

Splicing boundaries: The experiences of bioart exhibition visitors

by Wolfgang Kerbe and Markus Schmidt

© ISAST

Wolfgang Kerbe, Biofaction KG, Grundsteingasse 36/41 1160 Vienna Austria,
kerbe@biofaction.com

Dr Markus Schmidt, Biofaction KG, Grundsteingasse 36/41 1160 Vienna Austria,
schmidt@biofaction.com

Abstract

Bioart can cross the line between the scientific domain and the domain of arts and it may touch the boundary between the living and the non-living. This study asks how visitors of a bioart exhibition experienced the hybrid aspects of this form of art. Semi-structured interviews were held with 119 visitors of the “Synth-ethic” exhibition in Vienna, Austria, in May and June 2011. Analysis shows that for a majority of the visitors the use of bacteria and lower organisms does not pose an ethical problem, whereas integration of higher animals or even humans into the artwork is not readily accepted.

Introduction

Aim of the Study

The aim of this study was to find out about the gallerygoer’s response to a bioart exhibition.

It tried to answer the following research questions:

1. How do gallery goers judge the use of living organisms in the art exhibits?
2. What role does the issue of boundaries play in the reception of the ethical aspects of the bioart exhibition?
3. How do people experience disciplinary boundaries in the artwork concerning the art/science interface as well as the scientific disciplines involved?

The bioart exhibition “synth-ethic”

“We hope to provoke our visitors to reflection with this intriguing exhibit, whose meaning may not be apparent at first but perhaps at second glance.” [1]

The bioart exhibition “synth-ethic” [2] was hosted in the Museum of Natural History in Vienna, from May 13th to June 26th 2011.

“synth-ethic” assembled 10 contemporary artists, who in recent years begun to employ laboratory methods and biotechnology for their own purposes in new contexts and to modify living systems. The artworks were curated under the broad theme of synthetic biology (SB), the aim of which is not only to modify existing organisms, but to design or

even create life anew. The aim of SB is to make biology easier to engineer, by applying engineering principles to biology. Although it is still early days for SB, the potential consequences of this science and engineering field call for an ethical engagement. The exhibition "synth-ethic" offered perspectives on human intervention in biotechnology and the responsibilities that arises with it. Artists appropriated these technologies for their own purposes, seeing through the mania of novelty, behind the engineering mantra and beyond the constraints for an economic return of investment. The artwork presented in the exhibition examined a number of boundaries at the intersection of molecular biology and ecology, architecture and biochemistry, technology and nature, as well as cybernetics and alchemy [3].

The exhibition featured 10 artists, see Figures 1-10 [4]:

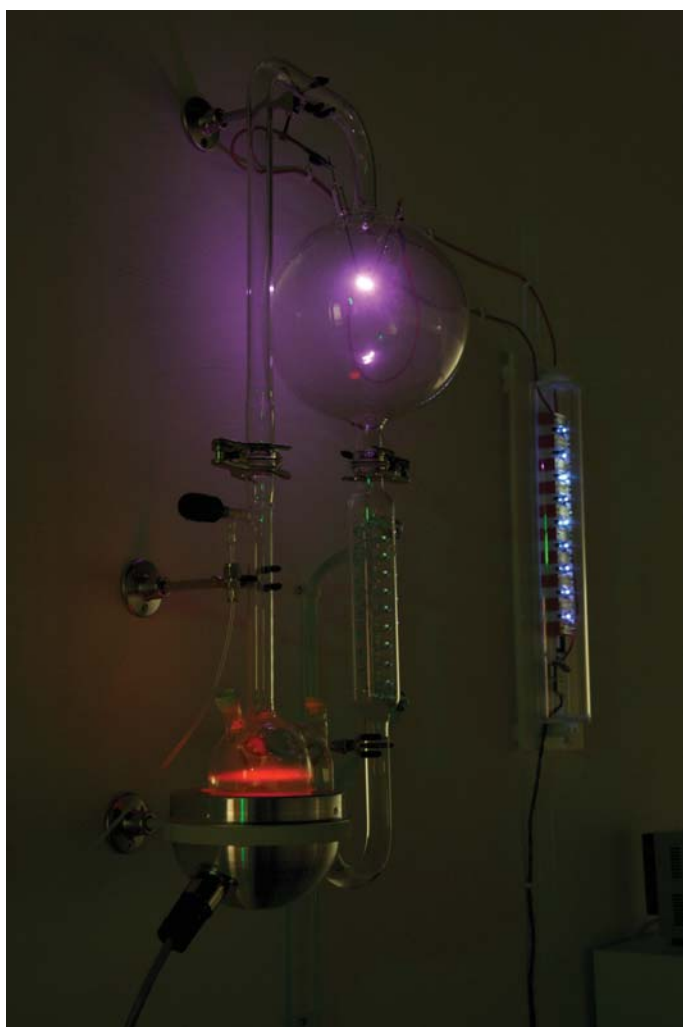


Fig. 1. Adam Brown and Robert Root-Bernstein: Origins of Life: Experiment #1.4 [5] The artist re-enacted the famous Urey/Miller Experiment in an aesthetic gallery installation. Instead of an early atmosphere Brown and Root-Bernstein attempt the synthesis of organic molecules in contemporary air in the presence of seawater and induced by electric sparks. (© Adam Brown)

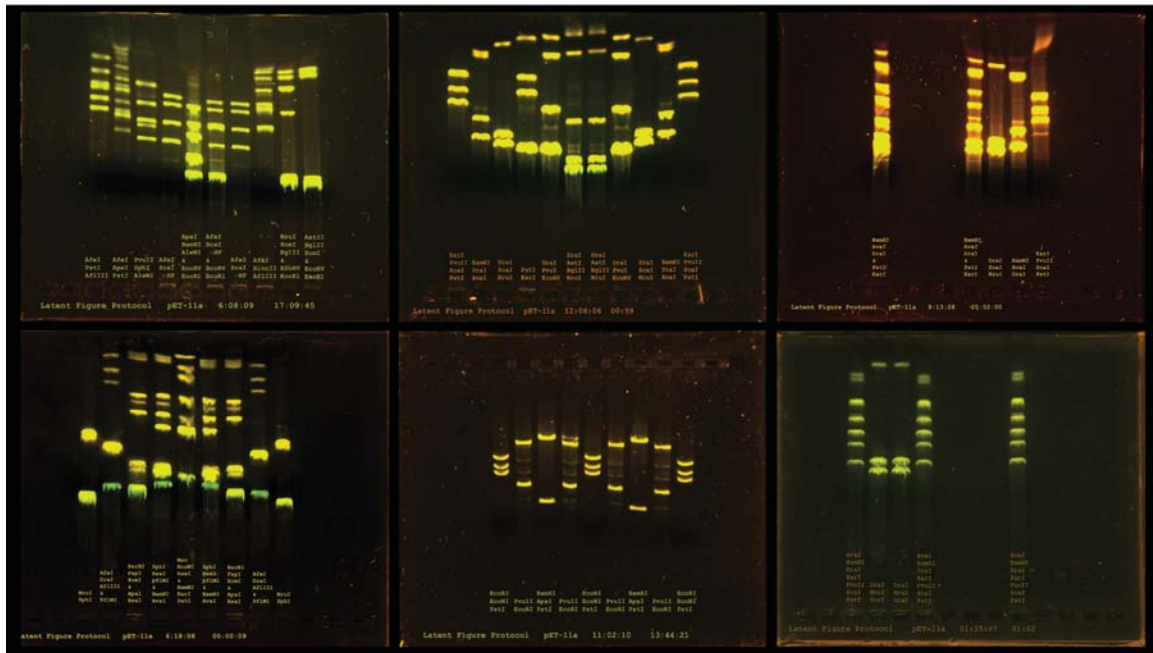


Fig.2. Paul Vanouse: Latent Figure Protocol [6]

Latent Figure Protocol represents manipulations of so-called “genetic fingerprints”. By using analytic laboratory methods Vanouse synthesizes significant motifs such as the copyright symbol or the “skull and crossbones”. (© Paul Vanouse)



Fig.3. Roman Kirschner: Roots [7]

As an analogy to the ideas of the French scientist Stéphane Leduc, who coined the term “synthetic biology”, Roots is an installation that presents the resemblance of inorganic crystal growth with the properties similar to organic life forms. With the help of electric current Kirschner creates a four-dimensional crystal object in liquid solution. (© Roman Kirschner)

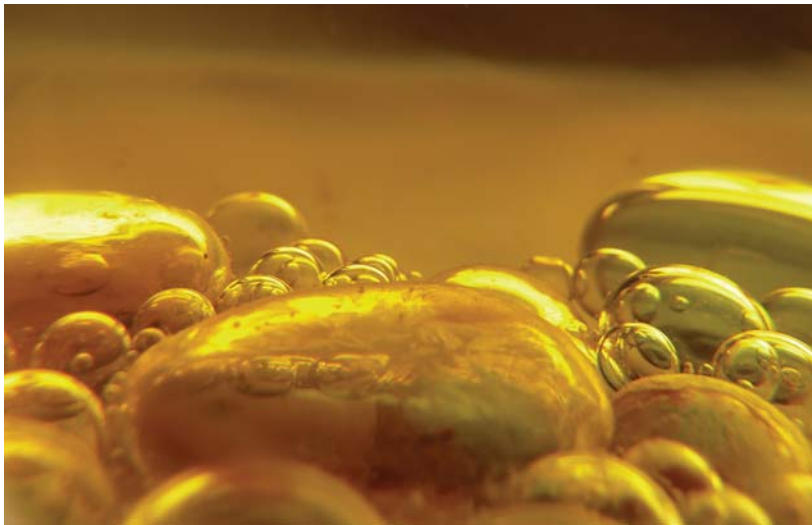


Fig.4. Rachel Armstrong: Living Chemistry & A “Natural History” of Protocells [8] Living Chemistry explores the emergence of protocells or giant vesicles at the interface of oil and water and their complex behaviors, whereas the short film “A “Natural History” of Protocells” presents these protocells in anthropomorphic “action” with imaginary subtitled dialogues between these entities. (© Rachel Armstrong)



Fig.5. Art Orienté objet (AOo - Marion Laval-Jeantet & Benoît Mangin): Que le cheval vive en moi [9]. Synth-ethic featured the outcome of a performance in February 2011 by AOo’s Marion Laval-Jeantet, who had been trained for the injection of a cocktail of horse immunoglobulines without falling into anaphylactic shock. The performance represents a continuation of the centaur myth, in which the anthropocentric attitude inherent in our technological understanding is questioned. (© Art Orienté Objet)



Fig. 6. Cohen van Balen: Pigeon D'Or [10]

By using “biobricks” Tuur van Balen tries to manipulate bacteria in the intestine of pigeons, to make them defecate a soap-like substance. Synth-ethic featured installations for feeding his pigeons and for using them to clean the windscreens of a car, freeing them from the stigma of being “flying rats” and turning them into flying cleaners. (© Tuur Van Balen)

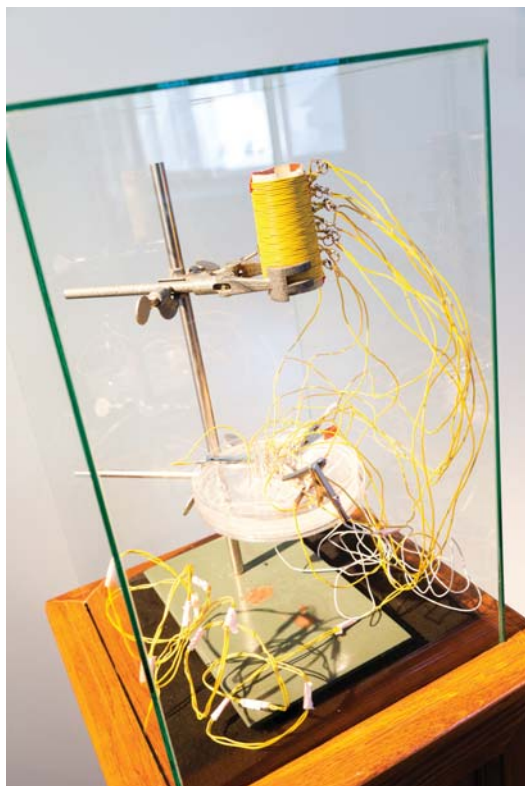


Fig. 7. Joe Davis: Bacterial Radio [11]

Joe Davis reverses the main goal of synthetic biology by applying biological principles to electronic engineering. His bacterial crystal radio consists of a conductive circuit secreted by genetically modified bacteria using genes from orange marine puffball sponges. (© Joe Davis)



Fig.8. Andy Gracie: Autoinducer_Ph-1 [12]

Autoinducer_Ph-1 is a semi-synthetic ecosystem. It combines three living organisms - rice, Azolla fern and cyanobacteria Anabena - together with computing processes and an electro-robotic component into an interacting and evolving system. It explores the mutual co-adaptation of living and non-living entities. (© Andy Gracie)



Fig.9. James Tour & Stephanie Chanteau: NanoPutians [13]

NanoPutians are organic molecules with anthropomorphic structures. The NanoPutians illustrate the human desire to ascribe life-like features even to our tiniest technical creations. (© Biofaction KG, Photo: Arman Rastargar)



*Fig.10. Tissue Culture and Art Project: The Semi-Living Worry Dolls [14]
The Semi-Living Worry Dolls are modern tissue-engineered versions of the Guatemalan worry dolls. They are here to listen to our worries about biotechnology. Photo by Arman Rastargar. (© Oron Catts and Ionat Zurr)*

In addition, Sonja Bäümel provided an exhibit for the entrance hall that was not included in the exhibition itself (Cartography of the human body, [15]).

Bioart and boundaries

By 2005, bioart did not have a widely accepted definition. Hauser stated that year, writing for *Ars Electronica*: “As a medium, Bio Art does not permit itself to be nailed down with a hard and fast definition of the procedures or materials that it must employ; the “manipulation of the mechanisms of life” assumes a very wide variety of forms both with respect to discourse and technique” [16]

Meanwhile the definition by Capucci and Gessert [17] that bioart is art comprised partly or entirely of living, nonhuman organisms, and/or art created in association with nonhuman organisms is in common use.

A sub-set of bioart was classified by Capucci as biotech art. By his definition it includes art that has technologically manipulated biological elements. This manipulation would include genetic engineering, tissue culture and other interventions like synthetic biology.

One aspect of bioart is its transcendence of boundaries. It can cross the line between the scientific domain and the domain of arts [18] and it may touch the border between the living and the non-living.

Although several of the art pieces of the exhibition fall under the definition of Capucci, this is not so clear for those that explore the boundary between the living and the non-living, like *Origins of Life* and *Protocells*, thus challenging the boundaries of bioart itself.

Boundaries of Life

Are there categories of life? Biologists would answer quickly presenting the whole discipline of taxonomy. However, as regards ethical issues like the moral status of natural or artificial life the boundaries must be drawn somewhere else than simply between species.

This leads away from mere biological definitions of life to a broader philosophical discussion. Christian Martin [19] points out that “life” is not a merely descriptive phenomenon, but also includes a normative component. He suggests a differentiation of the term life into three steps: (1) “*mere life*”, (2) “*prereflexively self-conscious life*” and (3) “*reflexively self-conscious life*”. The prototype for mere life is that of single cell organisms, whereas self-conscious life encompasses the experience of a “self” in the form of pain. Reflexive self-conscious life needs understanding, judgment and the ability to conclude.

Even in biology, there is no satisfactory definition of life. Most attempts to describe what life is, is limited to a list of functional features of life [20]. Molecular biologist Steve Benner describes this approach as a “laundry list” of criteria that must be met for something to be described as life, but any such list necessarily rests on the biases of the person creating it [21]. Therefore it is hard to define a boundary between the living and the non-living, even from a scientific point of view [22].

Disciplinary Boundaries

Bioart today is a contemporary of synthetic biology. The exhibition catalogue of “Synthetic” made explicit that the new techno-science called synthetic biology challenges our ethical approach towards biotechnology, by applying engineering principles in biology. Synthetic biologists not only intend to understand life better, but also to utilize it in applications, to minimize and optimize, to vary and transcend life, to design and to standardize it [23].

A fundamental trait of synthetic biology is its interdisciplinary character. To be able to deal with the complexity of biological systems, synthetic biology crosses disciplinary boundaries. And so, in a way does bioart, which not only crosses disciplinary borders within science but also the line between science and art.

In the context of boundaries and biotech art this study tried to address the questions mentioned above.

Method

Research design

We carried out 109 semi-structured interviews (70 in German and 39 in English) with 119 interviewees who visited the synth-ethic exhibition between May and June 2011. The duration of the semi-structured interviews without the demographic part varied between 1 and 12 minutes, with an average time of 3 min 14 sec (SD=1 min 42 sec). The questions concerned the visitors' general impression of the exhibition, the exhibits that stayed in their minds, general associations, the aspect of art, the scientific aspect, as well as the ethical issues addressed. They were asked what they thought about the use of living organisms in the art exhibits and finally they were interviewed about their motivation to come to the exhibition. In addition demographic items were answered concerning gender, age, education, and profession, and the interest in art and in science.

Participants

A total of 54.6 % interviewees were male, age range was from 13 to 67 with an average age of 36.1 years (SD=14.0), only 4 interviewees were younger than 18.

The interviewees were selected due to the time that they spent in the exhibition. The interviewers chose visitors who spent at least five minutes in the exhibition. Of the people who were invited to an interview 33% declined the request.

Participants were also asked about their interest in art and in science on a scale from 0 to 7, respectively. To get an impression whether people favor art or science, the difference was calculated between the two items. The distribution is shown in Fig11.

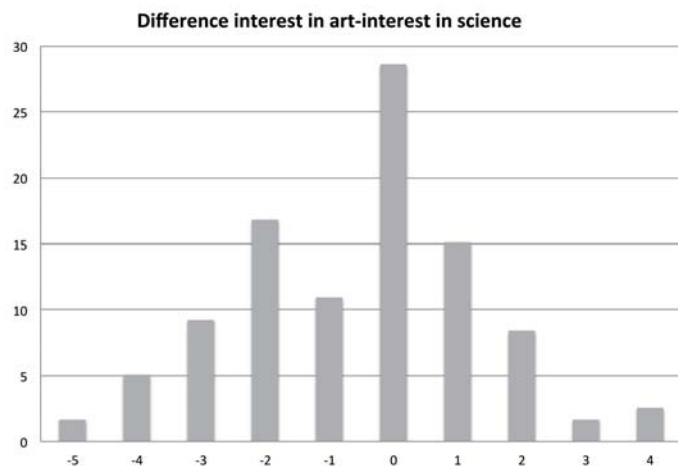


Fig. 11: Difference between the items interest in art and interest in science, both measured on scale from 0 to 7. The value -5 means that the respondent rated his or her interest in science 5 points higher than the interest in art, on the other hand a value of +2 means that the interest in art was 2 points higher than the interest in science. 0 means that art and science were of equal interest.

It shows a likeness to a normal distribution, with the mean slightly below zero (-.54). This difference between the means of the groups can also be shown with a t-test ($T = -3.802$; $df = 118$; $p < 0.05$) That means that the interviewed visitors were slightly more interested in science than in art. However, the graph shows also, that most participants had similar interests for art and for science.

Education: Fig 12 shows that the interviewees had on average a high formal education including many students and academics.

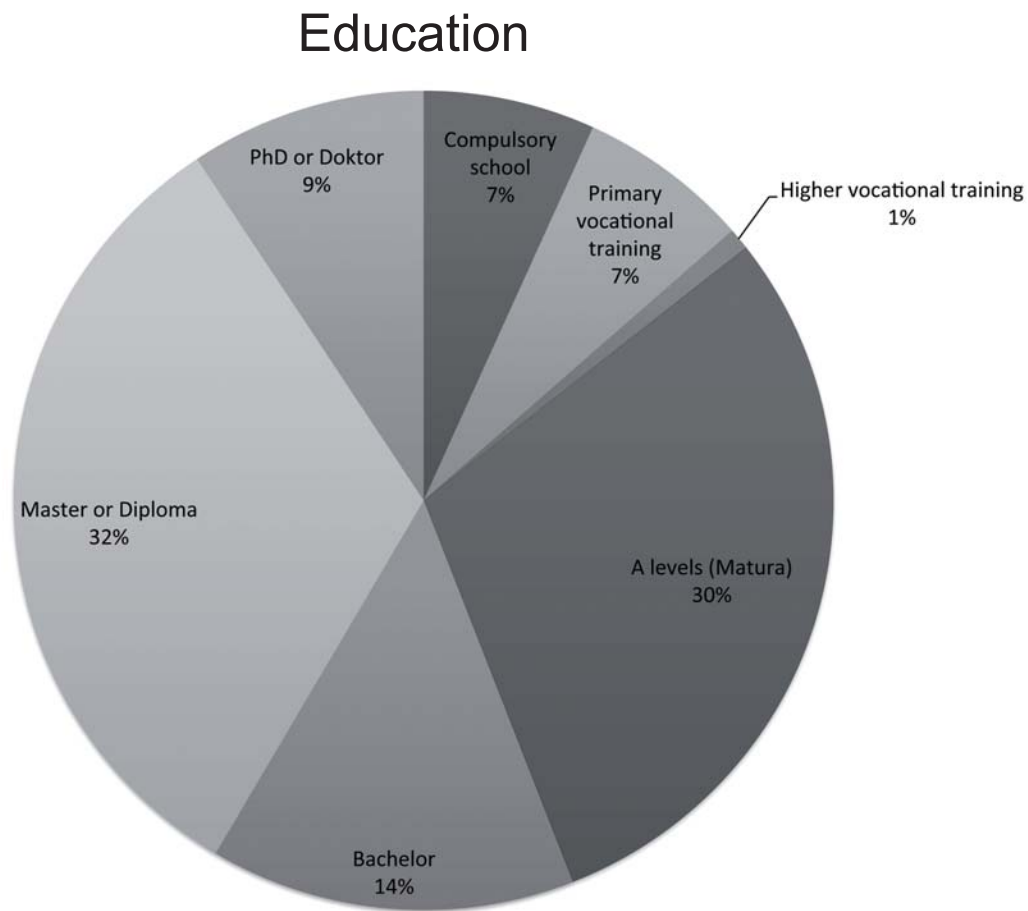


Fig. 12: Educational background of interviewees, $n=119$

Data Analysis

The semi-structured interviews were analyzed using quantitative and qualitative content analysis. For the identification of disciplines a simple word-count statistic was applied. Concerning the art exhibits, they were counted only once per interview, in which they were mentioned (compare Table 1). The data was mainly analyzed with structuring content analysis techniques. Then the quotations were paraphrased, summarized and then again coded using inductive open coding strategies [24] Atls.ti software was used for qualitative data analyses.

Results

Boundaries between disciplines: Synthetic biology or chemistry?

Although synthetic biology was mentioned explicitly in the exhibition guide, and in spite of the title “Synth-ethic” the term synthetic biology was mentioned only six times during all the 109 interviews. In comparison, words about genetic engineering like genes, cloning or genetic manipulation were mentioned 30 times and the term biology 33 times. Surprisingly the term chemistry was coded 53 times. This is possibly partly due to the chemical symbols on the exhibition poster (See e.g. Fig.9) and the association of synthesis with chemistry. Furthermore according to recent survey data, only 17 % of Europeans have heard the term synthetic biology. [25]

Boundaries : The acceptance of living organisms in art exhibits

Analysis of the interviews shows that for a majority of the visitors the use of bacteria and simple organisms does not pose an ethical problem, whereas the integration of higher animals (e.g. pigeons/horses) or even humans into the artwork is rather not accepted. For 91 interviewees it was OK or even positive to use living organisms. Only 15 visitors judged it entirely negative. Three interviewees had a clearly ambivalent attitude towards the use of living organisms in the exhibits. However, there were 16 statements about the limits of the use of living organisms or cells for arts projects. They argued that using microorganisms is OK, while they did not readily tolerate the use of vertebrates, as for instance pigeons, horses or human beings.

Furthermore, when comparing how often the exhibits were mentioned in total with respect to ethics, the ones that featured vertebrates came out much higher, indicating that there are clearly ethical issues connected (Table 1)

Table 1: Number of total quotes containing a particular exhibit (Total), compared with the number of quotes of an exhibit in connection to ethics/morale (Ethics).

Artist	Exhibit	Organisms in artwork	Total	Ethics
Art orienté objet	Le Cheval que vive en moi	Human and horse	34	10
Tuur van Balen	Pigeon d'Or	Pigeon and bacteria	18	8
Tissue culture and art project	Semi-Living Worry Dolls	McCoy cells (Mouse cell line)	31	2
Andy Gracie	Autoinducer_Ph-1	Rice plant, azolla plant, cyanobacteria	29	1
Tour & Chanteau	Nanoputians	None: organic chemistry	23	1
Roman Kirschner	Roots	None: organic chemistry	16	1
Rachel Armstrong	Protocells	None: organic chemistry	15	0
Paul Vanouse	Latent Figure Protocol	Only indirectly, DNA sample from artist's cells	12	0
Adam Brown	Origins of life	None: organic chemistry	12	0
Joe Davis	Bacterial Radio	Transgenic bacteria	3	0
Sonja Bäumel	Cartography of the human body	Bacteria	3	0

Ethics in general: a need for boundaries?

As mentioned above, when questioned about the ethical aspects of the exhibition, many respondents alluded to two of the arts exhibits, in which birds (8), a horse and a human being (10) were involved. For two respondents the ethical issue of the exhibition was animal experiments.

For some respondents the exhibition was about interfaces between nature and the artificial (2), between technology and nature (2) between science and art (1) or between technology and life (1). They clearly articulated the transcendence of these boundaries in the exhibition.

Many respondents claimed a need for boundaries as regards the development of the technologies in the exhibition (12).

Some were afraid of pushing or crossing these boundaries (2). With respect to ethics, the interviewees were reminded of the discussion about genetically engineered food (4) genetically modified organisms (1) and genetic engineering in general (2), but also stem cell research (2). Many thought about ethical implications of applications in a positive (9) as well as in a negative sense (2) and about future possibilities (3). Some spoke about mechanization of life (2). In the negative sense a misuse for economic interests was discussed (2). One respondent was reminded of a chemical computer. Some stated that the ethical aspects of the exhibition imply that we have to take care of the environment, nature and limited resources (8). This goes hand in hand with a big responsibility (5) that we have.

Others found ethical challenges in the manipulation of organisms and in the interference with life or nature (12) or even the creation of new life (3). God as creator was mentioned three times. The interviewees also talked about human enhancement or eugenics (6). Several respondents discussed the question of the use of organisms for arts exhibits in the context of general ethical questions (10). One respondent was afraid of the incalculable results of these developments. Interviewees also thought that this development is unstoppable (3). Some others underscored the importance of estimating the consequences and of technology assessment (4). Two interviewees said that there should be more information for the public and more science communication about these issues.

The art-science interface/boundary

The aspect of art

While 32 people did not respond to the question about ethics only 9 did not want to say anything about the aspect of art of the exhibition.

The predominant answer, when asked about the exhibition was a positive one. The art was characterized as creative, interesting or aesthetic (28). It was also frequently seen as something new, novel and unknown (18).

Some saw the exhibition as very artistic (7), some others as not very artistic (10) or ambivalent (4) or not the interviewee's taste (3). 11 respondents stated that the exhibition is not an art but a science exhibition. The art was believed to be inspiring for science and art projects (2), as critical or provocative (3) but on the other hand also as hard to classify (3) and hard to understand (9). Some respondents described the art aspect as strange, awkward or disturbing (9), some as offbeat (2). The exhibits were classified as abstract (3) sometimes too abstract (1). One person said that this was chemistry seen through the lens of the artist; one called it conceptual art and another one high tech. One respondent said that this kind of artwork is connected with a lot of effort of the artists. Three persons had expected something else.

The aspect of science

While 30 statements about science were entirely positive (e.g. interesting) 23 respondents claimed that they did not have enough knowledge to understand the scientific aspects of “synth-ethic”. Another 10 complained about a lack of good description or explanation of these aspects and 4 persons complained about a lack of time for understanding the scientific aspect. Two respondents made ambivalent remarks about the science in the exhibition.

Some interviewees regarded the exhibition as a good way of teaching science and as science communication (5); some found it inspiring for future arts or science projects (4). The exhibition was described as very scientific (5), mysterious (2) and high tech (2). Three people identified the scientific aspects of the exhibition as chemistry. Two respondents claimed that the scientific aspects of the exhibition must be judged exhibit by exhibit.

Several visitors had expected more as regards the aspect of science (6), four people said that it is an arts exhibition not a science exhibition, others said that the science in the exhibition is nothing special (5). One visitor classified the science in the exhibition as useless while others asked about the relevance of the scientific aspect (3).

Discussion

How do gallery goers judge the use of living organisms in the art exhibits?

In accordance with Christian Martin’s [26] normative approach towards life, gallery goers make a difference between different “categories of life”. As was shown above, the use of “mere” life, like bacteria, does not pose any problems to the interviewees. Critical reactions are mainly produced by exhibits that use “prereflexively self-conscious” levels of organisms like pigeons, and especially with “reflexively self-conscious” entities like human beings (in “que le cheval vive en moi”). Surprisingly to us, many visitors tolerate the use of living organisms in art exhibits. With a few exceptions, only the use of higher organisms like higher animals or human beings trigger skepticism or refusal. Not unimportant for artistic biofacts, it seems that using “higher organisms” increases awareness of gallery goers and art critiques. *Le Cheval que vive en moi*, and *Pigeon d’Or*, that were identified as the most ethically irritating artwork in the “Synth-ethic” exhibition, went on to win major awards at the Ars Electronica festival a couple of months later. While use of higher organisms alone will not guarantee success and recognition in the art world, it seems to elicit an additional level of complexity and depth that can – when appropriately explored and reflected upon by the artist – help the artwork to stand out. Obviously, crossing ethical boundaries just for the sake of it or for its “shock value”, on the other hand, is obviously no guarantee for artistic quality.

What role does the issue of boundaries play in the reception of the ethical aspects of the bioart exhibition?

One aspect of boundaries is the abovementioned hierarchy of living entities with respect to their use as art objects. This was also discussed in the context of ethics. In addition, people expressed the need for boundaries as regards the regulation of biotechnology in general. The “natural” boundaries between nature and technology should be respected as well as the limits of what science can provide. What exactly constitutes such a boundary between nature and technology, and where it is (or should be) drawn seems to be more or less clear to visitors. It has been shown in previous studies that humans do have an intuitive ontology in scientific understanding. Already at around the age of 4, humans develop what is called an “intuitive” or “naïve” biology that helps to distinguish artefacts, plants, animals and humans, that all have distinct essences [27]. Apart from those who develop either a personal or professional interest in biology or medicine, this intuitive biology remains as a kind of internal compass for laypeople to navigate in a world inhabited by living and non-living objects. We believe that scientific developments or artistic explorations that may trigger a disillusion of this intuitive understanding may cause uneasiness. To a certain extent these cross border activities shake up laypeople’s basic understanding of the world, something that could be compared to learning about the strange world of quantum physics. Few if any visitors we interviewed seemed to take advantage of the disillusion of their intuitive biology, e.g. starting to explore their own understanding of what is life (At least not directly after they visited the exhibition, which is when the interviews were carried out). Instead, a number of gallery goers seemed to miss a clear statement by the exhibition producers and curators about what is right and wrong, and how an ethical boundary should be defined.

How do people experience disciplinary boundaries?

Although many visitors mentioned the hybrid art-science character of the exhibition, visitors still had the urge to assign it either to the realm of science or the realm of art. Of those who saw it as a science exhibition, many complained about a lack of information about scientific facts and scientific background information. In other words, they saw the exhibition as a science communication activity that used artists to show the science in an aesthetically pleasing way, but wasn’t satisfactory in terms of its “real” goal, namely informing about a particular scientific field.

In a way these visitors called for help, since they expected the provision of more information and cognitive tools in order to establish categories, and cognitive boundaries. Those who saw the exhibition predominantly as an art exhibition had less difficulty with the limited scientific information on offer.

Synthetic biology, the scientific gravitational center of the exhibition, clearly, has not arrived in the minds of contemporary gallery goers (and other lay people) yet. Most gallery goers approached the exhibition either within the frame of (synthetic) chemistry or genetic engineering. Given the lack of previous knowledge of the field, the exhibition’s mascot and title poster (Tour and Chanteau’s “Nanoputians”) alludes to

synthetic biology in a rather subtle way. Many gallery goers did not pick up this lead and linked the exhibition to the better-known (synthetic) chemistry, keeping in mind that 2011 was also the international year of chemistry with a number of chemistry related events. Without a massive science communication effort, the reference from an art exhibition to an inter- or trans-disciplinary science field like synthetic biology was as ephemeral as the artwork in the exhibition itself (without constant care, feeding, watering and cleaning most artworks would quickly disintegrate, collapse or die).

Conclusions

Gallery goers expressed a need for boundaries, as regards the advancement of technology and its ethical implications. This wish for boundaries implies the hope to be able to understand and control the new and unfamiliar by restricting it and by defining its clear limits. A lack of boundaries on the other hand contributes to uneasiness in the perception of the visitors.

Synthetic biology, as an interdisciplinary discipline, could provide a scheme for understanding the complex allusions of bioart.

Bioart generates multiple associations. This diversity shows the success of the unconventional, out-of-the-box character of modern bioart to generate new ideas and to inspire unusual thoughts.

The use of living organisms did not pose any conceptual problem to the visitors, as long as it is restricted to “mere life”. As soon as feeling or even reflecting entities enter the stage, moral concerns appear.

Limitations of the study

The very specific exhibition and the specific audience (high education) raise the question of external validity. However, the interaction between art and science, two rather elite areas of interest, seems to be inevitably restricted to an elite – highly educated and curious – audience. Furthermore, the study did not include most school groups, who visited the exhibition, and other visitors who only took a short glance at the exhibits.

Acknowledgements

The authors are grateful to the Museum of Natural History, Vienna, to the exhibit curator Jens Hauser, and to exhibit producer Biofaction. The authors gratefully acknowledge the financial support provided by the FWF (Austrian Science Fund) project “SYNMOD: Synthetic biology to obtain novel antibiotics and optimized production systems,” project number I490-B12, through the EUROSYNBIO Program of the European Science Foundation.

References

1. Jens Hauser and Markus Schmidt *Synth-ethic Gallery Guide* 2011
http://www.biofaction.com/wp-content/uploads/2011/10/synth-ethic_gallery_guide_web.pdf Downloaded 2012-03-12
2. Synth-ethic Exhibition website <http://www.biofaction.com/synth-ethic/> Downloaded 2011-12-13
3. Hauser and Schmidt [1]
4. Hauser and Schmidt [1]
5. Adam Brown <http://adamwbrown.net/> Downloaded 2011-12-13
6. Paul Vanouse <http://www.paulvanouse.com/> Downloaded 2011-12-13
7. Roman Kirschner <http://www.romankirschner.net/> Downloaded 2011-12-13
8. Hauser and Schmidt [1]
9. Art Orienté Objet <http://aoo.free.fr/> Downloaded 2011-12-13
10. Tuur Van Balen <http://www.tuurvanbalen.com/> Downloaded 2011-12-13
11. Hauser and Schmidt [1]
12. Hauser and Schmidt [1]
13. Stephanie H. Chanteau and James M. Tour “Synthesis of Anthropomorphic Molecules: The NanoPutians” *Journal of Organic Chemistry* Vol. 68, No. 23, 8750–8766 (2003)
14. Oron Catts and Ionat Zurr <http://tcaproject.org/projects/worry-dolls> Downloaded 2012-03-12
15. Sonja Bäuml <http://www.sonjabaemmel.at/projects/cartography-of-the-human-body> Downloaded 2012-03-13

16. Jens Hauser *Bio Art – Taxonomy of an Etymological Monster* in Gerfried Stocker and Christine Schöpf (eds.) *Hybrid-Living in Paradox, Ars Electronica 2005* (Ostfildern-Ruit: Hatje Cantz, 2005) p.183
17. Pier Luigi Capucci and Franco Torriani- *Presentazione* in Jens Hauser (ed.) *Art Biotech* (Bologna: CLUEB, 2007) and George Gessert *Green Light: Toward an Art of Evolution* (Cambridge, London: MIT Press, 2010)
18. Andrew S. Yang “Interdisciplinarity as Critical Inquiry: Visualizing the Art/Bioscience Interface” *Interdisciplinary Science Reviews*, Vol. 36, No.3, 42-54 (2011)
19. Christian Martin *Zur Logik des Lebensbegriffs* in Peter Dabrock, Michael Bölker, Matthias Braun, Jens Ried (eds.) *Was ist Leben- im Zeitalter seiner technischen Machbarkeit? Beiträge zur Ethik der Synthetischen Biologie* (Freiburg & Munich: Karl Alber, 2011)
20. Gyula Pályi, Claudia Zucchi and Luciano Caglioti *Dimensions of Life*. in the same, (eds.) *Fundamentals of Life* (Paris, Amsterdam, New York, Oxford, Shannon, Tokyo: Elsevier, 2002)
21. Laura M. Delgado *The Search for Life Elsewhere Begins with Defining Life* 2010.
<http://spacepolicyonline.worldsecuresystems.com/news/the-search-for-life-elsewhere-begins-with-defining-life> Download 2012-04-13
22. David Moreira and Purificación López-García. *Ten reasons to exclude viruses from the tree of life*. 2009. *Nature Reviews Microbiology*. Vol. 7, 306-311
23. Anna Deplazes-Zemp “The Conception of Life in Synthetic Biology” *Science and Engineering Ethics* (2011) DOI: 10.1007/s11948-011-9269-z
24. Philipp Mayring *Qualitative Inhaltsanalyse (Qualitative Content Analysis)* (Weinheim, Basel: Beltz, 2008)
25. Special Eurobarometer 341 report.
http://ec.europa.eu/public_opinion/archives/ebs/ebs_341_en.pdf Downloaded 2012-01-02
26. Martin [19]

27. see e.g. Susan Carol Johnson *Building an intuitive biology: two case studies on the development of biological concepts* Thesis (Ph. D.) Massachusetts Institute of Technology, Dept. of Brain and Cognitive Sciences, 1994.
<http://hdl.handle.net/1721.1/11929> Downloaded 2012-06-04, H.M. Wellman and S.A. Gelman. 1992. "Cognitive development: Foundational theories of core domains" *Annual Review of Psychology* Vol. 43, 337-375 (1992), Helen De Cruz and Johan De Smedt. "The role of intuitive ontologies in scientific understanding – the case of human evolution" *Biology and Philosophy* Vol. 22, No.3, 351–368 (2007)

Manuscript received 14 August 2012

Biographical Information:

Wolfgang KERBE studied chemical engineering at the Vienna University of Technology before starting an interdisciplinary career in sociology and social psychology. His focus of interest is the analysis of communication processes regarding new and emerging biotechnologies.

Dr. Markus SCHMIDT has an educational background in electronic engineering, biology and environmental risk assessment. He has carried out environmental risk assessment, safety and public perception studies in a number of science and technology fields.