Makerspaces and SMEs: Collaborating for Open Source Hardware Development

30+ answers to frequently asked questions about collaborative settings in OPENNEXT

The future is open

Today's industrial product creation is expensive, risky and unsustainable. At the same time, the process is highly inaccessible to consumers who have very little input in the design and distribution of the finished product.

Presently, SMEs and maker communities across Europe are coming together to fundamentally change the way we create, produce, and distribute products. By sharing ideas and knowledge openly on digital platforms, the project of 19 partners in EU-countries called OPENNEXT, will establish new collaborations between companies and consumers. The industries in focus include eco-friendly mobility, consumer electronics, and built-to-order furniture.

OPENNEXT seeks to empower companies, maker spaces and consumers to co-design and co-manufacture products based on new mindsets, new business models, and new collaborative software solutions.

We see open-source sharing and co-creation as the natural next step in a digital transformation that is already upending global production and providing access to new, specialized knowledge everywhere. Closed business models and closed innovation environments are of the past – the future of product creation is open and inclusive.

By getting access to design processes, product design files and otherwise "walled-garden" digital fabrication systems, consumers will be able to take an active role in the design and fabrication of the things they consume. Similarly, even with limited resources, SMEs will have the ability to customize products in order to meet individual consumers' requirements.

Over the years we have been asked many questions regarding the collaboration of companies and makerspaces (or their communities) in the field of Open Source Hardware development, which we tackled both from a scientific as well as practical side. True to our mission, we have collected the most frequently asked questions raised by companies and makerspaces to answer them in this pamphlet. Take it as an invitation to check whether you feel ready to join the upcoming change. We are happy to share our knowledge and experience to help you get started.

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SMEs ask ...

1   What is the advantage of Open Source compared to classical product development?

Most user integrations such as feedback loops also work for proprietary products, so that's nothing specific for Open Source Hardware (OSH), despite contributions will be likely fewer and less useful. OSH enables decentralized production, maintenance and extension, e.g. by building new services on top of the OSH. That way, a relatively small company with few production resources can cover a relatively big market with a large variety of derivatives of the same product as for example Arduino or OpenWB did. Furthermore, the product comes with the promise of endless support (see Gardena) and modifiability (see CERN hardware, e.g. for White Rabbit). Market penetration is far easier since anyone using your concept is indirectly supporting it as can be seen at Android.

Generally speaking, your innovation process clearly increases. The base of innovation has increased massively in the past and it is not possible to be competitive if you are not opening your doors and collaborating with others. E.g., time to market is shorter when you make use of the power and knowledge of a large interdisciplinary community. Features are tested in the field in a decentralized manner and development costs are far lower when building on existent open source solutions, standards and infrastructure. The latter is possible since OSH Development does not just mean that you offer knowledge but that you can also use knowledge that has already been offered by others for free. There is no need to reinvent the wheel all the time. You can build upon what others have done before. Costs such as for product support can be externalized via the community that evolves around the product. If applied to external modules, your negotiating position in the supply chain greatly improves since you do not depend on individual manufacturers anymore.

By the way, many companies use open source projects for recruiting. You will get highly motivated, already incorporated, skilled developers.

But there is much more to OSH. Check e.g.:

- https://boldandopen.com/ideas-you-can-open-source-part1/
- https://boldandopen.com/how-open-source-will-be-everywhere/

2 What is the goal of OPENNEXT and how is it approached?

OPENNEXT focuses on encouraging and supporting SMEs to unleash the potential of open hardware through engagement in collaborative open design of products and services together with fab labs/makerspaces.

Open hardware extends open source principles from software to physical products (called open hardware). This played a huge part in creating the internet as we know it today and has the potential to upend entire industries.

We thereby enable SMEs to follow a community-driven approach.

3 Are there any modules already available for me to check?

For previous references please check our presentation at https://projects.opennext.eu. Highlighting the key benefits for the six SMEs participating in OPENNEXT:

- Fiction Factory: engagement with a new cluster of customers in an ecologically sustainable way by creating a new spin-off called future factory.
- Sono Motors: facilitation touch interaction community for independent servicing for their car.
- Opntec: diversifying their product with a community of skilled makers and experts, new application areas
- Stykka: exploring the new horizon of open hardware product as a service
- XYZ cargo: creation network of collaborative development to customize their product, made them ready for multi-purpose application
- Sodaq: exploring highly useful application for air pollution that is open and can be used by anyone which helps communities of concerns.

All of the above has been influenced by exchange with makerspaces and ICT infrastructure. Please also check OPENNEXT biweekly talks (Open Hardware future talks for SMEs-Makerspaces experiences) at https://opennext.eu/events/

4 Do you have some industry clusters already in focus?

OPENNEXT has three industries in focus:

- Eco-friendly mobility
- Built-to-order furniture
- Consumer electronics

5 What is in it for us if we participate?

In OPENNEXT, SMEs work closely with consumers, users, developers and other SMEs. They find support in building communities around an Open Source Hardware idea, can follow a collaboration path that has been pre-structured based on scientific expertise and best practices, and thus gain valuable experience with open source hardware development. The prototypes benefit from the diversity of skills and perspectives of the contributors. They thus have the potential to be truly innovative. All this remains with the SMEs long after the end of the project.

Participating in open source hardware development enables you to gain an interdisciplinary view on your product and its surrounding environment by collaborating with an interdisciplinary community. You can generate development speed and reduce your development costs by opening up. Collaborating with a makerspace, you have access to a well-equipped lab as well as the makerspace's prototyping and development infrastructure.

6 Who is funding these efforts? How much will this cost us?

OPENNEXT is funded by the European Commission. There are no charges or contractual obligations.

By engaging with communities that engage in open design and OSH development, your company can grasp the opportunity of collaboratively creating user-centric, viable, and sustainable products through an open exchange of concepts and technical knowledge guided by the makerspace and on digital platforms. These efforts will not only increase end-user participation in product creation but also reduce costs and risks, as well as guarantee sustainability in the long run.

Incurred costs by participating SMEs (e.g. for their own resources or prototypes) can arise. These are expected to be offset by the resulting opportunities.

Development of a product is costly, regardless if you do it open source or conventionally. The development can be cheaper making use of available resources and communities. But what you definitely have to invest is time. Time to build up your community and to maintain it, and to raise awareness for your product within the communities.

7 Can you help me find funding?

The OPENNEXT project cannot provide any funding for SMEs applying to the open call. We are currently also not aware of any other means to attain funding.

The four partnering makerspaces offer facilitation free of charge if you are selected to benefit from it. The facilitation offering has been tested with six SMEs within a 12-months period. The OPENNEXT partners will also provide selected SMEs with consulting and mentoring.

Incurred costs by participating SMEs (e.g. for their own resources or prototypes) are expected to be offset by the resulting opportunities.

8 Can the OSH nature of a product be a unique selling point?

The biggest advantage is that some of the basic work is already done when building upon existing open source solution, thus the customer has to pay only for the individualized service or adaption. Furthermore, the customers know what is inside the product. Therefore, they know what they buy and they are able to repair or modify it to their needs easily. In addition, of course, customers do not depend on the service of the manufacturer if they do not want to.

The generally most common advantages and thereby potential unique selling points of Open Source Hardware products are: Novelty, Endless customization, Ensuring future product support and repairability. But there are also advantages regarding pricing and interface design.

The speed at which OSH innovation happens means that the newest features, retrofitting to different use-cases, tweaks will most often beat any proprietary competing solution. So, you can be among the first to try a new feature.

OSH provides unprecedented possibilities for customization due to the 'hack-ability' or in some cases modularity of behind the products. Full documentation enables anyone to take ideas that suit their unique context and put them into action with the help of the company and the community.

Even if the originator company goes bankrupt, the community can still live on and the documentation will still be available, so if you are having issues using your OSH product, you can find help in the community, which moreover adds another social dimension to the product. Moreover, the customer usually has to pay only for the individualized service or adaption, since a major part of the development work has already been done when building upon open source solutions.

Island products find it more difficult every year to succeed on the market. Opening up products helps creating interfaces and connecting them to other products, which becomes more a basic requirement than a market advantage in our increasingly connected world.

9 Can you give us 5 business models that we can adapt to our needs?

Certainly, here they are:

1. Leverage through expansion with communities

Leverage through expansion with communities is a long-term objective, and it opens up the possibility to become a standard, a brand, a taken-for-granted player like the open source software examples and the IoT examples Arduino[1], and Particle[2] illustrate. Core of the OSH idea is the collaboration with both developer and consumer/user communities to leverage the potential of innovations, ideas and specific products. As we can learn from Arduino[3] (IoT), the approach helps develop a very flexible product for a variety of uses and modifications and thus becomes the standard, "the brand" of a sector.

2. Selling manufactured products

This is the "classical" and still the most used business model, where basics and components/supplements are sold (e.g. 3D printer and materials), establishing an online shop (like tinkerforge[4]; IoT). Successful examples for this are selling (complex) products like

- Local Motors[5] (open source cars) and OpenMotors[6] (mobility)
- RepRap 3-D printer[7] (machinery and materials)
- AKER Kits[8] (garden kits)
- Carla Cargo[9] (cargo bikes and trailers)
- Elphel[10] (digital cameras)
- Arduino[11] (IoT)

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[1] www.arduino.cc
[2] www.particle.io
[3] www.arduino.cc
[4] www.tinkerforge.com
[5] www.localmotors.com
[6] www.openmotors.co
[7] www.reprap.org
[8] https://akerkits.com
[9] www.carlacargo.de
[10] https://www.elphel.com/
[11] www.arduino.cc

3. Selling service, knowledge and expertise

Offering consulting & workshops can be a supplement business model, as Arduino does it (IoT). But also offering services like cloud services can be a successful business model from the intangible field as Particle[12] (IOT) does, just as access to knowledge via subscription as with the Air Quality Egg[13] (air quality).

4. Platforming

Selling platform transactions are another possible business model, for example when establishing and maintaining a 2-sided platform/marketplace. The focus here should be less a (single) product focus but more an ecosystem & industry focus. A successful example is OpenDesk[14] (furniture), a platform that pushes potential decentralized production by bringing together customers and registered makers that produce the OpenDesk product for the customer, the platform charging a fee.

5. Crowd- & Third-Party Funding

Sustainability and future-related projects that try to solve grand challenges, probably on a non-profit basis might build their business model around (public) funding strategies. Successful examples for this are:

- iCub[15] (visionary products e.g. robotics)
- Agua Clara Reach[16] (drink water treatment)
- Local Motors[17] (mobility, car)
- Calliope[18] (IoT in classrooms)
- Wikihouse[19] (housing)
- Lasersaur[20] (machinery)

10 How much time will we have to invest?

You certainly have to invest time to build up your community and to maintain it. How much depends very on the type of project, the project goal and the collaboration format. In the pilot phase of the OPENNEXT project, time investment of the companies ranged in between three hours and more than 50 hours a week. Within the activities of the Austrian matchmaking organization "industry meets maker", companies invest roundabout two hours a week for six months to develop a prototype together with maker teams.

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[12] www.particle.io
[13] https://airqualityegg.com
[14] www.opendesk.cc
[15] https://icub.iit.it
[16] https://www.aguaclarareach.org/
[17] www.localmotors.com
[18] https://calliope.cc
[19] https://www.wikihouse.cc
[20] http://www.lasersaur.com/

More important than the quantity of time allocated to the collaboration is regularity. Regular exchange in between players from company and the maker teams is crucial. It is highly recommended to agree upon at least biweekly touchpoints for the collaboration to work smoothly.

11 Would we have to develop a project as Open Hardware if we joined?

In the context of the OPENNEXT project Open Source development is always connected to hardware development. Therefore, it is essential that partners have an interest in a concrete Open Hardware development project.

By the way, experience shows that it is most promising to choose a completely new product or add-on to an existing system, rather than trying to turn a formerly closed product into an open one. This is mainly due to the degree of documentation that usually has not been done with the exactness required for an OSH product when the product has formerly been closed. The reconstruct development steps and data subsequently often leads to knowledge or data gaps, resulting in hard to manage numbers of community inquiries. For a new OSH product or add-on, the necessary documentation procedure takes place on the go and the community working on the project and depending on the information will recover gaps in documentation almost immediately. This way it works as a naturally self-controlling system. However, retrospectively opening up a product might also be possible, depending on the complexity of the product.

12 Why do we need a makerspace to work on our OSH idea?

Having an innovative idea and market experience are a good start for an OSH project. However, one's own experience also tempts one to see things from a certain perspective, which narrows the solution space. Especially in the area of open source, companies make use of the diversity of experience and perspectives of a community in order to compensate for their own blind spots.

Makerspaces are places of diversity and often already have a community that deals with OSH. This usually includes more advanced makers who can contribute greatly to the success of OSH projects. Even if no such community exists yet, it is the daily business of makerspaces to build communities. Therefore, they can be ideal partners for initial OSH projects. The diversity of people in such places enables the inclusion of many different use cases that may have not even been considered until then.

Another advantage lies in the working culture prevailing in makerspaces, which is characterized by co-creation and rapid feedback at eye level. Flat hierarchies generate a constructive, honest exchange. Companies that are willing to engage in this can count on great professional added value and a lively, creative and goal-oriented working environment in which the values of open source are lived every day.

The makerspace can be a communicator between the company and the makerspace community. They know all their members and their interests and profiles. Especially when it comes to building up a community around an OSH project this knowledge pays off. Anybody who comes to the makerspace and works on a project is a potential community member. The challenge lies in finding the right sub-community in the makerspace's general community to get started with the product

development. Someone needs to identify who has the right skills and who could be interested in the product. People are not hanging around in makerspaces waiting to do boring stuff for others. They need to be involved emotionally. For this, knowing the wider community to recruit from is crucial.

Makerspaces can take on the role of event manager, communicator and matchmaker, as well as coach for using the machines and developing technology. Thus, they can be a perfect interface between industry and communities. Thus, you probably do not need a makerspace to work on your OSH idea, but it makes things much easier for you.

13 What are communities in OSH development and how do we get one?

Open Source Hardware development needs communities, e.g. groups of people who commit their resources to the further development of the product. These can be potential user groups who provide information about their needs in the early development phase in the sense of classic marketing or who test prototypes. It can also be groups that generate product ideas in the first place, or groups of people with more advanced technical skills that deal with design aspects. Anyone who wishes to contribute to the project can become part of the community. Which kind of community is needed for which OSH project depends very much on the specific case.

It is makerspaces' daily bread to build up and nourish communities around projects, thus collaborating with a makerspace can really push your community-building. First of all, each makerspace has an active community that is involved with co-creation projects on site. These are practitioners with varying degrees of technical expertise and professionalism. In addition, makerspaces have large networks of former partners from a wide variety of fields who are open to new recruitment if projects resonate with their interests and values. Makerspaces are experienced in using open calls, meet-ups, and fairs along with many other formats to get in touch with exactly the people that could be promising community members for a certain project.

In OPENNEXT each SME will be collaborating with a major makerspace that will bring in its expertise in the field of community building. Furthermore, a structured approach to defining and designing the projects is offered in a sprint format which helps identifying what kinds of community would help push the project forwards.

14 How will the collaboration within the project look like?

Collaboration can contribute to develop or evaluate project or product ideas together with users or a community. It can also aim at putting together a core team as well as a community suiting the project, designing prototypes in a diverse team, or getting access to machines and tools needed for prototyping or production.

Especially when collaborating to develop ideas together up to the prototyping stage, regular exchange in between players from company and the maker teams is crucial. Agile formats with sprints of two weeks can be a very productive working mode. In this scenario, every fortnight the partners exchange ideas again and refine what they have done so far and what to do next.

When developing products openly with communities, the outcome is often unpredictable. Thus, strict timelines with milestones of predefined product results will most likely not work out and just lead to irritation regarding professionality and commitment, although it is actually the tool that has been chosen unwisely. It is important to keep an open-minded position towards the developments of the project. Planning in phases rather than outcomes is a promising approach when collaborating with communities. An OSH development project might be divided into e.g. initial phase (getting to know each other), opening phase (making an open call, building teams etc.), and development phase (up to a prototype presentation of the individual status reached), followed probably by iteration phases steering towards ongoing community involvement, if this is what the project is aiming for. Those phases can be specified in further detail as things develop.

OSH development collaboration for you might be a journey into hitherto unknown lands that you and your partners start out on together. This expedition will most likely require moving within new surroundings with new working modes, methods and perspectives. Probably even more important than the product might be getting to know the process of engaging in the Open Source Hardware world.

Curiosity and openness are essential to take home the biggest possible output from the collaboration. A true commitment to OSH development of all partners is indispensable at least for the time of the collaboration. Otherwise, the project is most likely going to be a waste of time, energy and resources for all partners.

Collaboration is a respectful mode of working together with people on eye-level who might see things differently. Makerspace operators are not mere service providers, nor is the community a low-cost workforce, nor the company just a financier. Collaboration means that all partners allocate their resources, may it be experience, expertise, money or time, to the common project goal. Team spirit is a major predictor for successful OSH projects, thus hierarchies are low. Especially when working with communities, an appreciative relationship can be a real game changer.

15 What are the roles within the collaboration?

The company most likely defines the challenge or the goal of the development process, coordinates regular meetings and contributes own expert and market know-how as well as sometimes materials, machines and infrastructure. The makerspace can act as a matchmaker, infrastructure provider, coach and communicator. The makers or open source hardware developers develop the product or contribute to the development process. However, it might also be a community that defines a need and recruits a company to collaboratively develop and market a solution.

It is useful to create a team, consisting of both the makers and developers of the company. The makerspace is the infrastructure provider and moderates the process like interpreters, translating between the maker language and the business language. The makerspace can for example help to organize an innovation workshop in which either party gets familiar with the spirit and the perspective of the other one and where they ensure that everyone understands the goals, which is a very important basis for a collaboration.

16 What do we have to do and what do we gain from each task?

Throughout the project, the SMEs have access to the collaboration platform and its members, for example to recruit and involve interested parties, experts and other members of the (online) community in their project. Furthermore, they have access to the network of partner makerspaces and the maker community as well as a toolkit including methods and templates for the different phases of product development in collaboration scenario.

For the practical implementation, the collaboration phases follow a sprint design, gearing it towards efficient and effective working modes.

During the "preparation phase" or the "strategy sprint", the SMEs gain insight into the development of Open Source business models. Importantly, the ideas of the organizations involved are visualized and mutual expectations and responsibilities are explicitly clarified in this phase. This results in an elaborated shared project vision and project planning.

In the "problem framing sprint" or the "analysis and identifying potential phase", the SME gets an extended view of reference products and documentation of the state of the art. In addition, it establishes contact with customers/users of similar products/services including their needs situation (e.g. through interviews & surveys). This can lead to new perspectives on the own portfolio. At the end of the phase, a list of possible product profiles (including needs, use cases, customer/user analysis) is created, which documents the actual problem for which a solution needs to be developed and can be evaluated.

From the design sprints of the "concept and specification phase", the SMEs receive a list of possible solution ideas and concepts for the selected problem, including the evaluation of these to track the decisions. In addition, there is early feedback on the solutions developed through rapid prototyping.

Through further design sprints in the "realization phase", elaborated demonstrators are created, which can be integrated into the existing environment and validated. The iteratively developed and sufficiently documented prototype generations enable the development of a series prototype and can also serve as inspiration for future projects. In addition, the SME can build up a good contact/trust relationship with makers/community members and involve them in future projects (e.g. spin-off).

In the "reflection phase", the SMEs receive an overview of the lessons learned and best practices of the project for future OSD projects and cooperation, so that an internal SME evaluation of such a cooperation is possible.

17 Are materials and tools provided by the makerspaces?

The makerspace's infrastructure can be used for prototyping as part of the project. Also access to further machinery from within the makerspace's network might be possible. If there is scrap material (which is often collected for use in prototyping) available at the partner makerspace this can often be used. However when it comes to bigger loads of material or special materials that need to be purchased by the SME.

18 Are there specific collaboration platforms that we should use?

Collaboration platforms are a necessity of successful collaboration. Relying on e-Mail or mere messenger services will lead to misunderstandings, time loss and probably a frustrated team. Furthermore, since OSH projects need to carefully document their progress, using an openly accessible collaboration platform avoids unnecessary double work and is thus a question of efficiency.

There are a number of collaboration platforms that can be used, e.g. Wikifactory, Hackster, or Github among others. Whatever platform you choose, make sure that it provides the following basic features:

- communication
- community building (demonstration and participating options)
- documentation
- version management

Within the OPENNEXT project we rely on Wikifactory, which is also one of our project partners.

19 Is there the risk of patent trolls suing us?

No matter what you do, there is always a risk of patent trolls suing you. But that also does not mean that they will be successful in their lawsuit against you.

At least, by publishing the documentation for your innovations openly, you are effectively removing the ability for anyone to get any patents accepted that will create problems for your subsequently to your publishing date. Further, by having a community of users actively using and co-developing your product it can be hard for a patent troll to argue against your case.

Generally, people overestimate the risk of patent infringement with open source and underestimate what simple research on patents related to the item in question can do.

You can even state clearly how you have actively searched for any potential infringement and encourage anyone in the community of co-creators to notify you upfront if they find something.

However, for companies developing bleeding edge technologies as OSH, there might be a risk of being sued since this is a field patent trolls are acting in and because documentation is open, patent trolls can assess the success of a trial to some degree beforehand. Therefore, companies could outsource their documentation activities to non-profit or research organizations. For those players other rules may apply (e.g. reverse engineering is legal in most cases in the name of research) and it is much harder to sue them.

20 Can you increase our visibility and that of our product?

Outreach is indeed intended to attract enthusiastic co-creators.

First, the makerspace will co-organize open calls with your team around the project idea. They will bring in and attract skilled makers from their network to co-create together with existing and potential customers and other enthusiastic contributors.

The envisaged open hardware project will be shared for open collaboration on the Wikifactory.com platform with 80,000 members from 190 countries, which are mainly product designers, engineers and enterprises.

Moreover, the resulting open hardware product will be linked on an open hardware reference database co-developed by Fraunhofer and WikiMedia to make visible the different components and locations where the product documentation is being developed.

21 Will you provide services also after the end of OPENNEXT?

The engagement is limited to a maximum of six months. SMEs are free to engage in independent future collaboration with the project partners (labs) or externals based on mutual agreements.

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Makers ask ...

1 What is in it for us if we engage in Open Source Hardware?

First, the maker spirit is all sharing ideas and results, making together and getting feedback from each other. Therefore, every makerspace is to some extend already participating in Open Source development.

If you consider getting involved on a more professional level by collaborating with companies, there are basically three major advantages for you and your makerspace: You will be pushing socially responsible and sustainable business models while at the same time expanding your own business model and enhancing your technical and entrepreneurial competencies.

Feelings of *giving something back to society* or *making the world a better place* are a strong non-monetary pay-off when engaging in OSH development. If your goal is to not just add any value but a value that benefits the most, you need access to real customers, who can help to define features that are most valued. Company collaboration might give you access to real target groups. As companies' collaboration partner you also get the chance to integrate your own ideas into products with no financial risk.

However, if you want a share of revenue in case the product turns out to be a huge success, make sure to settle for respective agreements with your partner company. The learnings you get out of the collaboration regarding OSH development, specific tools and machinery as well as understanding how business works and developing competencies as a professional business partner, will certainly be beneficial to your own business setup.

OSH development is a good tool to build up collaboration relationships with companies. Makerspaces' experience in building up communities and engaging with diverse groups of people is a competency that many traditionally organized companies lack. However, when it comes to OSH development, this is a basic requirement. Thus, companies that are interested in OSH development can be expected to be open for makerspaces' and makers' input.

2 If we concentrate on OSH development, how are we going to pay our bills?

For the long run, there are two basic approaches you can consider:

1. Put the foundation of your project on an Open Source basis but make that part of the project proprietary which is the USP of your product.
2. Build a paid service around the core OSH product, e.g. by customizing it to your customers' individual needs. If you give your customers the opportunity to build the hardware by themselves, it is probably cheaper for them to get started with your service compared to your competitors' offering.

Engaging in OSH projects that are publicly funded or setting up a project based on crowd-funding can also be good starting points for your OSH engagement.

3 What should we consider before getting started with OSH development?

First, you need to develop a basic feeling for the market by getting an overview of the status quo of current Open Source Hardware developments, i.e. the most important platforms, licenses, and players. If you are still looking for a suitable OSH product to develop, try to think of products where property rights are less important than getting on the market very fast. Those are the products with which it makes sense to go for Open Source and make use of what others have developed already.

4 I would like to push OSH in industry. What kind of companies should I look out for?

Search for companies that are already active on OSH platforms. If they have already developed products with open hardware licenses or participated in events like the Open Hardware Summit, even better! Another question you could ask yourself is: Does the company develop products for a type of customer that might be keen to get involved in the development process itself? In OSH development you can involve your future customers from the very beginning in the product development process, which can be an advantage for both, the customers and the companies. However, this only works if the customers are interested in getting involved.

5 How can I approach companies for OSH collaboration?

A person of contact is always the best entry point. Therefore, ask around in your community to find people who can introduce you to companies. Ask the mangers from your makerspace (if you are a member) or from other makerspaces (if you are an operator) if they know someone from the Open Hardware scene and contact that person via his or her profile on Open Hardware platforms or social media profiles. Within companies the innovation managers, if there are any, are good first contacts.

6 What is the very first thing we should do when starting a company collaboration?

Clarify the expectations of all involved parties: short-term, medium and long-term expectations. This is the crucial point in a collaboration. Learn to know each other, each one's goals and expectations, and very importantly working styles. In industry, the working style is very different to working routines in makerspaces. A nice starting point is to arrange a workshop were the partners switch roles, so that the company partners have to look with makers' eyes at the project and vice versa. By the way, it can be helpful to engage an external moderation for the initial workshop so everyone can fully join the exercise and the moderator can be free of judgement.

7 How do we go on after the initial phase?

After the initial brainstorming workshop sessions, where you clarify your goals and get to know each other, you need to have regular meetings on the progress, where the next steps and the development processes are coordinated. Regular exchange in between players from company and the maker teams is crucial. It is very important to have a communication tool for the running exchange. E.g. a chat tool and a file sharing server make collaboration so much easier. However, live meetings are indispensable. You could find an agile format with sprints of e.g. two weeks. Then you exchange ideas again, refine what you have done and decide what you want to do next.

8 At which point does our project become "open"? When do we invite the world in?

This has to be decided on an individual basis from project to project. Basically, the perfect moment to do so is as soon as possible when all partners are convinced they want to go the Open Source way. When teams are formed from the makerspace community for the development process, e.g. via an open call, the project is opened up for contribution.

However, experience shows that in the early phase of the development the team should be kept rather small to be opened up further only a little later. In a time when the direction of the project is not yet clear you do not need hundreds of developers who are doing something and then the management discards 90 % of the work they have done. This demotivates the makers. Thus, it is better to have a clear vision where to go first and then invite people to join.

9 When building up a community, who do I definitely want to recruit and who rather not?

Generally, you should look out for idealists, optimists and inventors with team spirit. Try to avoid inviting pessimists, cynics and cholerics. Optimally, you have people in the team that belong to the project's target group, e.g. makers who feel the need for the envisioned product personally.

When it comes to putting the team together, the makerspace operator needs to know the makerspace's community. Which skills are present within the community and what weak points need to be balanced out by recruiting people from outside the makerspace's core community? What kind of characters can you rely upon? For knowing this, you must be interested in your makerspace's community on a day-to-day basis: who are those people and what are they working on?

10 How do we manage to get a highly diverse team working on our OSH idea?

Diversity within the team is important, especially in the early development phase, to benefit from maximum variation of perspectives and ideas. Depending on the project the following measures can help diversifying your team:

No exclusion of target groups. You might need specific skills and know-how in your team. However, there is a lot of perspectives that further team members, that do not have these skills or this know-how, can contribute, probably even because their expertise lies elsewhere. Have you ever considered including groups that seem to have no connection to your product, for example kids? It could be an enlightening experience.

Low entrance barriers. Try to make your call as welcoming as possible by mentioning that no specific skills are needed that everyone is welcome. In the ideation phase try to keep in mind that you wish to collect ideas not final prototypes.

Broadly disseminating calls. You have an online platform and a physical notice board where you can advertise your call? That is great. But why not also make postings in external event calendars, ask fellow makerspaces to include your call into their newsletter or send a message to the media, both to local and maker specific publications? You could also design fun stickers and plaster your place with it or attend events, conferences or fairs that are connected to your project's topic to introduce your upcoming idea.

Use (at least) gender neutral language. This is not just relevant for calls, but also for documentation and all other communication settings. If you want to go even a step further, make sure that the pictures you use for promoting and presenting your project will show people of as many different physical appearances (sex, age, skin color, clothing and hair style, physical (dis)abilities, visible religious affiliation etc.) as possible. You could also make separate calls that specifically attract underrepresented target groups.

Have an English version of everything. Website, project description etc. should always be accessible in your local language as well as in English (this is for projects from the European setting – in other parts of the world another language frequently spoken by expats might be more useful). This way you explicitly invite international people who can contribute different perspectives.

Go for an interdisciplinary project. You have not defined your project yet? Try to design it to include several disciplines to attract people with different profiles.

11 How can we ensure smooth collaboration with the company?

A good connection to your SME partner is certainly necessary if you want to let it loose upon your makers. As stated before, initial workshops that are only about getting to know each other and negotiate your goals are the very basis of a good relationship. Since working modes might differ in between the project partners, regular calls help avoid misunderstandings. A constantly updated platform where all necessary files are shared and communication is supported makes knowledge exchange so much easier and helps avoid frustration due to time loss and complicated communication procedures.

Try to keep in mind the SME's position: what are they trying to sell and to whom? This is probably their way to make their livelihood and needs to find respect. However, at the same time make sure to remember your own as well as your makers' values. Respect for the other one's position does not mean to let go of one's own. However, understanding each other surely helps coming to an agreement if conflicting interests arise.

12 How can an OSH collaboration with a company look like?

Collaboration can contribute to develop or evaluate project or product ideas together with users or a community. It can also aim at putting together a core team as well as a community suiting the project, designing prototypes in a diverse team, or getting access to machines and tools needed for prototyping or production.

Especially when collaborating to develop ideas together up to the prototyping stage, regular exchange in between players from company and the maker teams is crucial. Agile formats with sprints of two weeks can be a very productive working mode. In this scenario, every fortnight the partners exchange ideas again and refine what they have done so far and what to do next.

SMEs find it easier to adapt to the different working mode of makers if some of their "project language" is adapted within the project, e.g. drafting a time line with rough milestones. Of course, it is hard to predict the outcome of open development activities with a community. However, pit stops at which the current development status is presented and discussed can be planned in advance (also together with the community), just as organizational dates such as launching an open call. You could start by planning your collaboration in broad phases e.g. initial phase (getting to know each other), opening phase (making the call, building teams etc.), and development phase (up to a prototype presentation of whatever status has been reached), followed probably by iteration phases steering towards ongoing community involvement if this is what the project is aiming for. Those phases can be specified in further detail as things develop. You do not have to define at what point which team will present a prototype of which maturity level. There are certainly degrees of freedom while providing the company a rough orientation.

OSH development collaboration for you might be a journey into hitherto unknown lands that you and your partners start out on together. This expedition will most likely require moving within new surroundings with new working modes, methods and perspectives. Probably even more important than the product might be getting to know the process of engaging in the Open Source Hardware world.

Curiosity and openness are essential to take home the biggest possible output from the collaboration. A true commitment to OSH development of all partners is indispensable at least for the time of the collaboration. Otherwise, the project is most likely going to be a waste of time, energy and resources for all partners.

Collaboration is a respectful mode of working together with people on eye-level who might see things differently. Makerspace operators are not mere service providers, nor is the community a low-cost workforce, nor the company just a financier. Collaboration means that all partners allocate their resources, may it be experience, expertise, money or time, to the common project goal. If this finds general agreement, tensions arising from different perspectives can be overcome.

13 What are the roles within this kind of collaboration?

This of course depends on the kind of project and who is initiating it. In the classical scenario in which a company is looking for partners to get involved in OSH development, the makerspace operator can be a communicator between the company and the makerspace community, since they know all their members as well as their interests and profiles.

It is useful to create a team of both, makers and developers from the company. The makerspace can act as the infrastructure provider and moderates the process like an interpreter, translating between the maker language and the business language. In this scenario, the company will most likely be in the lead since it should know its customers and the current market needs. The makerspace is the event manager, communicator, matchmaker, and also a coach for using the machines and developing technology. The makers will develop the OSH product.

14 Are there specific collaboration platforms that we should use?

Collaboration platforms are a necessity of successful collaboration. Relying on e-Mail or mere messenger services will lead to misunderstandings, time loss and probably a frustrated team. Furthermore, since OSH projects need to carefully document their progress, using an openly accessible collaboration platform avoids unnecessary double work and is thus a question of efficiency.

There are a number of collaboration platforms that can be used, e.g. Wikifactory, Hackster, or Github among others. Whatever platform you choose, make sure that it provides the following basic features:

- communication
- community building (demonstration and participating options)
- documentation
- version management

15 Should we expect controversies with our partner company?

Yes, you most certainly will experience controversies for example regarding working cultures and expectations. This is why it is so important to clarify from the beginning: what are the goals, what can you expect and what can you not expect from each other and also the makers. To reduce alienation, you should really take time to generate a common understanding of the collaboration before you start with the actual development. For the ongoing process, it is very important to talk about upcoming issues as soon as they are detected, even if it is in the form of yet a nondescript irritation.

A common challenge is the different working speed of companies and maker communities. Processes in companies are often slower than among makers. Another possible conflict lies in the profit-orientation of companies, which applies much less to makers, especially if they are from the open source scene. You have to make sure that the makers are treated fairly. If it becomes apparent, for

example, that the company joined the project not so much because it can identify with Open Source principles but because its marketing department thought this would be a good idea, it is better to stop the project.

16 What do companies expect makerspaces to contribute to an OSH collaboration project?

SMEs expect makerspaces to support their project in three fields of expertise that are useful when building up a community for company-community collaboration and which the company might lack: experience with communities, technical skills paired with creativity, and OSH experience.

The expectations regarding experience with communities reaches out to the entire field of building up, managing communities, and profiting from communities. Companies hope to get access to a network of contributors via the makerspace and to benefit from the makerspace's expertise in putting teams together and being in regular exchange with them, probably motivating, negotiating and counselling the team members, e.g. reacting to whatever might come up in a favorable manner. They rely on makerspaces' skills of knowing their community and how to approach them, probably even hoping to get a framework for that and being counselled to do so. Sometimes companies also believe research institutions and funding organizations to be part of a makerspace's wider community and expect the makerspace to propose funding opportunities or funding models for co-designers.

Furthermore, makerspaces are perceived to have both, technical expertise and creativity, which makes them interesting brainstorming partners for planning OSH development projects, especially in the design phase. Some SMEs might also hope to receive practical technical assistance or counselling from their makerspace partner.

Makerspaces' orientation towards collaboration and openness nourishes the expectation that makerspaces are also experienced with OSH development. When collaborating with makerspaces, SMEs might hope to receive information about OSH, training on how to use OSH in product development or even ideas for business models around OSH.

These are expectations expressed by SMEs. However, those expectations might not correlate with makerspaces' reality. Thus, make sure to ask your potential partner about any expectations he or she might have and put those into perspective if they do not match your reality. Make clear what your partner can expect from you and your makers, and what not.

17 At what point should the makerspace pull out of the project?

Makerspaces have great expertise in working with communities and rapid prototyping. Ideally, they accompany the product development in the early ideation phase, i.e. at the very beginning of the product development process, when it comes to developing a wide variety of solution ideas and developing initial prototypes.

For all further phases of product development and marketing, the competence clearly lies with the companies. Makerspaces usually do not have the necessary resources to bring products to market, nor is that part of their business model. Thus, the market launch is the company's responsibility.

However, OSH development is often rather an ongoing process that cannot be easily defined in classical project terms to have a clear end. They can last longer, theoretically even forever. The goal should be permanent involvement of the open source community. Once there is an OSH community developing on the project, they keep working on it even though the product is on the market already. In such an optimum case there is no end point when they give the results to the company and are no longer involved. Of course, the community management can then be done by the company itself and the makerspace plays a role as part of the community. If the product goes into mass production, this is certainly the expertise of the company, not the makerspace.

Nevertheless, many makerspaces have experience in crowdfunding, for example. Marketing activities from this area can certainly be taken over by makerspaces.

18 Can you give me a success story of a makerspace and a company collaborating for OSH?

Fabman[21] is such an example from the makerspace scene. *Fabman* is a management system for makerspaces. It consists of a hardware component and a software service. The project was started by HappyLab Vienna as a closed product with the result that many customers approached the HappyLab with special needs regarding the hardware. Since it was impossible for the team to adapt the hardware product to all those individual needs and get it CE-certified, which is a time-consuming process, they decided to opened the product up. The code was shared and the customers could develop hardware solutions meeting their specific requirements. As a result, there was a huge increase of users and thus customers that were attracted to the service around the hardware product which is flourishing to this day.

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[21] https://fabman.io/