Open Source Hardware in Medical Physics and Its Potential to Accelerate Innovation

Open Source Hardware: General overview
by Francois Therriault-Proulx

Open Source Medical Devices: lessons learned from a complex collaborative research project
by Surendra Prajapati

Open Source Hardware in the context of simple and widely shared clinical applications
by Adam Cunha

open source hardware

We will all start to collaborate,
for the benefit of the patients, the
field, our profession, and each other.

Open Source Software

- Linux (1994!)
  - 90 countries
  - 3000 developers
  - **created billions in profit and countless jobs**

"given enough eyeballs, all bugs are shallow"
-Eric S. Raymond in *The Cathedral and the Bazaar*

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Open Source Software in Medical Physics

Source: arduino.cc

What is Open Source Hardware?

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. The hardware's source, the design from which it is made, is available in the preferred format for making modifications to it. Ideally, open source hardware uses **readily-available components and materials, standard processes, open infrastructure, unrestricted content, and open-source design tools to maximize the ability of individuals to make and use hardware**. Open source hardware gives people the **freedom** to control their technology while **sharing knowledge** and encouraging commerce through the **open exchange of designs**.

Source: http://www.oshwa.org/definition/

"The richer you are, the more you give;
The more valuable the gift, the more respect you gain.
Very similar to academia with publications and conferences.
Knowledge is the currency here, <u>not money</u>."

J. M. Pearce, Professor at Michigan Tech University
Creator of the Michigan Tech's Lab in Open Sustainability Technology

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Components	Filament Consumption (g)	ABS Costs (USD)[a]	Electricity Cost (USD)[b]	Total Cost (USD)	Estimated Commercial Price (USD)[c]	Percent Savings (com.–open)/com.
Optical rail	–	–	–	10–12/m	320/m	97
Base on Optical Rail - optical foot (2x) - optical mag (3x) - rod base (4x)	39.52	1.50	0.27	3.08	150–730	>97
Filter holder	8.98	0.34	0.06	0.40	58–80	>99
Lens holder	5.35	0.20	0.04	0.24	20–180	>98
Mirror holder	7.40	0.28	0.05	0.33	18–200	>98
Fiber switcher	10.41	0.40	0.07	0.47	22–138	>97
Screen holder	1.55	0.06	0.01	0.07	18	99
Thumb screw (6x)	7.98	0.30	0.06	1.32	12	89
Sample holder	6.00	0.23	0.04	0.27	18–109	>98
Lab jack	133.20	5.06	0.92	5.98	35–1000	83–99
Automated filter wheel changer	295.1	11.21	2.02	20.43	1000–4250	>98
Optical base (4x)+steel sheet vs. optical table 1 m²	46.28	1.76	0.32	25.58	3619–5288	>99

Source: Zhang C, Anzalone NC, Faria RP, Pearce JM (2013) Open-Source 3D-Printable Optics Equipment. *PLoS ONE* 8(3): e59840. doi:10.1371/journal.pone.0059840

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Open-source vs. patents

- Imitation reduces the profit from current discovery, but raises the probability of follow-on innovations, which improve future profit.
- Because the imitator may have valuable ideas not available to the original discoverer, the overall pace of innovation may thereby be enhanced.
- The original innovator has at least a temporary first-mover advantage.
- Each potential innovator takes a different research line and thereby enhances the overall probability that a particular goal is reached within a given time.

- Thus, equilibrium without patents is more nearly optimal with sequential than with static innovation.

Bessen J, Maskin E. Sequential innovation, patents, and imitation. RAND J Econ 2009;40(4:611-35);

Open Source Hardware in Academia

- Massive peer-review in the development of background material and experimental design
  - Shared online as quasi-publications -> Students more careful

- Improved design leads to higher performance

- Increased visibility, citations and public relations
  - Good for your institution and for you

Source: "Open Source Lab: How to build your own hardware and decrease research costs.", Joshua Pearce, 1st edition, 2014, p.14.

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Open Source Hardware in Academia

- Increased funding opportunities
  - Making your research available and driving down the cost of research should be very appealing to funding agencies
  - Definitely good for both you and your institution

- Improved student recruitment and research-related training and education

Source: "Open Source Lab: How to build your own hardware and decrease research costs.", Joshua Pearce, 1st edition, 2014, p.14.

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No derivatives

Non Commercial

Share Alike

Source: https://creativecommons.org

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Open Source Hardware in Medical Physics

- Army of technologically savvy people coming from different fields of physics
  - ~6000 Medical Physicists in the USA only
  - Different strengths: software, hardware, clinical, etc.

- Lot of in-house solutions are developed, but often stay within the institution
  - The same wheel is reinvented again and again, in parallel.
  - Multiple wheels would speed things up, isnt?

- Culture of sharing could lead to sequential innovation and therefore accelerate developments in the field.

Open Source Hardware in Medical Physics

- However, the Medical Physicists have to be ready to take ownership for validation of any application they get from other institutions
  - Medical Physicists already have the responsibility to validate the quality of processes, software outputs, methods, treatment plans, etc.
  - This would just strengthen Medical Physicists value proposition

- Research budgets are more and more restricted
  - OSH is a good way to cut down the cost.

- Challenges change whether you are a working on a research-based device or a smaller clinical project.