Open Source Hardware Seminar
Class 5 – Technical documentation for reuse

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Organisational matters

Schedule

Date	Title	Description
10/05/2023	Introduction - OSH fields of application	Principles of open source and collaborative work, the overall landscape and pathways
17/05/2023	Matching of groups and project scoping	Introduction and brainstorming with practice partners
31/05/2023	Ideation and business models	Overview of steps for defining OSH projects
07/06/2023	OSH collaborative development processes	Tools for working open, version control, modularity, prototyping
14/06/2023	Technical documentation for reuse	The user and the developer perspective of technical documentation
21/06/2023	Interim presentation	Peer review of project goals and work plan
05/07/2023	Licences and standards	Existing licences and standards, features and criteria for application
12/07/2023	Working with OSH communities	Open leadership, governance, defining communication channels
19/07/2023	Final presentation	Presenting results, feedback for final report

TOC

- Recap, class 4
- OSH ecosystem and design reuse
- Technical documentation contents
- Assignment

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Recap, class 4

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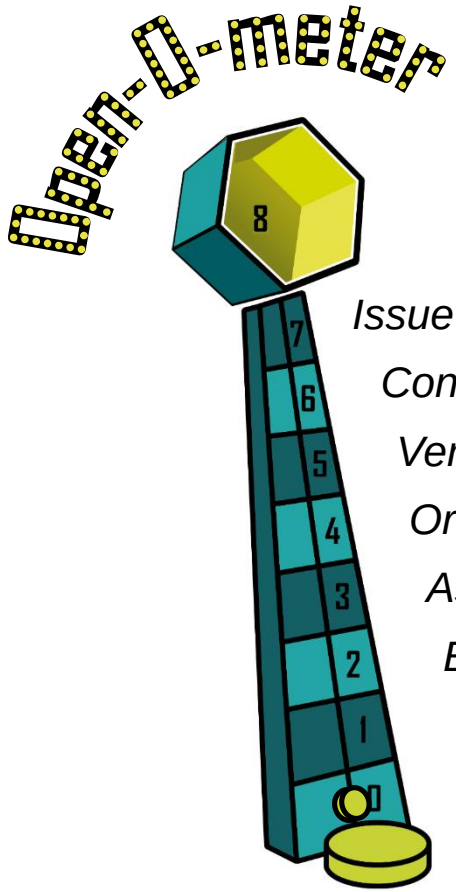
Practices in OSH

The specifics of sharing hardware

Beyond software towards materials and designs



Issue tracking system
Contribution guide
Version control system

Process openness

Original files
Assembly instructions
Bill of materials
CAD files
OSH compatible license

Product openness

Bonvoisin, J., & Mies, R. (2018). Measuring Openness in Open Source Hardware with the Open-o-Meter. *Procedia CIRP*, *78*, pp. 388-393.

Practices in OSH

The specifics of sharing hardware

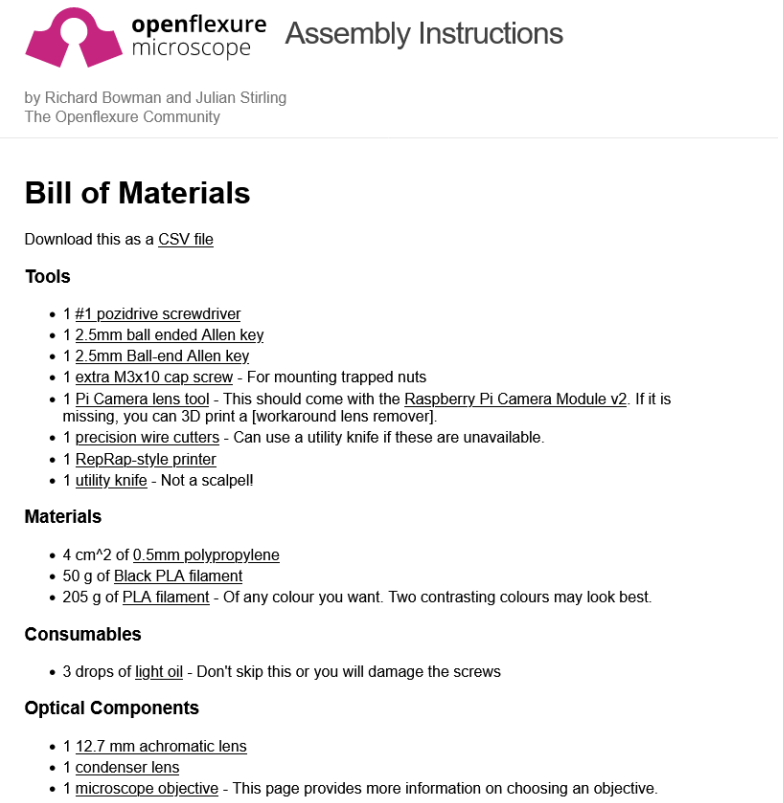
Bill of materials

A bill of materials is a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts, and the quantities of each needed to manufacture a product.

It is commonly named "BOM". Some projects also include bill of tools and bill of skills.

It should answer four main questions:

- What parts are used?
- Where can they be sourced?
- Criteria for use
- Requirements



openflexure microscope Assembly Instructions

by Richard Bowman and Julian Stirling
The Openflexure Community

Bill of Materials

Download this as a CSV file

Tools

- 1 #1 pozidrive screwdriver
- 1 2.5mm ball ended Allen key
- 1 2.5mm Ball-end Allen key
- 1 extra M3x10 cap screw - For mounting trapped nuts
- 1 Pi Camera lens tool - This should come with the Raspberry Pi Camera Module v2. If it is missing, you can 3D print a [workaround lens remover].
- 1 precision wire cutters - Can use a utility knife if these are unavailable.
- 1 RepRap-style printer
- 1 utility knife - Not a scalpel!

Materials

- 4 cm^2 of 0.5mm polypropylene
- 50 g of Black PLA filament
- 205 g of PLA filament - Of any colour you want. Two contrasting colours may look best.

Consumables

- 3 drops of light oil - Don't skip this or you will damage the screws

Optical Components

- 1 12.7 mm achromatic lens
- 1 condenser lens
- 1 microscope objective - This page provides more information on choosing an objective.

Image: BOM of the OpenFlexure microscope project, available at https://build.openflexure.org/openflexure-microscope/v7.0.0-beta1/high_res_microscope_BOM.html

Practices in OSH

The specifics of sharing hardware

Source files: CAD

Why is CAD relevant for OSH?

- Almost all OSH projects produce computer-aided designs (CAD)
- Significant engagement point for contributors
- Multiple software options generating both source and export files in native formats
- Now available for electronics design: KiCAD

	Export file	Source file
Formats	.stp .stl .pdf	.svg .ods
Size	Light weight	Large files
Editable	No	Yes
Audience	Users	Contributors

Arancio, Chagas, Kutschera (2019) Open Hardware Makers Curriculum. Available at https://curriculum.openhardware.space

Practices in OSH

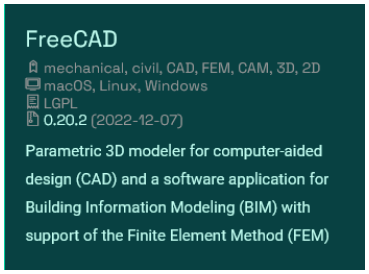
The specifics of sharing hardware

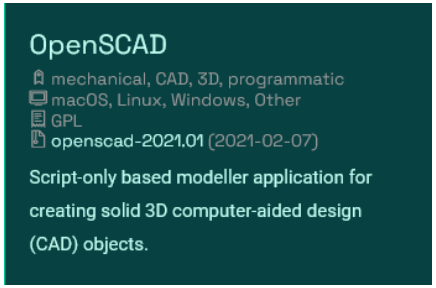
Software for hardware design

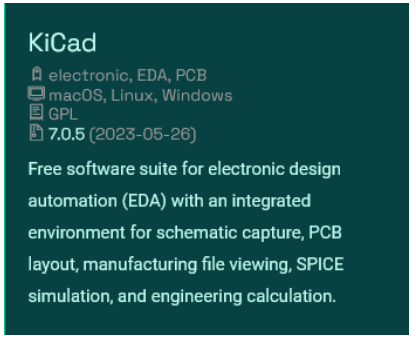
Today there is no 100% open toolchain for hardware design.

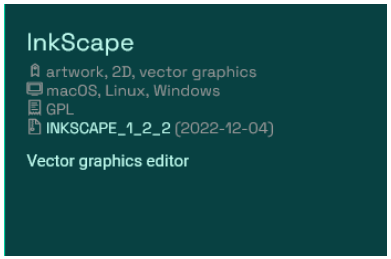
Proprietary vs FOSS

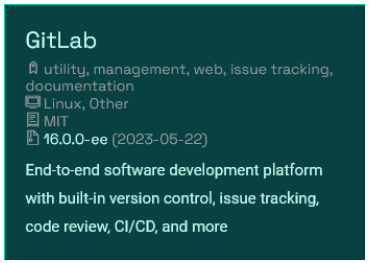
- Proprietary software often offers better functionality and User Experience
- Proprietary software diminishes interoperability due to native file formats & there is risk of lock-in
- FOSS is growing and specific projects improving (FreeCAD, KiCAD)
- Sharing editable formats is always the best option to minimize impact of software preference

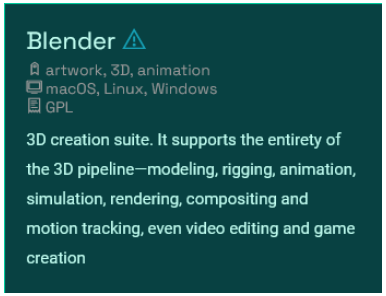












Open Toolchain Foundation, available at https://opentoolchain.org/tools/

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OSH ecosystem and design reuse

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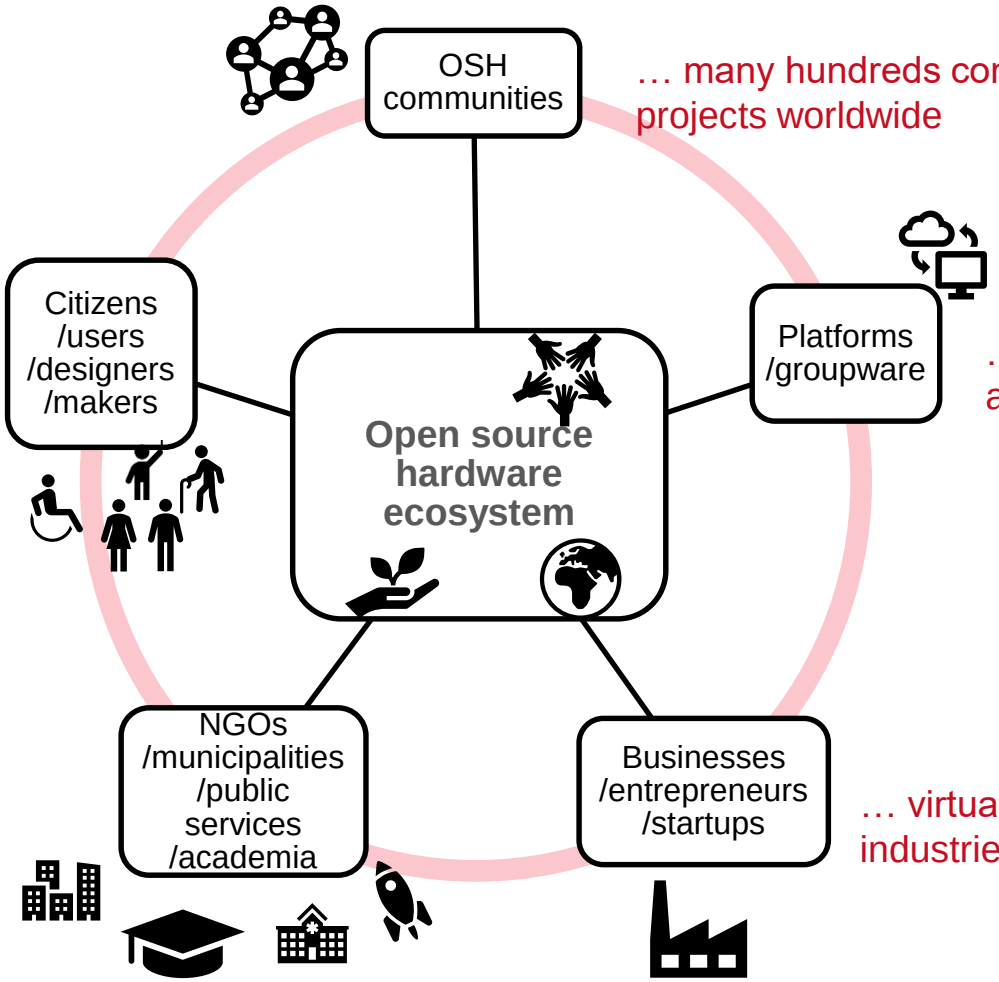
OSH ecosystem and design reuse

OSH ecosystem



… many hundreds community projects worldwide

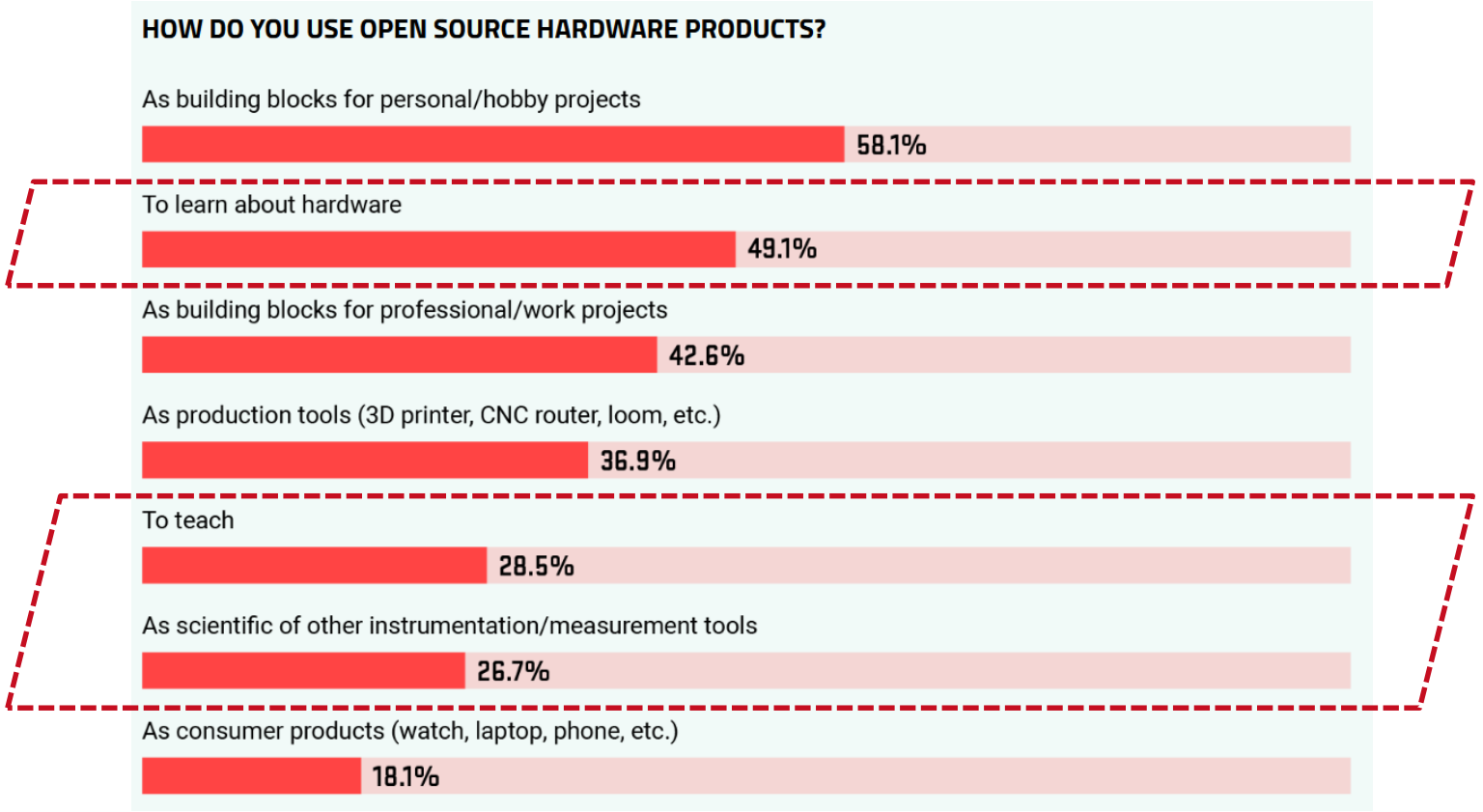
… about 80 platforms worldwide and many websites

… virtually all discrete manufacturing industries in twin-transition

Fields of application

Usage

Report - “The State of Open Source Hardware 2021”



OSH ecosystem and design reuse

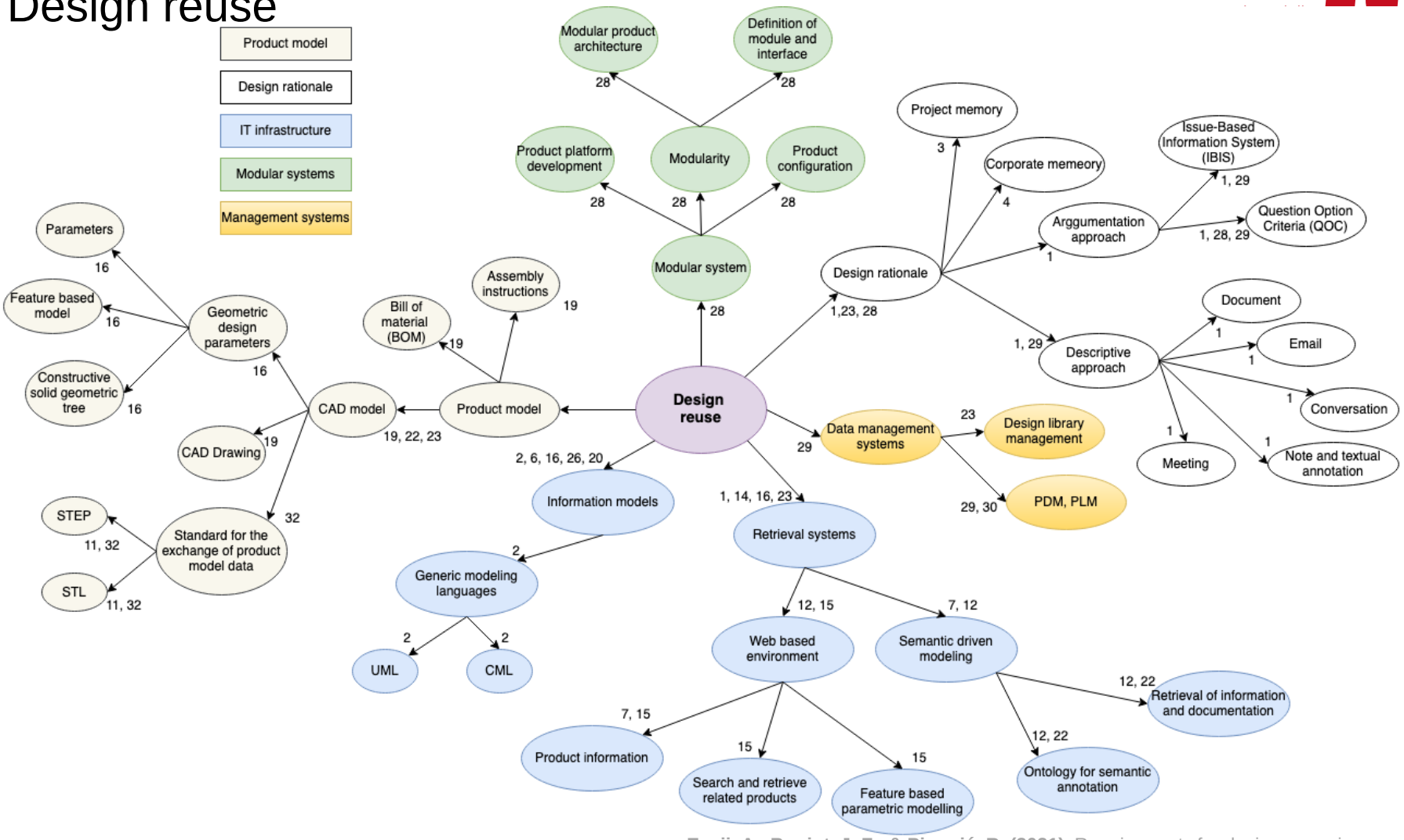
General motivations

Why document and share hardware?

- keeps a record of your work (reference)
- enables others to appropriate (reuse) what you have produced
- enables others to contribute, give feedback and improve your documentation

OSH ecosystem and design reuse

Design reuse



Ezoji, A., Boujut, J. F., & Pinquié, R. (2021). Requirements for design reuse in open-source hardware: a state of the art. *Procedia CIRP*, *100*, 792-797.

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“Open source hardware is hardware whose design is made publicly available so that anyone can study, modify, distribute, make, and sell the design or hardware based on that design.”

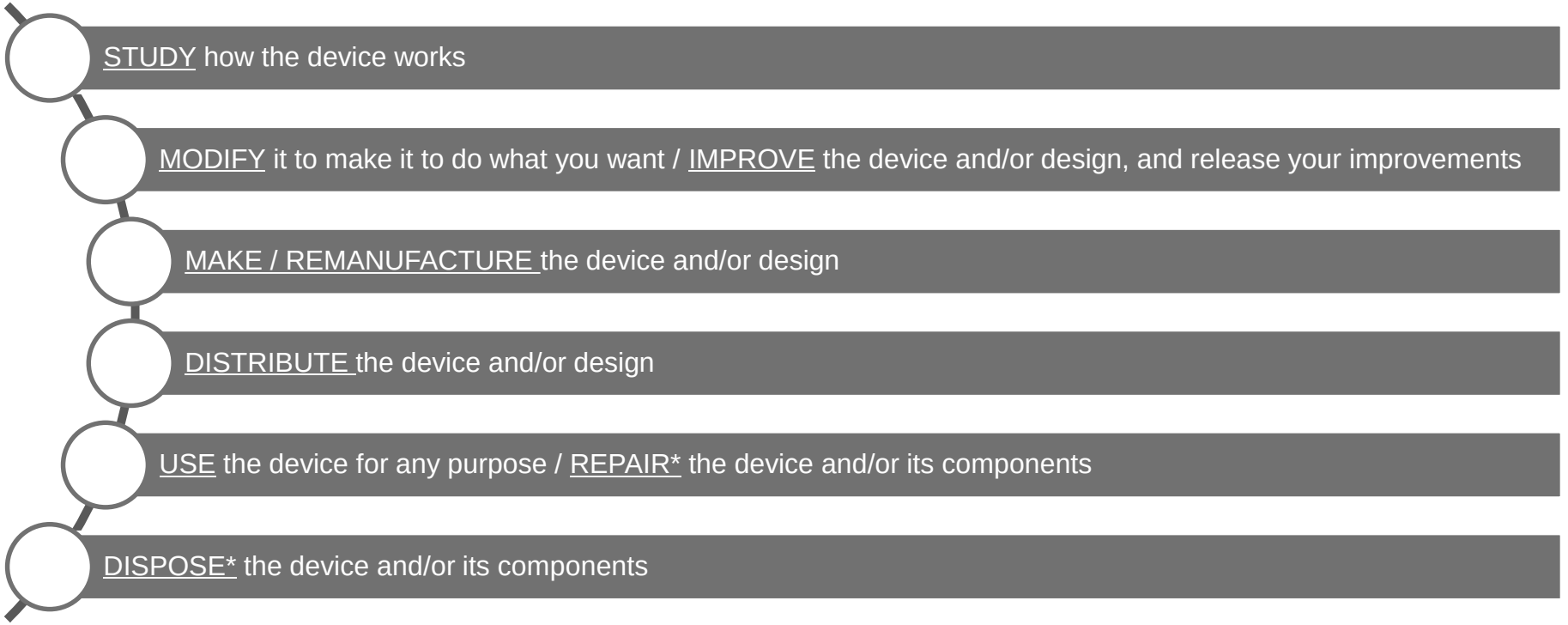
Open Source Hardware (OSHW) Definition 1.0

URL: https://www.oshwa.org/definition/

OSH ecosystem and design reuse

Design Reuse

Freedoms of OSH



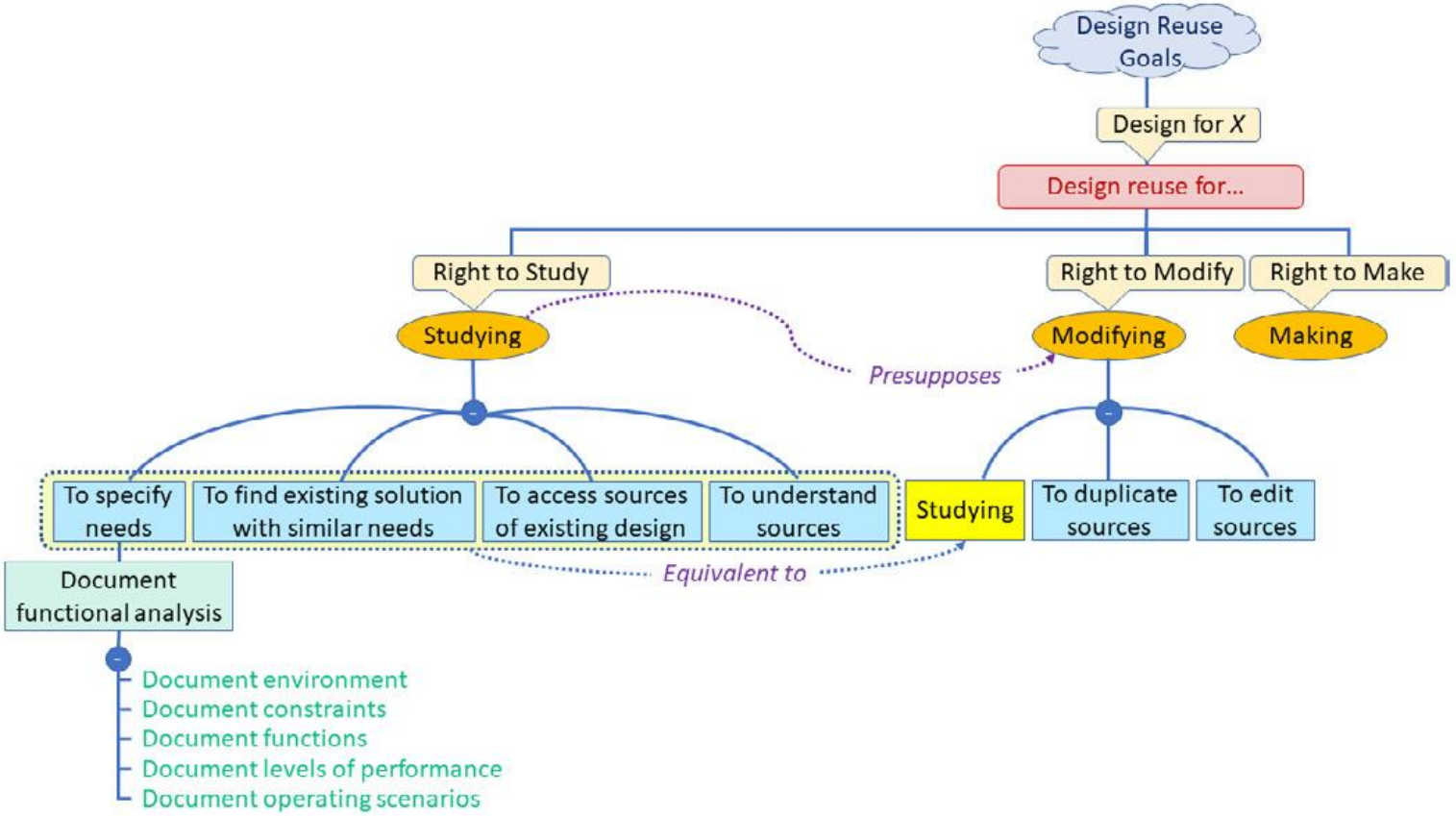
**freedom added*

Powell, A. (2012). Democratizing production through open source knowledge: from open software to open hardware. *Media, Culture & Society*, *34*(6), 691-708.

OSH ecosystem and design reuse

Design Reuse

Freedoms of OSH



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Technical documentation contents

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Technical documentation contents

Process-related

To study & modify

STUDYING		MODIFYING
▪ Context & users	▪ Contact points	▪ Licensing terms
▪ Design rationale	▪ Communication channels	▪ Contribution guidelines
▪ Data	▪ List of contributors	▪ Versioning history
▪ Educational resources	▪ Relation to other projects	▪ Development stage
▪ Scientific publications	▪ Standard compliance	▪ Required skills
▪ Funding note		

Technical documentation contents

Checklists 1 of 2

CHECKLIST	#	Information item	Description	Check?
Process documentation (STUDY, MODIFY)	1	**Context & users**	For whom, in which context and under which conditions	
	2	**Licensing terms***	Name of the license and link to its complete text, if possible with SPDX identifier, for every content (design files, documentation, software)	
	3	**Development stage**	Description of achieved, current and future development stage (for instance with technical readiness)	
	4	**Versioning history**	Versioning history of the project	
	5	**Design rationale**	What it actually does, what problem it solves	
	6	**Contact points***	Contact (email address) and details (name, organisation)	
	7	**Communication channels**	Social medias and / or forum, chat	
	8	**Contribution guidelines**	Explicit indication on how to contribute to the project	
	9	**List of contributors**	List of persons contributing to the development	
	10	**Relation to other OSH items***	Redesigns or use of existing parts from other OSH projects	
	11	**List of required skills***	List of skills required either to study, modify, make or use the hardware (can be related to safety, but also to understanding)	
	12	**Data**	IOT & open data repositories	
	13	**Educational resources**	Open educational resources available	
	14	**Scientific publications**	List and links to publications related to the hardware	
	15	**Requirements / standard compliance***	Set of requirements including for compliance with any standard	
	16	**Funding note**	Funding information about the project	

*needed for enabling freedom to make/distribute as well

Technical documentation contents

Product-related

To make, distribute, use & dispose

- Index of documentation
- BOM
- Architecture
- Assembly instructions
- Design files
- Modelling/production tools

- Testing instructions
- Health & safety notice

- Software & firmware (operation)
- Operation instructions
- Maintenance instructions

- Disposal instructions

Technical documentation contents

Checklists 2 of 2

CHECKLIST	#	Information item	Description	Check?
Product documentation (MAKE, DISTRIBUTE, USE and DISPOSE)	1	**Index of product documentation**	Single page / document presenting the whole documentation architecture	
	2	**BOM**	A list or spreadsheet describing part numbers, putative suppliers, costs, and a short description	
	3	**Architecture**	Defines the overall structure, modules & interfaces	
	4	**Assembly instructions**	Instructions for going from your design files to the working physical hardware, including manufacturing process	
	5	**Design files**	CAD files available and viewable with no need for proprietary software	
	6	**Modelling tool list**	A list of required tools and associated settings for software used for development	
	7	**Production tool list**	A list of required tools and associated settings for physical (e.g. machine) tools for production.	
	8	**Software & firmware for operation**	List of any code or firmware required to operate your hardware	
	9	**Health and safety notice, risk assessment**	A summary of the most important risks and hazards associated with making, using, maintaining or disposing	
	10	**Testing instructions and report**	Instructions for testing and/or quality management.	
	11	**Operation instructions**	Indications on how to use the hardware	
	12	**Maintenance**	Indications on how to maintain the hardware	
	13	**Disposal instructions**	Indications on where or how the hardware can be repaired, and indicate how to dispose or recycle the hardware if it is beyond repair.	

Technical documentation contents

Scope-related

Depending on…

Target audience

- developers & contributors
- users
- makers
- educators
- …

The purpose of engaging in OSH

- record
- reuse
- contributions
- …

You can document as…

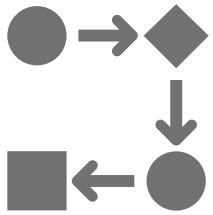
- A recipe / manual 
- A technical report 
- An experiment notebook 
- A user guide 
- A scientific article 
- A journal article 
- A story about the hardware 
- …

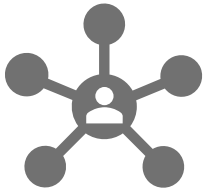
Technical documentation contents

Scope-related

Planning steps for documentation process

- ✓ Define target audiences
- ✓ Arrange based on overall development process and different stages
- ✓ Allocate main responsibility within core team for tracking, maintaining, merging contributions if any and tools (ICT tools/infrastructure)
- ✓ Identify specific documentation requirements early (information products, needs, formats, users, milestones)
- ✓ Consider communication actions (e.g. for releases, for activating contributors, events, etc.)
- ✓ Documenting early reduces time and costs





Summary

- The OSH ecosystem encompasses a wide range of diverse actors from industry to science to citizens and there are many platforms for collaborating and sharing.
- There can be different motivations for documenting and sharing hardware which ranges from general project and specific documentation requirements for design reuse.
- Generally, OSH enables different freedoms for design reuse, namely to study, modify, make, distribute, use and dispose.
- Specific information products are needed to respond to those freedoms considering appropriate formats for target audiences and overall project goals.
- Documenting, integrating and sharing documentation should be planned from an early stage and continuously coordinated hence forward.

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Group assignment

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Assignment

- Collaborative work in HackMD
- Go to https://hackmd.io/FeJo18xQRrSwxs5tieQFag
- What is your specific motivation to document hardware and for whom?
- How do you plan to document your hardware in terms of:
  - Contents
  - Formats
  - Dissemination channel

Thank you for your attention!