Do It Yourself, Science and Design

by Juul Koene

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Introduction

In 1935 two people with different backgrounds came together to invent something groundbreaking. They accomplished to keep cat and bird organs alive for as long as 21 days. Alexis Carrel (1873 - 1944), a French surgeon and biologist, had been researching a way to keep tissues and organs function outside of the body. He managed to make a formulation of a nutrient-rich fluid that supported the cells of organs. But to let these cells bath in the fluid with a steady heart-rhythm of oxygenated blood, he needed a type of technology to make this possible. Charles A. Lindbergh (1902 - 1974), an author, inventor and explorer, who shared his interest in the workings of the body with Carrel, happend to have an extensive knowledge of mechanics and design. By collaborating with Alexis Carrel he helped solve the problem by designing and perfecting a structure of a rotating glass valve. This valve could properly regulate the pressure in the pump which was necessary to keep the organs alive.[1] By combining different backgrounds and unique perspectives Lindbergh and Carrel created a unique way of problem solving that made the perfusion pump possible.

Perfusion pumps (1935) by Charles Lindbergh and Alexis Carrel.

What if Alexis Carrel and Charles Lindbergh had never collaborated? Maybe the invention of this groundbreaking equipment would have never occurred. The perfusion pump is one example of many others that show the importance of a collaboration between different professions. As the project shows, a not so obvious collaboration between a scientist and a designer gave new insights and new possibilities. In this case the designer actually gave a solution for the scientist's problem. By collaborating, Alexis Carrel and Charles Lindbergh made the impossible (in 1935) possible. If you ask me, the perfusion pump also demonstrates how science should be open and available to everyone.

The exact sciences - biology, chemistry and physics - can be very complicated for non-scientists. This is often caused by a language barrier - not everyone speaks fluent science - or by the location where scientific questions get researched: not everyone has access to private companies, laboratories or universities. This often makes the knowledge of these exact sciences difficult to access. As a result it becomes even more difficult for us as non-scientists to relate to these sciences, even though it is a fundamental part of our every day life. Rain is science, riding our bike home is science and even preparing our diner is science. However, It's a pity, we are not always aware that science is all around us.

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[1] Sarah Lake, *What we don't remember Charles Lindbergh for: The perfusion pump,* http://americanhistory.si.edu/blog/2013/08/what-we-dont-remember-charles-lindbergh-for-the-perfusion-pump.html, Consulted on May 20, 2016

Picture yourself, no matter who you are. Even you, as unlikely as it may seem, can make a personal contribution to these exact sciences with the knowledge that you have. It could be you who can make a difference. Like the perfusion pump made a difference in the medical industry as it literally made it possible to preserve an organ before it gets transplanted in the human body. The perfusion pump saved and still saves the lives of many, many people. Be as it may, we do not understand or have knowledge of exact sciences, we can not form an opinion or contribute to those sciences and thereby, in a way, to society.

This is where the designer comes in; science does not have to be a black box. I think that designers can definitely make a difference in how we approach science. Besides viewing things from a different perspective, the designer's strong suit is to make tangible, understandable and visual translations. Where a performer converses with its audience by performing on stage, the designer interacts with its spectator in a conversation that takes place by language, image and context. By using scientific phenomena or knowledge and taking it out of its difficult and incomprehensible context, the designer is able to translate and demonstrate (parts of) the exact sciences in a way that everyone has an opportunity to understand or relate to these sciences.

An example where the designer uses science is *2.6g 329 m/s* (2011)*,* also known as *Bulletproof Skin,* a work by the Dutch artist and entrepreneur, Jalila Essaïdi (1980).[2] The title derives from the performance standard for bulletproof vests. The maximum weight of a .22 calibre Long Rifle bullet is 2.6g and the maximum velocity of a .22 calibre Long Rifle bullet is 329 m/s.[3] *Bulletproof Skin* is an artwork that approaches the concept of bullet proof from a different angle. Normally bullet proof vests are made of a shaped sheet of advanced plastics polymers.[4] Essaïdi discovered that spider silk thread is even stronger than steel. This made her wonder whether humans could be impenetrable by bullets if the human skin would be able to produce this kind of thread. Together with the Forensic Genomic Consortium she researched this phenomenon and started experimenting; they implanted genetically modified spider silk in the human skin to see if it could actually be protected from bullets.[5] Even though the skin did manage to restrain a couple of bullets, the work wasn't able to stop those at full speed.

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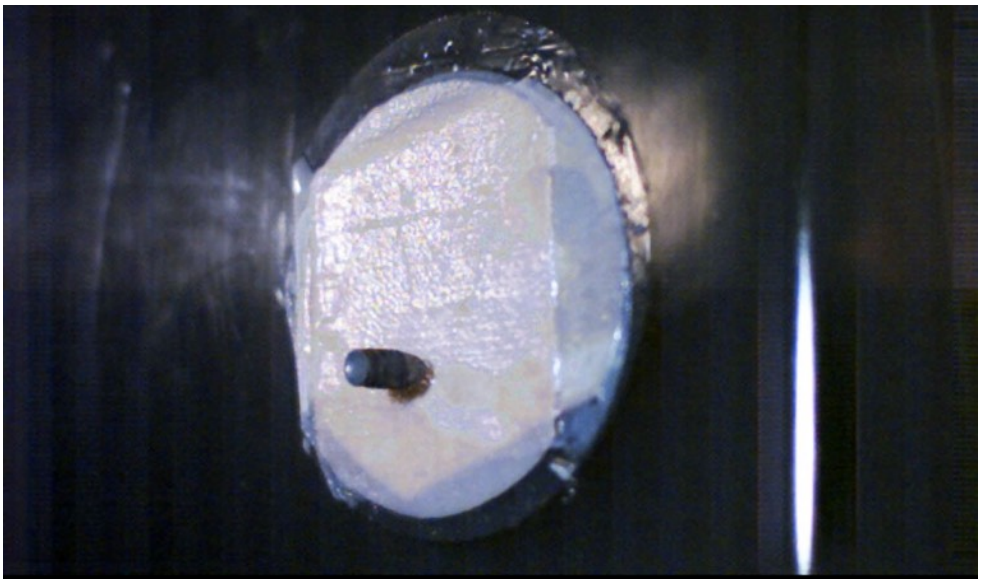
[2] Jalila Essaïdi, http://jalilaessaidi.com/2-6g-329ms/, Consulted on March 3, 2017

[3] Jalila Essaïdi, http://jalilaessaidi.com/2-6g-329ms/, Consulted on March 3, 2017

[4] http://www.madehow.com/Volume-1/Bulletproof-Vest.html, Consulted on March 3, 2017

[5] Jalila Essaïdi, http://jalilaessaidi.com/2-6g-329ms/, Consulted on March 3, 2017

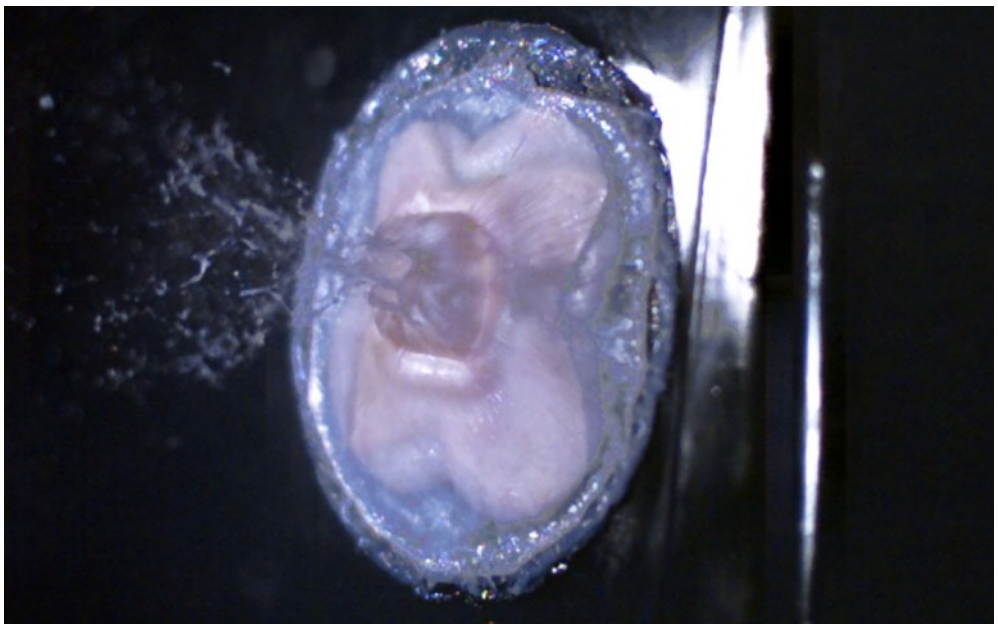
Bulletproof Skin (2011) by Jalila Essaïdi, Bullet approaches skin.[6]



Bulletproof Skin (2011) by Jalila Essaïdi, Bullet enters skin.[7]

[6] Lara Mikocki,'bulletproof skin made from spider silk proteins and human skin cells', *designboom*, http://www.designboom.com/art/fusing-skin-cells-with-spider-silk-for-bullet-proof-skin-by-jalila-essaidi/, Consulted on March 3, 2017

[7] Lara Mikocki,'bulletproof skin made from spider silk proteins and human skin cells', *designboom*, http://www.designboom.com/art/fusing-skin-cells-with-spider-silk-for-bullet-proof-skin-by-jalila-essaidi/, Consulted on March 3, 2017



Bulletproof Skin (2011) by Jalila Essaïdi, Feedback Skin on bullet.[8]

Although Essaïdi aims at showing that safety, in the broadest sense of the word, is a relative concept, *Bulletproof Skin* also takes a scientific, biological fact out of context and makes it more relatable and tangible for non-scientists.[9] By exploring and researching this area of science as a designer, she could make the translation of a standard product of nature into something that we, in a time of terrorism and threats, can all relate to.

Another example of how science can be deployed within design is *Ambio Light* (2014) by the Dutch Designer Teresa van Dongen (1988).[10] This work not only uses exact science, it also lets the spectator play an important role. *Ambio Light* contains bioluminescent bacteria in a saltwater solution. These bacteria - obtained from an octopus - will light up when they come in contact with oxygen. Teresa van Dongen uses *Ambio Light* to represent a new way of light or energy. She wants to make us aware that we deplete our energy and light sources and that it is wise to look for (less harmful) alternatives.[11] For the creation of this design Van Dongen collaborated with B.M. Joosse and R.M.P. Groen, two Dutch Life Science and Technology students from the Technical University in Delft. Joosse and Groen provided the bacteria Teresa used.[12]

[8] Lara Mikocki,'bulletproof skin made from spider silk proteins and human skin cells', *designboom*, http://www.designboom.com/art/fusing-skin-cells-with-spider-silk-for-bullet-proof-skin-by-jalila-essaidi/ Consulted on March 3, 2017

[9] Jalila Essaïdi, http://jalilaessaidi.com/2-6g-329ms/, Consulted on March 3, 2017

[10] Teresa van Dongen, http://teresavandongen.com/Ambio Consulted on March 4, 2017

[11]Teresa van Dongen, http://teresavandongen.com/Ambio Consulted on March 4, 2017

[12] Teresa van Dongen, http://teresavandongen.com/Ambio Consulted on March 4, 2017

Ambio Light (2014) by Teresa van Dongen.[13]

The designer made an important choice in her work: Van Dongen actually chose to let the viewer participate instead of using a motor to move the light. Without the participation of the spectator, Ambio Light would be 'Ambio Light Out'. Only when the viewer gives a gentle push to the lamp, the bacteria come in contact with the oxygen and will light up. Without the push, there is no light. In order to keep the light on, you need to continue to give a gentle push once in a while.

The choice Van Dongen made is an important design choice; by having the spectator participate in this work, he or she has the possibility to actually understand what is happening. By allowing the spectator to participate, the designer adds another layer to her work. It makes the viewer relate to her lamp/design and to the research that made the lamp as it is.
In addition to being a self-contained beautiful object the lamp can also become an interesting and experimental object. She is literally handing her work over to the beholder, resulting in the evaporation of the boundary between her work and the beholder. I think this is a very interesting and also significant aspect of interaction design.

For me the participation method Van Dongen uses has a direct link with the concept of Do it Yourself (DIY). You have probably heard of the concept of DIY. Maybe you have fixed something by yourself once or twice and often, but not always, in a *hacky* way. Just google *DIY* and you will get a million different results: from how to make your own Christmas ornaments to how to stitch yourself up. The Do It Yourself community is a community that turns a passive onlooker into an active participant.

However, DIY is more than that. The American writer, editor, and historian Chris Carlsson (1957) states in his book *Nowtopia* (2008)*: "DIY challenges the direction of science and technology of below. Instead of passively awaiting results from corporate and university laboratories that might actually be useful."*[14] In other words, what Carlsson is trying to say, is that DIY is a very accessible way of approaching science and technology. Instead of waiting for other people to solve problems or scientific questions, DIY is used by all to find out easy ways to come up with a - temporary - solution for the problems we have.

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[13] Teresa van Dongen, http://teresavandongen.com/Ambio Consulted on March 4, 2017

[14] Carlsson Chris, *Nowtopia: How Pirate Programmers, Outlaw Bicyclists, and Vacant-lot Gardeners are Inventing the Future Today,* the University of Michigan, 2008, p. 47

By Following the concept of user-participation as a design method and the concept of DIY as a way to make science and technology accessible, I found myself asking the following question:

How can the designer use DIY to facilitate access to exact sciences and make those sciences more understandable for the public?

To answer this question I have researched and analysed several different design ideas and projects, which I will share with you in this thesis. During my research I found out that I could divide these projects into three main themes of DIY that make the exact sciences more accessible. I will interpret, illustrate and explain each theme and the corresponding designs and projects in the following chapters.

In my first chapter I will address the first theme: the use of DIY to indicate or solve a (significant or present-day) social issue. I will introduce this theme with the concepts *Bio Couture* by Suzanne Lee[15] and *Victimless Leather* by Oron Catts and Ionat Zurr[16]

In the following chapter I will introduce the second theme: the use of DIY as an alternative tool. Here I will dig deeper into the benefits and consequences of a DIY tool by using the works *Anaerobic Chamber*[17] by Nelson Ramon and *Open Surgery* by Frank Kolkman[18].

My third and final chapter will define the last theme: the use of DIY as a participating method in design. Within this chapter I will analyse and interpret the projects *SuperWeed Kit 1.0* by Michael Boorman of Natural Reality[19] and *Cypher* by Eduardo Kac[20].

At the end of this thesis I will close with my conclusion where I will draw the outcome and connections between the particular theories or concepts discussed in the previous chapters. By doing so I will attempt to provide an answer to my main question: How can the designer use DIY to facilitate access to exact sciences and make those sciences more understandable for the public.

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[15] Suzanne Lee, http://thisisalive.com/biocouture/, Consulted on March 19 2017

[16] Oron Catts, Ionat Zurr, http://www.tca.uwa.edu.au/vl/vl.html, Consulted on March 19, 2017

[17] Nelson Ramon, http://genspace.org/project/DIY-%20anaerobic%20chamber Consulted on 13 November 2016

[18] Frank Kolkman, http://www.opensurgery.net, Consulted on 20 November 2016

[19] Natural Reality 'SuperWeed Kit 1.0',https://itp.nyu.edu/classes/germline-spring2013/files/2013/01/SuperWeed.pdf, Consulted on March 19, 2017

[20] Eduardo Kac, "Cypher", transgenic poem, 2003. http://www.ekac.org/cypher.html, Consulted on March 19, 2017

DIY to indicate or solve a social issue

A lot is happening in our current society. Everyday new problems pop up and old problems get bigger. One old time problem is global warming. This issue is very complicated otherwise we would have already come up with a solution years ago. It is of significance that we can relate to the content of this problem, as I have highlighted in the introduction: if the non-scientist would have acces to this matter, it can offer a different perspective on this case. In order to make this happen it is of importance that we can relate to the problem and to a possible solution. As it is up to the designer to make a translation for the public, how can he/she contribute towards a sustainable and more environmentally friendly world? As I stated before in the introduction, I believe that the concept of DIY is a great way to make science accessible to all. So the main question at this point is: how can the designer use DIY to address a significant or present-day social issue in order to make science accessible?

Sustainable production and our exploitation of other living beings

A great example where DIY is used to address a social issue is *Bio Couture* (2003).[21]
Ten years ago, the American fashion designer Suzanne Lee (1970) was introduced to the concept of living materials by the Scottish biologist David Hepworth. Hepworth told her that organisms like bacteria could grow cellulose, the most common fiber in the world.[22] They started to collaborate on a fashion experiment which resulted in the *Bio Couture* production method.

It can be said that this production method is not the most conventional as it is established by a fermentation method of a symbiotic mix of yeast and bacteria that grows bacterial cellulose.In order to explain and understand this material, Suzanne Lee calls it a kind of vegetable leather.[23] This method is not bound to a special lab or place but can be done wherever you want with the right supplies and ingredients.[24] For *Bio Couture* - which aims to develop a new sustainable material - it is very important that it is open for everyone to explore. Only when it is and remains transparant it can deliver its message within its full potential to our current consumer society. With all the plastic and chemical waste that cannot be properly handled, we should consider options that have some form of sustainability.[25]

BioCouture Shoe (2013) by Liz Ciokajlo[26] and Suzanne Lee, a result of Bio Couture (2003)[28]

Fermentation Method Bio Couture[27] (2003) by Suzanne Lee

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[21] Suzanne Lee, http://thisisalive.com/biocouture/, Consulted on March 19 2017

[22] Daniel Grushkin, 'Meet The Woman Who Wants to Grow Clothing In A Lab, Cultured couture', *Popular Science*,http://www.popsci.com/meet-woman-who-wants-growing-clothing-lab Consulted on March 19, 2017

[23] Marcus Fairs, "Microbes are "the factories of the future"", *dezeen*, February 12, 2014, http://www.dezeen.com/2014/02/12/movie-biocouture-microbes-clothing-wearable-futures/ Consulted on March 19, 2017

[24] Marcus Fairs, "Microbes are "the factories of the future"", *dezeen*, February 12, 2014, http://www.dezeen.com/2014/02/12/movie-biocouture-microbes-clothing-wearable-futures/ Consulted on March 19, 2017

[25] Suzanne Lee, http://thisisalive.com/biocouture/, Consulted on March 19 2017

[26] Liz Ciokajlo, 'Bio Couture Shoe',http://lizciokajlo.co.uk/project/biocouture-grown-shoe/ Consulted on March 19, 2017

[27] Suzanne Lee, http://thisisalive.com/biocouture/, Consulted on March 19 2017

[28] Suzanne Lee, http://thisisalive.com/biocouture/, Consulted on March 19 2017

What's good about *Bio Couture* is that it is a method: we're not just spectators, we can also participate. This makes this method DIY as it is accessible and feasible for people at home. David A. Kolb (1939), an educational theorist, sees the importance of participation experiences as the source of learning and development.[29] This is also referred to as 'learning through reflection on doing' which results in actual understanding what is happening. In the case of *Bio Couture* the participant not only gets the work and its message to today's society, the spectator also learns from this work and thereby gains a better understanding. This is a great example of how exact sciences become more accessible. Thereby we are not just listeners to the designer's opinion. By developing, exploring and interpreting this method to a greater extent, the non-scientist can form his or her own opinion on our current consumer society.

The reason why *Bio Couture* can keep on developing is because it is based on the concept of open source: *Bio Couture* provides the rights to study, alter, and distribute the recipe to anyone and for any purpose.[30] This is great because it means that anyone can use it to his/ her own needs. The Lebanese, Canadian Ayah Bdeir(1982), founder and CEO of littleBits said something about DIY that reflects on this specific work.[31] Bdeir said the following: *"it is similar to cooking, everyone uses the same ingredients but the outcome is always different."*[32] This explains exactly what Bio Couture is about. It is a method visualised in the form of a recipe available to everyone. Yet the outcome of the recipe depends on how it is implemented by each individual.

The goal of *Bio Couture* is to provide a new design method to be adopted by production industries to work towards a better future, *Victimless Leather* (2004), a work by Australian artist and researcher Oron Catts (1967) and the English artist, researcher and curator Ionat Zurr (1970), on the other hand takes a different direction. *Victimless Leather* - a prototype of a stitch-less jacket grown in a technoscientific "body" - revolves around the concept of people using their own vulnerable body to protect themselves from their direct environment.[33] This concept consist of a semi-living piece of clothing. Lakshmi Sandhana a freelance Science and Technology Journalist said the following about the content of this garment: "*The Cells that Iron Catts and Ionat Zurr use in Victimless Leather are cells that come from a so-called immortalised cell lines, or cells that divide and multiply forever once they are removed from an animal or human host, essentially forming a renewable resource".*[34] This makes it somewhat abstract for the non-scientist, but Catts and Zurr took this garment out of its context and presented it as an art object. By doing this they can communicate a message about the cultural meaning of clothes as a second skin.

As with *Bio Couture*, *Victimless Leather* sheds light on a significant, present-day social issue: the modest act of survival has become a complex social ritual which transformed the concept of a "garment" into a suggestive object that cannot be taken on its face value. Oron Catts shares the following in their project description: *"Garments are humans' fabrication and can be explored as a tangible example of humans' treatment of the Other."*[35] *A* garment or a piece of clothing became an expressive tool. A tool to project one's social class, political stand, identity and so on.

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[29] Kolb, D.A (1984). *Experiential learning: Experience as the source of learning and development.* Englewood Cliffs, N.J: Prentice-Hall

[30] Unknown, 'Bio Couture, Suzanne Lee', LAUNCH http://www.launch.org/innovators/suzanne-lee

[31] Ayah Bdeir,CEO Little Bits, http://tegenlicht.vpro.nl/afleveringen/2014-2015/de-nieuwe-makers.html,

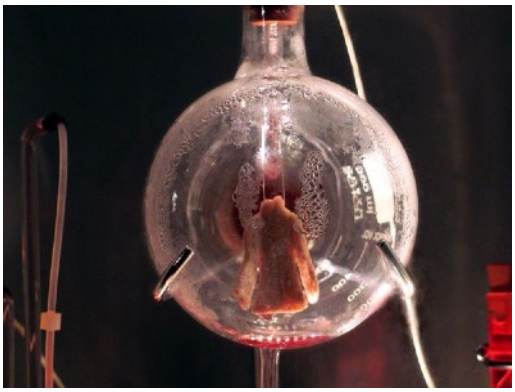
[32] Ayah Bdeir,CEO Little Bits, http://tegenlicht.vpro.nl/afleveringen/2014-2015/de-nieuwe-makers.html,

[33] Oron Catts, Ionat Zurr, http://www.tca.uwa.edu.au/vl/vl.html Consulted on March 19, 2017

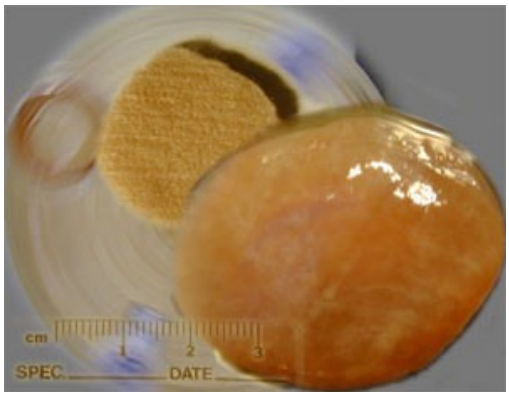
[34] Lakshmi Sandhana, 'Jacket Grows From Living Tissue', *WIRED,* 10.12.2004, https://www.wired.com/2004/10/jacket-grows-from-living-tissue/ Consulted on March 19, 2017

[35] Oron Catts, Ionat Zurr, http://www.tca.uwa.edu.au/vl/vl.html Consulted on March 19, 2017

The duo sees their work as more of a starting point for cultural discussion and as a way to raise questions about our exploitation of other living beings, rather than a commercial product.[36] *Victimless Leather* engages with the spectator by taking something we all relate to and pulls it out of its context. Catts and Zurr choose to display their work rather than to make it wearable, which takes it even more out of context. The spectator can view the work from a distance, giving him or her the possibility to develop an opinion about their work and thus about today's society.



Victimless Leather (2004) by Oron Catts and Ionat Zurr



Victimless Leather (2004) by Oron Catts and Ionat Zurr

By making *Victimless Leather* semi-living, Catts and Zurr problematise their concept even more. Their grown garment will confront people with the moral implications of wearing parts of dead animals for protective and aesthetic reasons. Furthermore it will confront people with the notions of relationships with living systems which have been manipulated.[37] The spectator is confronted with a possible future where sciences play a bigger part in our lives than we would have expected in the first place. The spectator is able to relate to science on a higher level. Even though the viewer only takes part through discussion, it is a good way to map a social issue in today's society by using science and design.

Correlation between *Bio Couture* and *Victimless Leather*

The two design works which I have previously discussed have different ways of expressing themselve, yet they share a similar goal. Bio Couture and Victimless Leather both speculate on an alternate future. In the alternate future of Bio Couture we no longer rely on materials obtained from unsustainable industries or on land used for the production of food. Instead we move to a biotech model. Suzanne Lee sees this biotech model as a closed loop system that contains synthetically engineered organisms with the ability to ferment materials. These materials will immediately form into finished products with no need for chemical dyes or finishes and there is no waste.[38]

Victimless leather speculates on a similar future but approaches it from a less commercial angle. Catts and Zurr aim to challenge and stimulate people to form an opinion about our cultural meaning of clothes as a second skin. *Victimless Leather* also provides the user with insight into what is happening in today's society. As Ionat Zurr and Oron Catts say: "This piece also presents an ambiguous and somewhat ironic take into the technological price our society will need to pay for

[36] Oron Catts, Ionat Zurr, http://www.tca.uwa.edu.au/vl/vl.html Consulted on March 19, 2017

[37] Oron Catts, Ionat Zurr, http://www.tca.uwa.edu.au/vl/vl.html Consulted on March 19, 2017

[38] Suzanne Lee, http://thisisalive.com/biocouture/, Consulted on March 19 2017

achieving “a victimless utopia”.”[39] Catts and Zurr want to see what potential effect these futures could have on our cultural perceptions of life. [40]

Other similarities in both projects lay in the use of clothing as an expression of human kind and the consumer waste as a result of the clothing we use in today’s society. They made the translation from something scary and gross as bacteria to something to which we can relate. *Bio Couture* presents itself as a method to make alternative materials to address our consumer waste and *Victimless Leather* is an art object that uses the spectator to take part in the conversation about clothes as a second skin and to address our exploitation of other living beings. Both works are connected with the concept of fashion. Each work points out several critical social issues in today’s society in order to make the world a better place.

Making science accessible

With *Bio Couture* we can participate in science and with *Victimless Leather* we can relate to a critical issue. We understand and can therefore take a stand. We are already retaining the various social issues that are used here. It is the challenge for the designer to ensure that we get a better understanding of these social issues. By involving the spectator through DIY and discussion, the spectator gets a general idea of the importance of the situation. In this case, it is important to look for alternatives to counteract ethical issues which concern wearing leather and consumer waste.

What I aim to achieve by discussing and reflecting on these two works is to show the importance of science being accessible to everyone. Both works have different approaches and different goals, but together they support me in reaching my goal. By using these works I want to address in which ways DIY can be used to make the exact sciences accessible and thereby point out a social issue. *Bio Couture* addresses a specific social issue and therefore uses DIY (as method), and the exact science (as content). *Victimless Leather* takes on the cultural discussion about clothes as a second skin and translates this by making a garment out of ‘skin’ cells. Hereby the exact science is again used in the content of the work. As well known Canadian media theorist Marshall McLuhan (1911-1980) once said: “ The medium is the message” [41] By using science as the significant predominant factor, it plays a significant part in the performance of the work. The exact sciences create a symbiotic relationship by which the medium influences how the message is perceived.

The Bio Couture Shoe (2013) a collaborative work by Suzanne Lee and Liz Ciokajlo an American product, furniture and fashion accessories designer is a product of the *Bio Couture* method.[42] ‘[43] The shoe demonstrates what is possible with this method and how it may develop further in the future. By keeping this method transparant, anyone can contribute towards a new future perspective. Bio Couture does not leave you in the dark. It brings the possibilities of experiments with bacteria at home to light. The bacterium becomes tangible and does not remain in the vagueness of science. It is great that Bio Couture is so open and accessible to others, up to the public to take this next level. Bio Couture Shoe as one possible result can make people excited to work with Bio Couture because it is aesthetically attractive. Other reasons why people would experiment with Bio Couture is because it withhold a relevant issue which they want to solve or maybe they just really like this method.

Victimless Leather deals with an ethical issue in which they treat the concept of material to create awareness with the spectator. By making the work semi-living they force the spectator to see their

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[39] Oron Catts, Ionat Zurr, http://www.tca.uwa.edu.au/vl/vl.html Consulted on March 19, 2017

[40] Oron Catts, Ionat Zurr, http://www.tca.uwa.edu.au/vl/vl.html Consulted on March 19, 2017

[41] Understanding Media: The Extensions of Man by Marshall McLuhan http://web.mit.edu/allanmc/www/mcluhan.mediummessage.pdf

[42] Suzanne Lee, http://thisisalive.com/biocouture/, Consulted on March 19 2017

[43] Liz Ciokajlo, ‘Bio Couture Shoe’,http://lizciokajlo.co.uk/project/biocouture-grown-shoe/ Consulted on March 19, 2017

‘garment’ through the eyes of a scientist and designer and thereby show what can be done when you have the right equipment. It can also confront people with their way of living and stimulate people to work with living cells, making the step towards semi-living clothes smaller.

We now know how the designer can use DIY to address a significant or present-day social issue and thereby make science accessible. Both *Bio Couture* and *Victimless Leather* present their own ways of highlighting different social issues by involving DIY and science. *Bio Couture* does this as a method that contains exact science and *Victimless Leather* does this by conducting a conversation that takes place around the concept of science. In this way each work involves spectators by allowing to take part in the work and by doing so both projects make the exact sciences accessible to the public.

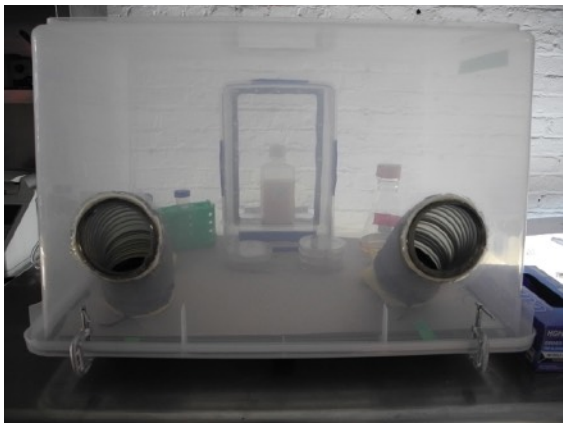
DIY as an alternative accessible tool

In today's society we have acces to all kinds of equipment, some very accessible as a screw driver or computer - both low cost and available to everyone - and some not so accessible as medical equipment or lab equipment - often very expensive and bound to a special place like a hospital or private company. That medical and lab equipment is high cost is generally known, but we are not aware of the consequences this has. It is very important that we are conscious of this because when we know and understand we can relate to these issues. At this moment healthcare is becoming over expensive and researchers who are not bound to a private company or university are not able to do research with the right tools. DIY can be a way to make some room in these fields for accessible alternatives and the non-scientist who can bring an out-of-the-box view to these industries, by looking for possible options outside of these closed money systems. How can the designer play a part in highlighting these issues and design alternative tools to provide access to these industries?

Cheaper sustainable alternatives

A work where the designer used DIY to design lab equipment is *Anaerobic Chamber*[44] (2012) by the American Nelson Ramon[45], a the interaction technologist and experience designer with a background in computer science. *Anaerobic Chamber* is a lab piece that was built to grow cultures of bacteria that need a low oxygen environment.[46] The function of the *Anaerobic Chamber* is to protect these air-sensitive organisms (or chemicals) from highly destructive oxygen[47] Usually a piece of lab equipment like the *Anaerobic Chamber* runs in the thousands of dollars, that makes it hard to use for individuals who want to experiment with organisms or chemicals. The goal of Nelson Ramon, was to not only make a decent piece of equipment that could be used over and over again but also to keep the costs low, to give anyone who has access to a hardwares store or the internet the opportunity to make and use this lab equipment.[48]

Instructions of how to build an *Anaerobic Chamber* by Nelson Ramon[49]



Anaerobic Chamber by Nelson Ramon[50]

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[44] http://cargocollective.com/nelramon/DIY-Anaerobic-Chamber Consulted on April 15, 2017

[45] Nelson Ramon, 'Interaction Technologist | Experience Designer', *Resume,*http://www.nelsonramon.com/cv/ResumeNelsonRamon.pdf

[46] Nelson Ramon,http://www.genspace.org/blog/2013/04/15/diy-anaerobic-glove-box/ Consulted on 13 November 2016

[47] Sean Michael Ragan, 'Maker Faire New York: How-To: DIY Anaerobic Chamber/Glove Box', *Makezine,* http://makezine.com/2012/09/18/how-to-diy-anaerobic-chamber-glove-box/, Consulted on April 15, 2017

[48] [48] http://cargocollective.com/nelramon/DIY-Anaerobic-Chamber Consulted on April 15, 2017

[49] [49] http://cargocollective.com/nelramon/DIY-Anaerobic-Chamber Consulted on April 15, 2017

[50] [50] http://cargocollective.com/nelramon/DIY-Anaerobic-Chamber Consulted on April 15, 2017

To make it a sustainable piece of equipment *Anaerobic Chamber* had to comply with the regulations of a simple lab. Depending on what you want to do in the lab, the lab needs different requirements. For instant if you want to use human tissue in a lab, than you are restricted to certain locations that have higher regulations than when you want to experiment with modified plants. To make the *Anaerobic Chamber* a decent piece of equipment it had to meet the Bio Safety Level 1 regulation[51]. The importance for this equipment to fulfil this Bio Safety Level 1 regulation is that it then could be used in a lab. An example of a environment where a DIY equipment as *Anaerobic Chamber* can be used, is Gen Space.

Gen Space (New York) is a nonprofit organisation and the world's first community biotechnology laboratory.[52] Gen Space is a place where anyone can experiment and learn from exact sciences. The reason that made Gen Space possible is the big community evolving around it. The same community Nelson Ramon shares his project *Anaerobic Chamber* with.

The reason why this community is so important is that lab equipment is too expensive for the everyday scientist. Only big private company's and universities funded by the government can afford these kind of equipment that are needed to create a complete lab. One piece of equipment is not enough to build a lab around because scientific research usually involves multiple steps to come to a result. For each step, different equipment is needed. That is where the community and thereby the designer comes in.

By making equipment like *Anaerobic Chamber* everyone can participate in a lab. Everyone around the world - the scientist but also the non-scientist - can make, change and improve this equipment. This results in a growing DIY community around labs and as an effect more labs as Gen Space can rise. Low key equipment that fits the regulations, not only makes it possible to acces the exact sciences but also makes it easier and thereby more attractive for the non-scientist. The effect here is that the bar of the exact sciences is decreased, so anyone any time can participate. By letting the non-scientist relate to these exact sciences, he or she can make a contribution and form an opinion about these sciences.

Besides *Anaerobic Chamber* being a piece of equipment, it also reflects on our current society, with large companies having monopoly on certain instruments of research laboratories. Big monopoly companies can be addressed when the community around these DIY equipments grows. This underlying reason behind *Anaerobic Chamber* makes this kind of work important. The designer reveals things that would normally not be visible. It shows the importance even more for letting people participate. The non-scientist can use his or her own background and perspective to come up with ideas for better, cheaper alternatives that can be used in labs.

That it is important to come up with cheaper alternatives does not appear alone. *Open Surgery*[53] (2015) a DIY surgical robot by the Dutch experimental designer Frank Kolkman (1989), addresses the same suggestion for the field of healthcare. *Open Surgery* critics the inaccessible and costly professional healthcare industry. Kolkman investigated if it was possible to build a DIY surgical robot outside the scope of healthcare regulations and if he could provide a low-cost accessible alternative. *Open Surgery* does work, but the biggest limitation is that you would still require a trained surgeon, or someone with extensive knowledge of the human anatomy and knowledge of surgery, to perform the operation.[54] Frank Kolkman also wrote the following in his project description:*" The project aims to provoke alternative thinking about medical innovation by challenging the socioeconomic frameworks healthcare currently operates within".* His actual goal was not necessary to succeed but rather to ask questions about the medical industry in today's

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[51] Information about content Bio Safety Level 1 https://www.cdc.gov/biosafety/publications/bmbl5/bmbl5_sect_iv.pdf

[52] http://genspace.org/page/About Consulted on 13 November 2016

[53] Frank Kolkman,'Open Surgery', http://www.opensurgery.net, Consulted on 20 Februari 2017

[54] Frank Kolkman,'Open Surgery', http://www.opensurgery.net, Consulted on 20 Februari 2017

society. What he actually means is that if we want to make a contribution to the healthcare industry we have to have a different way of thinking about these medical innovations. If we would stay in the framework of the healthcare industry we will always be limited with our ideas and designs. Only when we would think out-of-the-box of this framework we are able to do something about it.

Open Surgery by Frank Kolkman[55]

What's great about this work is that it also highlights the DIY community that already exist out of the scope of healthcare. People are driven to come up with their own solutions and alternatives, because they can't afford healthcare. The American writer and theorist Jeremy Rifkin(1945) says in his book *The Zero Marginal Cost Society* the following:*" at this moment more than one-third of the human race is producing it own information on relatively cheap cellphones and computers and they're sharing it via video, audio and text at almost zero marginal cost."*[56] That this happens at almost zero marginal costs makes it very accessible and that is what makes this community grow. Everyone with access to a internet connection can share their own knowledge. Many videos on youtube show medical hacks from how to make your own dental fillings to performing minor amateur surgery.[57] This makes it possible for the non-scientist to contribute because the bar of healthcare in a hacky way is reduced.

Even though these video's are for some people all they have, these hacks can not always be trusted. I think the designer can play a part in this community by providing alternatives that meet a certain standard. With this standard I mean when we think about healthcare, hygienics are involved and when we think about the usage at home, we have to take a look at usability. Kolkman choose therefore to use accessible prototyping techniques that are available worldwide - like the laser cutter and 3D printer - and by using the internet he looked for ready-made parts that were sterile enough to do surgery with.[58] This makes it very accessible for the non-scientist, because anyone who has acces to these techniques can make cheap alternatives of certain equipment inside the healthcare industrie. For example, instead of going to the hospital to get medical attention for a broken arm, you can 3D print a brace to help your arm heal without a huge hospital bill. Because of the huge community you can completely customise your brace to your own needs, size and look.

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[55] Frank Kolkman,'Open Surgery', http://www.opensurgery.net, Consulted on 20 Februari 2017

[56] Jeremy Rifkin ,*The zero marginal cost society*, Page 5, Chapter One
The great paradigm shift from market capitalism to the collaborative commons

[57] Anne-Marie Geurink is a Dutch graphic designer who, in 2011, has made a DIY medical encyclopedia by documenting found medical tutorials on YouTube at the time. link

[58] Frank Kolkman,'Open Surgery', http://www.opensurgery.net, Consulted on 20 Februari 2017

For me, Open Surgery is a great example of how the designer can participate in the field of healthcare and exact sciences. The designer can approach the topic of healthcare from a different angle. This angle makes that people outside the complicated healthcare industry can relate to the problem, and that they can take the problem by its roots instead of just watching healthcare getting more expensive. Sometimes someone who has no medical background is more likely to make a contribution than someone who has been in the field of healthcare industries for years.

Likewise as *Bio Couture* from chapter one, Frank Kolkman wonders whether this DIY medical pragmatism could become a model. As *BioCouture* tends to a biotech model, *Open Surgery* can be an example of many to come, of a DIY medical model. This would be a model for the development of more accessible alternatives inside the high cost medical industry.[59] Similar to *Bio Couture, Open Surgery* is also open source. The electronics to control *Open Surgery* are more or less copied directly from the designs that are used in 3d printer communities. Frank Kolkman choose for this because it would not only increase the availability but it would also get community support when needed. For the same reasons, the software was build with an open source scripting language namely Processing.[60] The non-scientist can use these communities to experiment in the field of making and the non-scientist can also be part of these communities to provide other people with different perspectives for their projects.

Correlation between *Anaerobic Chamber* and *Open Surgery*

Both design works address different fields in today's society. *Anaerobic Chamber* addresses scientific research labs and *Open Surgery* points out the healthcare industry. Similar both works are low-cost alternative tools for those fields. Anaerobic Chamber is more a commercial product with a manual for everyone to access and make who has entry to the internet and a hardware store. *Open Surgery* is also a low-cost alternative tool but not meant as a commercial product.

Frank Kolkman wants to encourage people to think different about the current healthcare industries where big companies have a monopoly on most of the medical equipment. Small business company's do not even make a chance to compete with that. This results in an impermeable healthcare industry, and that is why it is important to look around these closed industries.

Anaerobic Chamber and *Open Surgery* also ask a lot of questions about the ethics involved in these works. Where *Anaerobic Chamber* is lab equipment, questions like: 'how far can you go with the material in the lab' and 'who is responsible for the result' come up and with *Open Surgery* questions like 'what if the robotics become self learning' and 'is a human surgeon stil needed to do surgery'.

Lowering the threshold of research labs and healthcare industries

The availability of cheaper alternative tools already lowers the threshold of the different industries. Anaerobic Chamber provides an alternative tool that can be used by anyone at any time. This makes this tool very accessible for the non-scientist and thereby makes science reachable. The non-scientist can relate to the tool, he or she understands what the tool is for and therefor can make a contribution with this tool to the exact sciences. Labs go from a far away inaccessible vague thing to an easy reachable work space for researchers but also for the non-scientists. Because of spaces like Gen Space anyone can experiment with the exact sciences. By contributing in making more low cost tools for these kind of labs, the community of researchers, scientists and non-scientist only grows bigger and this will have benefits in society. Benefits like faster results in cancer research, or improvement of the equipment that exists in labs today.

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[59] Frank Kolkman,'Open Surgery', http://www.opensurgery.net, Consulted on 20 Februari 2017

[60] Frank Kolkman,'Open Surgery', http://www.opensurgery.net, Consulted on 20 Februari 2017

For *Open Surgery* the results are similar, it only doesn't provide a tool for anyone to use with a manual, but it shows a possible option that can result when people would think outside the frame of healthcare. This result makes anyone relate to the problem of healthcare being a closed unaffordable system. *Open Surgery* stimulates people to think outside the scope of healthcare to come up with tools that could make healthcare accessible again. Hereby supporting the DIY community that already tries to make themselves better with alternatives on youtube. I think especially someone who doesn't have to do anything with the healthcare industry can make a contribution. Only then new perspectives enter the medical industry. Like Frank Kolkman as an experimental designer contributed with *Open Surgery* to provide a message.

What I wanted to achieve with these works is to show the importance of accessibility in fields that are completely closed for the non-scientists. Although in *Open Surgery* the term non-scientists leans more to non-medical specialist, the meaning is still the same. Both projects have different approaches in different fields but eventually the importance of either projects is the accessibility of the fields science and health. By using these works I wanted to address in what form DIY can be used to make these fields accessible and to make the non-scientist and non-medical specialist relate to these fields in a way that they can make a contribution by bringing new perspectives.

After reading this, we now know how the designer can use DIY as a alternative tool to make science and healthcare accessible and thereby point out important issues in our current society. Either *Anaerobic Chamber* and *Open Surgery* present their own way of making theses different fields reachable. *Anaerobic Chamber* as DIY lab equipment and *Open Surgery* as a DIY surgery robot. Both works involve the spectator, *Anaerobic Chamber* by giving the viewer a tool to use in a lab and a method to make this tool and *Open Surgery* involves the spectator in discussion by presenting a tool that brings up the conversation about the closed medical industry. By doing so both projects make these industries open and accessible and thereby understandable for the public.

DIY as an participating method in design

We are now living in a society where the internet gives a whole new world of possibilities. It gives people the possibility to connect to information and thereby gives people the opportunity to participate in that information. Most of this knowledge is easy to access and to understand, because everyone has entry to some sort of computer or device that has an internet connection. Depending on what you search for the content of the information is harder to access. For the most common and trending searches there are often multiple websites with the same content but different expressed. If you would search for more complicated queries as scientific researches, then you probably encounter some obstacles in content, language and construction. For non-scientists it hard to relate to these researches, but it is really important that precisely they can participate in these researches. They can bring an out-of-the box mindset and thereby make the research switch directions to come to a better result. Even if there is some sort of interest and a little understanding, it is still not enough to participate because translation for these things just by text can be equal as reading a book in a completely different language. Since the designer is really good in making a visible translation and DIY is very accessible I ask the following question: how can the designer use DIY as a participation method to make the exact sciences more accessible?

The spectator as the decisive factor

An example where the designer lets the spectator participate in the result of the design is *SuperWeed Kit 1.0* (1999) by Activist Michael Boorman of Natural Reality. *SuperWeed Kit 1.0* is a low-tech DIY kit capable of producing a genetically mutant(GM) superweed.[61]Natural Reality's *SuperWeed Kit 1.0* was meant for everyone who thought that the authorities in the United Kingdom would undermine the majority of the populations wish. Not any wish but the wish to ban genetically mutated[62] crops. When you do not agree with the authorities of the United Kingdom, because you think they won't respect the wishes of the majority, then you can cultivate SuperWeed 1.0 and release it in the UK. A Super Weed kit 1.0 contains a mixture of naturally occurring and genetically mutated (GM) Brassica seeds (Oilseed Rape, Wild Radish, Yellow Mustard, Shepard's Purse).[63]

Figure 1, Wild bananas [64]

Figure 2, Genetically Modified Bananas [65]

[61] Natural Reality,'SuperWeed Kit 1.0',http://www.irational.org/cgi-bin/language/language.pl?url=http://www.irational.org/cta/superweed/kit.html Consulted on April 15, 2017

[62] *Gen mutation is an permanent change in DNA, for example people mutate the genes of bananas to make them last longer and over time they completely changed in structure. See figure 1 & 2.*

[63] SuperWeed Kit 1.0, https://www.kaaitheater.be/en/agenda/super-weed-kit-10 Consulted on April 15, 2017

[64] http://www.clovegarden.com/ingred/banana.html, Consulted on April 20, 2017

[65] https://www.organicfacts.net/health-benefits/fruit/banana.html, Consulted on April 20, 2017

SuperWeed kit 1.0 by Michael Boorman of Natural Reality[66]

So what Boorman actually does is he gives the result of *SuperWeed Kit 1.0* completely in hands of the spectator. Instead of letting the viewer participate in a method or in a conversation, he lets the spectator take the final decision in a politic stand. Michael Boorman gives the participant all the steps to complete his design. He gives the reason, why you should cultivate this superweed - because of all the big companies working on genetically modified crops - and he tells you when its a good time to cultivate - when you disagree with the authorities over these genetically modified crops-. Still those guidelines are very open, so he actually lets you decide in everything, when you feel like it, you can do it. Its your personal perception of his design. Besides those open questions there are also some specific instructions in how to cultivate this SuperWeed, it is after all a classic *DIY SuperWeed Kit*.

What makes *SuperWeed Kit 1.0* very interesting is that the results can have huge consequences on the society. The name SuperWeed is not for nothing, it resists two current herbicides (Weed Killers), that can result in not only threatening the grow of genetically modified crops of big companies but also the production and distribution of these herbicides.[67] It will take a long time to undo this politic action before all the crops grow back and new weed killers are found. As the English historian of science and technology Hallam Stevens wrote in his book *Biotechnology and Society: An Introduction: "Superweed 1.0 is a mixture of political activism and art. It is a potential tool of resistance, but also a means of awareness raising about the dangers of GM crops. The kit also makes use of biotechnology itself, redeploying it as a tool of resistance, rather than a vector of capitalism profit-making. This inversion draws attention to the multiple possibilities and diversity of uses that immanent in biotechnologies."* What Stevens actually says here is that SuperWeed Kit 1.0 not only can be used as a politic stand against the corporate monoculture but also as a way to make people aware of what these GM crops actually do.

Even when the designer gives all strings to the spectator, Boorman still did a good job in transferring multiple messages. One message to these big companies, as a politic statement to destroy and delay these corporate monocultures, and another message by showing the spectator how dangerous these genetically modified crops are. This results in that the spectator can relate to multiple things. The participant can relate to the scientific genetically modified crops, what they are and their dangers. The spectator can also relate to the proces of cultivation, how to execute the seeds to make them effective, and thereby can relate to the society. By knowing what is happening

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[66] Verbeke Foundation, Heath Bunting (UK),http://www.verbekefoundation.com/all-artists/heath-bunting/ Consulted on April 15, 2017

[67] Cultural Terrorist Agencyy, *Press release* https://www.permaculture-guilds.org/pipermail/central-coast-ca-permaculture/1999q1/000127.html, Consulted on April 20, 2017

in the cultivation of the SuperWeed the participant can make a contribution to the exact sciences. For instant the participant can come up with new purposes for this SuperWeed or similar seeds in the exact sciences.

Boorman uses SuperWeed Kit 1.0 to address multiple things where the participant decides if these things become visible or not. Another work where the participant decides in the final cause is *Cypher*(2003) an artwork by the American contemporary artist and professor of Art and Technology Studies Eduardo Kac(1962). *Cypher* is a DIY transgenic kit - a DIY kit that includes DNA - this DNA is used by Kac to encode a poem he specific wrote for this artwork. The act of reading this poem is procedural. By following the protocol the spectator creates a new kind of life, in a literall and poetic sense, the viewer gives life to the artwork[68] As Eduardo Kac wrote in his project description: *"Cypher presents itself as an invitation; it is a call to engage with a set of procedures that merge art and poetry, biological life and technology, reading/viewing and kinesthetic participation."* What he means here is that *Cypher* makes the proces and connection to biology attractive. *Cypher* invites the spectator to participate by presenting it as an attractive and clear object.

Cypher, a DIY transgenic kit by Eduardo Kac[69]

"Cypher" is initially handled like a book, only to reveal itself as a nomadic laboratory with everything included to transform bacteria from their normal pale state to a red glow. This indicates that the artwork is alive. The poem is composed of a high statistical invasion of four letters representing the four bases of DNA that replace alphabet. Namely Adenine, Cytosine, Guanine and Thymine.[70]

It provides a different view of science: using DNA to hide a poem. It is not only limited to an abstract view but the spectator can participate by searching for the right translation. In *Cypher,* science and design are connected. Without the science, there is no design here because the design is embedded in the DNA. The spectator can discover this relationship while following the protocol to give life to the poem.[71]

What makes this work great is that science and design are equal on one and other. In this work they don't exist without each other. Likewise as *SuperWeed Kit 1.0* the spectator is the decisive factor in the work. It also shows that a work doesn't have to have its original purpose. Eduardo Kac presents his work as a book, but it is not a book. He said the following: *"Cypher" is an artwork that merges sculpture, artist's book and a DIY transgenic kit".*[72] As a designer, I see that subject areas within the academy are blending. For example, fashion students try to embed technology in their

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[68] Eduardo Kac, "Cypher", transgenic poem, 2003. http://www.ekac.org/cypher.html, Consulted on March 19, 2017

[69]Eduardo Kac, "Cypher", transgenic poem, 2003. http://www.ekac.org/cypher.html, Consulted on March 19, 2017

[70] Eduardo Kac, "Cypher", transgenic poem, 2003. http://www.ekac.org/cypher.html, Consulted on March 19, 2017

[71]Eduardo Kac, "Cypher", transgenic poem, 2003. http://www.ekac.org/cypher.html, Consulted on March 19, 2017

[72] Eduardo Kac, "Cypher", transgenic poem, 2003. http://www.ekac.org/cypher.html, Consulted on March 19, 2017

clothes, graphic design student try to make kinetic installations, and interaction designers, like me sometimes try to almost do engineering to create a project. *Cypher* shows very well that a work does not have to be limited to a certain direction but everything is possible. And by allowing the public to participate, it also relies on the DIY community. By inventing and executing the project, the public can relate to the project and thereby to the exact sciences and they can also discover the poem.

Correlation between *SuperWeed Kit 1.0* and *Cypher*

Cypher and SuperWeed Kit 1.0 have different purposes in their works. Boorman uses *SuperWeed Kit 1.0* as something that can become a politic stand, depending if the user decides to cultivate this kit. Kac uses *Cypher* to hide a message and let the availability of this message depend on the spectator participating to search for the message by following the protocols of this nomadic lab.

Both works make science accessible. In SuperWeed Kit 1.0 the content exists of seeds that by executing the instructions available with this kit, the spectator is capable of producing a genetically mutant(GM) superweed. By leaving the performance of the kit in the hands of the viewer, the viewer can relate more to the exact sciences. With *Cypher* the spectator can relate to science through DNA sequels, hereby the fulfilment of this kit also completely lays in the hands of the viewer. By participating in this artwork the spectator can relate to the working of DNA sequels by using to decode the poem.

Either *SuperWeed Kit 1.0* and *Cypher* are DIY kits that are functionally easy to use and with a low threshold, but a strong meaning. SuperWeed Kit 1.0 to make a politic statement and Cypher to go through layers of coded DNA to figure out a poem.

Accessibility of science by participating

By leaving the performance of both kits in the hands of the viewer, the viewer can relate to the exact sciences because they have the capability to fulfil the goal of the designer and thereby walk through specific scientific steps. These steps let the spectator relate on a content layer and a visible layer. As for *SuperWeed Kit 1.0* the content contains seeds and the visible layer becomes visible when the spectator cultivates these seeds, in the result but also in the consequences it will have in society. For *Cypher* the content of the kit contains DNA and petri dishes, which makes the spectator relate to the change of DNA sequels and to the result this has in the language of a poem.

What I wanted to achieve with these works was to show the importance of letting the spectator participate in the work to make exact science accessible. This is important because by participation the viewer gets a better understanding of what is going on and thereby can make a contribution. For instant both works can be reused for a different purpose, when cultivating the weed, you can re-use it by letting it disseminate and when decoding the poem, you can throw away the content of the petri dishes and re use them for a different experiment.

When we have read all of this, we know how the designer can use DIY as a participating method in design and thereby make science accessible. SuperWeed Kit 1.0 and Cypher have both completely different results but they use the same method. The viewer becomes the participant and is the all-round factor. Without the spectator both works are just objects with a possible meaning, but when the viewer participates the works transform in two individual strong projects that express their meaning not only with its purpose but also with an underlying meaning by making science accessible.

Finale

From all the works that I have analysed it appears to be very important to involve the public by using DIY in a certain way. In *Bio Couture* the importance lays in the purpose of the design. The design is a production method with as goal to provide a possible future and a commercial sustainable product with a message towards consumer waste. By letting the spectator participate in this method, the future goal can be much more achievable and the spectator can relate much more to the message *Bio Couture* wants to bring.

Not only the spectator takes part in a method, but can also conduct a conversation that takes place around the concept of science, shown in the project *Victimless Leather*. Hereby the designer wanted the spectator to participate in a conversation about our exploitation of other living beings and thereby go in discussion whether semi-living garment is ethical.

Another way the spectator can participate happens in the work *Anaerobic Chamber*. Within this project the participant takes part by making accessible lab equipment using cheap parts from the internet or a hardware store. By doing this the spectator not only relates him or herself to this lab equipment but also to the bigger whole, namely the inaccessibility of lab equipment for the everyday scientist, researcher or the non-scientist.

In *Open Surgery* the viewer participates in a conversation that highlights the importance of having an out-of-the-box view. Hereby the spectator can take part in this view by using accessible techniques like the 3D printer or laser cutter to make accessible alternatives for the closed medical industry.

When we are talking about participation there is always one classic form, and that is the spectator as the executive producer. In *SuperWeed Kit 1.0* the spectator is the all-round decision maker in the outcome of the work. By cultivating the weed, the spectator decides whether or not make a politic statement by relieving this weed in the wild.

The last form of participation discussed is in the work *Cypher.* Here the viewer relates to DNA and has to follow protocols to decode a poem. These are specific scientific steps that need to be followed will the spectator ever come to the message of the designer. Similar to SuperWeed Kit 1.0 the spectator here also decides whether or not the work is going to be alive.

My purpose of analysing these works was to provide an answer on the following question:

How can the designer use DIY to facilitate access to exact sciences and make those sciences more understandable for the public?

All these works contain Do It Yourself (DIY), science and a message. The message of every work is an important message, a strong message, its a message that makes the viewer relate to an everyday issue. What I think that all these works have in common is that they all make science accessible through DIY. Even if the meaning of each work is different, because the works are more focussed on social, economic and political issues. These issues could only be addressed as they are by using DIY and science in the design. Without those essential parts, the works would just be an artwork, with no meaning, with no innovation and no purpose for accessibility. By implementing the concepts of DIY and science these works become much more valuable. Not only today but also in the future, these DIY projects will inspire people to make new works resulting in new possible connections, new desirable and imaginable solutions and provides new insights for our future world.

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