

The Emergence of Open Hardware Phenomena in Different Technological Environments

HEPTech Workshop on Open Hardware

June 13, 2013

GSI, Darmstadt

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Outline

- ➔ Definitions and Terminology
- ➔ Atoms, Molecules and Hardware
- ➔ Technological Environments
- ➔ Summary of the Observations
- ➔ Discussion of the Consequences



What does
trade regulation
have to do with
open hardware?

- ➔ **Definitions and Terminology**
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The Notion of Emergence

“the whole is more than the sum of the parts”

“the emergent, is essentially *novel* [not foretold], to be contrasted with the *resultant* (a linear combination that can be foretold).”

Ablowitz, Reuben. ‘The theory of emergence.’
Philosophy of Science, 6, no. 1 (1939): 1-16.

Complexity

(dictionary) difficulty, twisted, intricate, problematic

(complex systems) many measures, no simple way to unify the definition

Lloyd, Seth. 'Measures of complexity: a nonexhaustive list.' *IEEE Control Systems Magazine*, 21, no. 4 (2001): 7-8.

Lloyd, Seth., and H. Pagels. 'Complexity as thermodynamic depth* 1.' *Annals of Physics*, 188, no. 1 (1988): 186-213.

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Simple & Complicated Machines

Mouse-trap

Steam Engine

CPU board

Memory chip

LHC

Complex Machines

Atoms

Molecules

Polymers

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Synthetic Biology (1)

BioBricksFoundation (BBF) - public-benefit organization founded in 2006 by scientists and engineers who recognized that synthetic biology had the potential to produce big impacts on people and the planet and who wanted to ensure that this emerging field would serve the public interest.

“The BBF’s mission is to ensure that the engineering of biology is conducted in an open and ethical manner to benefit all people and the planet.”

Synthetic Biology

Registry of Standard Biological Parts

The iGEM Registry is a growing collection of genetic parts that can be mixed and matched to build synthetic biology devices and systems.

...it provides a source of genetic parts to iGEM teams and academic labs.

Synthetic Biology (3)

The International Genetically Engineered Machine (iGEM) Foundation is dedicated to education and competition, advancement of synthetic biology, and the development of open community and collaboration.

Synthetic Biology (4)

Synthetic Biology (4)

Artemisin: antimalarial drug

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Artemisin: antimalarial drug

low cost production process

Synthetic Biology (4)

Artemisin: antimalarial drug

low cost production process

proprietary

The economics... (5)

“... a part’s value increases each time it is used.

“[the Registry] this minimal intervention makes openness significantly more likely.

“What mix of patent and open source incentives is most likely to deliver the cheap and abundant parts that synthetic biologists (and, by implication, the world) needs?”

Henkel, J, and S Maurer. ‘The economics of synthetic biology.’ *Molecular systems biology*, 3, no. 117 (2007): 1-4.

Nanotechnology (1)

“Both technical complexity and bureaucratic mishandling of nanotechnology patent applications have created a dense patent thicket of overlapping claims and rights.

“This intellectual property tragedy restricts downstream innovation by preventing development of more complex technologies due to exorbitant transaction costs.

Pearce, Joshua M. “Open-source nanotechnology: Solutions to a modern intellectual property tragedy.” Nano Today (May 2013). <http://dx.doi.org/10.1016/j.nantod.2013.04.001>

Nanotechnology (2)

Open Source Nanotechnology

Cafer T. Yavuz et.al. 2010. “Pollution magnet: nano-magnetite for arsenic removal from drinking water” *Environmental Geochemistry and Health*, 32(4): 327-334.


Lounsbury, Michael, Christopher Kelty, Cafer T Yavuz, and Vicki L Colvin. “Toward Open Source Nano: Arsenic Removal and Alternative Models of Technology Transfer.” In *Measuring the Social Value of Innovation: a Link in the University Technology Transfer and Entrepreneurship Equation*, edited by Gary D Libecap, 19:51–78. Bingley: Emerald Group Publishing, 2009.

Optics Equipment

“Just as the power of the open-source design paradigm has driven down the cost of software to the point that it is accessible to most people, the rise of open-source hardware is poised to drive down the cost of doing experimental science to expand access to everyone. To assist in this aim, this paper introduces a library of open-source 3-D-printable optics components.

Zhang, Chenlong, Nicholas C Anzalone, Rodrigo P Faria, and Joshua M Pearce. “Open-Source 3D-Printable Optics Equipment.” *PLoS ONE* 8, no. 3 (March 27, 2013): e59840.

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What is **emerging**?

Open-source ideals

“[A]pplying open-source ideals to biology and encouraging amateur practices has not so far disrupted the course of professional research and the fierce competition between industrial countries

“As long as sophisticated and expensive technical platforms equipped with up-to-date instruments are needed for achieving reliable syntheses, garage biology will remain a hobby for young creative people (or for eccentric millionaires).

Bensaude-Vincent, Bernadette. ‘Discipline-building in synthetic biology.’ *Studies in History and Philosophy of Biological and Biomedical Sciences*, 44, no. 2 (2013):

u^b 122-129.

Open-source ideals

(synthetic biology)

“Noble discourses about freedom, creativity and the annual festive jamborees in Cambridge are far from sufficient to initiate a democratization process.

“Despite the discourses and the promises, the discipline grows in the USA with no democratic basis and no concern for democratization.

Bensaude-Vincent, Bernadette. ‘Discipline-building in synthetic biology.’ *Studies in History and Philosophy of Biological and Biomedical Sciences*, 44, no. 2 (2013): 122-129.

Sustainable Development

“Open source appropriate technology (OSAT) refers to technologies that provide for sustainable development while being designed in the same fashion as free and open source software (Buitenhuis, et al. 2010)

Pearce, Joshua M. “The case for open source appropriate technology.” *Environment, Development and Sustainability* 14, no. 3 (January 19, 2012): 425–431.

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Two competing Methodologies

- Proprietary Regime
 - Paris Convention 1883 (patents)
 - Berne Convention 1886 (copyright)
- OS
 - OSI since 1998 (software)
 - OSHW since 2012

“while the patent-and-publish method is a *transactional* method based on the exchange of extrinsic goods (patents in exchange for research funds), the free and open-source methodology is a *transformational* method based on a visionary ideal of science, which leads to prioritising intrinsic goods in scientific research over extrinsic goods.

Marturano, Antonio. “When Speed Truly Matters, Openness Is the Answer.” *Bioethics* 23, no. 7 (2009): 385–393.

Questions

Thank you

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