

## Overview

During July and August 2021, the Open Source Hardware Association (OSHW) conducted a general survey of people working on open-source hardware (OSHW) in academia – anyone affiliated (or formerly) with a post-secondary ("higher-ed") academic institution who was/is currently/interested in getting involved with an open-source hardware project during their time in academia. This population includes tenured professors who manage research groups, for whom open-source is a promising avenue for community outreach and social impact; graduate students incorporating open-source principles into their dissertation work; students of all levels engaging with the open-source movement through classroom learning; and many others.

### *Questions*

The survey questions can be summarized with two goals:

- understanding the common **challenges** that OSHW practitioners face when working in academia (Q 1, 2, 3, 4, 6, 7, 8, 9)
- finding **opportunities** for OSHWA (or more broadly the OSHW community) to help people overcome these obstacles (Q 5, 10, 11, 12, 13, 14)

### *Distribution*

The survey was prepared as a Google Form where participants could respond anonymously, then distributed primarily through emailing academics who have shown interest in open hardware. Some recipients then forwarded the survey to their colleagues through email and messaging platforms, e.g. Slack and Discord.

### *Participants*

There were a total of 27 participants who responded to the survey. Participants are referred to with numerical codes (P #).

- The survey did not collect any identifying information, but some participants shared context in their text-based responses that mentioned working under an advisor or holding a tenured position. We can infer that the group included some students/early-career academics (P 14, 24, 26) and some faculty/senior academics (P 2, 16, 18, 27).
- Three participants shared their contact information to reach out to others doing related work (P 2, 15, 26). See Discussion section for details about their work, current projects, and how to get in touch.

### *Methods and Analysis*

All of the survey responses were exported to a spreadsheet in Excel/.CSV format. Using a Python notebook to parse the .CSV file, we also used some simple text processing and scripting to categorize responses in a variety of views.

## Open Data

In the spirit of allying OSHW with open science and other practices under the open-source philosophy, our data and analysis tools are publicly available.

- Spreadsheet of survey responses
- Python notebook analysis (Google Colab)

## Summary of Results

This section gives a brief summary of the challenges and opportunities evidenced in the participants' responses. For a more detailed analysis, see the following Detailed Analysis section.

### *Challenges*

The challenges that participants experienced touch upon four basic **needs**: time, money, other people, and appropriate spaces. Lacking one or a combination of these factors could severely impede an OSHW project's progress (P26), or prevent an interested academic from engaging in OSHW altogether (P16). For instance, someone who is interested in open-sourcing their hardware project might not have the extra time needed to document their work and maintain a public repository, because their institution or supervisor does not consider those tasks part of funded research efforts. Furthermore, without other supportive colleagues or established spaces to raise awareness of OSHW, changing the institution's stance would be difficult.

While these challenges (and human needs) are not specific to academia, an academic setting creates unique circumstances for OSHW. Several participants cited two established ways that academia assigns **value**: peer-reviewed publication, and securing intellectual property (IP) through patents, copyrights, etc. Open-source work often falls outside of these structures -- in the case of patents and closed IP, open-source is diametrically opposed. Both processes also have established infrastructure (e.g. tech transfer offices) within institutions that do not currently have protocols or guidelines to support open-source research output.

### *Opportunities*

While academia may create certain obstacles for people doing OSHW, its structure also presents particular opportunities for promoting OSHW in education and technological innovation, where OSHWA may have an impact. Participants shared feedback on how effective certain initiatives (Q 10, 11, 12, 13, 14) might be, including authoritative metrics, case studies, and institutional processes. While they disagreed or remained ambivalent about which metrics and case studies would be most helpful, these two strategies would make the case for OSHW by speaking the language of academia. In the words of P2, "academics need credit." Synthesizing the participants' responses across questions, nearly all of them (n=20) mentioned that receiving "credit" or "recognition" for the "**impact**" of open-source work would help them succeed, or that a lack of "awareness" or "understanding" throughout the academic hierarchy (leaving no way to get "credit") was an obstacle. Whether these metrics and case studies will

measure how many research dollars an OSHW project brought to an institution, or share an instance of how a successful OSHW project is at the heart of several industry products as an "unsung hero", such works would demonstrate the impact of OSHW (with "impact" being the institutional equivalent to an individual's "credit") and give credit to deserving academics.

While shifting institutional attitudes about OSHW would be an ambitious goal, some of the more immediately-actionable suggestions in Q14 for OSHWA include templates for documenting and publicizing OSHW projects, hosting an OSHW education summit or "show-and-tell", and awards/badges for people demonstrating OSHW best practices. These outreach efforts would also directly connect OSHW practitioners across institutions and disciplines. Beyond promoting awareness and increasing visibility for open-source practices in academia, participants discussed their need for "**community**" and stronger networks to support their OSHW work. Because OSHW is not generally well-known in academic institutions (MIT is a notable exception), there are usually a handful or fewer people engaged in open-source work in a single institution. In their isolated circumstances, an OSHW practitioner in academia would have to advocate for themselves by educating their colleagues and immediate network about the benefits of open-source, an undertaking made even more challenging when they also encounter institutional structures that resist open-source practices *and* they still have to fulfill their usual work expectations. Increasing visibility for OSHW success stories and hosting events that connect OSHW academics to each other would foster a supportive community for academics to shift perceptions among their colleagues about OSHW.

## Participants Seeking Collaborators

Three participants shared their contact information to reach out to potential collaborators (P 2, 15, 26).

**P2:** [Joshua Pearce](#), [joshua.pearce@uwo.ca](mailto:joshua.pearce@uwo.ca)

In Q8, Pierce offered help with their experience as a professor having "the initial meeting with tech transfer to explain their rationale," which they have written about in <https://doi.org/10.3390/inventions3030044>. In Q13, they also offered to help publish business case studies at the Business school at Western U. and invite anyone that wants to partner.

**P15:** [Dan White](#), [dan.white@valpo.edu](mailto:dan.white@valpo.edu)

In Q13, White shared that they are working on hardware associated with Libre Space Foundation / SatNOGS that they intend to certify, offering it as a decent case study.

**P26:** [Ali Shtarbanov](#), [www.softrobotics.io/contact](http://www.softrobotics.io/contact)

In Q7, Shtarbanov mentions having to develop their own funding model to realize their OSHW work on FlowIO, which they elaborate upon in Q8 and offer as a potential case study for Q13. They are currently testing the viability of their "Creative Commons Hardware" model, which if successful, they hope can achieve, even with few resources, the "mission of making creative opportunities for technological innovation and creative exploration more accessible for all." They

encourage people to read more on the project website, and are inviting collaborators to flesh out this model further.

For any future surveys, we would include an optional field for participants to identify themselves, if they so choose. They could share their contact info and whether they are seeking collaborators or other forms of engagement for ongoing projects. This de-anonymization option would allow us to give named acknowledgements to the participants, and also give them a chance to promote themselves in return for the time spent on the survey.

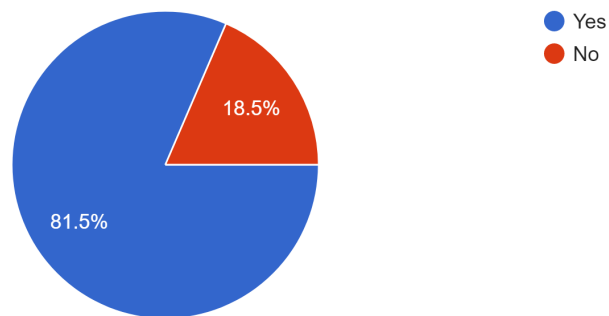
## Detailed Analysis

The survey consisted of two types of questions: one which provided *quantitative* data in the form of yes/no questions (Q 1, 3, 4, 10, 12) and one multiple-choice question (Q2); the other questions generated *qualitative* data by asking participants to freely respond in writing (Q 5, 6, 7, 8, 11, 13, 14).

### Quantitative Data

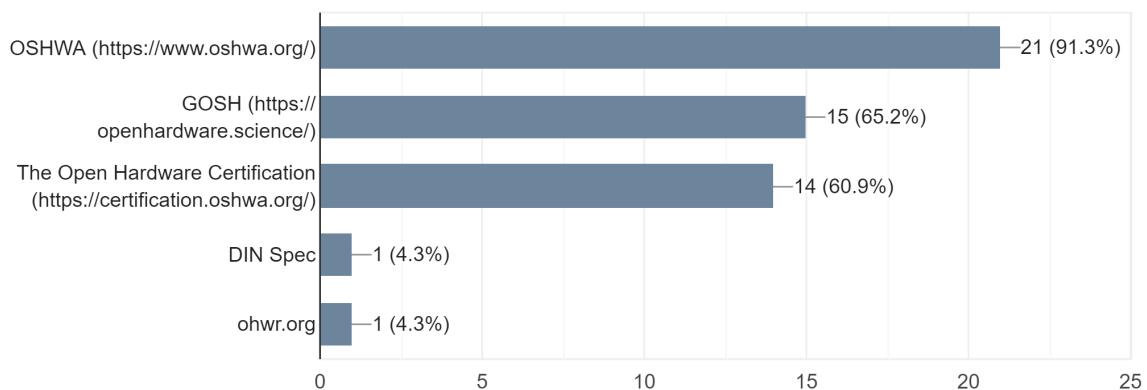
#### 1. Have you previously developed open source hardware (OSHW) at an academic institution?

27 responses



Participants 6, 11, 13, 16, and 23 were the ones who had not developed OSHW.

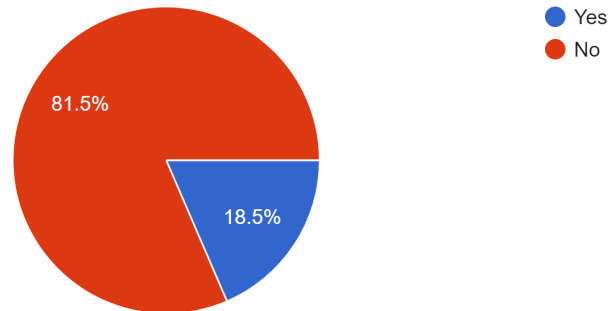
#### 2. Check all organizations in this space that you are already aware of:



P9 wrote in ohwr.org. P12 wrote in DIN Spec.

### 3. Have you been published in an Open Hardware journal?

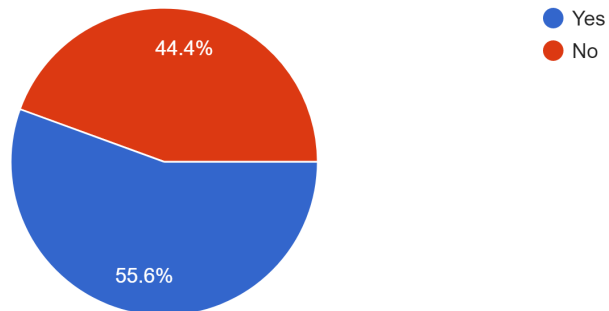
27 responses



Participants 2, 5, 12, 20, and 27 had published in an Open Hardware journal. This group seems to correlate strongly with more senior faculty/academics, who are more likely to be familiar with a variety of publication venues, or have even established/edited a journal.

### 4. Have you worked on OSHW with people at external institutions?

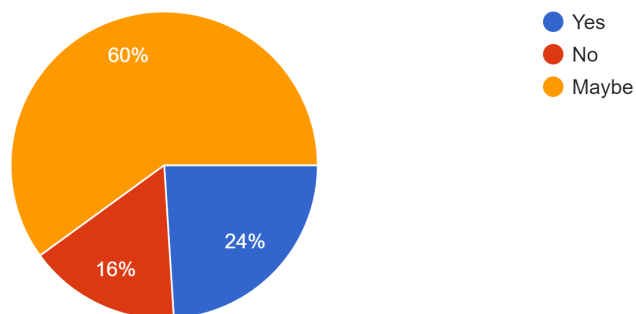
27 responses



This could suggest that OSHW projects could facilitate cross-institutional collaborations, but more data is needed.

### 10. Would quantitative details from a governing body such as OSHWA about your career within OSHW be helpful for tenure?

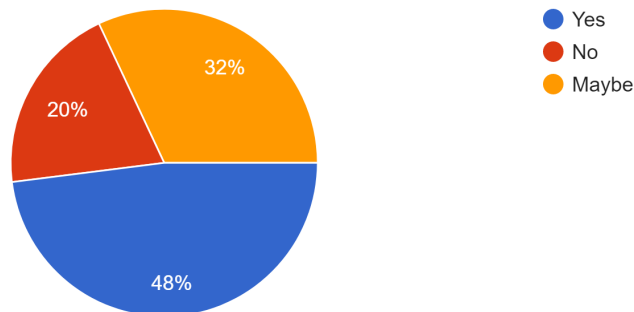
25 responses



Q11 directly asked participants to qualify their responses to Q10. See analysis of Q11 in the next section, Qualitative Data.

## 12. Would academic awards from OSHWA be helpful for tenure?

25 responses



Some participants shared additional thoughts on awards in Q14, and there were earlier mentions of awards/recognitions in Q5 as "helpful" things.

### *Qualitative Analysis*

## 5. What would be most helpful for you to do OSHW in academia?

As discussed earlier, the professional needs of an academic doing OSHW could be framed in a combination of basic needs: time, money, other people, and appropriate space. The last two could be combined as "**social**" needs, such as a sense of community, networking, recognition in their field, and governing policies/guidelines/protocols. Participants' needs could also be categorized as being concrete and material-based (e.g. equipment, available funds) or more abstract and symbolic, such as funding models. We coded the responses to this question based on whether they touched on "time", "money", and/or "social" needs. In summary, 11 responses mentioned "money", including funding, hiring personnel, and purchasing materials/equipment. 15 responses mentioned a "social" need, such as recognition in their field, having public events, supervisor approval, teaching about OSHW, as well as incorporating OSHW into standard curricula and institutional processes. Lastly, 4 responses touched on "time" – needing time to learn about open-source or train on equipment; wanting to re-allocate their work time from other duties towards developing, maintaining, and documenting OSHW projects; and needing other people, such as technicians and administrative staff, having available time to support the OSHW work. For a full list of responses and how they were tagged, see the Q5 table in Supplemental. These categories are obviously not neatly separable or rigorously defined (the "social" category is particularly nebulous), but they do highlight how supporting academics will require a multifaceted approach. Additionally, having many other needs outside of "money" suggests that there are several ways for an organization like OSHWA to effectively support academics without a major financial cost.

Responses to questions 7 and 8 touched upon very similar themes of social factors in academia. Namely, there are systems for valuing academic work that determine how successful

an individual academic is in their career. These systems, including tenure, publication count, and "impact" assessment, are very hierarchical and determined by one's superiors. Furthermore, academics also have to consider how their success also reflects back to earning merit for their home institutions. As such, institutions will prioritize traditional publications such as patents and peer-reviewed venues because those are established processes with existing bureaucratic structures (e.g. tech transfer offices) to support academic work going through the pipeline. In short, the structure of academia is not inherently prohibitive to open-source work, but the level of support that an OSHW practitioner receives depends greatly on having supportive superiors. In fact, one participant (27) believes academia should be "THE ideal place" for OSHW according to its core principles, as most institutions receive some form of public funding, so the work should be open to the public as well.

### **9. Are the problems with OSHW in universities unique to your university, or do you see this as a widespread problem?**

Nearly all participants believed that their situation was not unique, and that OSHW faces "widespread" challenges. Problems with doing OSHW seemed to be common for "large research universities" and other "teaching-focused institutions". For these academic settings, the traditional value placed on peer-reviewed work and "closed IP" (intellectual property) means that institutions "don't know how to evaluate this type of work".

The three participants who differed from this opinion did not necessarily believe their struggles were unique in academia. Rather, two of them (P 18, 24) felt that they did not struggle with OSHW because their positions were unique -- P18 had shared in Q6 that they were business faculty who did not focus on patents as outcomes; P24 acknowledged that their research group was likely more supportive of open-source work compared to those at other institutions. P25 believed that these problems "mostly depended on country-wide regulations and thinking" rather than academic culture.

### **Questions 11 and 13 asked for suggestions for quantitative metrics and case studies that OSHWA or another governing body in the field could provide.**

Both of these questions targeted how OSHWA and other authoritative voices on open-source work could better speak the language of academic structures, as metrics and case studies both align with the aforementioned systems of establishing credibility and merit for academic work. Some suggested metrics included translating "impact" and "citations" for OSHW via GitHub forks and other engagement, and quantifying how much research funding an open-source project had brought to an institution. In Q13, Participants 2 and 27 gave further context to who these case studies would be convincing: business and innovation/tech transfer entities within the institution. The responses suggested case studies in several different categories:

- Success stories
  - Comparison to commercial solution [3] - when OSHW works
  - RepRap social impact [4]
  - Widespread adoption -> fame and fortune
- Post-mortem of OSHW projects: how community develops, versions evolve

- Metrics of success [6]
  - saved money
  - reliability
  - competitiveness [3,6]
- Best practices of OSHW - quality assurance (translating to metrics)
- Unsung hero effect [15, 16] - accelerating R&D, quantifying reach of OSHW like ubiquity of Arduino in EE programs

**14. If the Open Source Hardware Association could set up one process in education to get more educators creating open source hardware, what would it be?**

Respondents suggested a variety of initiatives, including workshops (which could be one-time events or series), more specific awards and certifications, specialized funds, and developing collaborations with other entities. Of these, workshops and awards/certifications seem to be the lowest-hanging fruit. Suggested workshops included a walkthrough for reproducing an OSHW project; an OSHW crash course or quick start that showed how "it can really be used and easily accessible", thereby reducing the time investment for OSHW practitioners; and an OSHW networking summit with show-and-tell and discussion of projects. One participant's suggestion of "templates", assuming they mean content templates for teams documenting and publicizing their OSHW projects, would also reduce the time commitment concern. Awards/certifications would not only target educators, but their students as well. For other suggested processes, while their implementation seems much more difficult, they ultimately reflect how participants might see OSHWA's role in advocating for the OSHW academic community: to convince academia of the value of OSHW by providing authoritative information and a visible presence.