A Synthetic Community

Jonathan Stuart Ward
University of St Andrews iGEM Team 2010
jw497@st-andrews.ac.uk

September 16, 2010

Abstract

Synthetic Biology is touted by many as an "Open Source" science. Indeed there are many open source projects, including iGEM, which promote synthetic biology and attempt to foster a community around the field. This immediately draws comparison with the pioneers of open source: The Free Software movement and asks is it feasible both logistically and ethically for a more traditional scientific community to adopt an open source model.

1 Introduction

Community is pivotal to identity. Individuals are defined by the many forms of community of which they are members. The traditional sociological definition of community describes it as "a group of interacting people living in a common location"; however in the modern era whereby instantaneous communication is the norm community is more often referred to as "a group centered around a common set of principles, ideas or beliefs". This definition of community has truly come to fruition with the birth of the Internet age - the first globally accesible communities, formed in the early nineties, centered around the early adopters of Internet technology. The most advanced of these communities was and still is the Free Software community which has evolved from a close knit band of ex MIT evangelicals to a thriving global community with millions of active members. Two decades after the genesis of the Free Software community the seeds of another proto-community are taking root. Once again people at MIT are at the heart of this new open community, however this time different and greater difficulties must be faced.

2 Open Produce

Any successful global community thrives due to openness. Large communities shrouded in secrecy are doomed to failure as for community to grow and flourish it must be open and accepting to new members. In line with this the product of the community must also be open in order for the community to advance. For the well established Free Software community source code is its product. For the new and emerging synthetic biology community the BioBrick is it's key export. Like all good technological products the BioBrick is a well documented standard. However unlike the product of the Free Software community, the BioBrick is not pervasive. Source code is fairly ingenious in nature; it is human readable, logical, unambiguous and portable. A BioBrick conversely is a far more complex beast and lacks the mathematical elegance of source code. This is not to say the BioBrick is inferior to source code in a direct comparison - such a comparison would be entirely unfounded. As a product of a community, source code is ideal due to its pervasive nature and the ability of it to be understood. Outlining BioBricks as the key produce

of the synthetic biology community may be somewhat of a misnomer. The BioBrick is indeed the produce of the open portion of the synthetic biology community. However there is disassociation within the community as to correct form of standard biological part. There exists other standard part formats with alternative plasmids and restriction sites. The key defining feature of the BioBrick which other standard parts formats lack its position as an open standard. While there is contention that the BioBrick standard is not the best, it is however the most widely used and the most readily accessible. The number of individuals trained and untrained whom can understand source code outnumber those who can understand BioBricks 100 fold. This is not to imply that the synthetic biology community should choose an alternative or that they should even modify their product. It merely highlights a significant underpinning, that is that the synthetic biology community, due to it's product, will only ever be comprised of trained and educated scientists. This is traditional for a scientific community but synthetic biology contends to be different by employing open initiatives such as the OpenWetWare, The BioBrick Foundation, iGEM and The Registry of Standard Biological Parts. These projects seek to promote synthetic biology knowledge and research out with the traditional academic-scientific hierarchy. As such the synthetic biology community would present itself to be somewhat of a hybrid; a child born of academia and of Open Source ideology. Hence the synthetic biology community is partially open and partially concealed by the scientific-academic complex. This tight-rope walk is perilous and it is all too easy to fall down on the side of concealment, thus we may wonder how two seemingly diseparate identities can coexist, thrive and more so consider whether or not this form of community model is indeed sustainable.

3 Of Wizards and Merchants

In the Cathedral and the Bazaar, Eric Raymond's authoritative investigation into the Free Software community he defines two forms of open communities.

Cathedral The product of the community is freely available but development between releases of the product is restricted to an exclusive group.

Bazaar The product is developed via the Internet in full public view by a non exclusive community.

The earliest Free Software projects all followed the Cathedral model. The first large scale Free Software project, the GNU Project, is a prime example. So too do some of the open projects of the synthetic biology community. While this model still affords outsiders the fruits of the community's labour it does not grant the benefits of having a large and expansive pool of talent to leverage. It is the Bazaar model which has launched Free Software to the world stage. By enabling a constant influx of talent Free Software communities are constantly expanding and embracing new ideas. However this is something which the synthetic biology community is yet to facilitate. The synthetic biology community at present is a very traditional cathedral. The usual hierarchies of academia permeate the synthetic biology community, level of contribution to the community relies upon standing in the academic hierarchy and contribution from uninitiated outsiders is strictly forbidden. Given that this is highly unlikely to change it is evident that the synthetic biology community will never experience the precedented boom that the bazaar driven Free Software community experienced in the mid nineties; however would adopting a bazaar model advance the synthetic biology community?

4 Code and Codons

Software and biological organisms (save the analogies of many a lecturer) are scarcely equatable. Software is for all intents and purposes harmless. The primary ethical issues regarding software revolve around privacy, encryption, piracy, intellectual property and freedom of speech and many of these issues are purely philosophical in nature. Synthetic biology alternatively has far more pragmatic ethical issues; First and foremost synthetic biology deals with the engineering of life. As such there is a real and present risk of accidental or malicious misuse to produce harmful pathogens which could be hazardous to human health or the environment. Given this a far more considered approach must be taken with regards to the proliferation of synthetic biology than with software development. Consider for a moment the synthetic biology community if it were to follow a bazaar style model: The upper echelons of the community would largely remain unchanged, with the traditional kings of academia retaining their positions but the contributers, testers and developers who engineer synthetic organisms could and would come from out with the inner circles of the scientific community. While this may afford the synthetic biology community a near limitless pool of renewable talent and could well lead to many new discoveries and developments it would make regulating and controlling the access to sensitive materials and equipment virtually impossible. For this reason a bazaar style community for synthetic biology is entirely infeasible and irresponsible. This does not mean that an open source community centered around synthetic biology is doomed to failure - Far from it. It merely means that the models of community which were naturally developed by the emerging Free Software movement are not quite compatible with a more traditional scientific discipline. Thus any legitimate synthetic biology community must follow a different model. Although dedicated individuals will still attempt to develop synthetic biology projects in a bazaar model.

5 Rebels with a Cause

While the existing synthetic biology community largely centers around traditional academic institutes there are a number of sub groups which operate entirely outside of academia. Taking their name from the early pioneers of Free Software so called Biohackers are hobbyists experimenting with genetics and synthetic biology. Through the use of online sellers of DNA and less than scrupulous sellers of lab equipment these 'citizen scientists' are able to create impressive lab setups and work on their own synthetic biology projects. For many, biohacking is a fascinating insight into the biological world. For others it is a troubling example of the lack of regulation endemic to synthetic biology. If one is to ignore the ethical issues relating to amateurs gaining access to dangerous equipment and consider how successful biohacking is as a community the results are poor. While this is a harsh criticism for a community in its infancy it is, never the less, true. If we are to judge a community by its output - a very simple, but effective metric - the biohacking community has very little meaningful output. Similarly if we are to judge a community based upon its social cohesion and its vocality in sharing and expressing new ideas, the results are equally as dismal. While the biohacking community is relatively new and lacks any clear leaders or initiative to push it forward the sheer nature of the biohacking is likely what prohibits it. Being of dubious legality and suspect ethics the biohacking community is not well respected by the mainstream synthetic biological community. As such there is limited sharing of ideas, equipment, materials or talent between biohackers and mainstream synthetic biology. This lack of resources and lack of expert knowledge has effectively stifled a sub-community in its infancy. The only possible way for biohacking to survive and flourish is for it to be incorporated into the greater synthetic biology community. Otherwise biohacking, shrouded in controversy and safety issues is likely doomed to continued obscurity and eventual failure.

6 The Grass is Greener...

If we are to continue to identify distinct types of open source community then it bears notice that while elements of the synthetic biology community behave as cathedrals and others as bazaars the community as a whole is quite a different entity. Firstly while the development group is not entirely open to public involvement it is far from a Cathedral, initiatives such as iGEM inject new talent into the community and regular talent comes from the expansive pool of academia as opposed to a single elitist organisation or company. Secondly, while there are small bazaar like elements these are by no means representative of the community. Finally unlike the Free Software movement the synthetic biology community has a duty to protect the world from the risks associated with its work. For this reason I propose a third form of open source community, one which I feel represents the direction in which the synthetic biology community is moving in. This form of community is a Citadel - a city fortified against attack. Within the heart of the citadel lies the traditional forces at work, the hierarchies of science and academia preside over the town. On the outskirts of the citadel, beyond the wall lie the traders and mercenaries whom are occasionally permitted in the citadel for the benefit of the town. The wall, the key line of defence, separates the town from the outside world. This wall represents the levels of regulation - both self and external - which prevent the rouges and the scoundrels from raising the town within the citadel. This form of community is open, the citadel shares its wealth of knowledge with the villages out with the walls, however for the protection of the land it safeguards the knowledge against misuse. Hence:

Citadel The product of the community is freely available however the means to implement the product are restricted in the interests of safety and to protect the community against misuse of it's product.

This portrays the synthetic biology community quite accurately. At its heart it is predominately a collection of well ordered traditional academic and scientific institutes. Far from the center of the community are the biohackers and the would be students eager to learn and experiment. Crucially the city wall, consisting of layers of regulation, procedure and scrutiny, ensure the ethical conduct of all wishing to enter the citadel. This model of open source development safeguards against misuse and defends the project from the world and the world from the project. Hence it is the naturally developed model for open development in a science whereby the more conventional bazaar model raises serious ethical and safety issues.

7 The Future of the Kingdom

There is one quintessential problem with the citadel model and that is growth.The walls of the citadel protect the community from unwanted external influence however the wall also serves to bar the community from expanding quickly. For any significant synthetic biology research to be performed, individuals must be within the walls of the community in order to gain access to the necessary materials and equipment. Given that this is a requirement for success it stands to reason that the community can only grow in direct proportion to the available facilities. As this equipment is inaccessible beyond the walls of the community there exists the precarious situation whereby growth and success of the community is dependant upon finance. This is quite evident with the iGEM competition (a phenomenon on the periphery of the community) whereby success of an iGEM team depends highly upon the equipment and resources available to that team. Thus very much unlike the Free Software movement, the synthetic biology community will grow slowly and methodically rather than explosively. The success of the community will depend highly upon the abilities of the leaders of the core community to initiate the amateurs and the

promising talent into the heart of the community. Should the leaders of the community build the wall too high, the open community will slowly stifle. Similarly should the core community through either political or financial motivations bar access to potential talent the open nature of the community will again be placed in jeopardy. The only way to ensure the continued success of an open synthetic biology community is to maintain a leadership dedicated to openness and transparency and to ensure adequate funding to current and future projects to embrace potential talent.

8 Conclusion

The synthetic biology community is lauded by both proponents and the media as being an open source community. This is indeed the case but most definitely not in the same manner in which the traditional Free Software movement is open. The primary reason for this is that the synthetic biology community for reasons of ethics and safety cannot be all embracing. Instead the community must regulate itself, it must act as the proverbial citadel. To embrace the uninitiated talent but shield itself from those who could do harm. The synthetic biology community will in the future continue to slowly expand, with individuals joining the core community as alumni of initiatives the likes of iGEM, DIYBio and OpenWetWare. The risk for the synthetic biology community is in building its wall. In finding the right means to both exclude rouge elements and embrace new and exciting talent. Shou

9 Further Reading

- iGEM `www.igem.org`
- Nature Article on Synthetic Biology `http://www.nature.com/msb/journal/v2/n1/full/msb4100073.html`
- The Free Software Foundation `www.fsf.org`
- DIY BIO `diybio.org/`
- University of St Andrews iGEM Team `2010.igem.org/Team:St_Andrews`