

From bicycles to synthetic biology – A discussion with experts and locals from Karlsruhe about innovation and responsibility

Karlsruhe, 16.09.2015. New technologies have often been accompanied by fear and skepticism on the part of the public. When the first bicycle was constructed by the German inventor Karl Drais from Karlsruhe in 1817 – in response to the need of alternative transportation after a shortage of horse feed – serious concerns were expressed about the health risks of driving the “Draisine”, as it was called. Would the risk of losing balance or crashing be too high, or would the sense of balance allow us to cope with this new way of moving?



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From bicycles to synthetic biology – under this heading the Institute for Technology Assessment and Systems Analysis (ITAS) at the Karlsruhe Institute of Technology (KIT), in collaboration with the Centre for Cultural and General Studies (ZAK), organized a public discussion on chances and risks of synthetic biology. The audience was invited to ask questions, but also to take a seat next to the experts on the podium: the philosopher Dr. Joachim Boldt, Director of the Institut für Ethik und Geschichte der Medizin (Department of Medical Ethics and the History of Medicine), Freiburg University; Christopher Coenen, Synenergene Coordinator and political scientist from ITAS, and Dr. Michael Liss, research and development group leader from Thermo Fisher Scientific, a globally acting company designing and selling nucleic acid sequences, e.g. synthetic genes, among other activities. The evening was the third in a series of participatory events in Karlsruhe, after a theater play and a public screening of films from the Bio-Fiction film festival (<http://synenergene.eu/resource/bio%2B7fiction-science-art-and-film-festival-report>), all aiming to engage the public in the debate about synthetic biology.

A short introductory video started the discussion, showing interviews with people from Karlsruhe being asked: “What is synthetic biology?”, “Is it good or bad?”, or “Should politics regulate the technology?” The answers were in line with previous studies showing that awareness of synthetic

biology is low and that it is associated primarily with genetic engineering of plants. Some people acknowledged the possible usefulness of genetically manipulated plants for human needs whereas others rejected genetic engineering in principle or because of the Christian belief in creation by God. Is synthetic biology an expression of the progress and diversification of scientific fields, a mere PR label that may help to raise funding, or a chance to constructively restart the debate on genetic engineering? The discussants suggested different reasons to explain the use of the new term "synthetic biology". Michael Liss emphasized the new aspect of construction in biology, after the phase of description, in analogy to the emergence of engineering in physics. Examples for this new way of doing biology are applications like the production of the antimalarial drug artemisinin in yeast, made possible by transferring the metabolic pathway from *Artemisia annua*, a slow growing plant naturally producing this chemical, into yeast cells. Furthermore, synthetic biologists try to produce fuels from renewable sources such as algae or speed up traditional vaccine production, using naturally occurring genes in new combinations and modifying them to improve desired functions of organisms. Joachim Boldt sees a new attitude towards biology: looking at organisms as if they were tunable machines. However, he also sees synthetic biology and its aims mainly linked to single-celled organisms like bacteria or yeast, whereas potential applications of synthetic biology in humans were too futuristic to transform our perception of being human in the near future.

According to a teacher in the audience who told the discussants about his students' questions, the public is indeed interested in the question whether scientists will not only modify, but create life in the next 50 years, including humans. Michael Liss tried to dispel concerns in this direction by assuring the audience that research would try to understand organisms by reconstructing parts of them, and that a *de novo* creation of organisms was no purpose of its own. However, in view of recent experiments with the novel genome-editing tool CRISPR/Cas9 on human embryos, the modification of human life does not seem so far away any more. Although such an application is banned in Germany and many other countries, the experiments as such clearly create unease, and the audience asked what was known about ongoing research in countries like China, where the embryo study was conducted. Indeed, not all countries have as strict laws regarding such research as Germany, and the attitude towards genome modification and reproductive techniques differs between nations, as seen in previous discussions, e.g. about the cloned sheep Dolly. Scottish-born Prof. Dr. Caroline Y. Robertson-von Trotha, Director of ZAK and curator of the discussion event, pointed out that Germans might be more skeptical towards synthetic biology compared with other nations due to a collective fear of new technologies, called "German angst" in the Anglo-Saxon language area.

The audience expressed mistrust in the power of regulation and law even in Germany when it comes to the practical implementation of ethical standards, pointing to examples of surrogate motherhood and surplus production of embryos during in vitro fertilization. Both is banned in Germany but cannot be prevented due to pragmatic reasons or lack of control, e.g. when the procedures are partly implemented in other countries. So the next dilemma is that laws can be bypassed. However, a ban on research was not seen as a solution, neither by the experts on the podium nor by the questioners from the audience.

Further questions were raised about investments in research and health care. Should basic research be valued as a cultural practice (as emphasized by one of the experts), or is only application-oriented research justified? Is it a moral obligation to develop novel therapies based on syn-

thetic biology in view of the potential to cure disease in spite of the ethical dilemma when balancing it with the associated risks? Or should money rather be invested in less technological solutions for our problems, e.g. good payment for clinicians and nurses, than in research on novel therapeutics which has an unpredictable outcome?



Picture: © ZAK/Felix Grünschlöss

A related issue relevant to the audience was who will profit from progress in synthetic biology. Is there a threat from big companies who could monopolize the field, like it happened in plant gene technology with Monsanto and Syngenta? Michael Liss could not give a definitive answer to that question and argued that ideas and potential applications, on the one hand, and their commercialization, on the other, should be considered separately. He gave the example of Google, which has a monopoly on certain Internet services, not due to the Internet or the stream of data as such, but rather due to how they commercialize their Internet-based services. Also in relation to agricultural applications of synthetic biology, one participant asked whether the influence of, e.g., genetically modified corn was assessed in advance by an interdisciplinary team of scientists from biology, ecology and meteorology. Is that even possible, given the complexity of nature and the interaction of organisms with each other and the non-living world? Michael Liss expressed the view that compared to other technologies the release of genetically modified organisms represents an almost negligible part of the overall influence of man on earth.

Despite all these concerns, the audience seemed curious about what is actually going on in daily synthetic biology research and to know how the work is organized. The handling of synthetic biological material – the question whether newly produced synthetic organisms are destroyed, stored or their generation is just documented – was also of interest, probably again due to concerns about the spread of genetically modified organisms and its impact on the environment.

There is probably a lack of real-world images to convey the fascination of science. The scientists' work is not easy to communicate, or at least it is not spectacular enough to attract large media coverage, as it consists in large parts of, as Michael Liss put it, "pipetting small volumes of liquid from one tube to the other". Molecular biology comprises reactions invisible to the human eye, but there is a chance to convey its fascination through computer-animated films. Demystification

can build trust, e.g. by showing that not every lab doing synthetic biology automatically manipulates human embryos, that this kind of work is laborious and sometimes dull, and that it is definitely not just for fun – as media reports of glowing rabbits and the like may sometimes suggest.

The closing point of the discussion was triggered by the question from the audience as to how to include people from other cultures and religions in the debate. Christopher Coenen and Caroline Robertson-von Trotha suggested that there are two prerequisites for an open, but not entirely emotion-driven debate: on the one hand the willingness of researchers and policy makers to include different value systems and world views, on the other hand a rational information basis on the side of the public. It is clear that this will take time and effort – on both sides. Opportunities must be taken already in school, when youths have time to spend on those issues and are most eager for knowledge, curious and open-minded. A prime example seen this evening was an ethics teacher asking the questions that his students had asked which he, in his own words, lacked the expertise to answer adequately. Things have become more complex since the times of Carl Drais. One critique from the audience was that videos could have been used to give a better understanding of this difficult technology. However, it is a balancing act to mix technical and scientific input and discussion in the right proportion. In view of the fact that probably all frequently raised issues around synthetic biology were touched in the discussion, but most of them could not be discussed in depth in just 1.5 hours, a strategy worth considering is to focus on one sub-topic, e.g. distribution of benefits from synthetic biology or regulations in research. This might allow more time to be spent on informing the public about a topic in advance, and to reflect on and answer their concerns and critical questions in more depth.

Although the discussion covered the whole breadth of ethical questions, it was very well-structured and gave the attendants the opportunity to bring in their views and express their concerns in an open and relaxed atmosphere. A short feedback of the audience on their change in knowledge and attitude towards synthetic biology will be evaluated by researchers from ZAK, and the entire discussion will be made available on YouTube (<http://youtu.be/TSvzyVJQn2U>).

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