Bio Art, DIY Biology, and Academics

A New Revolution?

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ABSTRACT

Bio art and Do-it-yourself biology have presented themselves as ground breaking new movements of the humanities working with the life sciences. They attempt to bring the scientific debate to the general public, both in their own way. However, are they really that different from each other in their attempt to break the scientific status quo, and with what means do they attempt to communicate with the general public? This paper will focus on the current status of bio art and DIY biology and their interaction with the general public, and explores the role of the academics in this situation.

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Introduction

Since the 1990's there has been a new art practice in which artists work with live tissues, bacteria, living organisms, and life processes. They use biotechnology to produce artworks in laboratories, galleries, or in their own studios. Artist Eduardo Kac first used the term "bio art" in 1997, in order to explain his works that involved biological agency. This art practice has lead to a wide range of biotechnological researches that go beyond the scope of the life sciences. In this way, the knowledge of the natural sciences is applied to create an artistic entity and question the ethics behind the used science.[1] Just as the scientific fundamentals behind the artworks, the art form will change over time with the development of newer technologies. However, it can be argued that without ever relinquishing its right to formal experimentation and subjective inventiveness, art can, and should, contribute to the development of alternative views of the world that resist dominant ideologies.[2] In other words, bio art always aims to create various forms of interruption of the barriers of science. These 'barriers of science' can be summed up as (1) abstraction and mystification; (2) the ambiguous nature of funding; and (3) legal instruments designed to protect knowledge as trade secrets or private intellectual properties.[3] To break down these barriers means to come to a popularizing of the scientific discussion, as to involve everybody into the discussion (even the non-specialized "lay" people). But can bio art actually create this utopian world of open scientific discussion? So far, there is no substantial proof that bio art has indeed become part of the popular "lay" culture. What can nevertheless be said is that a noticeable interest has been shown by the academics; both humanities, as well as, the sciences.

Alongside bio art, another movement has been seen to develop since 2012; the so-called "do-it-yourself biology" (DIYbio) has been growing rapidly ever since. The DIYbio movement, unlike bio art, are communities of non-experts that get together in self-built labs to emulate existing biotechnological experiments. By doing so, the movement often finds new ways to do existing

[1] Kac, E., p. 165
[2] Ibidem, p. 163
[3] Pentecost, C., p. 112

experiments, or build existing equipment, in a cheaper way. With a different starting point in the Internet era, and a different goal, the two movements seem to be different from each other at face value; are they really that different? The DIYbio movement has a global spread (mostly in "Western" countries) and aim to spread the use of biotechnology beyond the traditional academic and industrial institutions into the general public.[4] This practice includes a number of informal groups that have no professional relations with universities or corporate laboratories and which experiment with (developing) biotechnologies.[5] These groups consist out of a broad mix of amateurs, enthusiasts, students, trained scientists, and, perhaps surprisingly, artists. Their efforts are focussed on exploring genetics, coming to a deeper understanding of biotechnology, and even creating art.[6] Evidentially, DIYbio does not seem to be too different from bio art after all. They both work in the field of biotechnology, they both want to come to a better understanding of the ideology behind biotechnology (and the sciences), and they even both produce art. Yet, DIYbio seems to have a more practical and more accessible air. Can we then come to the conclusion that DIYbio has a better chance to come to break down the barriers of science? Or could the combination of these two movements be the beginning of a period of profound change?

In most writings and publications of these movements the conclusions are phenomenally positive. Overall, the academic publications, (as well as non-academic publications,) come to the conclusion that both bio art and DIYbio are able to educate the general public, yet no real evidence is available to support this claim. To come to a complete understanding of the current zeitgeist surrounding these bio-movements, it is necessary to come to an agreed upon definition of both movements. In this thesis I will research the current debate surrounding bio art and DIYbio, as well as the current role that academics play in these movements, and vice versa. In an effort to answer the question: are the humanities and biotechnology indeed a golden combination, or are we just blinded by hope?

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[4] Grushkin, D., Kuiken, T., & Millet
[5] Grushkin, D., et al., 2013; Landrain, T., et al. 2013
[6] Ibidem

1. On Bioethics

Bio art is, as the words itself already explain, a term used for multiple forms of art that work within the field of biology. Eduardo Kac, a Brazilian biological artist, first implemented the term in 1997 when he tried to define his projects in the 90's. Only a year later, the term "transgenetic art" was added to this list, but commonly this term is interchangeable used with bio art. Bio art is an art practice where the (bio) artists work with live tissues, bacteria, living organisms, and life processes, using biotechnology such as genetic engineering, tissue culture, and cloning, to produce their artworks; this is technology quite unfamiliar to a wide public. The artworks produced through this method are similar to products produced by scientists in laboratories. The works themselves are therefore also usually produced in laboratories, or in smaller laboratories set up in galleries, museums or the artists' studios.[7] These projects vary between genetically manipulating butterfly wings to produce a whole new pattern on their wings,[8] to artists altering their own body by placing another ear in their underarm,[9] and even genetically grown "semi-living" creatures.[10] It is not surprisingly then that these projects also demand artists to work with biological equipment in either a small home lab, or even in a full laboratory.

Since the traditional distinctions between science and art are blurring over time with rapid development in both fields and with political and social criticism that comes up consistently, one would think that bio art is welcomed with open arms. Contrary to this believe, it unfortunately encounters a lot of resistance. The sudden home-access to biological equipment strikes a fear in the general public, connected to bio-paranoia, one that is quite similar to the bio-paranoia of, but these topics will be furtherly discussed in chapter 2 and 3. At the same time, bio artists try their best to formulate a critique on the current bioethics and the tension between the scientific world and the humanities in the form of artworks. However, bio artists[11] themselves have no other choice than to work within the same context, since they make use of the same equipment and

[7] http://mashable.com/2013/10/29/cutpastegrow-bioart/#4_2mdoqtvPqz
[8] Marta De Menezes artwork Nature? For more information visit http://martademenezes.com/portfolio/projects/
[9] Stelarc's Ear on Arm project. For more information visit http://stelarc.org/?catID=20242
[10] Semi living worry dolls by Oron Catts and Ionat Zurr, See essay.
[11] and DIY'ers for that matter

techniques, which makes it particularly troublesome to evaluate bio art as an autonomous entity.

Even before some measures of evaluation of bio art can be formulated, we first need some basic understanding of the context of the life sciences. According to Claire Pentecost, this context is built on the idea of neoliberalism. As originally a political economic theory, neoliberalism maintains that individuals and society flourish best when government confides its function to the guarantee and protection of private property, free markets, and free trades.[12] Via this ideology, enforced through U.S.– and European-controlled supranational bodies such as the World Trade Organization and the International Monetary fund, anything humans value becomes a possession by one party at the literal expense of another. Not only material products, but also the basic life needs including nutrition, sanitation, medicine and water become commoditised. This has led to a transformation of the living world into limitless possibilities to stake legal property and an inalienable right to profit. In the case of life sciences, the system of public research and educational institutions have been gradually defunded, and so, relies increasingly on corporate partnerships and the generation of patentable, marketable knowledge products. [13] In other words, the context of life sciences today is one in which the entire system drives around the globe via brutal trade agreements in which intellectual property regimes are enforced by the world's economic superpower. [14] Researchers are directed by large companies on one side, and on the other, research outcomes are secured by patents to not be handled by other scientists, thus together, constraining the life sciences considerately. The possible pace of development in the scientific realm takes on a slower step with the intrusion of outside companies. Progress is no longer the aim of science, but making a profit of this progress is. The problem of science in service of neoliberalism is that it alienates the non-specialist whose life is affected by its commercial application. Science is still viewed in its traditional claims of truth and service to the public, whilst in reality science is

[12] Pentecost, C., p. 110
[13] Ibidem, p. 111
[14] Through FTAs (free trade agreements), BITs (bilateral investment agreements) and other forms of direct agreements between countries, the U.S. and Europe are insisting that the partner country adopt their standards of IPR (intellectual property rights) protection and enforcement.

shaped to market agendas. There are current mechanisms of alienation to extend the statues qua and thwart public contestation: (1) Abstraction and mystification; (2) the ambiguous nature of funding; and (3) legal instruments designed to protect knowledge as trade secrets or private intellectual property.[15]

Additionally, the life sciences are hugely influenced by bioethics. Cary Wolfe explains bioethics as followed:

> "Indeed, contemporary bioethics is best understood not as ethics at all, but rather as the apotheosis of what Michel Foucault has analysed as the rise of "bio-power" during the modern period […] in this context, Foucault argues, 'the emergence of the health and physical well-being of the population in general' becomes 'one of the essential objectives of political power.'"[16]

In this light, the general problem with contemporary bioethics, according to Wolfe, is that "bioethics presumes to serve as the self-designated conscience for those contemporary biotechnical apparatuses and institutions that exert power over life and death, but the obvious problem here is that the functions of 'conscience' and those establishing policies palatable to both state and economic power do not always or even often go hand in hand."[17] In other words, bioethics presumes they can declare a certain procedures immoral and impose an immediate ban, for example human cloning. This ban is called upon to protect the health and physical well being of the population, but at the same time to call for such an immediate ban it means that technology is ignored. These bans are highly questioned in both the political debate, as well as in the philosophical debate. So what role can bio art play within these debates? Yves Michaud makes an argument for art, saying, "Art will never be outdone."[18] Art has, for a long time already, the role to engage itself in new fields of acts and works, in this situation: one that employs the materials and processes of life.[19] According to him, there are in the case of bio art two paths that open up with their own questions. The first is when the artist might seek out the relatively insignificant, but spectacular,

[15] Pentecost, C., p. 112
[16] Wolfe, C., p. 96
[17] Ibidem
[18] Michaud, Y., p. 388
[19] Ibidem

aesthetic effects. They might later rediscover the logic of spectacle and fantasy in entertainment. In this context he places Eduardo Kac's "GFP Bunny"[20] one of Kac's most well known bio art works. For this work he genetically manipulated a bunny with the Green Fluorescent Protein (GFP gene), a gene also found in jellyfish,[21] so that it would glow under a certain light. There was a lot of media attention spend on the bunny, consequently this makes Michaud wonder whether the art world will provide the world with the "mouse that roars" or "a couple of dinosaurs for Jurassic Park."[22] Or more specifically: art that turns out to be relatively insignificant but has spectacular aesthetic effects. This type of art, according to Michaud, is the art that is intended to be a spectacle rather than critical. The other option is when the artists take up a truly hideous and transgressive program with strong but dangerous aesthetic weight in real consequences as well as in their philosophical and ideological background plan. This side of art is described as a dark, transgressive dimension to art. According to him, bio art must not produce a reproduction of the world as we know it, but a new world. A new world where values may not be only those contrary to those now accepted, but where new values are simply incomparable to the ones in the world we now know and experience This is the adventurous and dangerous power he looks for in art.[23] However, this is exactly the problem bio artists face when designing new artworks. Michaud is looking for art that can be critical on the work/art bio ethical scientists work with, but at the same time, bio art has to work within this same framework. To add to that on a more practical level, to actually be able to present the world a 'new world where values may be not only those contrary to those accepted in the world as we know it, but are simply incomparable', it not only needs to try to escape the current dominant hegemony, but it also needs to reach a wide public to make a difference – something that can only be done by becoming a 'spectacle'.

So it seems that bio art hardly would ever be able to fully fulfil a role for the public debate. However, Lori B. Andrews argues otherwise when she describes the possible role of bio art in her article "Art as a Public Policy

[20] For an image of the "GFP Bunny" see list of illustrations
[21] A more in-depth explanation on this artwork see: the chapter on Bio Art
[22] Michaud, Y., p. 393
[23] Ibidem, p. 394

Medium". The value of bio art, according to her, is not merely one of aesthetics, not one that is necessarily transgressive, but one in which the works of art can help society as well. According to her the use of bio art can confront the social implication of its biological choices; understand the limitations of the much-hyped biotechnologies; develop policies for dealing with biotechnologies; and confront larger issues of the role of science and the role of art in our society. [24] In this case, bio art is the one and only medium between the life sciences and the general public, which would mean that even by just existing it would already fulfil its purpose of educating the general public and providing a critical view on the contemporary life sciences. Bio art is therefore the pioneer in shaping the public discourse about genetics and reproductive technologies. However, whether or not 'life science art' will indeed become a new school of art, a lobbying effort, a means of social criticism, or perhaps all three, is a question that only can be answered by time.[25]

Unfortunately, this does not provide any of the much-needed answers on how to perceive bio art in the context of bio ethics. So to come to a direct measures of evaluation of bio art Claire Pentecosts describes the following: "not about trying to make a case for bio art as art in the conventional, vexed, socially exhausted definition of art. The bio art that I am interested in does not want to become propaganda ware for the biotech industry. I make the assumption that it wants to address a kind of problem in the world where most people live."[26] A measurement of evaluation for bio art still proves to her to be more difficult than anticipated. It is not a simple checklist but rather Claire Pentecost attempts to provide her readers with a set of guidelines to expose the unique causes and outcomes of artistic efforts.[27] Where science is influenced by neoliberalism, art is seen as part of the Western art historical canon and bio art hovers somewhere in between. Bio artists may face the same challenges scientists do in relation to an alienated public, since art is displayed in a specific language uncommon for the general public. Pentecost describes the problem as followed:

[24] Andrews, L., p. 126
[25] Ibidem, p. 128
[26] Pentecost, C., p.112
[27] Ibidem, p. 116

> "Unless its practitioners [artists] are willing to radically change the nature of art itself and the apparatus of its distribution, it is hardly a good candidate to significantly redefine the public's relation to science. Moreover, professional artists interested in the life sciences and subject to career pressure for visibility and the command of resources, tend to select projects according to the same biases driving professional scientists, who must command resources to do any science at all. Understandably, artists want to address the controversial issues raised by the commercialized life sciences. Unfortunately, this can reinforce Big Science's deformation of all meaningful biological inquiry into profit-yielding questions (e.g. genetics) while the urgent project of understanding the stunningly complex field of ecology is being starved."[28]

Evaluating bio art from this viewpoint becomes much more difficult. Claire Pentecost takes the time to explain her evaluation of a few bio-artworks, including Kac's "GFP Bunny". She claims that through its notoriety it does offer a useful starting place for discussion between more and less informed people.[29] The work raises a wide range of questions surrounding biotechnology, with as starting point the introduction of transgenic animals as pets. The discussion about "ownership" of the (and any type of) animal starts with the artwork. Yet, at the same time the work provokes the question: "How can I get one?" Only illustrating the difficulty bio art has within the dominant neoliberalistic thinking within the life sciences and communicating a critical response.[30]

In short, the context in which bio artists and DIYers work is interconnected with the bioethics designed by biologists. This bioethics is very much interrelated with the dominant neoliberalistic thinking and the economical society. We are a consumer society and there is no way around it. However, whilst working within this context it proves to be difficult to fully give critique on this dominant hegemony. Adding to this problem is the uninformed, or even misinformed, general public, which causes bioparanoia and the extreme fear of bioterrorism.

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[28] Ibidem
[29] Ibidem, p. 118
[30] Ibidem

1.1 Bioparanoia and Fear of Bioterrorism

The connection between bio art and the sciences is now well established, but how does the general public react to these findings - and what can we say about the rhetoric of science? The initial reaction to many of these concepts is "Bioparanoia", a concept that has evolved over time and has a major influence on the general public in many ways. The Critical Art Ensemble explains the concept of bioparanoia divided into three phantoms: "The Disinfected Body", "The Aestheticized Screenal Body", and "The Abused Body". The first concept, "The Disinfected Body," is explained as a relatively new imaginary entity and the eldest among this collection of phantoms. This concept emerged directly out of the material conditions of early capitalism in regard to human and public health.[31] This type of bioparanoia began in the 19th century, when cholera was still a wide spread danger in urban areas. Industrialisation caused cities to grow rapidly and without a proper sewer system, the water supplies of the city were usually used as both waste dump and as drinking water supply. In the summer of 1849, in London, the cholera outbreak was especially bad with a mortality rate of 50 percent. A physician named John Snow was the first one to suspect Cholera to be transferred via drinking water. Following close observations, he concluded that it was better to get drinking water from the north side of the city, where mortality rates were generally lower. The water pumps in the affected areas were closed and the cholera outbreak began to decline. The government began to understand what public health was and why it was important to pay attention to it. This was not the only aspect that led to idea of the disinfected body. Another great influence to this theory was when Louis Pasteur and Robert Koch proved the germ theory of disease in 1880. The 1880s are now known as the decade that launched the field of microbiology, which caused a lot of fear to the general public, since antibiotics were yet to be discovered 30 years later. In the 1880s and the 1890s scientists and doctors showed that germs could be carried in dust. This notion was immediately exploited by consumerism, and advertisements have kept the public focused on the dangerous bacteria. The germ hysteria that began in the Victorian era has never really subsided.[32]

[31] The Critical Art Ensemble, p. 414
[32] Ibidem, p. 414-19

"The aestheticized screenal body" ties into the idea of the disinfected body. The disinfected body is either a beacon of health or a failed body that is a reckless endangerment to everyone around it. The aestheticized screenal body then exists as either the perfect beauty, or as repulsively hideous; as brimming with confidence, or as suffering humiliation. Both these extremes are of use to capital. Products ranging from makeup and diet products to over-the-counter pharmaceuticals benefit from the fear of the public, yet at the same time this also means that productive energy is wasted to the anxiety inserted by capital.

"The abused body" is the last of the three phantoms described by The Critical Art Ensemble and is described as likely to change for the worse. This body signifies 'the fate of the flesh, should the crises that ever loom before us reach fruition'; a body that resides only in fantasy. It is a body that we only know in nightmares worthy of the most extreme gore films, an agony of global proportions. Yet, what role does this body have in society when it does not exist? The only reaction to this type of body is fear. A fear that even creeps trough the foundation of bio-warfare. For example: the warfare program in the United States researches anthrax, smallpox and Ebola extensively, although these diseases have killed only a small amount of people world wide.,[33] Smallpox could even be extinct by now if it was not for the U.S. and Russian military to keep specimens. This takes away from the research on more severe diseases such as HIV, hepatitis C, multidrug resistant TB and malaria that are a real danger to public health; diseases that kill millions of people each year.

This last phantom of the abused body is worth getting into a little further, because this idea ties into the general fear of bioterrorism. The fear of bioterrorism, or in other words, the fear of an attack with bio agents used as weapons such us: smallpox, anthrax, the plague, tularaemia, brucellosis and Q fever, has been one of the focus points in national security of the U.S. Government since the Cold War. Even though it should come as no surprise that biological weapons have been a concept long before the Cold War, it is interesting to note the low level of attention to these weapons between the World Wars, reflected the military reality that no nation had effective and

[33] Since the 1970s Ebola has a relatively small cumulative death rate of 683 people (2007), including the Ebola outbreak of 2014, Ebola death rates rise just over 2000 casualties..

reliable "biological weapons." It is the choice of words "biological weapons" that already give a wrong impression. Jonathan King describes it as followed in his essay "How Do We Insure Security from Perceived Biological Threats?":

> "The word "weapon" refers to a device that can be controlled by one side in a conflict so that the damage is done to the other side. But the fundamental nature of microbial pathogens is that they spread from one infected individual to another. Since all human beings on Earth are members of a single species, any agent that can effectively cause debilitating disease to an enemy can spread back to one's own troops and civilians. In addition, there are long and variable lag times from initial exposure to evident illness; considerable variation in individual susceptibility; and often considerable sensitivity to environmental conditions."[34]

During the Cold War the United States, Great Britain and other nations developed biological weapons programs.[35,36] Nonetheless, biological weapons have rarely been used in conflicts between nations, only incidentally as for example the Japanese use of infectious agents against the Chinese. Jonathan King gives this as one of the arguments in his argumentation against the military labs programs. These labs, according to King, cause more actual harm than it improves safety. He gives a detailed description on the history and development of bioterrorism programs in the U.S. and the decline in strength of the Biological Weapons Convention. This Biological Weapons Convention was a result of President Nixon's effort to revive the control of biological weapons during the Cold War. This treaty banned the use, development, testing, and stockpiling of biological weapons in 1975. Unfortunately, when Reagan's administration took over, it initiated a remilitarization of the economy. Through fear politics and national empowerment, bioterrorism labs were able to flourish in the U.S.. This was also partly caused by the entry of the commercial sector into the bioterrorism research, which does not necessarily give way to a better result on

[34] King, J., p. 402
[35] The U.S. bioterrorism response plan and its effectiveness has been researched by George Avery in "Bioterrorism, Fear, and Public Health Reform: Matching a Policy Solution to the Wrong Window." Read his article for a more detailed description of this plan and its effectiveness.
[36] King, J., p. 402.

the research done in this area. Better yet, it gives more room for mistakes. The funnelling of bioterrorism also creates a political constituency. For example: scientists who might previously have spoken out against the war in Iraq, or against the "missile shield" in Alaska, become much more hesitant since their funding depends on maintaining the public fears and concerns of the perceived threats. King does not necessarily undermine the existence of terrorists or extremists that will use bio weapons, but argues that the major source for these weapons will be the bioterrorism labs where the organisms are being generated.[37] There are those who claim that the development and growth of infectious agents in weapon form can be done anywhere. However, the opposite proves to be true; production of refined anthrax spores requires very complex equipment, air-handling equipment, very large volumes of sterile media, and sterile procedures. Even if one were to attempt to generate such a disease in his, or her, own garage, they would be infected long before generating the actual weapon.[38] Serious questions are still unanswered about whether categorical programs such as the bioterrorism program, even when based on sound public health practice, are the best way to deal with public health issues. And even then, the rhetoric of bioterrorism to gain public health resources have the potential to backlash in form of hysteria and hoaxes. This proved to be the case when more than 200 hoaxes were logged between 1997 and 1998, of which 13 involved more than 200 potential victims. These were blamed on the effects of media coverage and the rhetoric used by government officials.[39]

To summarize, the contemporary public's bioparanoia and their perception of bioterrorism is one that is constantly reaffirmed with fear-induced rhetoric. It is partly due to a long-lived bioparanoia that started in the Victorian Age and was kept alive by advertisement, and it is partly caused by an apocalyptic fear for what could happen by a bio attack. The multiple bioterrorism programs in the U.S. that focus their effort in preventing a bio attack strengthen this idea. Controversially, bioterrorism makes more problems in form of hysteria and hoaxes through a mixture of media coverage and the rhetoric used by government officials, , than it does through actual prevention of

[37] Ibidem, p. 408
[38] Ibidem, p. 411
[39] Avery, G., p. 284

bio attacks. The general public is kept in this state of fear, partly to induce the funding of these scientific programs, and partly because it is believed it is the best way to have an actual effect on the public in providing them with information. Under these circumstances, a misinformed public was created that demands extra safety against bioterrorism, whilst the same funding could be used to research present diseases that have a higher morbidity and mortality every year than the propagandized bio terroristic diseases have done the last century.

2. On Bio Art

It is within this difficult mixture of bioethics and bioparanoia that bio artists have to come up with a critical and communicative work of art. They are faced with, and working within, the dominant hegemony – and attempting to come with a strong critique. While they also have to deal in a careful manner with the bioparanoia of the general society. So even if they can come up with a 'good' work of art, the communication with a larger audience still proves to be an obstacle. Although, not unimportantly, the social discussion itself has always been important in the history of art too. It is exactly this contemporary science and technology which has given way for artists to bring this social discussion to a new, shock factor induced, art form: bio art. Already slightly touched upon, a well-known example of bio art is Eduardo Kac's "GFP Bunny" named Alba. The idea of this artwork was first described in the same essay in which he introduced the term transgenic art. He proposed the creation (and social integration) of a dog expressing green fluorescent protein (GFP). This protein is commonly used as a biomarker in genetic research, but Kac wanted to use it primarily for its visual properties as a symbolic gesture, a social marker.[40] In 1998, when the essay was written, the canine reproductive technology to realize this project was not developed enough.[41] Kac was able to realize his "GFP Bunny" in 2000. The work comprised the creation of a green fluorescent rabbit named Alba, the public dialogue generated by the project, and the social integration of the rabbit.[42] The work could be realized with the assistance of Louis Bec and Louis-Marie Houdebine, who Kac met at "Ars Electronica" in 1999. The first phase of

[40] Kac, E., p. 164
[41] Ibidem
[42] On his website he extends his description: 1) ongoing dialogue between professionals of several disciplines (art, science, philosophy, law, communications, literature, social sciences) and the public on cultural and ethical implications of genetic engineering; 2) contestation of the alleged supremacy of DNA in life creation in favor of a more complex understanding of the intertwined relationship between genetics, organism, and environment; 3) extension of the concepts of biodiversity and evolution to incorporate precise work at the genomic level; 4) interspecies communication between humans and a transgenic mammal; 5) integration and presentation of "GFP Bunny" in a social and interactive context; 6) examination of the notions of normalcy, heterogeneity, purity, hybridity, and otherness; 7) consideration of a non-semiotic notion of communication as the sharing of genetic material across traditional species barriers; 8) public respect and appreciation for the emotional and cognitive life of transgenic animals; 9) expansion of the present practical and conceptual boundaries of artmaking to incorporate life invention.
For a more detailed description of Kac's GFP Bunny visit http://www.ekac.org/gfpbunny.html

the project was completed in February 2000 with the birth of Alba in Jouy-en-Josas, France. Alba is an albino rabbit that glows when illuminated with blue light, in this light she glows with a bright green light. She was created with EGFP, an enhanced version of the original wild-type green fluorescent gene found in the Aequorea Victoria jellyfish.[43] The second phase, the on-going debate, started with the first public announcement of Alba. The third phase is when the bunny would join Kac to live with his family in Chicago and become, just like any other pet bunny, part of the family. Unfortunately, the second phase cause quite some media uproar, and the third phase was 'delayed' because the French institute where Alba was born used his authority to overrule the scientists who worked on the project and refused to let Alba go to the Avignon and then to come to Kac's family in Chicago. According to Kac, it was not until 2002 till Alba obtained her freedom, only after multiple efforts by Kac, including a solo exhibition entitled "Free Alba!"[44] Her freedom was short lived, for different media articles mention Alba's death in 2002, after living for 4 years. The final phase of Kac's work was never finalized in this case.

Kac's "GFP Bunny" caused a string of media up stirs and even to this day its been surrounded by controversy. Through this caused controversy, the "GFP Bunny" is known as one of the most talked about works in the field of bio art and, maybe even more importantly, it is one of the few instances the general public became involved with the artwork. Even prior to the actual realization of the GFP project, Kac proved himself to be able to spark the debate surrounding this topic by writing the essay "Transgenetic Art". In this essay he describes his idea of transgenetic art's purpose to take into question the romantic notions of what is "natural" and to acknowledge the human role in the evolutionary history of other species and vice versa.[45] In this essay he describes the interaction between

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[43] "Alba", the green fluorescent bunny, is an albino rabbit. This means that, since she has no skin pigment, under ordinary environmental conditions she is completely white with pink eyes. Alba is not green all the time. She only glows when illuminated with the correct light. When (and only when) illuminated with blue light (maximum excitation at 488 nm), she glows with a bright green light (maximum emission at 509 nm). She was created with EGFP, an enhanced version (i.e., a synthetic mutation) of the original wild-type green fluorescent gene found in the jellyfish Aequorea Victoria. EGFP gives about two orders of magnitude greater fluorescence in mammalian cells (including human cells) than the original jellyfish gene.
From Eduardo Kac's website http://www.ekac.org/gfpbunny.html

[44] Kac, E., pp. 164- 170, and, http://www.ekac.org/gfpbunny.html

[45] Kac, E., p. 180

humans and dogs in the history of human kind and the social meaning of dogs in our lives. This was supposed to be a preparation for his "GFP K-9" work, a glowing dog instead of a rabbit. The specialized public showed greater appreciation for the essay, but the response in the general media covered the whole scope of rejection to consideration of multiple implications to unmistakable support. It is undeniable that the shock generated by solely the proposal already evoked reactions mostly from a specialized public. It is therefore surprising how much response the actual finalizing of the project in the form of Alba created.[46] The artwork was able to use its shock factor through the media and include a wide public to the debate.

This is exactly the aim of bio art, to generate a discussion about biotechnology in the general public, it seems straightforward and easy to understand in this case. Yet, more often than not this shock factor is only well known in the academic spheres. Whenever these artworks are however recognized by the greater media and subsequently by the general public, it becomes even much more problematic. Problems arise due to the controversial context the media present whilst writing these stories, which can be rather confusing for non-experts. As mentioned before, bio artists work within a similar environment as scientists, but they work with different intentions. Given these points the bio artists work within a same position, but are completely misrepresented in the media. Following the problematic aspect of the general public's bioparanoia, how can we position the bio-artists in the biotechnological debate, and how much freedom should they have within this field of work?

What we do know is that artists often (if not always) have positioned themselves in the centre of controversy. Shaking up the status quo is one of the compelling aspects of art. Life science art raises new opportunities for social and legal constraints on artists.[47] It is not unfamiliar for the bio artist to have legal issues. A prominent example of the legal paradigm in which bio artists are able to work, is the case of artist Rick Gibson. He created a sculpture "to show the place of humans in society and how we treat human beings."[48] His sculpture was build up with a traditional representation of a woman's head. The head was

[46] Ibidem, p. 165.
[47] Andrews, L.B., p.136
[48] Ibidem, p. 137

'decorated' with two human foetuses (each of three to four month's gestation, obtained from an anatomy professor) that were used as earrings. Both Gibson and the owner of the British glary displaying his work were prosecuted for the common law offense of outraging public decency. The prosecution refused the request of the defence lawyer to charge the men under the Obscene Publications Act, which would allow a defence for art that is in the public good. The judge said: "I accept that your motives were genuine. But in a civilized society there has to be a restraint on the freedom to act in a way that has an adverse effect on other members of society."[49] Gibson was fined $875 and the gallery owner $612. Even though it can be discussed whether or not this artwork really is bio art, this does not mean these type of legal cases are a one-off. Another example is the case of Steve Kurtz, a member of the Critical Art Ensemble. Robert Hirsch explains the situation:

> "On the morning of May 11, 2004 Steve Kurtz, an Associate Professor of Art at the University at Buffalo (UB) and co-founder of Critical Art Ensemble (CAE), awoke in his Buffalo, New York home to discover that Hope Kurtz, his wife of 27 year and one of the original members of CAE, was not breathing. Kurtz called 911, but upon arrival the emergency medical team was not able to revive her. Because Hope's death was unexpected and she was under 50 years old the Buffalo police came to investigate. They found a table with scientific equipment in plain sight and fearing terrorism, notified the Federal Bureau of Investigation (FBI). The following day, as Kurtz was leaving home to make funeral arrangements, FBI agents arrived and detained him for extended questioning."[50]

In July of that same year Kurtz was not charged with bioterrorism, but with mail fraud and wire fraud charges. It took until April 21, 2008 when the indictment of these charges was ruled "insufficient on its face."[51] Both these cases beg the question: should bio artists be held to higher, equal, lesser, or just overall entirely different standards than scientists? A general system is yet to be applied

[49] Ibidem
[50] Hirsch, R., p. 22; for the full interview with Steve Kurtz visit http://lightresearch.net/interviews/kurtz/kurtz.pdf
[51] http://critical-art.net/defense/releases/cleared_6_11_08.html

to bio art, but thus far different artists who work in different fields of the life sciences are treated differently. Artists who undertake body art, for example, are generally held to higher standards than scientists. In the case of Gibson's art, it should be noted that the anatomy professor who gave Gibson the foetuses was not prosecuted. To take this train of thought even further: the woman whose foetuses became earrings, was not mentioned in the legal opinion at all.[52]

In conclusion, Kac's "GFP Bunny" is not a stranger of the bunch; in general bio art aims to call the "suitability" of modern art into question. A media up stir, and an on-going legal fight with the lab that created Alba. These artists try, through their works, to reach a greater audience and educate them about the current scientific debate. They attempt to raise true ethical and aesthetic questions that reach the realm of artistic censorship and scientific taboos.[53] Eduardo Kac was a pioneer in the realm of transgenic art. His work made a step towards opening up new horizons for transgenic art, because if the existence of natural mutations is a well-known fact, the creative space where this form of art could develop is located in the space of induced mutations and is able to keep the constructivist epistemological framework. Yet, this space has not opened up completely just yet. Transgenic art has provoked serious discussions about the status of artistic production within the field of art and its relations with the world of laboratories and genetics. Bio art proves over and over again to still be problematic in many fields. Although the fact to consider in this case is that for most people art contributes more to their daily life than science.[54] Bio art can explain to us how biotechnologies work and they can emphasize the limits of these technologies, and the likely social impact. By doing so, bio art might be able to serve as a guide and bridge between biotechnology and public policy. Bio art is there to fill the gap between the sciences and the general public, and therefore, often point out the gaps in regulation, the risks of these technologies, the inequities in access, and the way in which application of certain technologies may harm important social and cultural values.[55] Unfortunately, the gap between the role of artists and scientists or doctors will probably remain, and the

[52] Andrews, LB., p. 139
[53] Bec, L., p. 86
[54] Andrews, L.B., p. 141
[55] Ibidem, p. 142

paradigm is proven harder to break away from. Something that is not made any easier by the media.

2.1 Bio Art and the Media

The media has disrupted the image of bio art often enough, consequentially creating a large-scale misunderstanding of bio art. Eduardo Kac's "GFP Bunny" proves to be a good example again. Even though the artwork attempts to raise true ethical and aesthetic questions that reach the realm of artistic censorship and scientific taboos, as mentioned earlier, media powers often deform the meaning of these questions and the content of the works with sensationalistic remarks. Through this rhetoric the worries and uneducated fears are usually amplified.[56] Even though today the artwork is presented on Kac's website as fruitful, other newspaper articles, as well as essays, state the opposite. The first article I would like to discuss is by Carrie Dierks "Glowing Bunny Sparks International Controversy." The article discusses the reaction of animal rights activists and some religious leaders, who denounced Alba's creators for exploiting the animal and tampering with nature. There were also scientists who research legitimate uses for the GFP who criticized the artwork's creation through genetic engineering. These protests lead to the refusing of the French Institute to hand the rabbit over to Kac. Moreover, they state that they were planning to genetically engineer a fluorescent rabbit as part of their research on tagging embryos with fluorescent markers, long before Kac approached them. Their current fear of the controversy surrounding the mutant bunny is that it might obstruct further research, even though it has not obscured the scientific significance of GFP so far.[57]

Another news article written by Kristen Philipkoski for the Wired magazine, titled "RIP: Alba, the Glowing Bunny", addresses the discussion between Kac and the French researchers who genetically engineered Alba even more in depth. According to the French researchers Alba passed away at the age of four, which is about the normal lifespan in the research facilities, in 2002. Kac goes against this argument. According to him Alba is two and a half years old, since she was specifically bred for him in January 2000. Also, he believes that Houdebine declares the bunny gone in order to put an end to the two-year unwelcomed media attention. Houbebine denies this, stating that the GFP rabbits

[56]Bec, L., p. 86
[57] Dierks, C., describes the transgenic bunny on the website: http://www.labbench.com/news/genetics/bunny.html

already existed and were used for research and when Kac visited the facility he simply decided that one of them was his bunny. He even goes as far saying that Kac fabricated the glowing picture of Alba (fig. 1). He describes it as follows:

> "Kac fabricated data for his personal use," Houdebine said. "This is why we totally stopped any contact with him."
>
> "The scientific fact is that the rabbit is not green," he said. "He should have never published that. This was very disagreeable for me."
>
> […]
>
> The eyes and ears of the rabbit are green under ultraviolet light, Houdebine said, but the fur does not glow, because it's dead tissue that doesn't express the gene. Only if the rabbit were shaved would the body glow, he said."[58]

Nevertheless, even if the photograph is proven to be fake, the discussion about the role of genetical engineering did enter the public debate, and therefore, nearly all phases of Kac's artwork have been able to be completed. Even to this day, it is this bio artwork that is most known by the general public, so it could be said that it is one of the few artworks that could make the difference bio art aims to make.

[58] Quote from article "RIP: Alba, the Glowing Bunny" in Wired magazine on 8th of December 2002, written by Kristen Philipkoski

3. Do-It-Yourself Biology

Still within the context of bio ethics, there is also a movement called Do-It-Yourself Biology (DIYbio). It is a global movement that aims to spread and popularize the use of biotechnology beyond traditional academic and industrial institutions into the general public.[59] The emergent practice includes informal groups that work outside the university or corporate laboratories to experiment with, and develop new biotechnologies.[60] These practitioners include a broad mix of amateurs, enthusiasts, students, and trained scientist, as well as artists. They focus their efforts on exploring genetics, coming to a deeper understanding, and even creating art.[61] DIY biology groups are unique platforms on which community education and interaction are staged via hands-on engagement with biotechnology. The movement also embodies growing trends favouring flattened organizational hierarchies, collaboration and bottom-up innovation. This movement began to shape around 2000, when amateur biotechnologists were working on the Human Genome Projects. The media back then predicted that amateur genomicists would soon take a similar position as amateur astronomers, and would explore DNA in this role.[62] It was not until 2008-2010 before this became reality. The first amateur biologist, Rob Carslon, who was not an amateur in the definite sense (he had worked closely with synthetic biologists multiple times before), but he was the first to explain the ease of building a home lab in the *Wired* magazine published in 2005. Around the same time Jason Bobe and Mackenzie Cowell launched the DIYbio.org message board online. This website was used to announce events at local bars where small groups could perform simple biology experiments.[63] These were only the first steps towards DIY biology, because both of them were still too much connected to the expert field of biology. The turn point came with the 2008 recession, when Bobe and Cowell's efforts in biology also reached out to a wider group with graduates and highly skilled professionals, while at the same time the shrinking biotech companies began selling used equipment on the internet for an affordable

[59] Grushkin, D., Kuiken, T., & Millet, P.
[60] Grushkin et al., 2013; Landrain et al. 2013
[61] Grushkin, D., Kuiken, T., & Millet, P.
[62] Ibidem, p. 5
[63] Ibidem, p. 3-8

price.[64] According to Mackenzy Cowell Biohacking is: "Taking things apart and putting them back together in a way that makes them better."[65] With both the growing interest, growing accessibility, and affordability of the equipment needed, the two years following changed the whole area of DIY biology. At first the do-it-yourself labs were located in garages or kitchens, but slowly dedicated labs in commercial spaces were organized and set up. These "community labs" were equipped with the needed resources and equipment, and attract skilled volunteers to get the labs going.[66] Even today the DIY biology movement continues to grow. According to the 2012 survey of Grushkin et al. there were at that time at least 14 community labs across Europe and North America and 18 regional DIYbio meeting groups. The DIYbio message board had 3300 members and is still expanding ever since. [67]

DIYbio thrives on making and exploring things by combining wetware, software, and hardware within a tight budget. Often the use of simple kitchen equipment, mixed with lab equipment and mundane living entities (such as yoghurts) prove to be the base of many DIYbio labs. The combination of eagerness and easiness provides a new and different approach to science; one that builds on hybridity and creativity. DIYbio is often and mistakenly thought of as trivial and domestic due to its name. A believe which is fed by the rare occurrence of important scientific breakthroughs of these scientists, because they usually focus on more common DIYbio objectives. The natural conclusion is that DIY biology will not have a real impact for future innovation. So how can we still make an argument in favour of DIY biology? In a sense DIYbio is not an original phenomenon, nor is it an isolated one. Just as amateur astrologist, the breakthroughs that occur in these labs are just as rare as they are in any other amateur field.[68] According to Ana Delgado in her essay "Making things and Making Future" this is not at all the point of DIYbio.

> "Instead of producing sophisticated biological objects, DIY biologists produce rather mundane living things. DIYbio entails a different way of

[64] Ibidem
[65] Delgado, A., p. 66
[66] Ibidem, p. 69
[67] Grushkin, D., Kuiken, T., & Millet, P., p. 8
[68] Ibidem

engaging with science and technology, and with the making of things and futures. It is biology moving out of institutions and to the realms of the public."[69]

It is indeed the DIY-praxis oriented that proves the significance of DIYbio These current DIY expressions combine the focus on the "self" with a vision of 'the community' as well. This hacking process and the constant re-evaluation of things that already exist. With this emerge of DIYbio; it subsequently takes into question the institutionalized forms of biology with its technological and bureaucratic mediations. The researches done, and the 'ground breaking' scientific breakthroughs, are usually generated from a wish and demand from the market. The funding of these scientific researches is usually providing the direction of what needs to be researched. The re-evaluation of these researches gives them an added view without a biased background, and with this viewpoint Cowell's argument makes sense.[70] The influence of the neoliberalistic context of the life sciences is also very apparent in the DIYbio movement. So if DIYbio is seen discussed in this sense, it may relate to the production of the new. Unfortunately, there is still a lot of fear from the general public towards DIY biology, as I already slightly touched upon in the chapter bioparanoia. The research ''Seven Myths & Realities about Do-It-Yourself Biology", a project by Synthetic Biology and the Wilson Centre, addresses the seven most common fears the general public has toward DIYbio specifically. The document explains the basics of what DIYbio actually is and what the scope of DIY bio can mean within society. In this document they acknowledge the issue that there is no single voice that can speak on behalf of the community, since there are so many different individuals with different backgrounds who work within DIY biology. It is also impossible to know what every member is doing at any given time. This makes it difficult to assess safety and security risks and to rule them out with certainty. Despite this uncertainty, the general fear is still a misplaced one and therefore they decided to shine some light on a few of the myths of DIY biology.

The first myth: "DIYers work anonymously and solitarily". A myth caused by the name 'do-it-*yourself*', which implies working alone. The current numbers

[69] Delgado, A., p. 66
[70] Ibidem, p. 67

of DIYers prove the opposite. 92 percent of DIYers work in group spaces, including community labs, group labs, and electronics hacker spaces that house DIYbio labs. They also include traditional corporate academic, and government labs.[71] A few examples of these will be described later on. Only 8 percent of the DIYers work exclusively in home labs.[72]

The second myth: "DIYers are capable of unleashing a deadly epidemic". As previously discussed in the chapter bioparanoia, even if a DIYer would be able to produce a dangerous virus such as the smallpox, the virus would most likely first affect the DIYer himself, before being produced in quantities to serve d as a weapon.[73]

The third myth: "DIYers are incapable of contributing to biotechnology". In disproving this myth, they come to an interesting conclusion about DIY biology: "DIYbio's contribution to biotechnology should be judged in three categories: 1) technical and scientific achievements, 2) new business achievements, and 3) contribution to public awareness and education. DIYers are already showing progress in each of these areas."[74] In figure 2 an overview is shown on how DIYers would categorize their own projects, when asked.

The fourth myth : "DIYers are averse to government oversight". An assumption based on the absence of DIYers in the conversation about government oversight. Even though 75 percent of the DIYers believe that there should be no additional oversight now, these numbers change profoundly when they are asked about the oversight in the future. In this case only 57 percent of DIYers believes that there should be no additional oversight from the government. See figure 3.

The fifth myth: "DIYers lack the comprehension to do biotech ethically". This claim is also disproven by their survey, see figure 4. DIYers advocate for transparency in their work. Of all respondents to the question "what are your feelings about transparency and sharing your work?" only six percent preferred

[71] Grushkin, D., Kuiken, T., & Millet, P., p. 9
[72] Ibidem
[73] Ibidem.; and King, J., p. 402
[74] Ibidem, p. 12

privacy.[75] 73 percent selected 4 or 5.with one defined as being completely private, to 5 being completely transparent.

The sixth myth**:** "DIYers risk accidents and environmental release of genetically modified organisms". This belief ties into the bioparanoia similar to one of bioterrorism. Again it is important to underline that many DIYers work in community labs that follow the general guidelines for bio labs. It is indeed the private labs that could be a problem here, but again based on the survey results, the risks of DIYers presently pose to the environment is low, as the respondents answered. the kits needed to make genetically modified organisms, is regulated by the government, and therefore some of these kits require a permit.[76]

The seventh myth: "Group labs may become unsuspecting havens for bioterrorists". Again a myth is bases on bioparanoia, which is very unlikely because of the following five reasons. First, many DIY community labs have very strict rules about lab access. Second, directors in most labs have to approve the bought materials brought in and removed from the lab. Third, because of the lab's openness it is difficult to stay anonymous in these self-controlling community settings. Fourth, the labs actually lack facilities that would allow to work with dangerous pathogens, so they would be at risk themselves; and the final factor, in the U.S. the community labs have a strong relationship with the FBI.[77]

Many misinterpretations of DIYbio are disproven and even though this should provide DIYers the freedom to work within their labs, its overall significance is still questioned. The speech "*A Biopunk Manifesto"* ties into the thought process behind DIYBio, and argues in favour of the significance of the movement. This speech, given by Meredith L. Patterson, is a manifesto inspired by "A Cypherpunk Manifesto" written by Eric Hughes. A Cypherpunk Manifesto was written to address the issue of online security, following the discussion about cyber security. This discussion divided people into two groups; one group became afraid of foreign hackers being able to use the cyber security against them (them being the American government), and the other group arguing in

[75] Ibidem, p. 15
[76] Ibidem, p.18
[77] Ibidem, p. 19

favour of privacy for online payments.[78] The manifesto argues in favour of the ability to defend their won privacy, if they expect to have any. 'The Cypherpunks, as their followers call themselves, write code in order to come to software that defends privacy. However, the codes that they write are not private at all as they are shared with other Cypherpunk who can edit it and play with it. Unregulated by the government, the movement's sole goal is to achieve an online security. As Hughes states:

> "We cannot expect governments, corporations, or other large, faceless organizations to grant us privacy out of their beneficence. It is to their advantage to speak of us, and we should expect that they will speak. To try to prevent their speech is to fight against the realities of information. Information does not just want to be free, it longs to be free. Information expands to fill the available storage space. […] We the Cypherpunks are dedicated to build anonymous systems. We are defending our privacy with cryptography, with anonymous mail forwarding systems, with digital signatures, and with electronic money."[79]

Without the Cypherpunks the current online payment system would not exist. Going beyond the argumentation, and work voluntarily without payment on this online security service was indeed the way forward. "The Biopunk Manifesto" by Patterson follows the structure of the Cypherpunk manifesto closely, as well as the imbedded argumentation on freedom of information. According to her "Scientific literacy is necessary for a functioning society in the modern age. […] Scientific literacy empowers everyone who possesses it to be active contributors to their own health care, the quality of their food, water, and air, their very interactions with their own bodies and the complex world around them."[80] In other words, with this manifesto Meredith Patterson claims that the right to do biology is a political right. The manifesto carries the vision of a more democratic future, where the lay people have access to and can modify the biological world. A PhD in biology is no longer needed, rather DIY biologist can self-achieve the

[78] Patterson, M.L., taken from her website http://www.activism.net/cypherpunk/manifesto.html
[79] Quotation taken from the speech by Patterson, M. L., http://www.activism.net/cypherpunk/manifesto.html
[80] Ibidem

level needed for the DIY bio-labs, all out of enthusiasm.[81] Just like the Cypherpunks, the Biopunks are not structured by the regulations of large companies or the government; rather they aim to make the world a place that everyone can understand.[82] Be that as it may, what Patterson overlooks in her positive manifesto, is that most DIYers are actual DIY biologists who do have a degree in biology. There are indeed a few others who are entrepreneurs and artists, and even less commonly, curious citizens. On the other hand, the projects they do in DIY biology are the projects that in one way or another enact creativity, curiosity, and enthusiasm. It is exactly this that makes Biohackers different from normal biologists.[83]

So far the movement of DIYBio is proven to be harmless and could be of significant use to the world, but this does not outline the whole movement just yet. It seems that most of the movement is accessible via the web and its core existence developed online, so it would make sense if there was a unified movement. The contrary seems to be the case as there are distinct differences in the movement on each side of the pond.[84] Both the European, as well as the American DIYBio movements, believe in the democratization of science and the enabling of citizens to do biotechnology. This is one of the ground characteristics of any DIYbio group, and before emphasizing the difference it is important to note that they have more characteristics in common than there are differences. In general the activities of DIYbio try to uncover the societal gaps and challenge the created standards of health care and food safety by the local economic, cultural, and political circumstances. In contrast to the U.S.[85], the groups in Europe need to obtain a license in order to carry out genetic engineering experiments, which is why European DIYbio groups have not done any type of these experiments.[86] U.S. DIYbio groups have showed interest in DIY medicine as an alternative to the established health care practices, whilst European groups have showed hardly any interest in this and focussed their projects more on the

[81] Delgado, A., p. 66
[82] Patterson, M. L.
[83] Delgado, A., p. 67
[84] Seyfried, G., Pei, L., and Schmidt, M., p. 548
[85] Minding different state legislations
[86] As an exception, the UK-Netherlands based C-LAB art collective did obtain a license to exhibit a bio art work with living genetically modified organism in London, UK. For more information visit: http://c-lab.co.uk/projects.html

ability to help people in developing countries. Unlike the European DIYBio groups, the US groups have to face the public's fear of bioterror. After the 9/11 incidents, the country's media and politics focus on fear-induced strategies, whilst their European counterparts tend to focus more on biosafety. Therefore, the government regulates the U.S. groups much more strictly in terms of biosecurity and being monitored by the FBI. Another very interesting finding is that the European DIYBio groups much more often tend to work in collaboration with amateur biologist, as well as artists and designers. However, it is unclear whether or not this difference is due to the smaller size of groups, or if the art/science interaction is a typical European characteristic.[87]

The DIYBio movement has proven itself to be useful in multiple ways. It is diverse, goes beyond the dominant hegemony of science and is able to make a real change in this world. At the same time there are still many misconceptions about the movement, probably due to the large differences between DIYlabs/community groups. Even when focussing on The Netherlands alone, there are already great differences between the communities. As mentioned before, the core believes are similar, but at the same time they offer two different views on DIY biology.

[87] Seyfried, G., et. al., p. 549

3.1 Dutch Do-It-Yourself Biology Communities

3.1.1 Waag

In 2012 Pieter van Boheemen started up the Dutch DIYBio community as a virtual group on meetup.com.[88] The aim of this group was to bring people together who have a shared interest in accessible biotechnology and the implication thereof. The meet-ups provided a platform for exchange of thoughts, skills and experience. The platform did not only give way to conversation, but activities as well, which created the possibility to engage in DIYBio to the field of art, design, hacking citizens, science, ethics and philosophy.. The Waag Society is one of the Dutch DIYBio groups in the Netherlands that engage in the DIYBio discussions. DIYBio is an activity of Waag Society's Open Wetlab. The Wetlab focuses on life sciences and the design and ethics of life. Their website states the following: "We want to involve the industry, artists and designers, but also the political forces and the public, in the hands-on shaping of biotechnology, as well as in what biotechnology creates."[89] With lectures, the Biohack Academy, the Open Wetlab nights, and their online publications, they educate the public on what DIY biology is about and perhaps more importantly: why it matters. In an interview with Pieter van Boheemen, project manager at Science Allience, this becomes especially clear. According to him, it is indeed so that the first projects of many DIY biologists are replica's of what has already been done in a 'real' laboratory, but the fact that they are carried out in a DIY environment creates new challenges. Different questions and answers arise from these experiments, so if you look at DIY biology this way, it is not an altered repetition. [90] By doing the same as scientists, but doing them differently, DIYBio becomes indeed innovative. Even though DIYbio is not meant to be 'useful' but more about the experiment itself, it gives the DIY biologist the freedom to do something different from what large companies are doing.

When comparing this example to the general description of DIYbio, it fits into the whole figure of European DIYbio communities. How does this exactly translate into real life? A good example for DIY biology would be Pieter van

[88] http://waag.org/en/
[89] http://waag.org/en/project/dutch-diy-bio-community
[90] Waag Society, Interview with Pieter van Boheemen in "Bioart Special," p. 15. You can download this special via http://issuu.com/waag/docs/bioart_special

Boheemen's project with Jelmer Cnossen and Wouter Bruins, who are working on a device that can be used for Malaria diagnostics: "The Amplino". Even though this machine is already invented, and it can be found in nearly every hospital and laboratory, the machine is still not spread widely enough in places where they are most needed. By altering The Amplino in their DIYbio lab meant that they are able to make a cheaper version that can be used in low-tech environments. At the same time there is the strain that the design has to live up to the requirements set by the World Health Organisation. These requirements are, for example, that the device is able to work at places where there is no water or electricity, as well as in high temperatures and humidity and the machine has to be robust and someone with minimal training should be able to use it.[91]

This is only one of the examples of the DIYbio community in Amsterdam. Another 'cheaper' replica of an already existing biotechnological machine is the 'Your Open-Source PCR Thermocycler.' This OpenPCR is a low-cost but still accurate thermocycler that 'everybody' should be able to build by themself. The machine is capable of reliably controlling PCR reactions for DNA detection, sequencing, and limitless other applications.[92] From their website you can download the software needed and print the design and building manual, to build it yourself in only three hours. It is also possible to buy a complete one for only $640. Again, de Waag Wetlab focuses its efforts on developing cheaper alternatives of already existing technology.

[91] Ibidem
[92] http://openpcr.org/

3.1.2 BioArt Laboratory

Another well-known DIYbio laboratory based in the Netherlands is the Bio Art Laboratory in Eindhoven. This Bio Art Laboratory looks for the area in between DIYbio and bio art. Their vision and mission is described on their website as following: "A world of unlimited possibilities where science, nature, technology and creativity go hand in hand. Together they form the foundation for a sustainable bio-based society which offers ample room for the thinking and creating human. As pioneers, we offer an inspiring environment to experiment and to develop new ideas. Bioart Laboratories encourages innovation and facilitates entrepreneurship leading to new bio-materials, start-ups and crossover talents."[93] This laboratory focuses their organisation on innovation. The laboratory has been founded in 2011 by Jalila Essaïdi and established its physical foothold in Eindhoven, in 2012. It is founded on the idea to enable future talents to develop and make sure these future talents have the opportunities to make use of Essaïdi's experience and contacts. Based in Eindhoven, this bio art lab is at the design heart of the Netherlands. Surrounded by bio-based and agro-food industries, the creation of crossover talents, new biomaterials and start-ups, the lab finds itself in the perfect location. It also has a global network enclosed universities, research centres and specialized laboratories. The Bioart Laboratory provides a combination of get-togethers and learning moments in forms of laboratory researches, workshops, personalized workshops, exhibitions, and expert talks. They also actively participate in the Bio-Art & Design Award (BAD-Awards), a competition for young artists and designers for both Dutch and international talents who experiment with bio art and design.[94]

They stimulate own researches and bio art and already quite some works have developed from this. One of the prime examples of the Eindhoven's laboratory is the work of founder Jalila Essaïdi. The work 'Bulletproof Skin' (2011) was able to bio-engineer human skin, grown in a laboratory, combined with genetically modified goad 'milk' that was tweaked to produce the same protein found in spider silk. The spider silk is four times stronger than Kevlar,

[93] http://bioartlab.com/
[94] Ibidem

the material used in bulletproof vests. This type of silk is also much stronger and more flexible than the usual silk produced by silkworms, yet, much harder to generate due to the behaviour of spiders.[95] The project could be completed in collaboration with Forensic Genome Consortium Netherlands (FGCN) and Jalila Essaïdi, both with a slightly different agenda. The FGCN obviously wanted to conduct research in this field, whilst Essaïdi had a more artistic agenda. Her aim was not necessarily to produce unbreakable skin, but she wanted to show that safety in its broadest sense is a relative concept. The work did indeed stop a few of the bullets, but not the ones that were at full speed. The experiment was named "bulletproof skin" to lead to a conversation about how and which forms of safety would benefit society. [96] Or in her own words: "Exploring boundaries by piercing barriers". According to her she wanted to make this violence based artwork, because of the world's increased exposure to violence through news and (social)media. This exposure manipulates our feeling of safety, and gives rise to a culture of fear, where irrational responses are born to imaginary threats.

Again, this artwork is presented as more of an ethical discussion than a focus on bioengineering, as we are by now used of in the case of bio art. Nevertheless, we might find a more practical use from this artwork, as Essaïdi is the founder of the DIYbio laboratory in Eindhoven. The artwork is presented in the philosophical discussion on her website, but in the news the work has been described much more practical. In an interview with CNN the work is explained as an interesting experiment, but was never seen as a solution against gun violence, or even an addition to everyday life.[97] Which ties into the focus of this DIYbio community. This community, based in the 'design capital' of the Netherlands, wants to explore and develop new things within the biotechnological community; even if this means that it raises philosophical questions more so than it improves (or builds onto) the already existing biotechnology.

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[95] Dailymail article, and CNN interview accessible viahttp://www.dailymail.co.uk/sciencetech/article-2094364/Bio-engineered-bulletproof-skin-human-cells-spider-silk-revealed-video.html, and https://www.youtube.com/watch?v=Q6S4fMOxuyE, for extra explanation on bulletproof skin visit: http://www.designboom.com/art/fusing-skin-cells-with-spider-silk-for-bullet-proof-skin-by-jalila-essaidi/

[96] Essaïdi's website accessible via http://jalilaessaidi.com/2-6g-329ms/

[97] CNN interview, https://www.youtube.com/watch?v=Q6S4fMOxuyE

4. Compare and Contrast

On first sight both bio art and DIYbio give the impression that they are two very different ways of working with biotechnology and the life sciences. Even if we look at them separately, they seem to be presented as universally following the general guidelines implemented by each movement. This is even more so the case for DIY biology than it is for bio art, where they acknowledge the wide variety of art. When reading more about DIY biology, one must nevertheless admit that it becomes clear that there is a wide variety possible within the movement too. The question arises whether the two might not be so different after all. The overlap between DIYbio and bio art becomes clear when analysing the different possibilities for DIY communities. For example, two different DIYbio laboratories in the Netherlands have two very different goals and ways of working. The Waag Wetlab's efforts focus on emulating scientific experiments and improve them. The Wetlab is open for a wide public, without reservation. The DIYbio community of Eindhoven focuses their efforts on developing new scientific designs. Through this way of thinking, most of the members must have a background knowledge and interest in design and science. Even though both of these DIYbio communities aim to make improvements in the life sciences, it is the contrast in their approach that seems to be similar to the difference in approach of bio art and DIY biology. Is this the only example of overlap between the two movements? Not really, as the similarities are also clearly visible when we compare examples presented as bio art to the examples presented as DIYbio. Oron Catts and Gary Cass describe one example I would like to use to illustrate this overlap in the essay "Labs Shut Open, A Biotech Hand-on Workshop for Artists". They describe the SymbioticA Biotech Art Workshop, organized by SymbioticA, the art and science collaborative research laboratory at the University of Western Australia. The project was a unique biotech art workshop, originally commissioned in 2004, organized for people who have a professional interest in the life sciences and biotechnology, but who never had the opportunity to engage hands-on in a laboratory with the right tools of contemporary biology.[98]

[98] Catts, O., and Cass, G., p.143

> "It introduces participants to concepts and techniques relating to contemporary art practices dealing with the manipulation of life. Emphasis is placed on developing critical thought, discussing ethical issues, and exploring cross-disciplinary experimentation in art. Current and historical practices dealing with the manipulation of living systems are traced thorough exploring art, culture, and biotechnology. The tools of modern biology are demonstrated and used through artistic engagement, which in turn opens discussion about the broader philosophical and ethical implications of the extent of human intervention with other living things."[99]

For this project the workshop invited artists, theorists, philosophers, writers, ethicists, architects, designers, curators, and engineers to participate. The similarities with the idea of a DIYbio lab are self-evident. People uneducated in the life sciences are learning how to work in a biological lab and preform their own researches. The workshop had the desired effect. According to Catts and Cass: "The "us and them" feeling between the arts and sciences does exist, but this workshop may be a small step toward chipping away at these barriers. Successful art-science collaboration can be valuable for both parties only if both cooperate equally. We believe that the discussions and decisions emanating from such an alliance will have significant implications for interdisciplinary practice within the arts and sciences."[100]

Evidentially, there is more overlap between the two than they both like to admit. This raises the question where we can locate the line between a life science project and an artwork. Beatriz da Costa forms a possible answer to this question in her essay "Reaching the Limit. When Art Becomes Science." According to her it is important to first identify what type of role the intellectual should assume in our society. Foucault has made a distinction between the "universal" and the "specific" intellectual.[101] The "universal" intellectual's duty was to serve as the consciousness of us all. Its primary task was to fulfil this mission through the written word, distancing himself from the people who were

[99] Ibidem, p. 144
[100] Ibidem, p. 155
[101] These definitions are taken from Michel Foucault, "Thruth and Power," in *The Foucault Reader*. The definition I use is described by da Costa, B., p. 366

identified as the ones benefiting from such discourses. As described in the chapter "Bioparanoia and Bioterrorism" this is also described as nearly impossible in our current society. From a group that was not originally given the status of intellectuals at all, the "specific" intellectual emerged. These were the engineers, mathematicians, physicists, and other scientists, that were respected for their expertise, but were not given the role of transcendental context providers. Today's world is filled with these "specific" intellectuals,[102] and as mentioned before, these individuals are confronted with everyday struggles of working with the ideological and economic influences of multinational corporations. The idea of the "universal" intellectual and the ability to contact an objective and pure research, independent from the political outside, becomes almost an impossible position to hold onto to. Industrial, military, and political interests are directly tied to funding provided by the respective institutions.

The role of art in the life sciences could be compared to the early 1990s and the emergence of "New Media Art". It was a time when universities and other institutions of higher education were willing to invest and teach their students about technology and how to use it. The institutions identified the need to educate a generation of students to be able to understand both the technical, as well as, the aesthetic aspects of digital media. Suddenly artists were able to use these digital technologies to present their artworks via websites. The World Wide Web has become a newly acquired venue for the arts. Obviously, artists were not the only ones working with these newly found sites. Programmers, activists, information theorists, academics, engineers, journalists, and others were also able to explore and shape instances through the newly available technological information. The Internet proved to be perfect to establish models of "DIY Media". The wide use, and the role of the artists in this new techno-science space, did make way to faster developments. For example, there was an increased sophistication in the use of digital and electronic technologies. "Specific" intellect became part of the artistic toolkit. This also shifted the status of the artist self. Yet at the same time, this new career within the digital and media industries became the status quo to actually earn a decent wage with. [103]

[102] da Costa, B., p. 366
[103] Ibidem, p. 366-70

The development in the art caused by Internet is one similar to the current artistic ambition to venture into the scientific realm. However, this proves to be complicated. A common basic skill that had allowed the above-mentioned developments to happen is now missing: coding. An artist can still design his own custom software, but this does not necessarily mean he needs to be a computer scientist. He or she is able to learn that trade within a couple of years, even without formal training. This is completely different for the life sciences, where the equivalent of "programming" is non-existent.[104] The artists are fully able to learn how to use the tools of a laboratory, and perhaps eventually will ease into the life of the laboratory. It must be noted, that they do need to know what they are looking at in order to get anywhere with the work. The "specific" intellectual in this case is one that is highly specialized. Because this scientific debate is so highly specialized, it is also one that outsiders are kept out of. "The number of people 'allowed' to even formulate an opinion about the controversy at hand is intentionally kept low, until the controversy is resolved and ready to come to the surface as either a confirmed fact or a defeated one."[105] This is because scientific controversies are the most vulnerable ones to be exploited in the public media ant other interfaces that play the role as mediators between scientific pursuit and political decision-making.[106]

One would think bio art, and DIY biology, were unable to develop properly in this debate. Despite the hostile environment, multiple artists and general people have gone against the grain and practiced the nation of public amateurism. Artists have ventured to find help in the realm of hobbyists and DIY home recipes for conducting scientific experiments. Even though this enactment of amateurism did not go as easily as planned, as described in the chapter bioparanoia. Claire Pentecost has developed this notion of amateurism, and has been working on theorizing the figure of the public amateur. According to her:

> "In such a practice the artist becomes a person who consents to learn in public. It is a proposition of active social participation in which any nonspecialist is empowered to take the initiative to question something within a given discipline, acquire knowledge in a noninstitutionally

[104] Ibidem, p. 370
[105] Ibidem, p. 372
[106] Ibidem

> sanctioned way, ad assume the authority to interpret that knowledge, especially in regard to decisions that affect our lives. The motive is not to replace the specialist, but to augment specialization with other models that have legitimate claims to producing an interpreting knowledge."[107]

However, as mentioned before, the amateurs cannot fully work within the realm of the life sciences without a little help. Therefore they often seek expert help from scientists. This has lead to lay-expert relations that have changed the face of both the public amateur, as well as that of the scientists. One prime example of this is again the SymbioticA's research lab. This lab has the goal to establish collaboration between scientists and artists. For this lab it is not a temporary one, but is permanently part of the university institution. Not only Claire Pentecost has developed a notion on amateurism in her own right, Bruno Latour also talks about the boundaries between research conducted within scientific laboratories and experiments being done outside this environment:

> "The sharp distinction between scientific laboratories experimenting on theories and phenomena inside, and a political outside where non-experts were getting by with human values, opinions and passions, is simply evaporating under our eyes. We are now all embarked in the same collective experiments mixing humans and non-humans together – and no one is in charge. Those experiments made on us, by us, for us have no protocol. No one is given explicitly the responsibility of monitoring them. This is why a new definition of sovereignty is being called for."[108]

The public amateur does not always engage with life materials, but the demystification of science and the critical examination of its political repercussions, is certainly at the centre of their works. Because the work with life materials needs an expert's knowledge, the collaborations between the artist and the scientist is not a one-off. Often in researching these works the communication between both parties amplify the critical outcome of the projects. However, because of this interaction it also de-strengthens the critical

[107] Quote from Claire Pentecost taken from http://www.clairepentecost.org/publicamateur.org/index.htm. Used in essay of da Costa, B., p. 375.

[108] Quote from Bruno Latour taken from http://www.bruno-latour.fr/poparticles/poparticle/p095.html. used in essay of da Costa, B., p. 376

message the artwork could carry out. The critical message is destrengthened because the material the artists are working with makes him or her more into an expert in the field. Particular material needs particular skills of the artist to develop to properly engage in the scientific realm. The problem arises in the notion that this advanced knowledge and skill of the artist,could end up creating the same trap of developing expertise while becoming less accessible to a non-expert public.[109] In a way the DIYbio movement is a new way to be the public amateur. He or she is still able to produce an artwork by working in a lab, but because of its open community it takes away from developing expertise. This is also emphasised by the work "The Biotech Hobbyist", a public experiment by the Critical Art Ensemble. They invite interested individuals to open their own biotech kitchen in a home environment. They do this by either enhancing existing educational science kits from high or middle schools, or distributing their own kits. By not focussing on the expert knowledge, to not work within an academic environment, they are able to inspire new people to work within this amateur field of science.[110] This is again an example on the possible similarities between DIYbio and bio art.

After analysing both the aim of DIYbio and the goal of bio art, there is one thing that seems to connect them constantly. As I already touched upon, the interaction between experts and non-experts is not a one-off. Similarly, over the last two decades there has been an increasing tendency for artists to seek partnerships with academics and vice versa. What needs to be kept in mind, however, is that these collaborations are not solely about bio art, but just as well in different fields of the humanities. These exchange projects have become common practice and are also actively promoted. One example of this was the CO-Ops programme launched by the Netherlands Organisation for Scientific Research (NOW). These CO-Ops focused on the processes of knowledge production that take place when artists and academics work together on a common research question. This way there is a two-fold development: on the one hand the artists are encouraged to, with their projects, reflect upon their experience and the interrelationship between art and science. On the other hand,

[109] da Costa, B., p. 382
[110] Ibidem. p. 376

the academics aim to formulate new theories within the humanities by working with hybrid research projects.[111]

This collaboration of art and science embody the shared values of a common modern culture. It is not only in the field of science that art has generated new and unexpected perspectives on contemporary culture and society. Taking the CO-Ops programme again as example, the artworks made for this collaboration included works reflecting on globalization, commercialization and mediatisation. These developments have been investigated by diverse disciplines. However, the aim of the CO-Ops was not to work on equal footing but from different principles, but to come to a mutually productivity, with the underlying concept that art and science embody the shared values of a common modern culture.[112] As already mentioned, this fusion between art, science and the academics is not a unique one. As can be seen in the collection of essays in books such as "Tactical Biopolitics. Art, Activism, and Technoscience" by Beatriz da Costa and Kavita Philip, and "Signs of Life. Bio Art and Beyond" edited by Eduardo Kac, we can see a large variety of writers: artists, scientists, scholars of various disciplines, all share a wide interest in the topics of the life sciences, and more specifically, bio art. This interaction is easier for bio art than it is for DIYbio. Why is this? Firstly, bio artists tend to work within the university context because of funding. This way the artist has to worry less about the means to support his or her artwork. DIYbio does attract a similar audience. Partly because the two are quite similar as is mentioned above. However, with the more practical background of DIYbio, and its focus on a cheaper approach to the sciences, DIYbio does remove itself from the university in its work but finds its connection again on a more philosophical level.

Contrarily, this is not even a general difference between the movements. One of the differences is that in Europe the DIY biologists collaborate much more with artists, designers, and specialized biologists, as seen in Eindhoven. In this case we cannot see the two movements separate from each other in Europe, but this would only be from a DIYbio standpoint. From a bio art viewpoint it is often

[111] Zwijnenberg, R., p. 169.
[112] Ibidem

said that artists gain more from crossing the cultural divide between art and science than scientists do.[113] Although, there have been scientific researches, such as the IGER research[114], that would never have been undertaken without artistic presence. According to Heather Ackroyd and Dan Harvey "The subtlety and range of tonal colour captured in the grass photographs made a deep impression on our science colleagues and, in a remarkable shift in perception, they realized that observation of plant material could occur in very different circumstances than the established investigative paths."[115] In this case the interaction between art and the sciences also adds to the outcome of research. Which is also why art that uses biotechnology as its means of expression is often understood as "less as art and more as a discursive and often instrumentalized form of contributing to on-going public debates beyond the aesthetic realm."[116] This less than art definition is also the biggest problem in presenting itself to a larger audience. So far only a few people had the chance to experience these types of artworks, due to the limited exhibition record of 'wet' art. Obviously this limit is due to the difficulty of displaying. Bio art's use of 'new' material is ground-breaking in history, since the use of this material automatically leads to the question of its educational value, and in terms right away it questions what bio art really is.[117] Perhaps more than anywhere else, this is where academics play its part in bio art; and more than anything it displays the similarities between DIYbio and bio art. By combining academic papers with the artworks, the artworks are able to live on even in their 'afterlife.' Even after the works have been removed, the general public is still able to read about them, and not unimportant, academics also play a translating role. For DIYbio these papers give the opportunity to access a wider audience and at the same time give a detailed description on their work and how others could do them as well. Through these articles, the academics are able to describe the works and take part in it by

[113] Ackroyd, H., and Havey, D., p. 207
[114] The IGER researched the reaction of chlorophyll (the chemical that makes grass colour green) and the chemical changes that happened to chlorophyll as it disappeared from leaves. The project was done in collaboration with artists, who made photographic photosynthesis dried stay-green grass pictures. The discolouration both gave way to the scientific research, as well as, a new material for artists to work with.
[115] Ackroyd, H., and Havey, D., p. 207
[116] Hauser, J., p. 83
[117] Ibidem, p. 94

adding a philosophical critique to the current hegemony of bioethics. Both movements are constantly connected to academics and here is where they find their real impact.

Conclusion

Times are ever changing and the ongoing development of technology has an everlasting impact on our society. Often, one is interested in where all these developments lead to, but I think it is important to first sketch an outline on what impact technology currently has on our society. Bio art and Do-it-yourself biology, both products of the ongoing development of technology, have both lived through interesting developments to come to their current status and both have had a significant impact on the world. Even though the roots of these movements can be found throughout history, it is only for the last 20-or-so years that they really took shape. Bio artists and DIYers attempt to bring the life sciences debate to the general public. They believe that through the humanities, science can become a part of the public debate since everybody should be able to raise their voice on these important issues. Every representation written or presented by someone who has an interest in these movements presents this as a working method to broaden the general publics thinking and to provide this general public with a critique on the current bioethics. Next to that, these two movements work within the same field of studies, although they present themselves as very different from each other. I do not believe it can be understood as to be so clear-cut. To make an understanding about the current role of bio art and DIYbio in the general public as well as in academics, it is needed to know whether bio art and DIYbio have indeed been able to be appealing enough for the general public to participate, or if they only have generated an interesting debate in the field of academics.

In a way they are appealing to the general public. Both bio art, as well as DIY bio, work within the specialized fields of the life sciences. Without the help of experts in these fields, the movements could not have developed as they have done. This means that the artists working in this field, and the DIYers, can translate a specialized type of knowledge to an easier, understandable, and more common language. However, an easy downfall could be that the artists and DIYers would adopt the expert type of knowledge and instead of bringing the life sciences to the public; they themselves become 'specialists' and get further removed from the general public. Bio art's danger in this situation, is that it is often perceived as an educational value, rather than an artistic critique.

Another troublesome aspect is that there are a lot of misconceptions about DIYbio and about the life sciences in general. From the 19th century onwards there has been a general fear called '"bioparanoia." Advertisers have strengthened this fear by using it for selling cleaning products. Politicians have not been much better by using fear-induced rhetoric in order to catch the public's attention on public health. This, unfortunately, has lead to more problems than solutions, and even though this paper does not provide a clear-cut solution, it is important to note when talking bio art and DIYbio. The misconceptions of DIYbio have their roots in this notion of "bioparanoia." Because of the constantly misinformed public these projects have often been misrepresented in the media as well. Only distancing DIYbio and bio art from the general public, instead of generating a debate.

One example to which the general public reacted to was the "GFP Bunny" by artist Eduardo Kac. His glowing bunny was able to make headlines, including the general pubic into the debate about the life sciences. DIYbio also has an open image to the general public and to come to an example in The Netherlands, de Waag Wetlab, is one that is open to the community. Here one can emulate scientific researches, and perhaps even improve on the research. However, it is important to keep in mind that these are two examples and are not necessarily representative for the whole movements. Academics do see the worth of this interaction between science and the humanities. Over the last two decades there has been an increasing tendency for artists to seek partnerships with academics and vice versa. From these interactions artworks and academic papers have resulted, perhaps causing only a more specialized field in which bio art and DIYbio can function instead of interacting with the general public. This has led to academics taking on the role of translators of the critique provided by the movements.

Bio art and DIYbio both present themselves extremely positive and able to change the status quo, but there are many more obstacles to overcome before they are able to do so. Their biggest strength is their interaction with scientists and the humanities, but even this has to develop even more to come to a full and proper understandable translation toward the public. They are a compelling

promise for the future, even if for now their intentions and believes are the more prominent aspects of their work.

List of Illustrations

Fig. 1. Eduardo Kac, GFP Bunny (Alba), 2000.

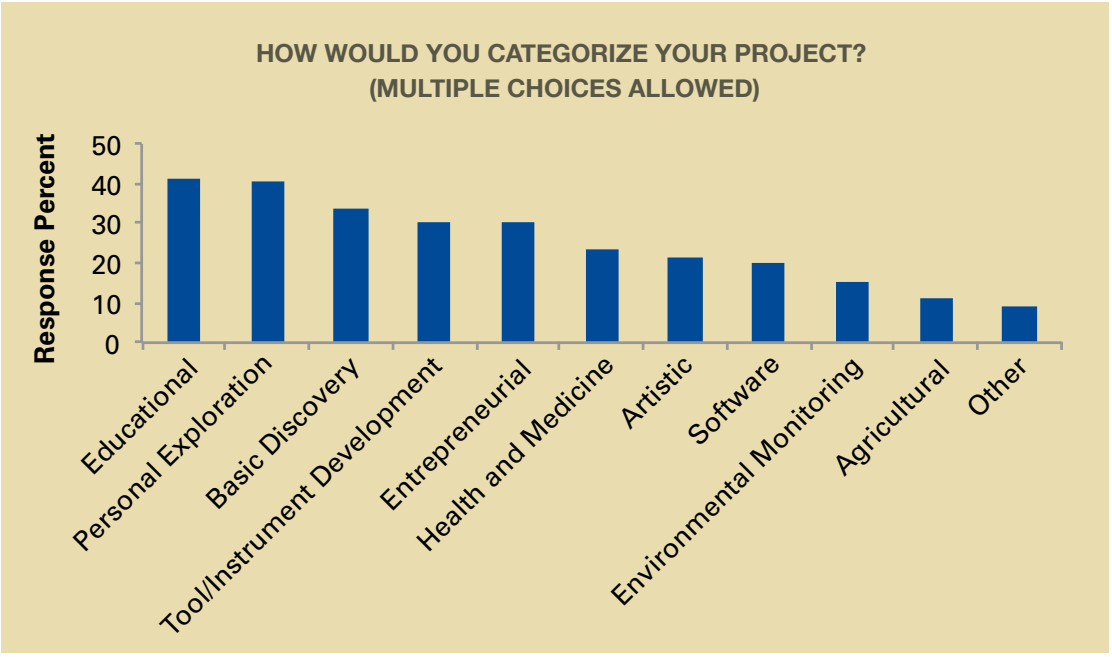

Fig. 2. DIYers categorize their projects.

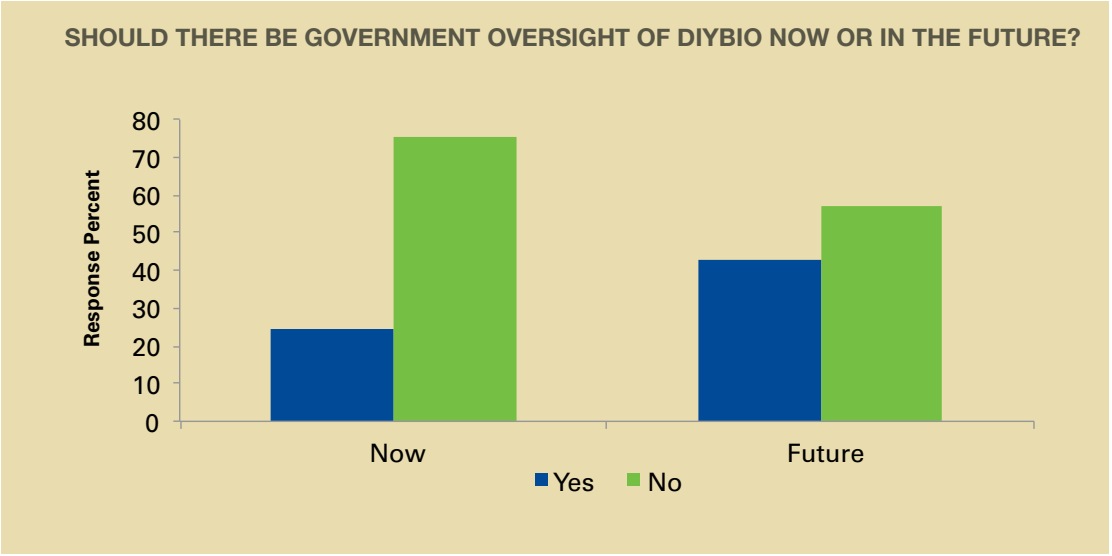

Fig. 3. DIYers vote on government oversight of DIYbio.

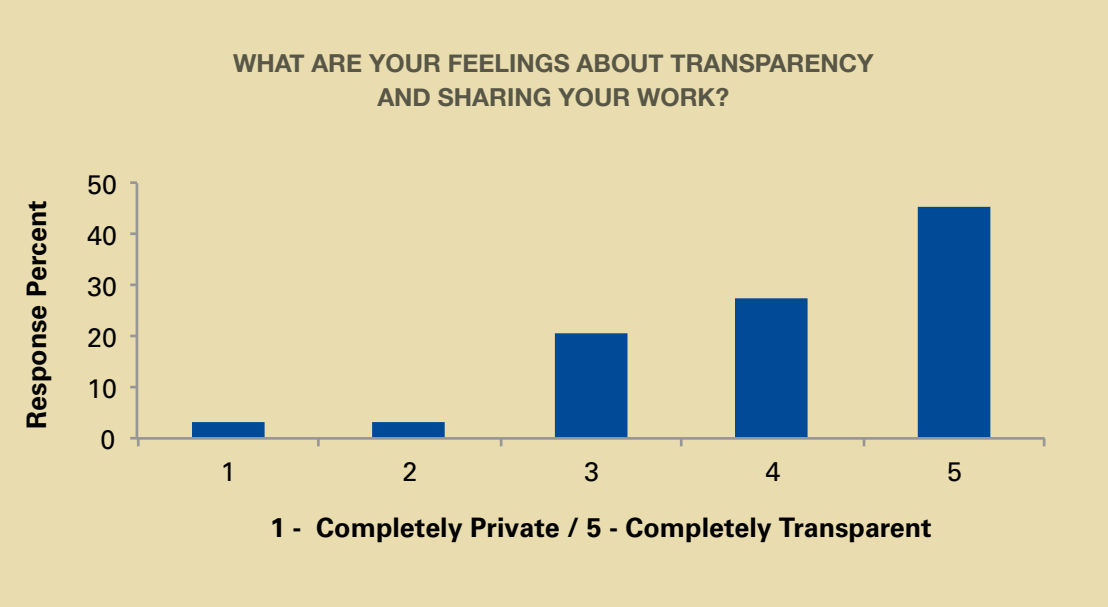

Fig. 4. DIYers feel on transparency and sharing their work.

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