supported by a much more practical view through *D5.3: First release of OSD Lab report* in summer 2021, suggestions for improvement and extension will be developed. In addition, lessons learned and best practices from makerspaces, SMEs and the community as well as their networks will be added. From this, further practical implications can be derived for the second release. To accomplish this, we will continue to support the work of the practice partners in the coming months and work closely with them on their OSD journey.

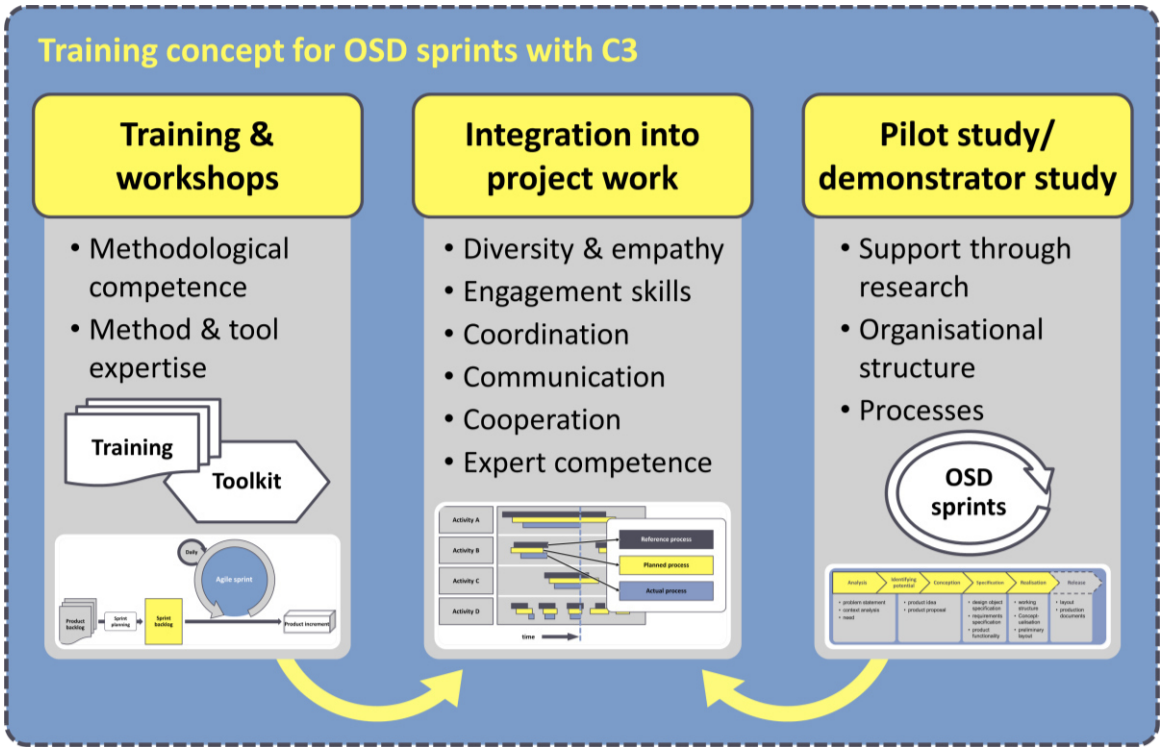


*Figure 16: Schematic structure of the PIL training concept in OPEN_NEXT*

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# Annex

# Interview guideline

„Product Creation in Makerspaces – Processes, Methods, Collaboration“

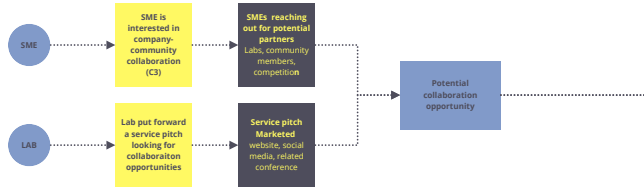
| Question/Stimulus | Key points to be addressed | *Comment* |
|---|---|---|
| **1 Introduction** | | |
| 1.1 Recognition of participation | Welcome and thanks | |
| 1.2 Explanation why this helps the projects and partners | We would like to understand better the makerspaces’ practices and needs in order to co-develop suitable collaboration methods for makerspaces and SMEs with you. Our learnings will be part of Deliverable 5.2 that we will have to hand in in December. | |
| 1.3 Explanation of interview structure | Therefore, we would like you to do the major part of talking and we will listen and ask for details in order to learn more about the way things are done in makerspaces.<br><br>In the first part of the interview, we would like you to tell us in quite some detail about one or two projects that were conducted in your makerspace and that you remember well.<br><br>In the second part we would like to hear your opinion on success factors in collaboration projects and makerspaces’ potential roles in such projects. | |
| 1.4 Are you all right with this? Do you have any questions or thoughts so far that you would like to share? | | *If something is shared, answer in adequate detail. When cleared ask if there are any other concerns.* |

| Question/Stimulus | Key points to be addressed | *Comment* |
|---|---|---|
| **2 Project Description** | | |
| 2.1 Great, then let's get started. Can you think of one or even two projects with a physical outcome that were successfully conducted at your makerspace? Probably even together with an enterprise?<br><br>If you remember more than two projects it might help to choose projects that you consider very different from each other. | Must have:<br>- Physical outcome<br><br>Nice to have in that order:<br>- Two projects considered very different by interviewee<br>- Successful<br>- SME collaboration | |
| 2.2 Could you give me a very brief summary what those projects were about? | | *Give each project a name (project title / product …) for being able to refer to it later.* |
| 2.3 Perfect. Let's talk about "*Title 1*". Can you explain a little how this project came to life? | - Where did the idea/ initiative come from?<br>- What was the motivation behind the project?<br>- How was the idea introduced to the community? | |
| 2.4 How did things develop from there? | - Actions step by step<br>- What was done exactly<br>- Who was responsible for what? (Roles)<br>- Who was included when?<br>- Which content was communicated in which ways to whom? | *Always keep the addition "exactely" in mind and ask correspondingly*<br><br>*e.g.*<br>*Q: in exactely which ways was communicated?*<br>*A: newsletter/brainstorming* |
| 2.5 At which point did you consider the project finished? | - criteria to define a project as finished | |
| 2.6 What happened to the outcome afterwards? | - Economically exploited<br>- Shared, e.g. published at repository | |

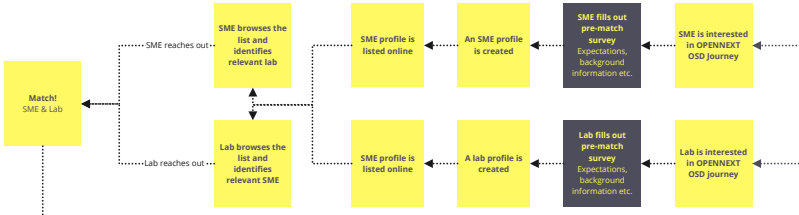
| Question/Stimulus | Key points to be addressed | *Comment* |
|---|---|---|
| 2.3 Thank you, that was very enlightening.<br><br>Could you now tell me more about "*Title 2*"? Just as before: How did this project come to life? | - Where did the idea/ initiative come from?<br>- What was the motivation behind the project?<br>- How was the idea introduced to the community? | |
| 2.4 How did things develop from there? | - Actions step by step including duration<br>- What was done exactly<br>- Who was responsible for what? (Roles)<br>- Who was included when?<br>- Which content was communicated in which ways to whom?<br>- Methods and Tools | *Always keep the addition "exactely" in mind and ask correspondingly*<br><br>*e.g.*<br>*Q: in exactely which ways was communicated?*<br>*A: newsletter/brainstorming* |
| 2.5 At which point did you consider the project finished? | - criteria to define a project as finished | |
| 2.6 What happened to the outcome afterwards? | - Economically exploited<br>- Shared, e.g. published at repository | |

| Question/Stimulus | Key points to be addressed | *Comment* |
|---|---|---|
| **3 Opinions and judgements** | | |
| 3.1 You considered such projects as successful. Why? | - Criteria that define this project as successful<br>- Factors that helped this project to become successful | *Ask for each project singularly* |
| 3.2 Can you think of projects that went not so well and explain why this was? | | |
| 3.3 What in your opinion are general success criteria for projects in makerspaces? | - Criteria to define a project as successful<br>- Factors that help a project to become successful | |
| 3.4 Do you think these criteria are the same in makerspaces and industry or in which ways do they differ? | | |
| 3.5 What do you personally believe, which role could makerspaces play in C3 Open Source Hardware Development? | (paid/unpaid, ethical questions)<br>- Which role could you imagine to play under which circumstances?<br>- Which roles would you reject? | *Motivate to name as many roles as possible. Give more time to consider after the first round has been named.* |
| 3.6 Do you have any local communities that you work with? | - Who is in that community?<br>- How stable are they?<br>- What drives them? | |
| 3.7 Do you have dream partners for the demonstrator phase? | | |
| 3.8 Is there anything else that you have come to think of during the interview or would like to talk about? | | |
| 3.9 Then, that was it. Thank you very much for sharing all this with me. | | |

**OSD Service Pitch**
Potential collaboration opportunity

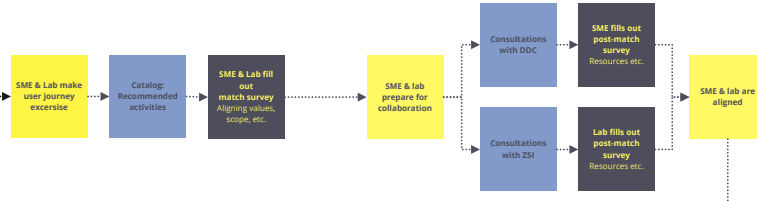



**Checklist step 1**
Finding the right match
***D4.1**: Section 1A (SME) & 1B (Lab)*




**Checklist step 2**
Seeing eye to eye
***D4.1**: Section 2 (both)*

**Checklist step 3**
Getting off on the right foot
***D4.1**:Section 3A (SME) & 3B (Lab)*




**Pre-pilot bootcamp**

# Phase 0: Preparation

"Prepare everything for a great collaboration with the community."

1 month

**Where are we?**

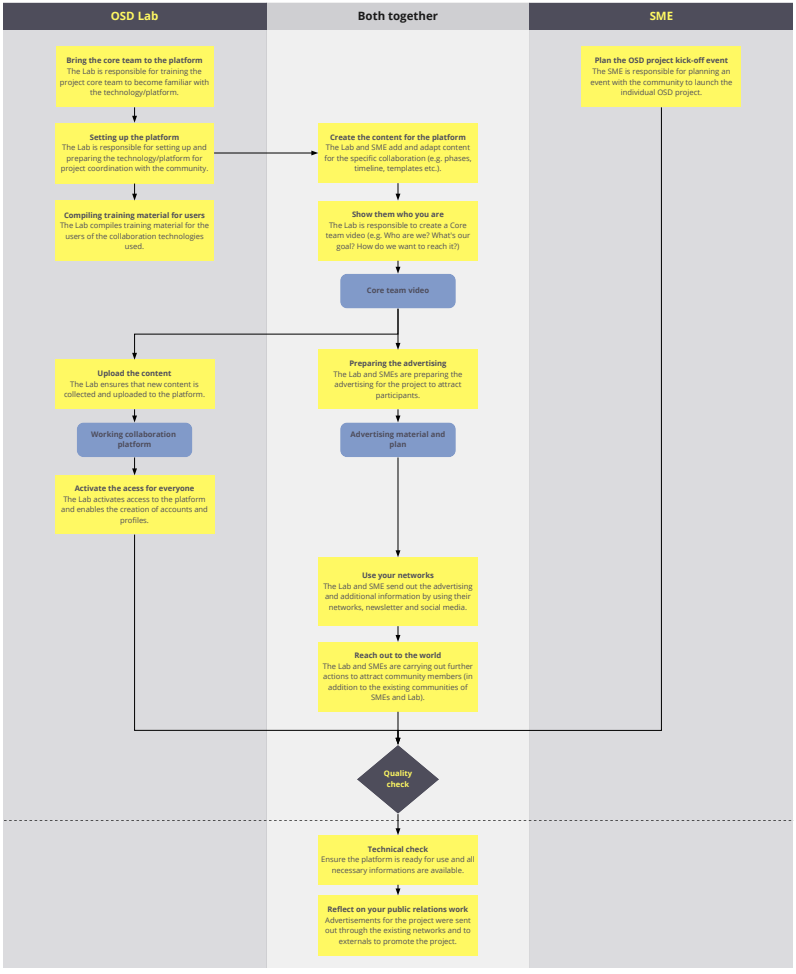
After a successful matchmaking between OSD Lab and SME, joint cooperation terms were defined & conditions checked. Based on this, the partners worked out a common plan for the development project and visualised their vision e.g. in form of a challenge brief. Furthermore, a core team was defined and responsibilities were clarified. Together with the OSD experts from OPENNEXT everything was optimised once again and is now available for further steps.

**What are the challenges?**

Now two questions in particular arise: "How can the OSD journey participants work together on a technical level?" and "How can the Lab and SME attract participants and community members for the OSD project?".

**What are the phase outcomes?**

- Working collaboration platform
- Advertising material and plan



# Phase 1: Analysis

"Digging deeper into your challenge area and gathering new perspectives"

1 month

### Where are we?

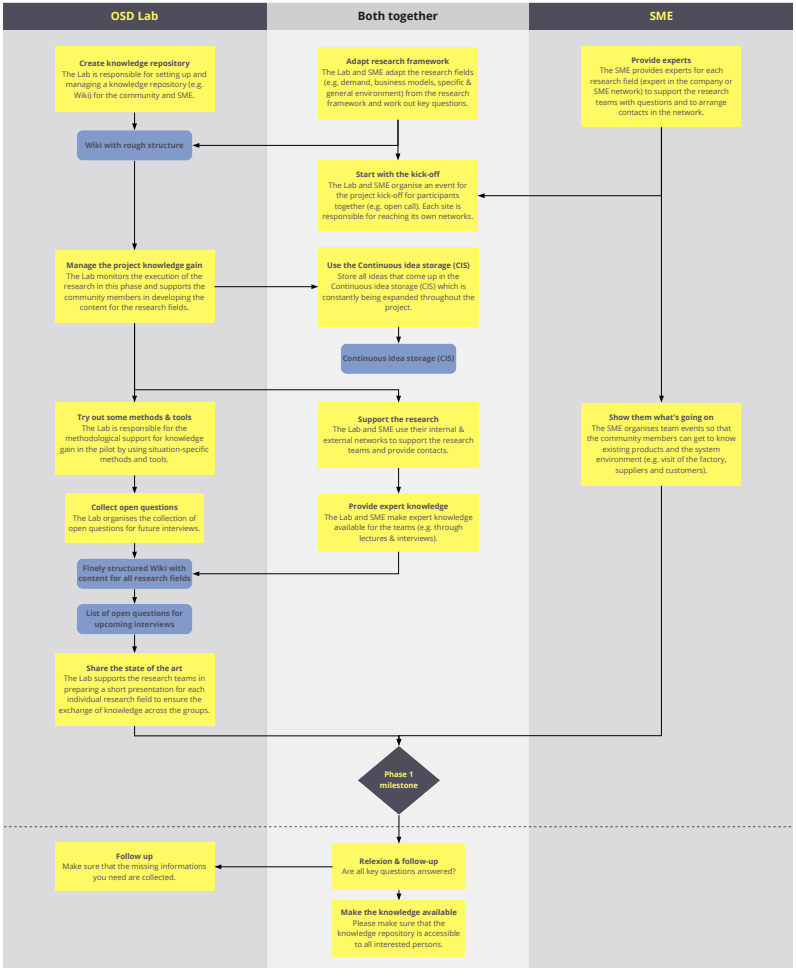
The collaboration technologies are ready for use and there are enough participants for the OSD project. The kick-off event not yet taken place, which means that the communities are not involved in the project yet.
The knowledge for certain topics or parts of the product is widely distributed and usually only available to individuals. Furthermore, there is no knowledge repository where all necessary information, data and references are available and can be openly shared.

### What are the challenges?

This raises the question of how basic knowledge about the background to the challenge can be gathered and made available to all. This is especially important for new collaborators joining over the course of the project, so that all the basic knowledge needed is easily accessible.
The second challenge is to motivate interested people to collaborate in the OSD project and to involve stakeholders.

### What are the phase outcomes?

- Wiki as knowledge repository
- Continuous idea storage (CIS)
- List of open questions for upcoming interviews



# Phase 2: Identifying potential

"Identifying new insights and looking for exciting opportunities"

1.5 months

**Where are we?**

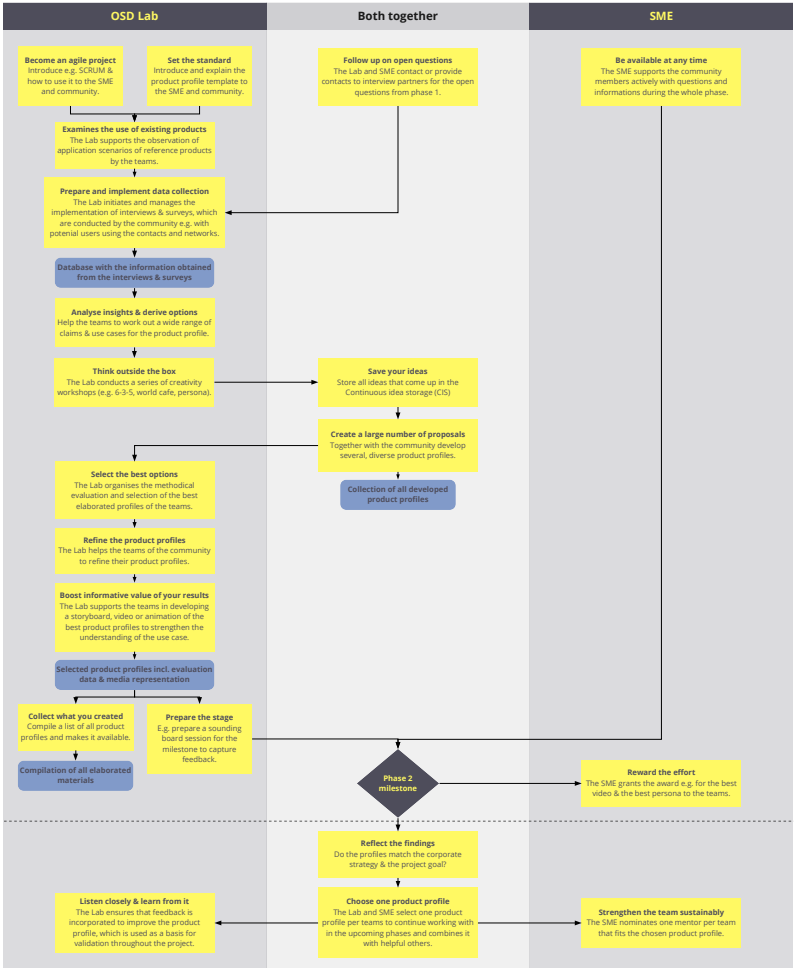
There is an initial, reliable knowledge repository, which will be continuously expanded in the course of the project. It also serves as a basis and entry point for new members of the problem solving team. Furthermore, an initial set of questions for further interviews and possible solutions was created. What is missing now is an extended basis for decision making (e.g. knowledge about users). This is needed for all of the following phases of the OSD process.

**What are the challenges?**

There are three major questions to be answered here: "What are the actual underlying problems behind the challenge defined in the project vision?", "How can the needs and requirements of the target users, customers and other stakeholders be identified and clearly documented?" and "How can market potentials be systematically uncovered?".

**What are the phase outcomes?**

- Data and insights from interviews
- Bigger picture of the actual problem to be solved
- Collection of all generated product profiles



# Phase 3: Conception

"Turning your idea into something tangible you can experiment with"

1.5 months

**Where are we?**

The needs and benefits of the stakeholders are analysed and recorded in the product profile. The overall problem and target group were also defined. Each problem-solving team now has a different focus and is assisted by an individual mentor of the SME.

**What are the challenges?**

So far there are no elaborated and validated solutions to the problem described. Therefore, ideas must now be generated and based on these, concepts must be developed and tested. Furthermore, basic knowledge of the principles of prototyping (e.g. the combination of artefact and confrontation method) is not, or only partially, available among individuals. Also how to make a good prototype must be taught.

**What are the phase outcomes?**

- Concept prototypes tested in a workshop environment
- Resource and cost plan for further iterations
- Collection of all developed ideas and concepts incl. evaluation data

time

## OSD Lab

**Show them how to prototype**
Conduct prototyping workshops with the community and give an introduction to the machinery including safety training.

**Encourage a creative mindset**
The Lab runs a series of creativity workshops to generate a great variety of ideas without directly evaluating them.

**Save the results**
The Lab ensures that all ideas are stored in the continous idea storage (CIS).

**Boost creativity to develop concepts**
The Lab supports the teams in the development of concepts by using appropriate methods and tools.

**Find the most promising concepts**
The Lab initiates and guides the teams in evaluating the concepts and selecting the top 3 concepts per team.

Collection of all developed concepts incl. rating

**Refine the concepts**
The Lab helps the teams to refine the concepts by by incorporating feedback.

**Collect what you created**
The Lab compiles a list of all ideas and concepts of all teams and makes it available to the community and the SME.

Compilation of all elaborated materials

**Prepare a pitch**
The Lap supports the teams to create a poster and a pitch. It also prepares a pitch setup for the milestone.

**Listen closely & learn from it**
The Lab ensures that feedback is incorporated to improve and to select features for the prototypes.

## Both together

**Rate and condense the ideas**
The Lab runs a series of workshops to evaluate, combine and select the best ideas together with the SME and the teams.

Collection of all developed ideas incl. rating

**Run a design sprint**
Lab and SME conduct design sprints to test ideas (e.g. 5 day sprint) together with very active community members.

**Fill the backlog**
Together, stakeholder feedback is reflected and fed into the backlog as tasks.

Initial physical represeantation of the tested concepts

**Phase 3 milestone**

**Reflect the findings**
Do the concepts match the product profile?

**Select concept to continue working with**
The Lab and SME select the concepts to continue working with in the upcoming phases and combines it with helpful others.

## SME

**Creating a good atmosphere**
The SME organises team events to strengthen the team spirit and the connection to the company.

**Reward the effort**
The SME grants the award for best poster & best pitch award

**Formulate a target agreement**
The SME formulate a target agreement with each team & mentor

**Calculate costs**
The mentor supports the team with material & cost planning for the upcoming phases.

# Phase 4: Specification

"Convert solution variants into concrete products."

2 months

**Where are we?**

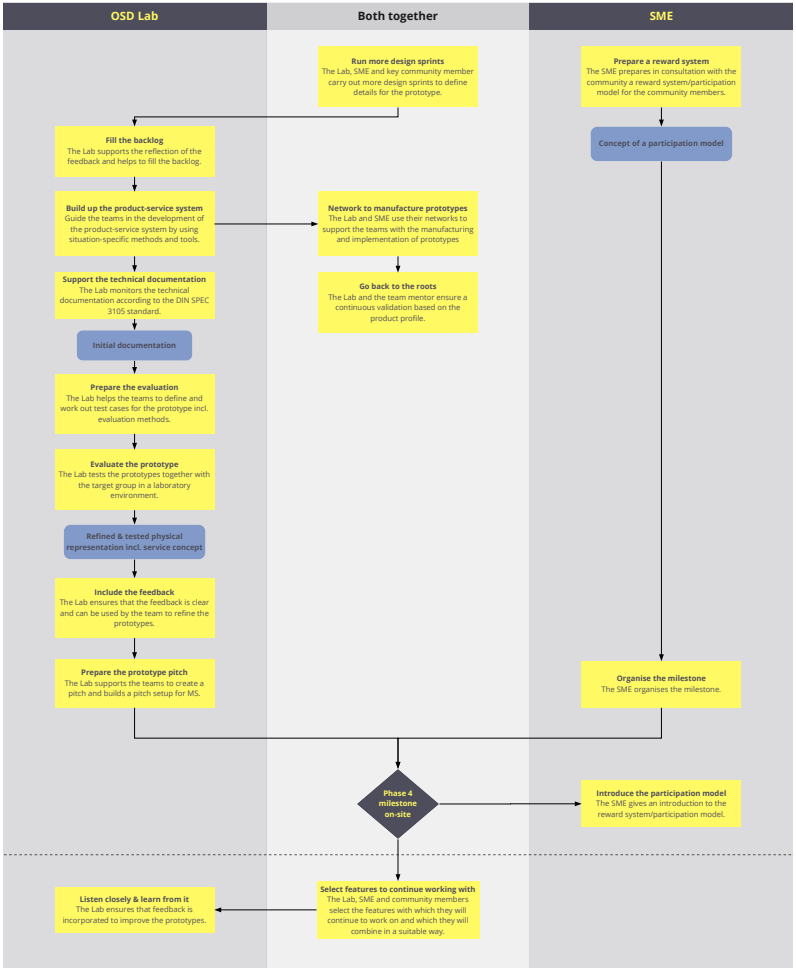
The concept was selected, evaluated in relation to the product profile and the prototype was successfully tested in a workshop environment. In addition, suitable functional principles were documented so that the solution can be further elaborated.

**What are the challenges?**

Now the concepts must be more and more adapted to the real users and the prototypes to the real system environment. In some cases, special technologies are required to manufacture and implement the prototypes. This may require the involvement of new cooperation partners. Furthermore, in this phase, more attention must be paid to the quality of the technical documentation in order to ensure the benefit for the open source community.

**What are the phase outcomes?**

- PSS prototype validated in a simulated relevant environment with a small group of users
- Initial product documentation
- Concept of a participation model



# Phase 5: Realisation

"Getting ready to launch your idea in the real world."

2 months

**Where are we?**

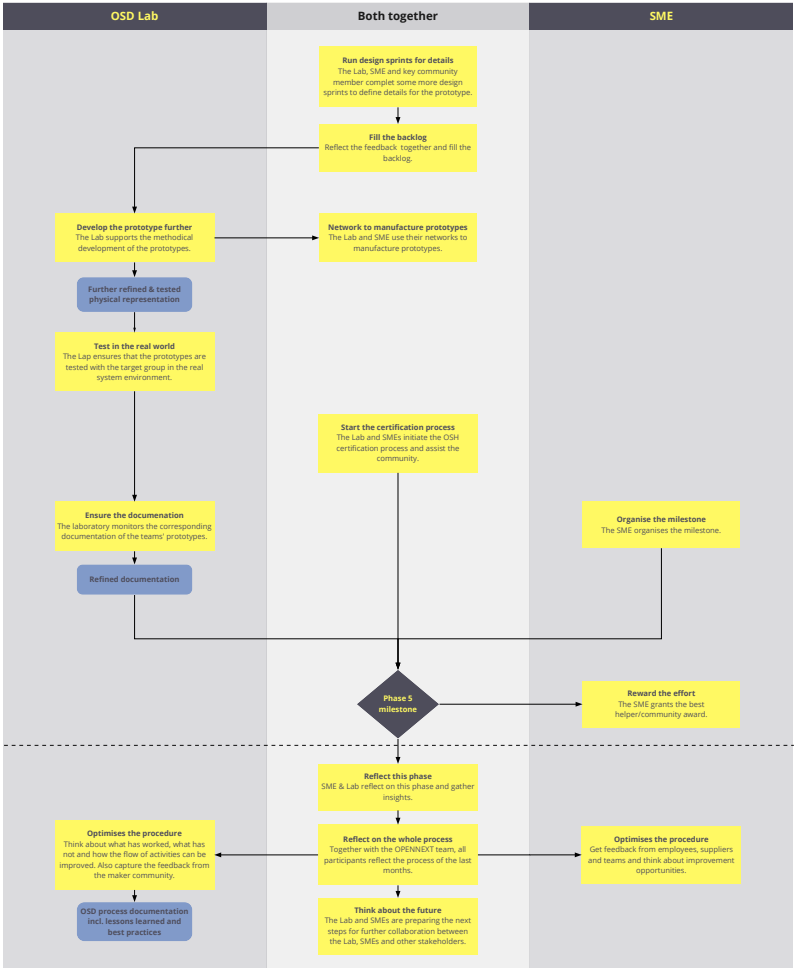
The first technical prototypes have been tested in a laboratory environment and the associated service concept has also been prototypically implemented in an artificial environment. In addition, the technical documentation was started and relevant stakeholders for this phase were contacted.

**What are the challenges?**

So far, tests of the product service system in the real operating environment are missing. These are extremely important because people behave differently in everyday life and the technical system itself is at the mercy of new influencing factors which could not be observed or reproduced in a simulated environment. In addition, proof of the reproducibility of the technical system is still missing, which also requires complete and comprehensible documentation.

**What are the phase outcomes?**

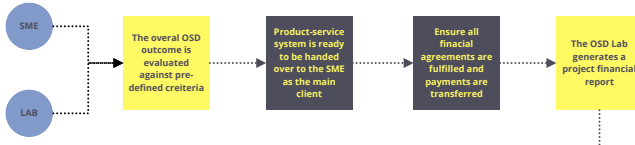
- PSS prototype tested in the realistic environment of the target user group's everyday life
- Finalised technical product documentation
- OSD process documentation incl. lessons learned and best practices



**Post-Pilot Boot camp**

*Step 1*

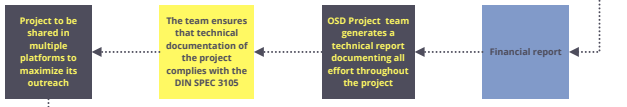
Outcome assessment & Project closure




**Post-Pilot Boot camp**

*Step 2*

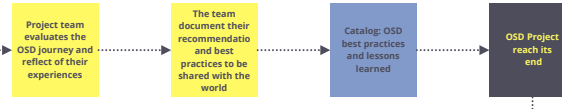
Documentation & knowlege preservation




**Post-Pilot Boot camp**

*Step 3*

Lessons learned & best practices




**What is next**