On the Economics of Synthetic Biology: Is Openness Feasible?”

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Sharing vs. Patenting – what characterizes SB?

"One of the nice things about SB at this time is that scientists around the world are working together in a way I've never experienced in other fields."

Drew Endy, Zurich, Feb 2006

Recent patent application, with rather broad claims, for "minimal bacterial genome."

J. Craig Venter Institute

Questions

- Openness in SB just transitory, due to the field's young age and academic nature?
- Pros and cons of "proprietary" and "open" approaches from an economics point of view?
- Why openness matters particularly for SB:
  - analogy to electronics
  - tipping dynamics
  - sets of compatible complements: libraries
- How can firms profit by being (selectively) open? The analogy to embedded Linux

Agenda

- Economic pros and cons of openness
- Why openness matters particularly for SB
- Profiting by being (selectively) open
- Policy choices for the Registry
- Conclusions

Economic pros and cons of openness

	patents	**openness (i.e., making inventions freely available)**
before a part is created	• provide incentives for innovation by allowing exclusivity ➔"*dynamic efficiency*"	• may fail to provide sufficient incentives to build (expensive) parts in the first place
once a part exists	• reduces use of the part due to royalties and transaction cost of licensing	• allows broad use of the part, at low (marginal) cost ➔"*static efficiency*" • also: simplifies subsequent innovations and informal collaboration

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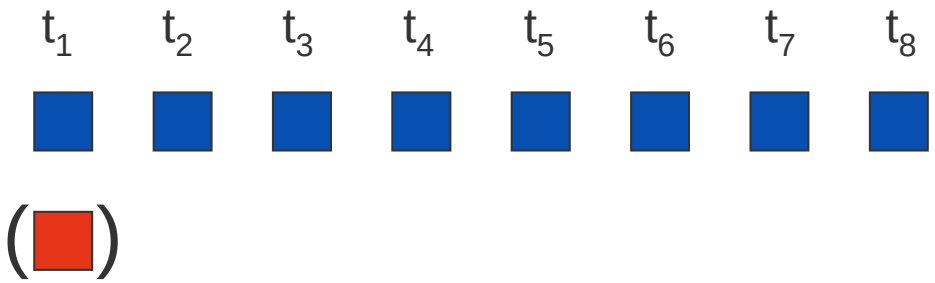
Tipping dynamics (1): Lock-in due to re-use

- Re-use of parts is at the core of the “parts agenda”
- Due to growing experience, using a part becomes cheaper the more it has been used before
  - Estimate: 25% cost reduction after first use (Keasling, 2006)
- If there are two or more different parts with identical functionality, the part which had been used most frequently will, other things equal, be preferred

➔ *User gets locked-in to the part used before*



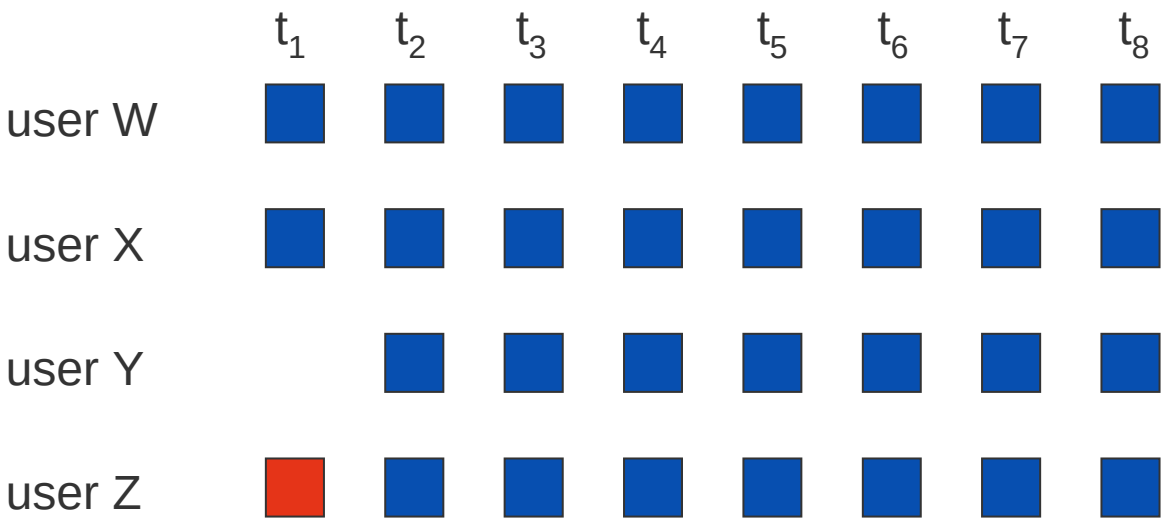
Tipping dynamics (2): Winner-take-all outcomes

- To the extent that users share their experiences:

➔ *Tendency for only one part to emerge as the "standard"*

➔ *Winner-take-all outcome; the market "tips"*

- Analogies in electronics: Windows, VHS, ongoing: Blue Ray vs. HD DVD



Tipping for sets of complementary parts

- A “set of complementary, compatible parts”: parts (A, B, C) that work well together
- Assume A’ is a substitute for A, B’ a substitute for B etc.
- When the parts (A’, B’, C’) are compatible, the set is an alternative to the set (A, B, C)

➔ *Since the logic of “tipping dynamics” translates from parts to sets of parts (and is even strengthened), we expect winner-take-all outcomes also – and in particular – for sets, or “libraries,” of parts*

➔ *Tendency for one set of parts to emerge as the standard*

- Analogy to electronics: Microsoft Office vs. alternative office suites

Competition between sets of parts

- Of competing sets of parts (of comparable functionality), the set with lowest overall cost can be expected to win
- Cost items:
  1. royalties
  2. transaction cost
  3. cost of getting it to work
- Even if an open, freely available set exists, a proprietary set with a lead in use (lower cost 3) may be preferred over a commercial one with royalties

➔ *The winning set (or library) may well be proprietary (and costly to license) even if free contenders exist*

➔ *Which set wins is determined early on – royalties are charged later, when lock-in has set in!*

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Examples of devices running Embedded Linux

Source: Linuxdevices.com

What is “embedded Linux”?

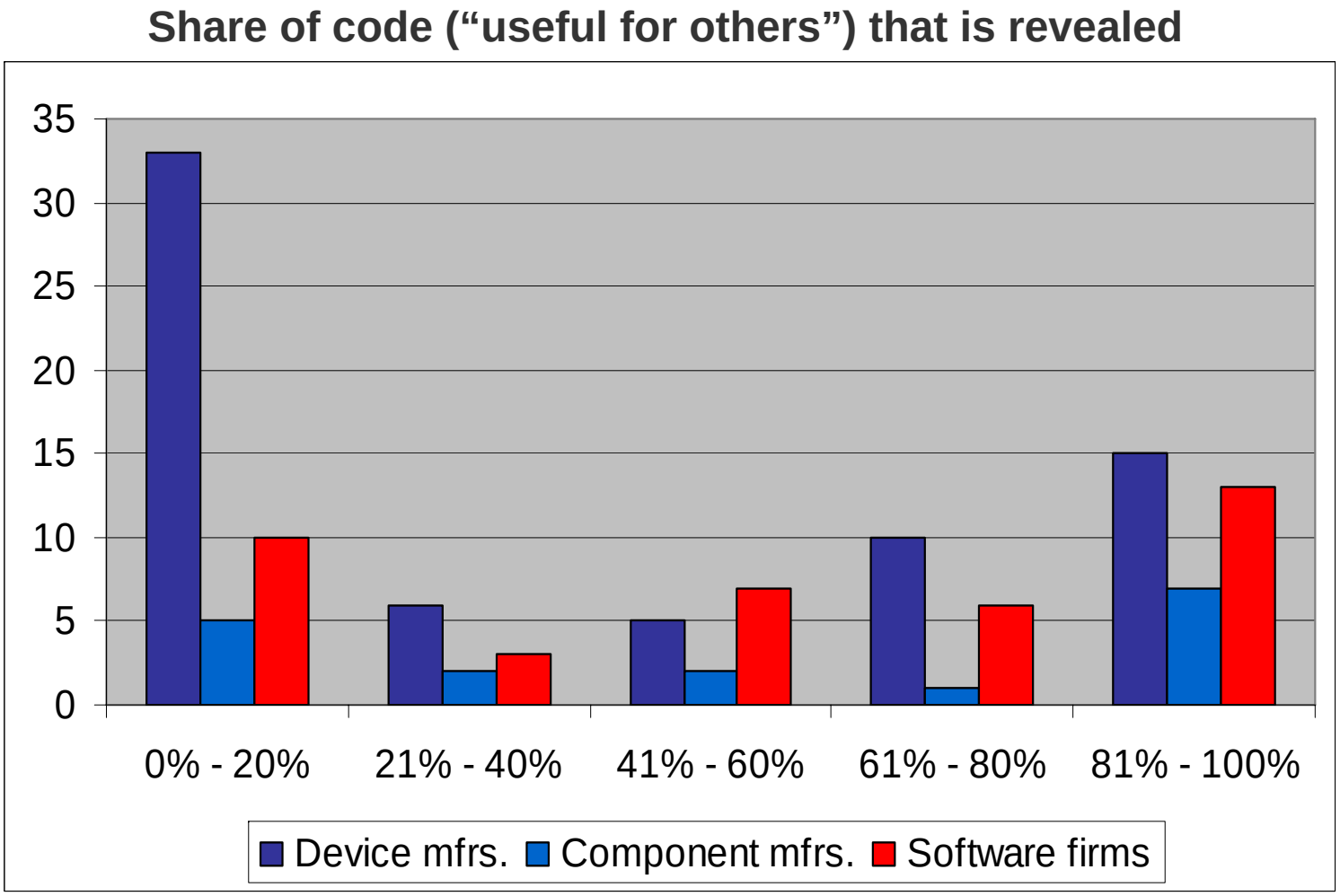
- Flavors of Linux dedicated to use in embedded devices (e.g., VCRs, machine controls)
- Embedded Linux is nearly exclusively developed by commercial firms

➔ **IP issues** highly relevant

  - Example: Device that bundles 48 UMTS channels. The hardware is generic, but the drivers contain important proprietary protocols

- Still, firms make about 50% of their code freely available before they have to do so!
  - Henkel (2006)

Extent of Revealing in embedded Linux



How can embedded Linux firms profit by being open? (1)

Benefits:

- Informal collaborative development – “Jukebox Innovation”
  - bugfixes, maintenance support, further development by others, complementarity to others’ technologies
- Standard setting: getting one’s solution widely adopted
- Complementarity
- Marketing
  - getting visibility, demonstrating technical prowess
- Reciprocity, reputation

How can embedded Linux firms profit by being open? (2)

Absence of drawbacks:

- Protection by other means (e.g., customer contacts, protected hardware)
- Specificity of needs, so others can't benefit by copying 1:1
- Licensing small improvements would be difficult and costly
- Protected solutions can easily be substituted ("invented-around")
- Infringements would be difficult and costly to detect
- Modularity makes selective revealing easy and cheap

Are factors favoring openness given in SB?

Potentially favoring openness in SB:

- Informal collaborative development
- Standard setting
- Complementarity
- Marketing
- Reciprocity, reputation

- (Protection by other means)
- (Specificity of needs)
- (Licensing difficult and costly)
- (Solutions can be substituted)
- (Infringements difficult to detect)
- Modularity

Speaking against openness in SB:

- Patents required for VC funding
- Patents required for cross-licensing
- “Culture of patenting” in genetics

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Policy choices for the Registry

- Registry of Standard Biological Parts at http://parts.mit.edu
- Could become THE platform for parts and complementary information regarding users‘ experiences in using parts
- Winner-take-all dynamics also work in favor of the Registry
- The community can use the value of the Registry to promote openness
  - accept only free parts (?)
  - oblige users to contribute back experiences made with parts
  - require contributors to make parts, after some protection period, openly available
- Goal: to guarantee that, what is achieved and invented, happens with as few exclusion rights granted as possible

Some practical suggestions

Dealing with patents:

- When putting parts into the public domain, make sure “prior art” is created and found (so that no-one else can patent the part)
  - point out the existence of parts.mit.edu to patent offices
  - simplify searching for patent examiners
  - make sure the date of the publication can be proven
- Collect and provide information about existing patents
  - researchers can then recognize and, if desired, avoid patented parts

Supporting openness:

- Allow reputation-based motives to play a larger role
  - put more information about the inventors on parts.mit.edu
  - this may also be attractive to small companies (marketing!)
- Lower the benefits to patent owners
  - mark those sequences on parts.mit.edu which are patented (if you know) such that users can avoid using these parts

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Conclusions

- If sufficient incentives exist to invent a part *without* patent protection, then it is highly desirable that this happens
- For more costly core inventions, patents most likely are the right means to provide incentives
- However, several characteristics of SB favor (selective) openness
- Winner-take-all dynamics make it imperative to think about the future of openness in SB *now*

➔ Reference: Henkel, J., Maurer, S. (2007): "The Economics of Synthetic Biology." *Molecular Systems Biology* **3**: 117

➔ Ongoing study of these issues by Martina Zinsmeister, Martha Loleit, and Verena Rathgeber. Please consider giving an interview when approached!

Thanks

Comments welcome

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Backup

Benefits of revealing – Quotes

"...in general there are, on the public lists, different ***competing companies contributing to improve the public version****. That's very obvious."*

(Embedded Linux sw company, EU)

Abstract of the talk

- “One of the nice things about SB at this time is that scientists around the world are working together in a way I’ve never experienced in other fields.”
- This statement by Drew Endy, made at a workshop on SB in 2006, is in stark contrast to the importance commonly attached to intellectual property protection in genetic engineering and related fields.
- This presentation, based mainly on an article coauthored with Steve Maurer and published in Molecular Systems Biology (2007), addresses the question of knowledge disclosure in Synthetic Biology.
- In the article, we analyze SB from an economics perspective, identifying “network effects” and a resultant tendency towards “winner-take-all” outcomes.
- Drawing parallels to a specific case of commercial open source software development (“Embedded Linux”), we ask under what conditions firms may be willing to make - selectively - some of their inventions public. We finally discuss means that could help maintain a commons in SB.