

European do-it-yourself (DIY) biology: Beyond the hope, hype and horror

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The encounter of amateur science with synthetic biology has led to the formation of several amateur/do-it-yourself biology (DIYBio) groups worldwide. Although media outlets covered DIYBio events, most seemed only to highlight the hope, hype, and horror of what DIYBio would do in the future. Here, we analyze the European amateur biology movement to find out who they are, what they aim for and how they differ from US groups. We found that all groups are driven by a core leadership of (semi-)professional people who struggle with finding lab space and equipment. Regulations on genetic modification limit what groups can do. Differences between Europe and the US are found in the distinct regulatory environments and the European emphasis on bio-art. We conclude that DIYBio Europe has so far been a responsible and transparent citizen science movement with a solid user base that will continue to grow irrespective of media attention.

Keywords:

■ amateur science; art and design; biosafety; democratization; DIYBio; open access; synthetic biology

Synthetic biology and do-it-yourself (DIY) biology

Synthetic biology (SynBio) is the attempt to make biology easier to engineer [1]. As the technology advances, SynBio is expected to become simpler and easier to use than traditional genetic engineering. Thus, the advent of SynBio will also broaden the user

base well beyond academic institutions and industry. It will attract new players (amateur biologists) into a field traditionally reserved for highly trained professionals [2–4]. Amateur research societies have been founded in many scientific disciplines (e.g. electronics, information technology, astronomy, spaceflight, agriculture). These amateur movements are important in encouraging public engagement with science.^{1,2} DIY biologists (or “biohackers”) are “individuals who conduct biological experiments as an avocation rather than a vocation” [5]. They are most likely to be individuals who are highly curious about the scientific principles

and/or methods being used. There are probably over a 1,000 amateur biologists worldwide with interests in DNA sequencing, microbial screening, environmental monitoring, or applications for health care and energy [6]. The leading group is DIYBio.org, a community with more than 2,000 registered members in more than 30 countries [7]. Currently, most of these DIYBio groups are focused on education, teaching members basic knowledge via seminars, workshops, and hands-on activities.³ Some DIYBio groups have built “community labs” [8, 9].

The following features characterize DIYBio:

- (a) Interdisciplinarity.
- (b) Primarily a not-for-profit endeavor.
- (c) Design and use of cost effective tools and equipment (see Fig. 1).
- (d) Focusing on open source and open science innovation, thus positioning itself as an alternative to so called “Big Bio”.
- (e) Democratization and self-empowerment as the biggest difference to conventional research activities.

Generally speaking, the majority of the amateur biologists are often highly creative, curious, and likely to “think outside the box” [5]. Despite the potential achievements of amateur scientists, DIYBio raises concerns, mainly in the areas of research safety, the safety of potential products, risk to public health and environment, dual use research issues (biosecurity) and the ethical

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¹ See <http://www.openspaceuniversity.org/#!rocketchallenge/c22xk>.

² See <http://www.budgetastronomer.ca/>.

³ See <http://diybio.org>.

and social implications of the projects [4, 10]. The DIYBio movement has been reported in the mainstream media, mostly in an exaggerative manner, highlighting its hope, hype, and horror. While the press seems to consistently overestimate the capabilities of biohackers and underestimate their ethics [11, 12], synthetic biologists barely take DIY biologists seriously, calling them unsophisticated and far from cutting edge [8, 9]. What seems to be missing is a factual assessment of DIYBio beyond the hope, hype, and horror.

So far, no study has been carried out to provide an up-to-date analysis of the background, structure, motivations, and aims of the European DIYBio groups. Here, we investigate and reflect on the European amateur biology movement to find out who they are, what they aim for and what similarities and differences can be found with respect to US groups (see Box 1).

DIYBio Europe: A network in the making

In less than five years, a lively DIYBio network has been established in Europe.⁵ Personal interest, passion, commitment, the scientific background of the founders, and leadership skills have played a highly significant role in the shaping of the practices and development of DIYBio in Europe. Here are some examples:

One of the first European groups, *La Paillasse*,⁶ was established in Paris in 2009. The approach and development of *La Paillasse* was largely rooted in the leadership of the founder; a PhD student in SynBio and former iGEM participant, together with the help of his fellow teammates; members of hacker-groups like tmp/lab and Electrolab, and experienced scientists from institutions like *La Gaité Lyrique*, and *Genopole* [9]. With the help of his experience in biology, and in-kind donations of lab equipment, he was able to set up the *La*

Box 1

Comparison between European and North American groups

The *DIYBio movements* in the US and Europe have a lot in common. Beliefs in the democratization of science and the enabling of citizens to do biotechnology are shared by all groups on both sides of the Atlantic. In general, they have more in common than what sets them apart. However, there also seems to be aspects where the groups in the US and Europe differ from one another.

In contrast to the USA (minding different state legislations), the groups in Europe need to obtain a license in order to carry out genetic engineering experiments. So far, the European groups have not done these types of experiments, but some of them plan to go through the licensing procedure and obtain a license. As an exception, the UK-Netherlands based C-LAB art collective did obtain a license to exhibit a bioart work with living genetically modified organisms in London, UK (<http://c-lab.co.uk/projects.html>). The work itself, however, was done in collaboration with a university research lab.

In the US, some groups showed interest in DIY medicine as an alternative to the established health care practices. Such attempts are rare in Europe and rather focus on helping people in developing countries [17].

In general, the activities of DIYBio and the maker culture uncover the societal gaps, niches, fissures, and

challenges created by the local economic, cultural, and political circumstances in sensitive areas such as health care and food safety.

Yet another difference relates more to the different socio-political environment that the groups are embedded in. In the US, at least since the 9/11 incident, there is a strong focus on bioterror and biosecurity, whereas in Europe the focus is much more on biosafety, as a direct consequence of the GM-food debate [18]. It comes as no surprise that the DIYBio groups in the US have had to address critical biosecurity issues and are monitored by the FBI, while the European groups have received only little (publicly visible) attention by the European (national) law enforcement agencies. In recent years, however, the remarkable division over safety and security as the main concern is fading away (see the Code(s) of Ethics),⁴ with US groups highlighting safety concerns and European policy makers considering biosecurity governance measures of amateur biology [19].

A rather surprising finding, compared to the US, is a stronger collaboration of amateur biologists with artists and designers in Europe. It remains to be seen whether this observation is only due to the small sample size of groups, or if the art-science interaction is a real European characteristic.

Paillasse lab. The lab is relatively well equipped and fully functional, capable to host a number of diverse projects and to carry out genetically modified (GM) food testing and more. Currently, activities in the *La Paillasse lab* are limited due to regulations regarding GM organisms. *La Paillasse* has started the process to obtain a license that will allow them to make full use of the technical, scientific, and creative potential of their lab [8, 9].

BiologiGaragen was founded by three students in Copenhagen in 2010, as a part of *Labitat* (a successful, vibrant makerspace⁷). *Labitat* and *BiologiGaragen* share their space, equipment, and knowledge, opening up a lot of

⁴See DIYbio Code of Ethics from North American and Europe: <http://diybio.org/codes>.

⁵See <http://www.diybio.eu/european-diy-bio-network/>.

⁶See <http://www.lapaillasse.org/>.

⁷A makerspace is a community workspace where people gather, socialize, and collaborate on computers, technology, and science projects [13]. See e.g. <http://dallasmakerspace.org>.

makerspaces like tmp/lab, Electrolab, or Labitat, provide(d) support (space, equipments, funding) to start workshops, hold exhibitions and help projects become fully operational. The more successful groups in Europe have also managed to get support from established institutions (e.g. museums, research institutions) in terms of space and equipment.

DIYBio groups in Europe are predominantly the result of the push by a few highly motivated individuals that frequently work or study in the area of bioscience or information technology [16]. Lack of dedicated leadership can result in the shutdown or inactivity of a group [9].

Observing the DIYBio groups in Europe, one might ask if the movement is a rather short-lived fashion, a reaction to the *Zeitgeist*, or if the groups, the structure of the community and the commitment of the key players are sustainable and long term [16]. Our assessment is that DIYBio in Europe is here to stay, with new groups emerging across the continent and established groups growing in participants, projects and sophistication. The hype generated in the media around “biohackers” in the past years has brought a lot of attention to amateur biology. However, the groups are based on the solid work done by a dedicated core of enthusiasts.

There are few indicators to see DIYBio as a test-bed for biotechnology start-ups since its main goal is to provide non-profit, open source and open access biotechnology. Few DIY groups in Europe attempt to commercialize their products or skills, but prefer to provide research tools and protocols for the public. The impact on the future bioeconomy, however, should not be ignored. Not only does DIYBio level the playing field between experts and the public, it might also help to introduce a new culture of makers, sparking a greater and more common interest in biotechnology.

The combination of DIYBio and crowdfunding may have far-reaching consequences since future research projects can circumvent traditional funding sources and their established power structures. Therefore, it challenges established power constellations and perhaps will shape completely

different focuses in research. The *Glowing Plants* project at kickstarter.com illustrates the different aspects of this potential.¹¹

Research objectives that have been left aside because of economic reasons, or which were considered as trivial, pointless or even unethical, can gain in importance as the financial and symbolic support increases and reaches a critical amount. Decisions on the meaning and the importance of innovations and liabilities are partly shifted to a non-expert public sphere. Not only could this process lead to cheap and accessible (medical) solutions, but when it comes to financial support and public awareness, it also creates a levelling process where, for example, cancer research can find itself face to face with projects rooted in pop culture. With this backdrop, a variety of small and dynamic research projects in collaboration with small communities, companies, or NGOs are possible. This initiates new production relations and methods, articulated by the exchange of and access to knowledge, for example, through open source systems, expertise exchange initiatives, patent pools, and open licensing. With the inclusion of the general public, designers, and artists, we might see the establishment of a participatory innovation process beyond the current producer-consumer distinction.

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