BIL Gates and the BioBrick Foundation: A new paradigm for biotechnology?

Karl Stephan, Consulting Engineer, Texas State University, San Marcos

No, that’s not a typo in the headline. I’m not talking about the founder of Microsoft, though he is no doubt the reason that biotechnology researcher Drew Endy decided to name his new computer-in-a-cell devices Boolean Integrase Logic gates (BIL for short). The technology, which I’ll get to in a minute, is fascinating on its own. But what is even more interesting is the thing Prof. Endy has done with it: He has put the intellectual property relating to it in the hands of the BioBrick Foundation, where it can apparently be used by anybody free of charge—anybody, that is, who knows how to use it. That knocks out most of us right there, but the idea itself is intriguing, to say the least.

What is a BIL gate? Bear in mind that this is being written by a person who successfully avoided taking even a single biology course, all the way through high school, college, and graduate school. (I couldn’t stand the idea of cutting up frogs.) But the San Jose Mercury-News item that brought Prof. Endy’s work to my attention had a nice little ten-minute PowerPoint-type presentation attached, evidently narrated by the professor himself, and I gleaned enough from it to give you a brief idea of BIL gates.

The basic idea is that these BIL gates work just like normal electronic logic gates, taking in inputs and sending out outputs that are logical functions of the inputs. A two-input AND gate, for instance, puts out a HI (or Yes, or 1, whatever you want to call it) if and only if both of its inputs are HI. Otherwise, it sends out a LO. Devices like these form the essential building blocks of all digital computers.

The same logical functions are performed by BIL gates, except instead of wires and transistors you have paths that biological molecules can travel, and places where the molecules can either pass by or be blocked. The passing-by or blocking is done by another control molecule. The description is vague on exactly where all this happens, and what the things look like. But if you make the same thing happen in a whole bunch of cells, you can tell it works when they all light up because of a

fluorescent tracer molecule, for instance.

Prof. Endy has demonstrated all the basic combinatorial logic operations, and says we are now set to do simple computations inside cells. You can imagine, for instance, rigging liver cells to count how many times they divide. If the number of divisions gets so high that the cell is probably cancerous, you could trip a biological switch so that the cell would self-destruct. Result: no liver cancer. Or you can detect chemicals, infectious agents, and so on, and send an unambiguous digital signal so that further action can be taken.

Sounds pretty neat, huh? What is even more remarkable than the technology itself, is that Prof. Endy has essentially donated it to an organization (of which he is board president) named the BioBrick Foundation. From what I can tell from their website, the foundation is aimed at seeing that synthetic biology (of which BIL gates are an example) is used “in an open and ethical manner to benefit all people and the planet,” as they say on their homepage. They have a registry of standard biological parts that seem to have enough detail for interested parties to use them. And while I haven’t hired a lawyer to go through their fine print (if they have any), their stated principle that “fundamental scientific knowledge belongs to all of us and must be freely available for ethical, open innovation” is clear enough.

Wikipedia’s article on Prof. Endy cites his strong support for “open-source biology." The open-source philosophy presumes certain conditions that do not always exist. Suppose you went up to an old-style nineteenth-century entrepreneur-inventor like Thomas Edison, for instance, and said to him, “Mr. Edison, I think you ought to donate your invention of the light bulb to humanity for free, instead of patenting it and building a giant corporation called General Electric around it.” After he got up from the floor where he fell down laughing, he’d throw you out and probably call you a Communist to boot. But thousands of technically savvy people, including everybody who writes for Wikipedia, now do something that amounts to that every day, and the world hasn’t come to an end yet. The conditions that open sourcing requires include a bunch of smart people who have day jobs as professors, engineers, or members of other professions that allow them enough slack to do “free” work. Of course, their employers are indirectly subsidizing all this free work, and sometimes their organizations they work for benefit from it as well. There is a basically open-source microcomputer platform called Arduino, for instance, which is increasingly being incorporated in commercial products. So in the proper circumstances, the economics of open-source technology works well. But it seems to work best with things of value that are easily reproducible: software, for example, or other forms of intellectual property. On the other hand, open-source gold mining does not have much of a future, I don’t think.

We may be seeing a fundamental economic shift that is in a way a secular working-out of the Christian injunction that “to give is better than to receive.” After all, simply as a matter of mathematics, if everybody gave away only twenty percent of

what they get, and that twenty percent was judiciously distributed among the needy, we could eliminate poverty in short order. But it takes special circumstances to bring that about voluntarily, and doing it involuntarily (through taxes, for example) causes other problems.

Nevertheless, in software, and now maybe in synthetic biology, we have seen that people with both intellectual power and good hearts can be generous with their discoveries and not end up losing everything. It is a fragile arrangement, and hard times, or even just the perception of hard times, could make everyone pull their horns in and get selfish again, and the whole thing could come crashing down. But Prof. Endy and his BioBrick Foundation are to be congratulated for at least trying to get the trend started, and history will show whether they succeed.

***Sources**: The San Jose Mercury-News website carried the article "Biological computer created at Stanford" on Mar. 29 at* http://www.mercurynews.com/science/ci_22891433/biological-computer-creat... *[1] I consulted the BioBrick Foundation website at biobrick.org and the Wikipedia articles on "BioBrick" and "Drew Endy."*

Karl Stephan has worked in the industry as a consulting engineer. He currently teaches college-level engineering courses at Texas State University in San Marcos, Texas. This blog was originally posted at http://engineeringethicsblog.blogspot.com/2013/04/bil-gates-and-biobrick-foundation-new.html [2].

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[1] http://www.mercurynews.com/science/ci_22891433/biological-computer-created-at-stanford.%C2%A0
[2] http://engineeringethicsblog.blogspot.com/2013/04/bil-gates-and-biobrick-foundation-new.html