Synbio Infrastructure & Platforms

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How can we support pre-competitive activities in biotechnology? What infrastructure is critical to collaborative efforts? What are potential organizational models?

Synthetic Biology (SynBio) is characterized by a bottom-up approach to designing biological systems for specific purposes (Endy, 2005). In 2014, the European Commission defined the field as "the application of science, technology and engineering to facilitate and accelerate the design, manufacture and modification of genetic materials in living organisms". It is a young field, but is now a global endeavor with research and development programs in many countries around the world. The ability to rapidly engineer organisms in laboratories by combining molecular biology tools with engineering principles holds "vast potential for the bioeconomy, and could dramatically transform high-impact fields such as agriculture, manufacturing, energy generation, and medicine." (USA National Bioeconomy Blueprint 2012).

SynBio is unique in its highly multidisciplinary nature and that by 'making biology easier to engineer' it also facilitates 'the contribution to scientific innovation from people who are not considered as professional experts in the traditional sense' (Zhang 2012) including students, citizens and entrepreneurs. In this unique context, how can we support pre-competitive activities in biotechnology? What infrastructure is critical to collaborative efforts? What are potential organizational models?

A highly successful example of organizational model to foster synthetic biology is the iGEM competition in which hundreds of student teams from around the world work on SynBio projects, gather at MIT to showcase their achievements and make their work freely available on an open-source database. A searchable map of the hundreds of projects that have been done by students around the world was recently published (www.synbioconsulting.com/igem-synthetic-biology-map/). Since 2004, iGEM has played a crucial role in the '''social'' engineering' of the upcoming generation of young scientists. iGEM 'is seen to have significantly promoted a global open-access culture', and by integrating so-called 'human practice' work in all projects it 'also facilitates global exchange and dissemination of concerns over biosafety, biosecurity, IPR, ethics and public engagement'. Many nations, including China and the UK see iGEM as a strategic move to promote domestic progress in the life sciences (Zhang 2012). Much has to be learnt from this incentive driven approach to fostering the growth of synbio which makes learning and contributing to innovation engaging and rewarding.

Distributed innovation through gamification has shown a lot of potential to improve bioliteracy and contribute to the development of synbio. In other life science fields, games such as Foldit and EteRNA have been highly successful in capitalizing collective intelligence to answer fundamental questions about protein and RNA folding respectively, while simultaneously educating the players. In both games, players have matched and outperformed state of the art algorithmically computed solutions (Cooper 2010; Lee 2014). This approach has yet to be adapted for synbio but could provide an incredible tool to foster bioliteracy and constructive dialogue between actors.

Synbio entrepreneurship is still in its infancy**.** An overview of the different small and medium companies involved in the field is provided in the following link (SynbioProject map: http://www.synbioproject.org/sbmap/). Beyond possible regulatory burdens, education and access to seed funding would foster synbio entrepreneurship greatly. Nowadays, graduate programs are still geared towards tenure track in academia and do not reflect the reality of the work place. Data published in the National Science Board's 2014 Science and Engineering Indicators show that a mere 29% of newly graduated life science PhDs (2010 data) will find a full time faculty position in the US. It is high time to introduce entrepreneurship and management skills (amongst others) into graduate programs. Beyond training, access to specific seed funding to kickstart companies is essential. Startup incubators such as YCombinator and Indie.Bio have recently been bringing a lot of fresh air into the synbio startup ecosystem by providing both support and founding.

From distributed innovation to gamification, and from entrepreneurship to science education, new organizational models are bound to revolutionize synbio. A collaborative effort should be made to foster the responsible and efficient growth of the field. In this process, knowledge should be exchanged and co-created between actors, and attention should be paid to embedding this new knowledge to minimize the mismatches between science, technology and their applications or uses (Roelofsen 2011) — in order to efficiently sprout new green bio-economies around the World.