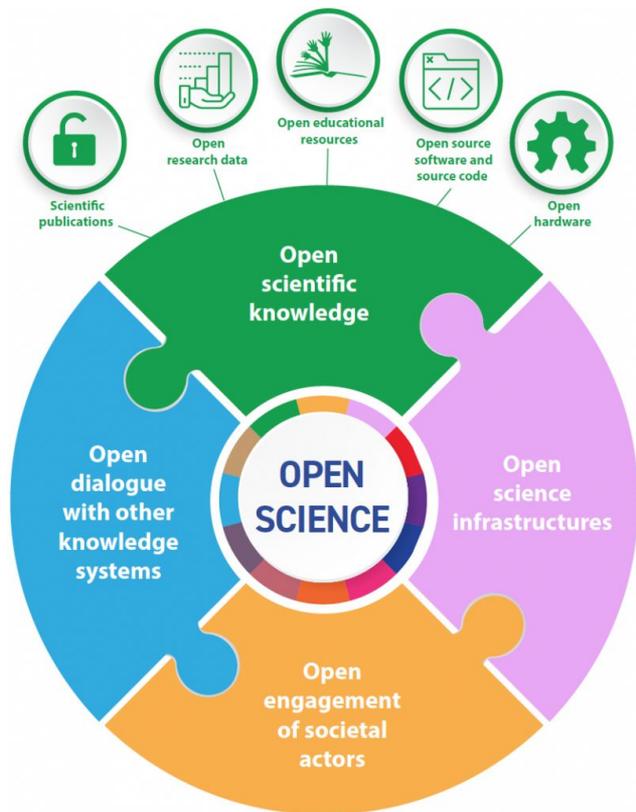


Open hardware: bringing scientific instruments back into the open science conversation

Dr. Julieta Arancio, Open Research Funders Group



Global consensus towards open science



Open hardware in the UNESCO recommendation



“The design specifications of a physical object which are licensed in such a way that said object can be studied, modified, created and distributed by anyone, providing as many people as possible with the ability to construct, remix and share their knowledge of hardware design and function.”

Open hardware as open science today

- Precedent: FOSS in science
- Most scientific instrumentation is proprietary
- More development of tools than consumption
- Still emergent, less mature than open access/data/software
- Cultural difference: how to work open with the constraints of the material world?

Poll

**Why do you think researchers
engage in open hardware?**

Why open hardware: one question, multiple answers

1. Hyper customization
2. Access to research
3. Greater impact
4. Risk reduction
5. Education

Why open hardware: customization

- Why limiting the questions you can ask to what proprietary tech allows you to do?
- Greater control over experiments
- Easier collaboration: reduce friction with open licenses
- A flexible way of trying new ideas
 - Not dealing with vendors' timelines
 - No need for extra funding
 - Rapid prototyping accelerates the process

Why open hardware: access to research

- Access to scientific instruments is asymmetrical
 - Import restrictions
 - Shipping costs
 - Availability of components
- Lack of funding prevents teams from doing science
- Prototype instruments with tools developed locally
 - Easier maintenance
 - Adapted to the context
 - Developing local capabilities

Why open hardware: impact

- Proprietary equipment is expensive
- Some studies require an isolated function rather than the full features
- With the same budget, more powerful studies
- Particularly relevant when:
 - Huge sample number needed,
 - Geographically distributed

Why open hardware: risk reduction

- Proprietary equipment makes labs dependent on vendors
- Vendors can go out of business
- Users are niche, can't really influence vendors
 - Delays
 - Costs

Why open hardware: education

- Develop customized setups for students
- Focus on the process gives students useful skills
- Particularly useful during the pandemic

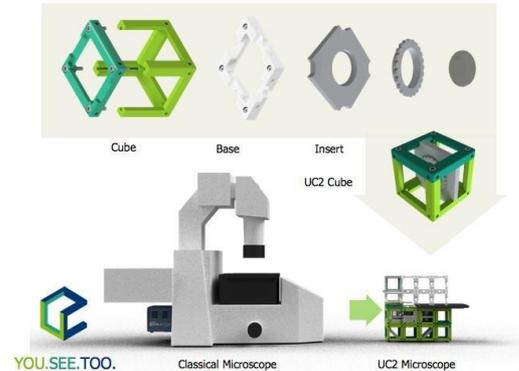
Poll

In your opinion, what is the most challenging aspect of sharing hardware in open science?

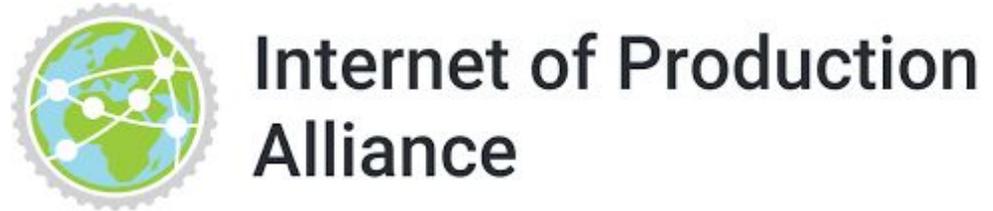
How open hardware?

- Documentation
 - schematics,
 - parts lists,
 - assembly and user instructions
- Licensing: CERN suite (<https://cern-ohl.web.cern.ch/>)
- Sharing: protocols for discoverability, specialised journals

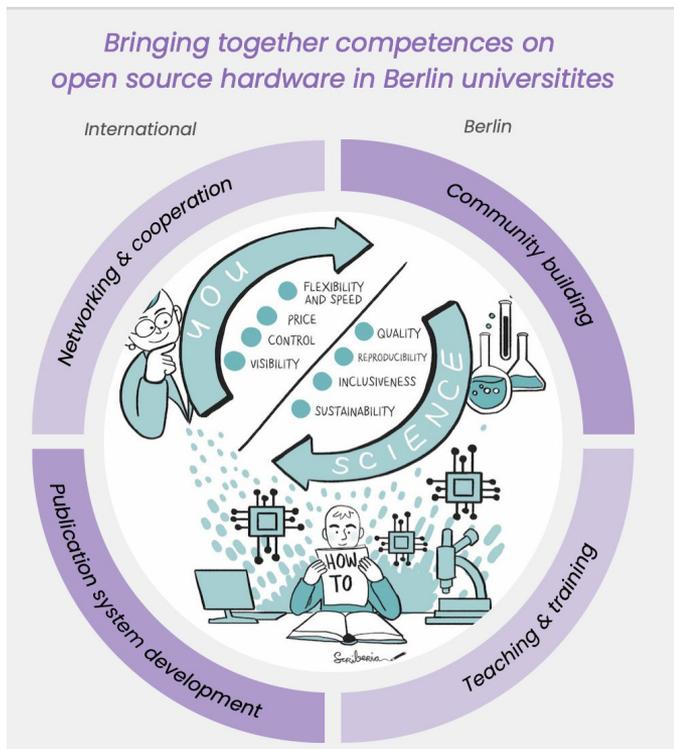
Open hardware in science - examples



Open hardware in science - communities



Open hardware in science - research



Analysis - 15 cases

#	Project name	Country	Description
1.	Open MRI /PTB	DE	magnetic resonance imaging (MRI) device
2.	OpenFlexure /Univ. of Bath	UK	optical microscope for research and teaching
3.	VentMon	CA	testing device & standard for breathing ventilator aids
4.	Plastic Scanner /TU Delft	NL	device for detecting different types of plastic
5.	White Rabbit /CERN	CH/FR	sub-nanoseconds time synchronization system
6.	unOrick	FR	ultrasound imaging development kit
7.	M19 Oxygen	IN	do-it-yourself oxygen concentrator
8.	Libre Solar	DE	portable solar generator
9.	Farmbot	US	CNC precision farming robot
10.	Smart Citizen Kit /IAC	ES	environmental monitoring device for open data sharing
11.	Craniobot /Univ. of Minnesota	US	milling machine for automated cranial surgery of rodents
12.	AudioMoth /Oxford Univ.	UK	acoustic logger for insects and bat sounds
13.	Gorgas Tracker	PE	GPS tracker for research on population movement in rural areas
14.	Hackteria	CH	biological art hacking web platform / wiki
15.	Gaudi Labs	CH	small portable polymerase chain reaction (PCR) machine



Open Hardware:

Open questions

Thank you!

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