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Innovation regimes based on collaborative and global tinkering: Synthetic biology and nanotechnology in the hackerspaces

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ABSTRACT

Typically nanotechnology and synthetic biology are discussed in terms of novel life forms and materials created in laboratories, or by novel convergences of technologies (ICTs and biological protocols) and science paradigms (engineering and biology) they initiated. Equally inspiring is their ability to generate novel institutions and global communities around emergent sciences, which radicalize the forms of public engagement and ethical deliberation. We are starting to witness alternative (iGEM competitions) and almost underground R&D engagements with Synthetic Biology (DIYbio movement), which inspired the emerging bottom-up involvements in nanotechnologies in projects, such as the NanoSmanoLab in Slovenia. These bottom-up involvements use tinkering and design as models for both research and public engagement. They democratize science and initiate a type of grassroots "science diplomacy", supporting research in developing countries. We will discuss several recent examples, which demonstrate these novel networks ("Gene gun" project by Rüdiger Trojok from the Copenhagen based hackerspace, Labitat.dk, the "Bioluminescence Project" by Patrik D'haeseleer from Biocurious biotech hackerspace in Sunnyvale, CA, and the "Biodesign for the real world" project by members of the Hackteria.org). They all use design prototypes to enable collaborative and global tinkering, in which science and community are brought together in open biology laboratories and DIYbio hackerspaces, such as Hackteria.org or Biocurious. In these projects research protocols encompass broader innovative, social and ethical norms. Hackerspaces represent a unique opportunity for a more inclusive, experimental, and participatory policy that supports both public and global involvements in emergent scientific fields.

1. Introduction

Synthetic biology and nanotechnology are discussed in this paper in terms of their ability to "design" and generate original social and institutional support for their research and development. This is a direct expression of the innovative forms of ethical deliberation, which professional scientists, but also science amateurs and hackers embrace in their projects. Design and tinkering are essential for understanding these present practices operating on various scales, from the molecular to the social, which create unique interactions between social customs, ethical norms and scientific and technical protocols, which we discussed in our paper of NanoSmanoLab in Slovenia [1]. The amalgams of norms and protocols, which we are starting to witness around DIYbio and similar efforts, are basically prototypes enabling collaborative and global tinkering, which we will discuss with examples.

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The complex relation of synthetic biology and nanotechnology to both science (biotechnology, systems biology, bioengineering, genetic engineering) and society (ethical, legal, social, but also ontological and philosophical issues) can be summarized as an issue of convergence and hybridity, in which design plays a central role. The convergence between biology, computer science and ICTs enables synthetic biology to envision and "design" artificial and hybrid life displaying new traits not existing in nature. By applying design as well as engineering principles and techniques, synthetic biology synthesizes unique life forms, "LEGO" like bio-molecular components from which minimal and de novo organisms are produced, or configures and redesigns existing organisms [2]. Whether it is this bottom up (creating new living forms from basic components) or top down approach (so called "chassis", tweaking the genetic circuits and biochemical pathways of existing organisms), the art of designing life by "playing" or even "outwitting" both God and evolution incites unique normative and ethical responses. Synthetic biology goes often beyond the common, deontological or utilitarian calls for anticipatory policy, risk assessment, code of ethics or legal and ethical prudence. It incites rethinking of ethics and policy by supporting experiments with new ways science is performed and practiced in the present, institutional settings.

The converging and hybrid aspects of synthetic biology created their own ways of ethical inquiry and deliberation, which also enabled novel and more inclusive forms of public engagement in science. We will describe them as "experimental", "process" oriented and design inspired approaches, such as the well-known SynBERC "human practices" [3], DIYbio "codes of conduct" [4], but also less known "ethobricks" [5], and calls for "reflective equilibrium" models of justification [2,6], interdisciplinary and interactive "socioethical engagements" [7], "upstream engagements" [8,9]. All these attempts connect the research protocols in direct and novel ways with ethical norms and embody the ideal of "technologies of humility" and the "participatory turn of science studies" [10]. Their aim is to enable involvement of the various stakeholders and citizens in the whole research process from discovery to testing and policy making.

In this paper we discuss how these unique interactions between ethical (social) norms and scientific protocols, between values and facts, relate to design and tinkering and how they define present citizen science labs and hackerspaces. These convergences between social and ethical norms with scientific protocols (but also institutional customs, policy regulations, and laboratory facts), in projects such as DIYbio "codes of conduct" [11] or Paul Rabinow's "human practices" [3], all emphasize tinkering and design as models for both science and experimental forms of ethical deliberation and decision making. These spaces and projects engage both experts and lay people in science by exploring new ways of connecting scientific practices and techniques with society, culture and nature. Furthermore, they enable alternative global networks for knowledge creation and sharing, which support research in developing countries by performing the potential of open science approaches.

The experimental models of ethical deliberation and regulation are often dismissed out of hand. It is claimed they are just another attempt to formulate professional codes of ethics leading to "scientist-centric ethics" [8] or "scientific self-regulation" that presumably are symptoms of deregulation, demise of governance and commercial pressure [12]. This paper proposes a very different perspective on these unique interactions between codes, norms and protocols, emphasizing their experimental potential in deliberation and public participation in science and their potential to create new networks of knowledge transfer. We will argue that rather than simplifying complex ethical issues or playing safe, they create opportunities for various stakeholders to take part in both research and assessment and to experiment with science and society, knowledge and policy.

The unique interactions and convergences which we are starting to witness in the hackerspaces around the world between scientific practice and community building [13] lead to a more resilient, democratic and experimental model for acting and decision making. These experimental collectives probe various relations and scenarios around emergent technologies, and they connect policy and design under what will be described as cosmopolitics [14]. The cosmopolitical forms of public participation and deliberation, instead of separating powers and domains of knowledge and acting, policy and research, ethics and science, human agency and non-human matter, involve the various powers, actors and communities across scales and ontologies. We observed these experimental involvements of various actors and scales in several hackerspace projects, which we will describe at the end of the article, after we discuss the importance of design in the present convergences of protocols and norms. The novel innovation regimes are defined by collaborative and global tinkering, which brings together policy, science and design to create unique opportunities for public participation in science and in support of research in developing countries.

2. Designing, tinkering, making and deliberating

The pursuit of new forms of life and matter in synthetic biology goes hand in hand with the pursuit of testing and experimenting with new hybrid institutions and tentative forms of regulation. Design plays an important role in the various alternative engagements with both synthetic biology and nanotechnology. It summarizes well the unintentional, serendipitous and somehow opportunistic processes of both scientific discovery as well as ethical deliberation, and is also present in the definitions and descriptions of synthetic biology per se. For example, "SynBERC" (Synthetic Biology Engineering Research Center) and related "Keasling laboratory" websites explicitly define synthetic biology as a "design and construction of new biological entities" [15] and "redesign" of natural living systems, which will "simultaneously test our current understanding, and may become possible to implement engineered systems that are easier to study and interact with"[Ibid].

These definitions of synthetic biology as design basically state that theory merges with practice when concepts and