

A CRITICAL REVIEW ON THE CURRENT FIELD OF SNEAKER DESIGN

INVESTIGATING THE PERKS AND DRAWBACKS OF DESIGNING
MORE EMBODIED AND PERSONALISED RETAIL EXPERIENCES
IN TRANSFORMATIVE ECONOMIES

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EXECUTIVE SUMMARY

Knitted sneakers have currently flooded the contemporary scenery of athletic shoes. With the development of more advanced knitting techniques and machinery; the manufacturing of such shoes became faster, straightforward and more importantly gave athletic shoes a more tailored fit.

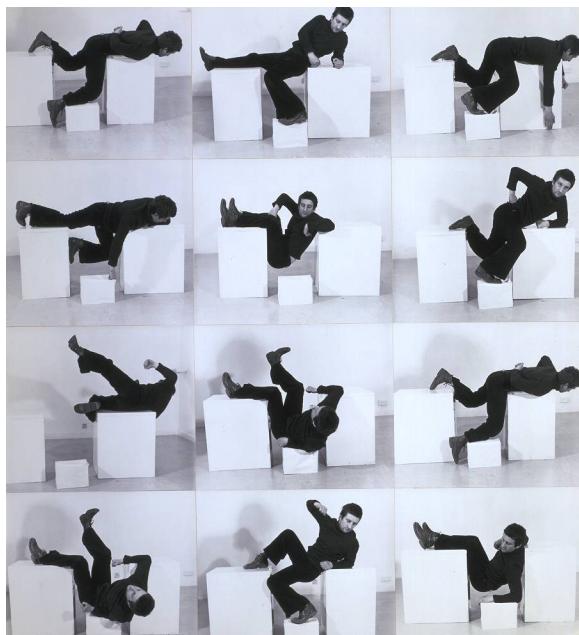
This project is proposing a more embodied in-store personalization in order to enhance the experience of purchasing shoes. How can we combine the maker movement together with innovative knitting techniques in order to deliver closer to the body footwear? Which stakeholders would such a proposition affect and what should be changed in the business plan? In what ways can we combine production and design in a service and what tools then we have to create to be able to do so?

1. EMBODIEDMENT

-A RETROSPECTION OF UNDERSTANDING EMBODIEDMENT THROUGH THE DECADES

Le Corbusier's Modulor man can be described as the first attempt to define how the human body experience space and the world around it from the engineering perspective. His published work The Modulor (1948) and The Modulor II tries to define mathematically the ideal human proportions and proposes a new set of a standardized measurements around the human figure. Using such a system of commensurate measurements Le Corbusier proposed that architects, engineers and designers would find it relatively simple to produce forms that were both commodious and delightful and would find it more difficult to produce displeasing or impractical forms. [Ostwald (2001)]

Despite being mathematically correct; his attempt to create a unifying rule for constructing spaces; failed. His perception of how people experience spaces was based on mathematical measurements which created extremely impractical, full with limitations and simply unlivable spaces for people to live inside. Le Corbusier's approach on the human experiences was based on the perception that our bodies are only in need of practically and functionality to be able to live inside a given constructed space. His mistake was to not take into account how our bodies interact, live and experience life.



POSE WORK FOR PLINTHS III 1971

(c) Bruce McLean, Tate modern

Last retrieved: 12/1/2017

[<http://www.tate.org.uk/art/artworks/mclean-pose-work-for-plinths-3-t03274>]

Some years before Le Corbusier's Modulor man; French phenomenologist Maurice Merleau-Ponty argued in his book Phenomenology of Perception (1945) that our bodies are the primary reason of understanding space. Through movement and embodied encounters with the world around us, we grasp space and our positions within space. His work regarding embodiment and experience has lightened the fire for extended research in the studies of art, fashion, interaction design and wearable technology. [Merleau-Ponty,(2002 [1945]), - Smelik,Toussaint, Van Dongen(2016)]

In the 70's and 80's and after decades of unstable socio-political events; contemporary artists from Europe and the US used embodiment as a medium to explore the relations between various socio-political and cultural subjects of their times. Primary focus among others were the relations of body and gender, body and space and body and power. By using the body as canvas; artists examined what it means to be human and uncover our deepest human feelings. Images of the material body of the artists performing or being present on the art scenes was something that had not been explored before. It was the first time that the audience experienced the story of the inner worlds of artists. [Phaidon Editors, (2015)] Notable artists that experimented with embodiment are Rebecca Horn, Marina Abramovich, Matthew Barney, Chris Burden, Dennis Oppenheim, Francesca Woodman, Bruce Mclean and many more.

In the late 90's and the start of the new millennium; the massive increase in computational power and the expanding context in which we put that power to use; suggested that we need a new way to be able to interact with computers. This led to the development of the field of Human Computer Interaction. [Dourish, P. 2001] A new approach to this field was initiated by computer scientist Paul Dourish in his highly influential work '*Where the Action is: Foundations of Embodied Interaction*'. Aware and taking account the work of Merleau-Ponty, Dourish argues that there should be a new way to interact with computers; away from the desktop and through the physical world, the world that we live and experience everyday.

He calls this new interaction as "**Embodied interaction**" and defines it as:

"the creation, manipulation and sharing of meaning through engaged interaction with artifacts." [Dourish, P. 2001]

2. SNEAKER CULTURE

-SNEAKER CULTURE IN THE EXPERIENCE ECONOMY

In the early 80's, sneaker culture became popular among the African American youngsters who experience poverty and racial injustice on a daily basis. They had no motivations or dreams in the American society. Hip-hop gave them an alternative and exciting lifestyle that was distinct and different from the mainstream white culture which was inaccessible and unreachable to them. A crucial event which changed the history of sneakers is the phenomenon of Michael Jordan. The African American basketball player started wearing his signature sneakers on the basketball court in 1984 under the logo of Nike. Except from the groundbreaking design of the shoes; what was much more interesting was the way that the shoes were marketed. It was the very first time that an athletic brand such as Nike used an athlete to promote its products. [Kawamura Y. (2016)].

Aside from his outstanding athletic performance on court, what Michael Jordan achieved was to create a powerful image that a lot of young people and especially people of colour could associate with. The status, the publicity, the financial stability and even the enjoyment of being a world famous basketball player were enough reasons for youngsters to empathize with the current brand identity that Nike was pushing at that time. It is easy to call this bourgeois but let's not forget that during the Industrial Era and when people relocated from the agricultural village context (where social status, roles and identity were clear) to urban environments for better job opportunities provided by the Industrial Economy, they benefited from higher incomes and access to products, but the progress came at a social price. Typically, urban lifestyle was accompanied with a loss of certainty, a loss of religion, a loss of cultural status and a loss of identity. [Brand & Rocchi (2011).] Therefore the Experience Economy gave those people and especially the youth a greater support to discover themselves and associate their lives based on what the brands were proposing to them.

-SNEAKERHEADS AND THEIR POWER

The years following the success of Michael Jordan's sneakers; brands grasped the opportunity for growth in that segment of the shoe market and invested even more to create stronger, more unique brand images and identities. This allowed them to differentiate and sell more shoes. Moreover seeing the opportunity to target those youngsters that loved shoes; they invested in creating a new market segment. This segment was later described as Sneakerheads. In a free definition of the term, Sneakerheads are defined as people who buy athletic shoes in order to collect them. The reasons behind those collections vary and depend on the individual. Some people for example love one brand, or one very specific type of a shoe which later on will buy in each and every imaginable variation that exists. Although most Sneakerheads empathize with the idea to own shoes that are unique, limited edition and they are the only ones that have them. [Kawamura Y. (2016)] There are also some sneakerheads whose main reason for collecting shoes is to be able to resell them on Ebay for great prices.

“Sneakerheads are mainly interested in [shoes] being unique. Having that one rare sneaker or having a custom made sneaker that nobody else has. So I would say [they are interested in] aesthetics or just for the sake of having it. I honestly see some horrible sneakers out there that get sold out in seconds just because of the hype.” - Mathieu Hagelaars, Footwear Designer (Studio Hagel)

“Sneakerheads really like the new things; they like the hype they provide. They are not known as consumers who judge shoes over quality or better wearability. For them is more about how cool it is and how big of an investment it is. They never look at it from the perspective of better comfort or how well made the shoes are.” -Slem, Innovation and Training Institute for Footwear Design

The power of sneakerheads is not only restricted in strengthening the brand itself but also it helps brands to sense which style, design and variation of shoes have the potential to become great hits in the more domestic markets. Usually brands will first release a limited edition shoes and according to the way that Sneakerheads will react to the general aesthetic of them, they adjust the design and push it to the rest consumers who are simple interested to “**...buy trainers to just wear for two years until they're completely worn out, then we just throw them away and get a new pair,**”

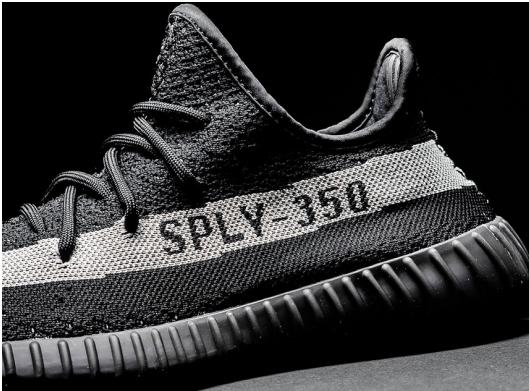
- Helen Kirkum, Footwear Designer

“The uniqueness of shoes is only a marketing thing; absolutely and only. That's actually how sneaker companies work. They have these different frontiers and they target different people. And usually the first frontier are Sneakerheads and that's why they release this very exclusive type of shoes and later on if they see that this is making a new hype; they move it to the rest frontieres which are meant for the classic consumers. For example with Adidas and the Y3 models they have tested a lot of fashion things on the models and later on they adapted some of the things into the Adidas main line of consumer goods.”

-Slem, Innovation and Training Institute for Footwear Design

Most notable is also the strategy of using celebrities to motivate Sneakerheads to buy those shoes. There are plenty of examples of brands doing special edition collaborations with athletes, artists mainly from the fashion and music industry. For example the latest and ongoing collaboration of Adidas with Kanye West is one of the most successful at the moment. No matter if you are into the sneaker world or not you sure know who Kanye West is.

“Sneakerheads have always liked shoes based on the publicity of the people that designed them. Like for example Yeezy is a terribly made shoe, with a very ugly upper in comparison to the [Nike] flyknit but people loved it because Kanye West wore it or designed it. Adidas has a long history of collaboration and is by far a more open company regarding cooperating with external freelancers or other designers or even celebrities like Kanye West. Nike is by far more traditional - closed company and they very rarely do collaborations with other external designers or celebrities.



Adidas Yeezy Boost 350 V2 Black/White
Image taken from <http://sneakernews.com/>

The fact that the most well known celebrity collaboration we know is with Michael Jordan also indicates that.”

- Suzanne Oude Hengel
Footwear Designer

“I think that the interesting thing in knitted shoes is how they have marketed it as a success. Because once I bought some Adidas knittied shoes just to know how they feel and to be honest they are okey but I don't like them that much. And it is interesting how they have make it work. Somehow they have make it with celebrities to actually like them. That is like they try to force it inside your mind to go buy them and wear them.”

-Slem, Innovation and Training Institute for Footwear Design

“Adidas and Nike have different suppliers which lead them to having different business models. Adidas is more open company to do collaborations either with artists or like designer studios (like Alexander Taylor) and be capable to try new things because its suppliers are not exclusive and they do not depend on them solely. Nike on the other hand has very strict contracts with their suppliers which doesn't let the be fast to react or create very often new concepts.

Moreover Adidas wants to sell the idea of being a cool innovate company but most of the times the shoes or the services they have released are just based on the promotion rather than really trying to see how could they create such business models. “

- Stoll, Industrial Flat-Bed knitting machine producers

Moreover it is known that the number of shoes that are being released in those exclusive editions/collaborations are extremely low (sometimes brands can release even only 50 pairs). The return income from those releases is also very poor in comparison to the other massively produced sneaker lines. Usually the big money goes to third parties who resell the shoes for outrageous high prices. Moreover the returned income is not even capable to cover the costs of the R&D and unique production of such shoes. [Davis, (2016)]

Then the question that arises is: why would brands engage to invest and develop unique shoes that have high costs but don't return investment? As the CEO of Diadora, Enrico Moretti Polegato said it:

“It’s not a matter of money. The value on the brand is way bigger than the cost of the collaborations.” [Davis (2016), Pearson (2016)]

The more people talking about shoes, the more the brand name is advertised.

-THE DEVELOPMENT OF SNEAKER CULTURE THROUGH THE KNOWLEDGE ECONOMY

-SOCIAL MEDIA

A new wave of sneaker phenomenon was developed and continues to unfold as the spread of more and more computational devices deluge our contemporary lives. [Kawamura Y. (2016)]. The popularity of smartphones and social media led to a global spread of the sneaker community and the wide rise of more and more sneaker enthusiasts around the globe. Instagram has been one of the most powerful social media to promote this sneaker culture. Brands are capable to detect and forecast the future by understanding the trends. They are also capable to promote their products by using the power of Sneakerheads who willingly promote their precious collections. Moreover the publicity of projects and shoes gives new opportunity for talents and new designers to emerge.

Footwear designer Suzanne Oude Hengel who is specialised in knitted sneakers mentioned that exposure to very specific instagram accounts or sneaker blogs is very important not only for the sneakers but more importantly for the designers themselves. After her interview was published in Conceptkicks blog (a famous sneaker blog by designer and sneaker lover Mr. Bailey) Nike approached her and then she was able to have a

collaboration and be part of a project with Nike. She stated that:

“Nowadays everything is about the right exposure to the right social media and all about the people how see you and your work.”



Photos taken from Instagram account: @makephoton

Last retrieved 12/1/2017, (<https://www.instagram.com/makephoto/>)

-AESTHETICS VS PERFORMANCE

If we examine the way that the current modern sneakers are being designed; it seems that they always fall into two big clusters; Aesthetics and Performance.

Aesthetics; is all about the colours, the materials, the style, the form and shape of the shoe even the fashion and brand identity that it follows. Notable examples of sneakers purely designed with only Aesthetics in mind are the Adidas Originals Stan Smith shoes.

Performance on the other hand relates to the intended functionality of the shoe, the activity the shoe will be used and the set of data that is needed to be able to design such a shoe to support the foot in such activity. Shoe soles are the primary compartment that performance is studied. Examples of pure performance shoes are shoes made for running marathons.

In recent years all companies try to be in the middle of those two clusters and combine both Aesthetics and Performance in the best possible way. This gives them the leverage to create shoes that both look astonishing and people want to buy, but also be able to market them as great shoes for people's help. This middle spot where those two clusters overlap is named as “sweet spot”. Examples of shoes that belong to the sweet spot are pretty much every shoe made with the Nike free sole and most recently the Nike Flyknit.

Aesthetics

- Colours
- Patterns
- Form / Shape
- Materials
- Fashion & Brand Identity Driven

Performance

- Functionality (Endurance - Comfortability)
- Collecting Data
- Medical Research
- Sports Driven

“sweet” spot

Nike



Adidas



New Balance



LIFESTYLE

Images taken from : nike.com , adidas.com, newbalance.com

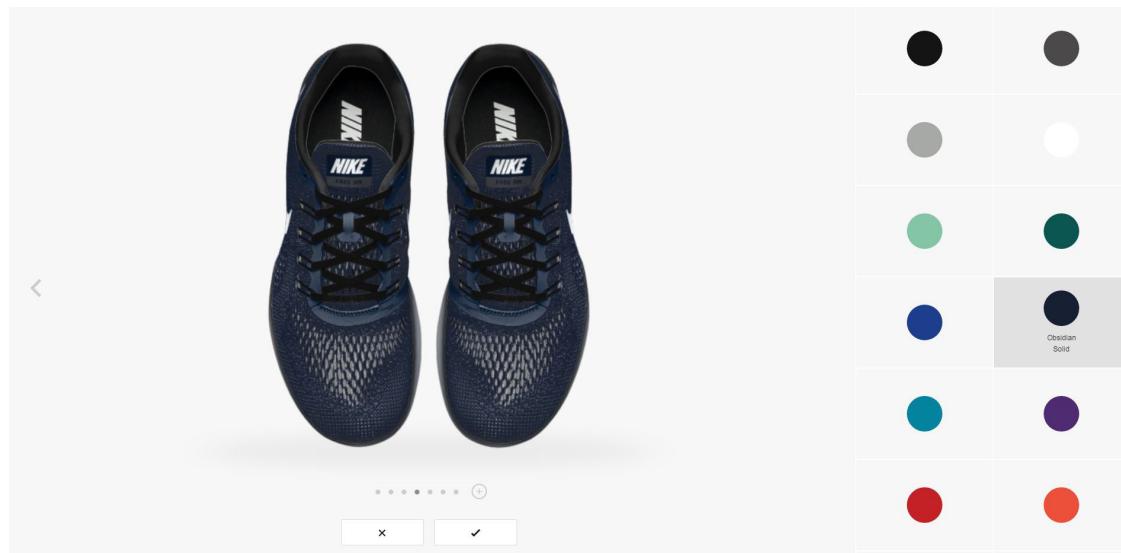
RUNNING

-PERSONALIZATION AND CUSTOMIZATION OF SNEAKERS

Nike iD

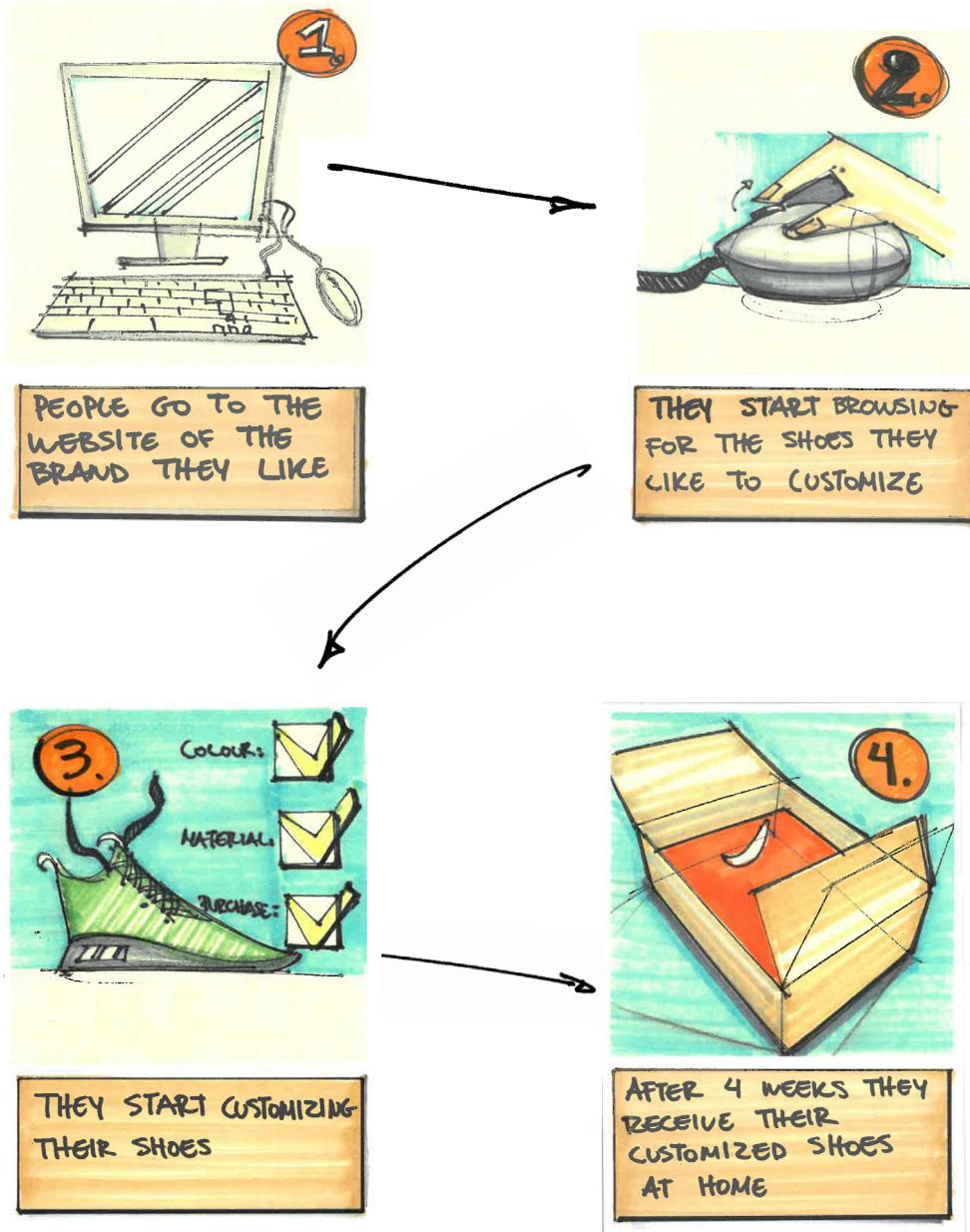
Grasping the change in society between Experience and Knowledge economies; Nike alongside its normal webstore; launched a new customizable online service in 2012 by the name of Nike iD [Kawamura Y. (2016)]. The main touch point of the service was to let people autonomously be exposed to a larger set of possibilities and features that they can chose from. This autonomy of customization even if it is mainly based on choosing different colours and materials, was enough to fulfill some of the needs of consumers who simply did not want to buy one more standard sneaker from their local retail shop.

As the time passed and people got used to buying things online; Nike developed better online services by providing a better and more user friendly interface and increased the amount of shoes and possibilities you can customize. Most importantly it reduced the prices of the shoes; making it now far more approachable and affordable to own your personalized sneaker from your favourite brand. Of course seeing the rise of sales in such service; Adidas and the rest of the athletic brands followed Nike to develop their own online personalised services.



Nike iD Current Interface. (Image taken from nike.com)

CUSTOMER JOURNEY FOR ONLINE PERSONALIZATION



NikeLab Bespoke iD

Alongside with their online offerings for customization; Nike is the only company that offers a more exclusive and luxurious personalised service so far. They called it NikeLab Bespoke iD.

“NikeLab Bespoke iD offers Nike’s most customisable and personal design experience with one-on-one appointments with dedicated Nike Design consultants. Choose An Air Force 1 high, Air Force 1 Low or an Air Max 1 and over 400 premium materials, all waiting to be tailored to your exact specifications. “

-NikeLab Bespoke iD, nike.com, last retrieved 12/1/2017

This premium customer service is only provided in special locations around the globe; such as New York and London. People who are willing to own such a pair of personalised sneakers will need to have deep pockets as long as the shoes together with the expenses for the service can cost from 500 euros to 1000 euros depending on the materials they will choose. That’s why most of the people willing to use such a service are Sneakerheads so far . [Youtube, 2010]

Although the service itself has some similarities with the online personalised service (Nike iD); the main differences between these two services; are:

- the personal encounter with Nike’s designer,
- the uniqueness of the location of the service provided,
- the memorabilia that you receive as part of the service
(things like a sketch of your personalized shoe and other small objects) and
- the extended and sometimes rare material collections you can choose from.



Images taken from NikeLab Bespoke iD, nike.com, last retrieved 12/1/2017



Screen shot image from Youtube video "Nike iD Bespoke" Last retrieved 12/1/2017 [<https://www.youtube.com/watch?v=7ap0obqutDg>]

Despite Nike using the name Bespoke, which refers to shoes that are tailored fit to the customer's exact feet measurements, there is no point inside the service where customers get a more tailored fit shoe to customize. Another aspect is that the traditional term "Bespoke" does not only relate to the craftsmanship and tailor fit that the bespoke shoes have. It is also meant to describe the unique relationship between client and craftsman and the more personal involvement of the client in the production of the shoes.

To close this, what is really the most exciting part of such a service is the personal encounter with a Nike designer and the Nike franchise in New York or in London. People have the possibility to be in a closer connection with the brand and participate in a unique experience. Even if the result is not totally Bespoke or tailored made; it creates a notion that despite the large capitalistic interest of Nike, they still care for the customer who adores their brand and wants to have their own shoes made by them.

-THE INVESTMENT IN NEW PRODUCTION TECHNOLOGIES

The competition in the sneaker industry does not stop only for creating shoes that are fashionable enough for consumers to buy. The sneaker manufacturers are always in pursuit to develop and produce the latest set of most advanced technologies around the production of shoes. It's not only the design or the pattern of shoes that make it be new but also the technology embodied in it. [Kawamura, (2016)] By providing the latest technology developments in shoes; brands provide all the right reasons for the enthusiastic public to not get bored of buying shoes.

-THE ERA OF KNITTED SHOES

In the lead up to the London Olympics; Nike and Adidas released their first knitted running shoes: Flyknit for Nike and Primeknit for Adidas. Both releases of the shoes were around the same time. What could be so beneficial for athletes to wear knitted shoes? Well, the reasons are plenty.

First it's the tailored fit that the knitted uppers provide. Their easily adaptable and manipulated structure and nature of the knit offers incredible comfortability in the foot because it takes the shape and the anatomy of the wearer. The shoe almost behaves like a "reinforced" sock.

"I believe that the term “reinforced sock” is a very simplistic way of putting it. A shoe is made of a lot of different parts and that does not mean that a knitted shoe or a shoe that has a knitted upper has less difficulties to be made or less components."

- Suzanne Oude Hengel, Footwear Designer

"It's also the instant comfort culture. That people will instantly say that they feel great [when wearing knitted shoes], it's just like putting some socks on! People feel that because it's a knit and they make the association with sweaters and they think that it is a natural material and it is absolutely not. With the knit and its different densities in different places; you can have more customized support in the shoe. You can make it with different grip or extra grip, if you want extra support. That though requires some high quality knits and goes quite slower as a process."

-Slem, Innovation and Training Institute for Footwear Design



Nike Flyknit, Image taken from Highsnobiety

Last retrieved 12/1/2017

[<http://www.hightsnobiety.com/2013/12/20/nike-flyknit-racer-december-2013-releases/>]



Adidas Primeknit,

Image taken from Instagram: @ alexander_taylor_studio

Then there are all the other unlimited possibilities that can be manipulated around the tailor fit. The use of different, stiffer, high quality and density yarns, or the different knitted structures that can be knitted to reinforce the specific parts of the foot that needs extra support. Moreover the yarns and the knitted loops of the knits behave differently according to the production procedures that are followed. Therefore different machines can also produce different results and open up even further the possibilities and variations of the embedded functionality or aesthetics of the knitted structures. Further, knitted uppers possess a very strong relation between the two clusters we saw earlier, Aesthetic and Performance. The material itself drives the development of each cluster but also connects them in a way that hasn't been done before with another material.

“With the knitting process you can build into the single knitted layer all the functionality you need, by adjusting the density of the knit in different areas”—a tighter weave to give the foot more arch support, say, or a thinner, breathable weave to create more airflow. The possibilities are limitless, he adds, because you can knit anything that can be made into a yarn: carbon, wool, Kevlar, even gold and stainless steel. Knitting also makes it easy to experiment with new colors and patterns. “Using one material, we can engineer it to do all the things that many pieces used to do.” says James Carnes, the global creative director of sport performance for Adidas.” -[Bonnie T. (2014)]

Most of the knitted uppers nowadays (such as the one that is being used in the popular Adidas NMD series) are being knitted in flat-bed knitting machines due to minimizing the production costs and failures that circular knitting machine have. Moreover knitted uppers are by far less labor intensive not only from the perspective of the machinery that is being used but also from the assembling of the different parts that a more traditional sneaker requires.



Photos taken from Instagram account: @makephoto

Last retrieved 12/1/2017, (<https://www.instagram.com/makephoto/>)

“It also depends on the type of the knitted upper; for example if it’s made in a circular knitting machine the options you have are very limiting and more difficult to be created. That’s why there is a reason why all the knitted shoes such as the Adidas NMD are made in flat bed knitting machines. Because it is easier to point out which part in the pattern needs to be more stiff or more flexible etc. Otherwise in a circular knitting machine it is very hard to know the correct position of the pattern. But in the circular knitting you can have extra support because it is basically one thing which also increases how comfortable and fit the shoe is.”

- Suzanne Oude Hengel, Footwear Designer

“Ideally you would use circular-tubular knits like as sock but that one is not being use at all. All the knits so far are made in flat- bed knitting because it is one pattern and it’s easier to manufacture it. Of course its quick, quick , quick, cheap, cheap, cheap... So now what you find is that you can create cheaper materials that are quicker to make and don’t require any skilled staff unless it is the programmers. Because this is a more robotic way of production and for example in the K-tec factory [Chinese company which uses Shima Seiki flat-bed knitting machines] there is a huge room with only machines with only very few people than are needed to operate them. They are seeing if the machines are stuck. Its extremely fast and cheap way of producing footwear and that is the only reason why at this moment this thing of knitted shoes is boosted.”

-Slem, Innovation and Training Institute for Footwear Design

“Besides of clean being a trend overall in fashion, I strongly believe that innovation also helped to create more clean sneakers. Knitting technologies are of course a very good example that you can keep your design very clean. The technology can be very technical, but still keeps the product look simple aesthetically.”

- Mathieu Hagelaars, Footwear Designer (Studio Hagel)

This leads us to next point which is sustainability and use of less material. Due to the fact that knitting is practically a mechanical manipulation of threads-yarns forming loops through an existing loop around themselves [Feijis, Toeters, Hu, J. & Liu, (2014)];

the material that is being used is made to order. This means that in traditional cut and sew sneakers there is a waste of material that can not be used.

“James Carnes, the global creative director of sport performance for Adidas, said that the conventional, high-waste method of making shoes is like working with a roll of cookie dough. “You always end up with something,” he says. “You start with bulk materials and cut things out. But with leather and mesh, you can’t roll it up and use it again. You end up creating waste, using thread, glue, and so on. Every single step is an additive process.” Carnes says Primeknit was conceived first and foremost as a sustainability solution” how do we build products with zero waste?—but unlike other processes tried to date, it ended up being one that didn’t sacrifice performance. With knitting, you start with a single thread, and you only use as much yarn as you need. “ - [Bonnie T. (2014)]

“The best part about knitted shoes is that you don't waste material because they are knitted all in one piece and of course it is easier to be put together. The only problem so far is the production time is quite high and they want to make it less”.

-Jan Willem Smeulders, Industrial knitting Operator (Technician), Textilmuseum Tilburg

What is more to say about knitted shoes is that companies such as Nike and Adidas have highly embrace the development of such shoes and continue to recognize the benefits they bring to their development of their brands. Not only because knitting has great potential to boost their profits but also because it adds even more to the image and status their products offer.

“Athletic shoes make up 30 percent of all footwear sales, and Nike and Adidas dominate, with \$14.5 billion and \$9.5 billion in sales, respectively, in 2013. Widespread use of the knitting technique could boost the industry's efficiency—cutting down on materials, labor, shipping, and time, as the products can be made start-to-finish in one place. This is good not only for consumption, energy use, and waste, but good for the bottom line, which is obviously a good investment.” says Jennifer Beaudry, who covers athletic and outdoor shoe trends for Footwear News.” - [Bonnie T. (2014)]

Even though it is not known to many, Nike actually tried to sue Adidas back in 2012 for patent infringement but lost the court battle. It's like trying to patent a knitted sweater, you can't. [Bonnie T. (2014), Reuters, (2012)] Something that could have also initiated the "fight" is that both companies use the same supplier for their flat-bed knitting machines.

"I know that both Nike and Adidas knitted uppers are made with Stoll machines. All other brands make their knitted uppers by a Chinese company called K-tec which uses the Japanese machines [Shima Seiki]".

- Suzanne Oude Hengel, Footwear Designer

"Stoll is the producer of both Nike and Adidas shoes and K-tec is using the Japanese machines [meaning the Shima Seiki machines]."

-Slem, Innovation and Training Institute for Footwear Design

"I know that Nike's shoes are being knitted by Stoll. In the beginning I was very skeptical about knitted shoes because for shoes you need a material that stretches only in one direction. And the problem with knitting is that it stretches in every possible direction so you have to come up with something to keep it from stretching. I know that Nike has a way with laces in the edges and the sides to keep it from stretching and Adidas has a thing with sticking plastic on the sides."

-Jan Willem Smeulders, Industrial knitting Operator (Technician),
Textilmuseum Tilburg

"You know that Nike and Adidas have different ways of assembling the [knitted] upper. Adidas for example uses heat pressed plastic to attach parts on the knit and make it more rigid. Nike has another way of attaching which is by sewing the different knitted pieces together.

- Stoll, Industrial Flat-Bed knitting machine producers

Therefore in order to protect their investments both Nike and Adidas filed different patents over three different things:

- a. The attachment of the plastic on top the of knit
- b. The way that the different knitted pieces would be assembled together and
- C. The way that the knitted upper would be attached to the shoe sole.

By filing patents to protect their production processes; we can conclude that even though both companies (Nike and Adidas) operate the same Stoll machines, the importance over the differentiation of the brands is happening on the decisive alteration of the knits after they have been produced. This is due to the fact that producing a knitted pattern in a shape of a butterfly from a flat-bed knitting machine is a. relatively easy thing to do with a machine like that (which means that it can be replicated by anyone) and b. it is not enough to differentiate one brand from another. Let's not forget that colours, shapes, patterns and textures can be reproduced.

To conclude, knitting has opened up a lot of doors to a lot of different things. From functionality to aesthetics and to new ways of minimizing production and labor to sustainability. Everybody agrees that knitting is the future of footwear and that there are still a lot of things to be discovered and be invented.

“Knitting is definitely the future. The possibilities are endless. New yarns are constantly been developed and the possibilities of different variations of knitted structures are incredible a lot. I think that it will never really stop developing.”

- Suzanne Oude Hengel, Footwear Designer

“I think that there is definitely future in knitting. I think the amount of knitted pieces that are being knitted is still growing rather than weaving textiles for example. Most of the things are knitted in China and other cheap labour countries. But everything is knitted now. You are interested in knitted shoes which used to be made from weaving textiles or leather and now there is more and more knitted shoes.”

-Jan Willem Smeulders, Industrial knitting Operator (Technician),
Textilmuseum Tilburg

“Oh knitting is never going to stop. New yarns are constantly being developed so yes, I do believe that knitting is the future. Now with shoes it is even more promising. But I think that nanotechnology can really help with the development of better machines and make them more efficient. Like finding out where the needles is going or what happens inside the machine. Most machines fail because there is a bad calculation of where the needles are and if nanotechnology can help with detecting the exact place where the needles stops is really going to be a breakthrough.”

-Thijs Verhaar, Industrial knitting Operator (Technician), Knitwear Lab

“Knitting won’t stop. There are so many things we don’t know yet and haven’t explored. Both from the machine perceptive and the software side we have a very long way to go till the moment we reach the end of knitting. Both yarn feeders and the cam system can be improved. Maybe one direction is nanotechnology, who knows?”

- Stoll, Industrial Flat-Bed knitting machine producers

But what is more intriguing and honorable to mention about knitting is that it has opened up the field of opening up the personalization. The low cost of production but also the unique characteristics of the material itself allow the knitted shoe to be shaped by the body rather than the opposite. Therefore knitted shoes are fostering and paving the way for the future of more affordable personalised shoes.



Photos taken from Instagram account: @makephoto

Last retrieved 12/1/2017, (<https://www.instagram.com/makephoto/>)

3. TOWARDS A TRANSFORMATIVE ECONOMY

After examining all those aspects regarding embodiment, the sneaker culture, the current personalization services and the new hype of knitted shoes; the questions now that arise are:

-How can we improve the current way of personalization of knitted sneakers by developing services that allow the introduction of data from the users to the production of the shoes?

-How can we move away from an on-screen interaction personalization services to more embodied ones where the physical world plays an important role to change and alternate the digital one?

-How can we develop such a personalization in a way that allows people to really be closer to production and design at the same time in a more local and in-store setting?

-What tools and machinery need to be developed to be capable to do so?

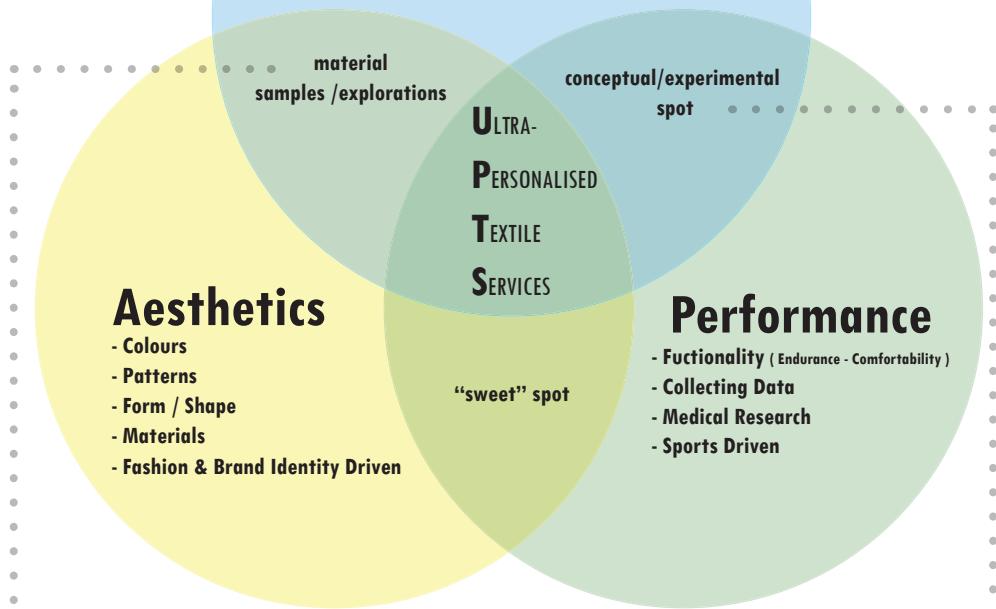
-RETHINKING PERSONALIZATION

First, a new model of designing Ultra-personalised shoes has been created; incorporating the aspects of Embodied Interaction, material exploration and research. The goal is not to “demolish” the old way of designing shoes (based on Aesthetic and Performance) but rather enhance those two aspects by bridging the gap between user’s body and material and user’s body and functionality. The user in the previous model was pushed to the sides; observing what the designers or the footwear experts will come up with.

In this current model we see two more aspects emerged. First is the material explorations which is the merger of Aesthetics and Embodiment and describes the exploration of new materials that have been produced or fabricated with new production techniques (such as 3d printing, laser cutting etc.) a new category to describe the use of new ways of fabrication. The second category that emerges is the experimental spot which is the merger of understanding how can we combine a specific functionality or performance into the shoe by enhancing natural experiences such as walking barefoot in the forest etc.

Embodied Interaction

is the creation, manipulation, and sharing of meaning through engaged interaction with artifacts*



Images taken from Instagram: @ alexander_taylor_studio



Image taken from Instagram: @ nikelab

- NEW CRAFTSMANSHIP

Secondly, the use of generative design and the developing of new fabrication tools as used by Adidas Futurecraft projects can help discover and define a new way of craftsmanship. By allowing people to program and design their own patterns we see that a new way of incorporating old and new craftsmanship.

“By being able to work and program the machines again we are bringing together production and design. So when we are programming our own shoes, we can easily program the code for the machinery by using machines that are not in factories but in your own studio. In a way we are going back to actually using our hands but now we are using our hands to code and something else does the other part rather than direct use it. And maybe it’s a combination of both; of coding, looking at the material, you hit it with a knife, you somehow manipulate and maybe you put it back into the machinery and do another process. “

[Tomico (2017)]

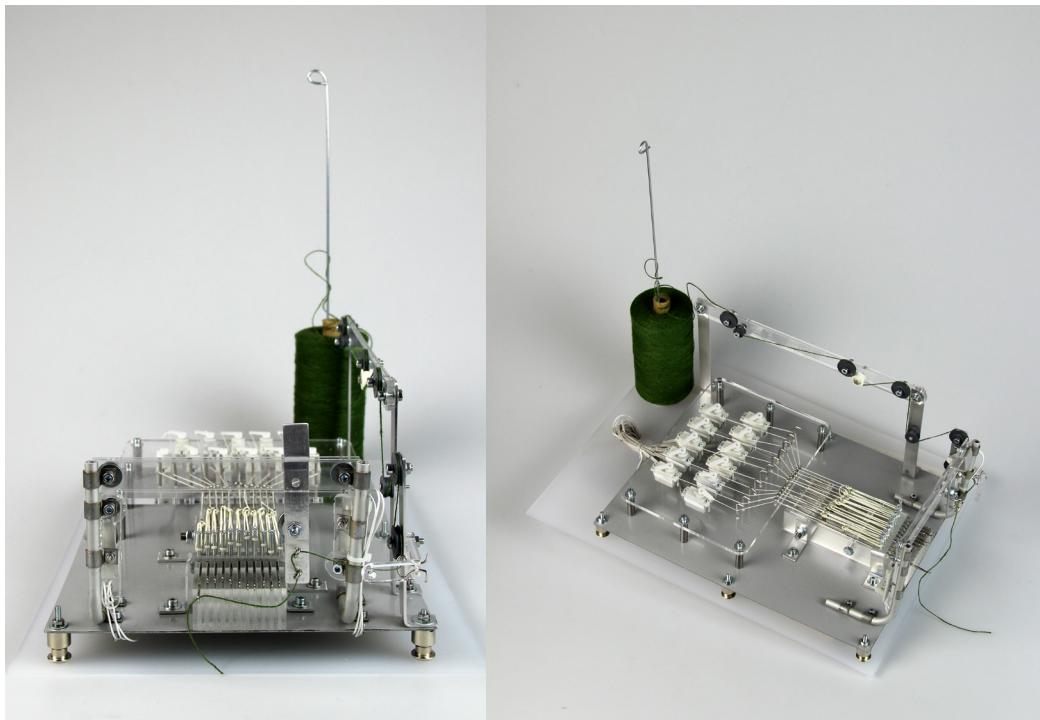
The reason why such a merger is important is because we bridge the physical and digital world in one service. [Tomico (2017)] This allows us to design interactive product-services-systems where the user's role is highly influential for the end result. Then the production and development of shoes is not seen anymore as a one time process inside a factory somewhere around the world but rather a continuous search for the best locally made and highly personalised shoes. In a way by localizing such services we are going back to the traditional craftsmanship of bespoke shoes but this time we are capable to do it faster, cheaper with better technology and in the end create products that have deeper connection with the users that wears them [Tomico (2017)]

-MAKER MOVEMENT

Moreover the maker community around the world not only has foster the idea of localizing production and consumption but also has embraced the idea that if you can't find the machines you want to use in the market you can make one yourself. In the field of textile producing and specifically knitting; there has been quite some people who have tried to hack and use old knitting machines (flat or circular) by combining old hobby technology with current understanding of electronics and machinery. Most famously projects are the Open knit and Circular Knitic. These projects have opened up the demand from people to be more involved in the production of their clothes-wearables.

-DESIGING NEW PSS TO SUPPORT ULTRA-PERSONALISED TEXTILE SERVICES (UPTS)

In order to combine all of the aspects discussed above, a new service is proposed here. The new service goes hand in hand with the recent release of the concept of Adidas Speedfactory.



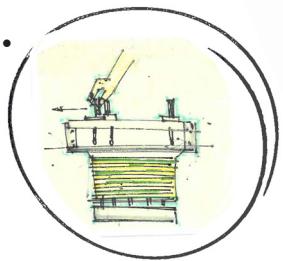
Customers are capable to visit special franchised retail stores where special flat-bed knitting machines would act as interfaces and allow people to participate in the production of their shoes. People will have the chance to interact with the machines; by pushing yarn feeders which will determine and generate a special and personalised knitted pattern. After users are pleased with the results; the production of their own personalised shoes can either take place inside the store as (Adidas Speedfactory suggests) or be produced in another facility and later on be shipped to them.

CURRENT CUSTOMER JOURNEY INSIDE A RETAIL STORE



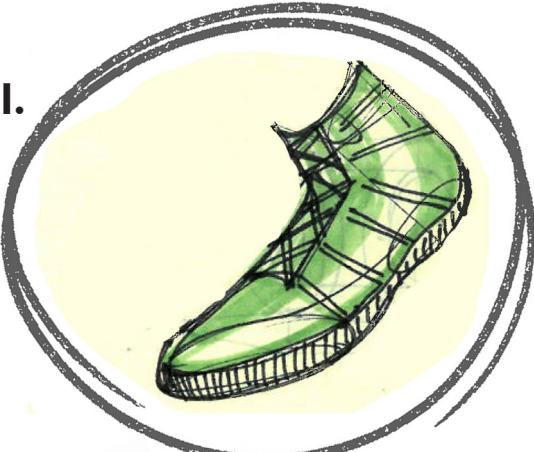
NEW CUSTOMER JOURNEY INSIDE A RETAIL STORE

I.



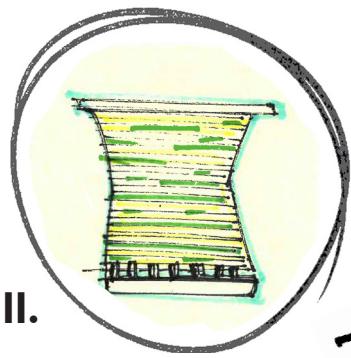
INTERACTION WITH MACHINE

III.



PRODUCTION OF SHOE

II.



GENERATION OF PATTERN

4. DISTURBED INNOVATION

The above proposed PSS involves multiple stakeholders. Therefore interviews and discussions were initiated in order to understand better what is the current status of innovation and collaboration in the knitting industry, in the footwear design field and last in the maker community. The goal was to grasp in a deeper level how realizable is such a proposed service, what are the main barriers that hold us back and last what still needs to be involved in terms of technological, societal and economical aspects.

By analyzing the discussions and interviews from the stakeholders it was obvious that there were some requiring themes and subcategories of barriers that seemed to be the main reasons causing disturbance. Those are:

I. The value of personalization:

- The stigmatization of bad personalization
- Harm on the brand identity
- Confrontation with production
- People's participation on personalization

II. Friction between new and old craftsmanship:

- Sustainability issues
- Generative Design as a new design process
- Approaching embodiment through two different sides

III. Problematic Knitting :

- Monopoly Interests
- The barrier of software
 - Trainings
- Mechanical Problems
- The essential role of industrial knitting operators (Technicians)
- Industry 4.0
- Credibility & Trust

I. THE VALUE OF PERSONALIZATION

-THE STIGMATIZATION OF BAD PERSONALIZATION

There seems to be a controversy related to when and why you should buy a personalized wearable. Most of the times people are still holding back to the idea that a personalized wearable will be unimaginably expensive. Moreover there is this notion that people consider to buy personalized tailor fit wearables for two reasons:

- a. When they want to have this special one life moment
(such as for a wedding dress/suit)
- b. When people are really (medically) in need of something to support them

The problem arises because if the reason for buying such a personalized product doesn't fit in those two categories then it is not considered to be a valuable reason to spend money. Furthermore the stigmatization is also correlated with the quality of those personalized products that are being made.

"Yes, price is definitely a touchpoint. But I think that on one hand if you want to have this one moment when you wear something unique for your wedding then people still consider it as an option and they see it as an investment or a lifetime opportunity for the occasion. But on the other hand you have the things that need to be personalised because the people are really in need of them but then often the personalizers do a terrible job. So the quality of the personally made shoes for example like my grandma is wearing are so ugly that then the personalization has a bad connotation."

-Marina Toeters, Fashion Technologist

-HARM ON THE BRAND IDENTITY

As discussed in the Digital Craftsmanship Elective, when people are capable to manipulate the personalization of their shoes (in any way) they are also adding their own brand name in the end product. Most brands so far are in control of such personalization by giving people predetermined choices such as specific set of colours or patterns. Although if we want people to engage in a deeper more meaningful and richer personalization we have to take into account the amount of "damage" that change has on the existing brand. Therefore the questions that arises is if brands are willing to give up a bit

of their own identity that for so long have been fighting to add in our lives.

-CONFRONTATION WITH PRODUCTION

Regarding the in-store production; there is a notion that if the consumers are exposed to seeing the production of their own shoes in speed factories for example; they will be shocked on how fast, common and cheap their products are made. On one hand maybe this initiates deeper connection with personalised products but on the other hand nobody is in control to know how this confrontation with reality will positively affect the decision buying process of consumers. Furthermore there is this belief that if we bring speed factories to stores that doesn't guarantee that people will have a chance to personalize their products.

“But as a consumer I hate it when I get inside a shop and I see a nice dress but then I see twenty five same dresses next to it. Then I don’t buy it. Once I was in a big warehouse and I saw a very pretty dress coming towards me and when it turned in the corner I saw thousands of the same dresses in different sizes being pushed. For me it was a big no-go at that time to see this as a consumer.”

-Marina Toeters, Fashion Technologist

[question] *But don't you think that Speedfactory can then have a chance to produce more bespoke-personalised shoes? *

“How told you that? Come on! To be so fast to make a shoe? I don’t think so.. In the athletic footwear industry where the automation plays a key role they have tried to simplify every aspect of the process. I was the other day in Nike factory in China where they were producing leather and they had to compete with the fabric upper. Nike requested that the leather upper should costs 9 seconds to be made. And imagine that this is an insanely slow speed. Now what would happened if you had a speedfactory and you are exposed to see that? And by the end of the line you have to pay 200 euros?. Moreover if you are the first brand to do such a thing then everyone is impressed. It’s cool and it’s hype etc. Everyone is focused on the technical possibilities but what people have to address is that such a thing will lead to totally different business models

and maybe lead to complete different prices.

But then let's say that Adidas brings speedfactory to its stores and people can see how it is produced and then Nike does the same thing and the other sneaker brands do the same. The risk that you run with exposing the production system to everybody is:

- a. that this process will demystify the product in a way,**
- b. it will confront people with the actual labour involved**
- and c. price competition will be a problem."**

-Slem, Innovation and Training Institute for Footwear Design

"Another reason why I don't believe in personalization is that I knew one technician who worked for the Unmade project. He was a full time technician and he was responsible for quite some machines. One weekend maybe they received six orders of personalised sweaters. That's it. Six sweaters to be knitted only every two weeks is a stupidly low production rate. Who is going to pay for the machines that are running without orders or who is going to pay the technicians? Also how many personalised sweaters are people capable to buy even if they have the money to spend? "

-Thijs Verhaar, Industrial knitting Operator (Technician), Knitwear Lab

-PEOPLE'S PARTICIPATION ON PERSONALIZATION

Not all stakeholders are in favour of letting people be physically involved in the production of products. This means that there is this notion that personalization should be a process that does not affect the pre existing machinery and technology that we have today. Otherwise producers of high end manufacturing machinery will be in need on investing and developing new tools for people to personalised in a more physical way; something that they are not willing to do. That's why everybody so far are embracing the on-screen personalization which will always works according to the way we are producing products today.

"You need to ask these questions to the people who are running factories now. They will love to have the personalization but their machinery that they have to produce their shoes is not meant for customization at all.

You have for example this huge injection molding machines that costs millions but I can not go there and tell them you will need to throw away those machines. For them the customization is a huge struggle.”

-Slem, Innovation and Training Institute for Footwear Design

“Why would you want people to engage with the machine? Why would they need to physically push the yarn feeders in order to produce the upper? Why would they even have to see the machine actually? We have made a very intelligent yarn feeding system which is also very complicated and expensive mechanical equipment with a lot of different functionalities.

Physically pushing a yarn feeder is quite stupid thing to do. I think it is quite stupid and worthless to let people be involved with the machines. People are not interested to play with machines or make their own shoes. It's like the 3d printer movement that people make something in 3d software and with the click of a button the design is transferred to the printer and after some minutes-hours it is finished. People like to be involved from a distance not actually physically be present with machines. Especially now with the youngsters and the 3d printing era. Moreover it is like your service goes one step behind from better interaction with machines because now we have screens to control our machines and you want us to go back and use physical tangible mechanical clicks or pushes or whatever else to do so.”

- Stoll, Industrial Flat-Bed knitting machine producers

“I think people like to be involved in the making part of their products. Sure it is not meant for everyone but either way personalised or tailor made products have never been for everyone. It is an utopia to think that people will have a machine that knits for them in their home but makers around the world like to play with machines and explore possibilities. So, personalised services have already very small audience although the reason why they like to have a personalised shoe or sweater is because they are also part of the process-service.”

-Gerard Rubio, Kniterate

II. TENSION BETWEEN NEW AND OLD CRAFTMANSHIP

-GENERATIVE DESIGN AS NEW DESIGN PROCESS

When talking about projects such as Adidas Futurecraft where we see the test between combining aspects of traditional shoemaking techniques with new generative design processes the opinions are mixed to say the least. All stakeholders appreciate the trials of such concepts although they all express deep concerns on the feasibility of such projects.

"I encourage all new ways of approaching a design process. But all designers have to keep the aesthetic-aspect in their mind. If the product isn't nice, people won't buy it and it's still a waste of material in the end. In practice this way of approaching is very time consuming and expensive. The brands that I've worked with till now simply don't have the time and financial resources to pay for these processes. The big brands are so capital powerful that they can afford this innovation."

- Mathieu Hagelaars, Footwear Designer (Studio Hagel)

Further aspects are that most footwear designers do not understand what generative design actually is. As they mention themselves they have no experience of such programming and they feel intimidated by their lack of knowledge. Despite that they still hold very strong opinions about what is generative and what is not and what uses of such design process are valuable and what are not.

[question] * Are you aware of this new way of using data and computational-generative design to design shoes? Do you use such techniques in your design process? *

"No, I dont use it but wish I could."

- Mathieu Hagelaars, Footwear Designer
(Studio Hagel)

"No, I dont use it but I wish I could. To be honest with you I am not sure if it really brings a real value to the shoes. I mean that except of this type of new aesthetic that it brings I am not sure how this can add more value to the person wearing those shoes. I feel that the aesthetic of such shoes is attractive to some people but not to everybody."

Moreover the way of generating such patterns is very difficult to be implemented in knitted shoes. Knitting is already enough complex and difficult on its own.”

- Suzanne Oude Hengel, Footwear Designer

* During a discussion they mentioned that they do not use any programming language such as Processing and they also mentioned that this type of design process is not for them*

“It’s not generative. [talking about Adidas Futurecraft]

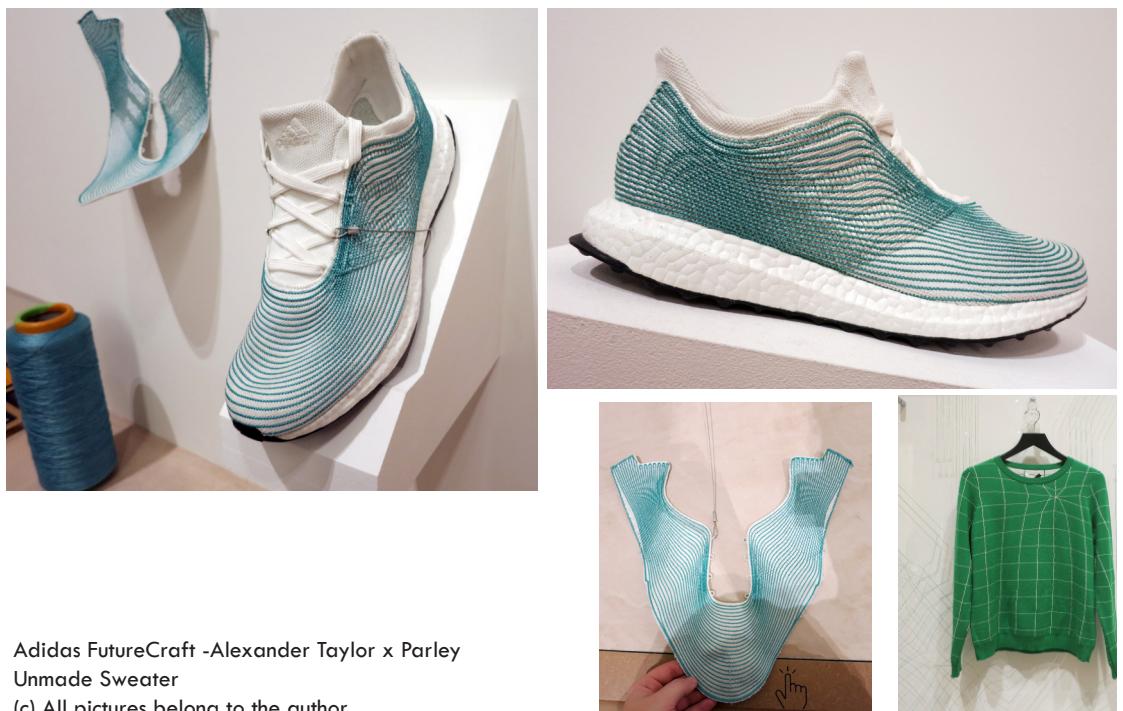
“Embroidery is just something you draw and then the machine embroiders it. You can program the shape. The techniques though are very interesting; those are definitely worth trying. But then again you can see what happens in the industry. For the shoe with the embroidery; it has been copied by so many other companies you will see now everywhere in China the best knockoffs to be embroidered. From the construction perspective it doesn’t offer any advantages whatsoever. It doesn’t offer any support, or performance or anything. In that sense you better wear a knit because at least it is more flexible. They could have used embroidery in a better way like embroidering with a substrate and create an embroidered piece that will work as a textile. That could be an interesting way to go but that’s not the way that it happened. A lot of those things in my opinion use technology as a gimmick rather using the value of technology because it is interesting technology in a away. If you want to create this type of structures [meaning generative design] then why it would be interesting to be implemented in a knit? Then again it is using the technology for the sake of gimmicky technology and to look cool.”

-Slem, Innovation and Training Institute for Footwear Design

Knitting machine operators on the other hand appreciate the fact that people are involved in the programming of new techniques although they do not see such techniques be implemented in the knitting industry. This is due to the fact that they only know how to operate the programming language provided by the knitting company. Even if some designers can create new structures from the programming languages that they use, it can not be adapted to the software that the knitting companies provide. Knitting machines producers on the other hand suggest that if you want to use such programming languages to manipulate patterns then you should make it as a screen based interface rather than being involved in the programming of the specific software that they provide.

"If you want to use such [generative] techniques then do it the same way that Unmade [a new company providing a screen based interaction interface where customers can personalised their sweaters] does it. There is not a real reason why it would be useful to manipulate the patterns by using one software and then translating it to the software that we have made. You can use a screen and then you can let designers pinpoint what the pattern should be where. But again that is the job of the technicians."

- Stoll, Industrial Flat-Bed knitting machine producers



Adidas FutureCraft -Alexander Taylor x Parley
Unmade Sweater
(c) All pictures belong to the author

-SUSTAINABILITY ISSUES

Another aspect of the problematic nature of such projects is how sustainable they are. Footwear designers coming from the leather sustainable industry find it to be a tragedy that the materials that are being used for such projects are being wasted. And they are not that completely wrong.

“-Oh god, why the hell would you need the spider silk?”

“ -She doesn’t like it. But I like that they are doing it but I don’t like the way that they are confusing people on how they are doing it. I did more of a research into it and it is not biodegradable [talking about the collaboration of Adidas with Alexander Taylor and Parley] or anything like that. And the footprint on the production of those shoes is huge. I like that Adidas is doing it all in once from the research to the development of a shoe but there is more to be made.”

“Its nice that they do all the research. I am not against any research inspired spider silk. The question is; if you use such a silk which is extremely valuable and difficult material to work with; why it would be that interesting to use it in that knitting upper. Because it doesn’t add anything to it or it doesn’t require that strength. The same thing with the ocean yarn. You take all the plastic out of the ocean and that’s awesome but then you put it in a shoe, in such a way that it would never be taken out of. So you embroidered the whole thing and then you glue it on top of one of the most toxic outsoles. If you really want to make a difference in sustainable footwear they would have already banned the outsoles. So now all the footwear related people know about this atrocity but people get so hyped about it but it makes no difference at all.”

“And would you like to wear a plastic on top of your skin? Not me. ”

-Slem, Innovation and Training Institute for Footwear Design

Therefore for traditional footwear designer whose main focus is producing shoes that have both aesthetics, functionality and sustainability embedded in them seeing such the misuse of such materials in the wrong way creates an extreme friction. This leads to demystify such technologies or processes and more importantly closes the door for understanding the end result of those projects. They don't understand how this type of technologies even if done wrongly with the wrong use of materials unite the use of data, production and digital fabrication tools in combination with the traditional crafts for better personalization.

-APPROACHING EMBODIEMENT THROUGH TWO DIFFERENT SIDES

All footwear designers do material explorations and different tests with materials. They have a deeper understanding of how the material (most cases is leather) behaves, adapts and form around the body. After so many years of craftsmanship they have developed this embodiedness and connection with the material. This leads them to understand better how to use it when making a shoe. Therefore they experience embodiedness through the value of craftsmanship that they have gain.

On the other hand as interaction designers; over the years we created our own theories regarding how people should interact with artifacts, products and services in order to enhance the experience and pleasurability of them. Human Computer Interaction was developed over the years and then after technological breakthroughs we were capable to develop new fabrication tools and machineries. This enabled us to be capable to produce, develop and deploy new interactive materials that behave, adapt and perform completely different from the ones we knew before. Therefore by using Paul Dourish's Embodied Interaction theory we proposed to test those materials again in the context of the body. Our body then would be capable to understand better in which ways those new materials can be used to enhance the experiences and pleasurability of products-services-systems.

To conclude it seems that both footwear and interaction designers are approaching the same subjects from two different perspectives. One from the perspective of experience as a craft and one from the experience as a more deeper and richer interaction with the world around us. The biggest separation between the two fields of approaching is the material explorations. On one side the material explorations are completely or solely made with leather whose functionalities are completely known and exploded to the craftman-designers. On the other side is the constant and repeatedly exploration of different materials with different functionalities which doesn't let designers develop a better,deeper understanding on how these new materials can be used in the best way possible.

“-Yes material exploration is important. You do sometimes see how it feels but if you do it just with leather and you have kind of play with leather for a while now and you sort of know how it behaves and you don't do it that often anymore.

-I have the same thing. For me is useless to make a design just for making a nice sketch there needs to be some reason, some material. If I have the material I need to play with it, even wrap it around my feet and walk that's actually why I am doing it to understand how it walks, how it behaves, to understand the folding of the material and what is the best way to use the material in order to present it.

-It also depends if its a new material that you don't know or it is a material that you like. Because for materials that you like you have figured out a long time ago. When is a new material then it would be more explorations.”

-Slem, Innovation and Training Institute for Footwear Design

III. PROBLEMATIC KNITTING

-MONOPOLY INTERESTS

Knitting so far has been a very closed industry. By having the advantage of the difficulty of the technology behind producing and developing high end production machinery the barrier of new entries is very high. That's why so far we have seen that in the textile industry related to industrial flat-bed knitting machines; only two companies have been the main leaders, the German company Stoll and the Japanese company Shima Seiki. Those two companies have differentiate their products and services that much that the knitting technology behind their machines and software is completely different. That means that people who know how to use an industrial flat-bed knitting machines from one company do not necessarily know how to use the machines from the other.

Companies also do not just offer the machines only, but a complete package of products and services related to the machines. That's why they also offer specifically developed software that runs with the machines and trainings for people to be capable to use them. The investment and dependance that other companies create by buying Stoll or Shima Seiki's products and services is huge. On average an industrial flat-bed knitting machine can cost between 50 to 100000 euros and the trainings for taking the courses (trainings for Stoll's software are divided in six different courses) are 1200 euros each. Together with the required key that needs to be purchased in order to use the software (which costs around 5000 to 8000 euros) the estimated price for all the investment starts from 62200 euros and can add up very quickly. To conclude once you buy ones company services and products you will likely stay with them forever.

“With Shima Seiki I have no experience at all because they have different software and all. That's just totally different programming and the machine is different. Of course if I would go to a company where they have Shima and not Stoll it would take me less time to figure out how to use it from a person who doesn't know who to use generally a machine or software. But then again we don't have Shima Seiki machines here.”

-Jan Willem Smeulders, Industrial knitting Operator (Technician),
Textielmuseum Tilburg

-THE BARRIER OF THE SOFTWARE

The software provided for the current knitting machines made by Stoll has had a great development over the years allowing more freedom and advanced patterning to take place.

“For Stoll they first had an apple computer that was the first one. Then there was a linux powered computer that was used for many years. Later on there was a breakthrough more or less when Stoll introduced an automatic programme called M1 which help you a lot and it was very user friendly. They let it work for quite some years and now they have improve it and its called M1 plus. The M1 software was mainly automatic programming but it had many limitations. The people that worked with the previous generation software (the Curix which was a manually operated programming system) convided Stoll to do changes to their M1 software to implement both automatic and manually programming systems. Therefore they introduced M1 plus before around 8 years and there are no limitations to programming anymore. You can do now either the automatic or overwrite it with the manual.”

-Jan Willem Smeulders, Industrial knitting Operator (Technician),
Textielmuseum Tilburg

“In the beginning we had an automated system for putting the loops correctly but then the technicians did not liked it. They would go and overwrite what the programme was doing and that was very difficult. The reason they didn't liked it is because they knew that the tension on specific patterns would be different from what the software was arranging and they wanted to have more freedom to change that. That's why we developed a software that allows technicians to be capable to manipulate the loops both with the automated system and the manual system.”

- Stoll, Industrial Flat-Bed knitting machine producers

Despite the evolution of better software, programming difficulties are still a problem. Therefore it is not easy to say that nowadays the programming of different functionalities that need to be implemented in the knit is straightforward process. There are also some bugs related to the software that make it also difficult sometimes to be operated.

"All kinds of knits are difficult. Every knit has a certain complexity. But for example a jersey looks very simple and more or less is simple to program. Although you need to know certain things like you need to know what type of shape you want exactly and how large you want the stitches and what yarn you will use. Because it's a highly complicated software and it's not like printing; you push a button and it prints everything. It is actually mechanical movements that have been prepared and arranged in advance in order to be able to do certain things inside the knit. This is mainly arranged by the certain company that provides the software and the machine. For example for the weaving machines that we have the software that we use is not made by the company that provides the machines. It is a Dutch company that makes the software and you can use that for your machines. If a third party is involved to make a software that is compatible with either a Stoll machine or a Shima Seiki machines then maybe it happens (easier way of personalisation). We can not change anything in the software. We found out that we had certain bugs and then we looked at the website and they had already published a bug fix for it. Sometimes we have bugs but they try to get feedback from all the people and then they change the software and inform us again."

-Jan Willem Smeulders, Industrial knitting Operator (Technician),
Textielmuseum Tilburg

"Even though I have a lot of experience with the software and everything I still find it to be a pain in ass. I call them [the service from stoll] and ask for help but you know everything is about how well you understand it. And the new updates sometimes the machine can not understand what is happening"

-Thijs Verhaar, Industrial knitting Operator (Technician), Knitwear Lab

Moreover the nature of the software doesn't allow more personalization or hacking from third parties. So it is true to say that as far as the software has very limited possibilities; the personalization of knitted structures that are based on different data each time has a long way to be discovered.

“Yes there is definitely. I know several people who are interested in that and they are working on that. I have also seen a project in Eindhoven at the Dutch Design Week where you can design your own sweater specifically for you. But still there is a lot of programming involved and more importantly it is heavily based on hand-programming per piece. It’s not just the numbers that just have to be put into the computer and then automatically goes to the machine and it starts working. It is not like that yet. But as soon as the knitting companies which provide the software say “well we want people to be able to do something like this” then maybe yes. Because you know with the existing software even if you want to knit something that is based heavily on your own measurements without using any pre existing pattern you need to overwrite the existing software that the companies provide. But they won’t allow it because it hacks their software. Of course there are people who can do it and I don’t know what the future of that is but for sure they won’t help you to overwrite their own software. Although I am sure that they will open it somehow. I think that the next generation of software will somehow open up an area where you can be able to be more free.”

*-Jan Willem Smeulders, Industrial knitting Operator (Technician),
Textilmuseum Tilburg*

“Let’s be honest here, personalization in knitting is pretty much non-existence. It’s always the same things that change the fit, the colour variation and the patterns. There is always this game between those three aspects because nothing else can be more personalised because the software doesn’t allow it. And do you know what is the more pathetic thing ? That a sweater or a scarf that you can buy in H&M that costs 10 euros or 20 euros but is not personalised has exactly the same pattern with the scarf and the sweater you will personalised. But in the end one product costs 300 euros and the other 10 or 20. Both factories here in the Netherlands and in Bangladesh that H&M sweaters are produced by using the same software so the actual difference in the patterns is none.”

-Thijs Verhaar, Industrial knitting Operator (Technician), Knitwear Lab

-TRAININGS

Each company (Stoll or Shima Seiki) has their own training courses which people can take and learn how to use the machines. As said before the trainings are essential part for being able to use the machines and the software. Stoll has six courses for each level of difficulty. In the end of the course you simply get a paper that verifies the participation of the course.

“Well they have very good courses [at Stoll]. I think they have 6 courses. It starts with a hand knitting course where you learn how to knit with hand knitting machine. You learn what kind of stitches are possible but you have to do it manually and that’s a two week course. Actually every course is a two weeks course. The second course is when you learn to operate the CMS machines. This course is more mechanical but it’s a combination of learning how to operate the machine but also how to change things and how to fix them. The third course is the first programming course. You learn the very basic programming which is in the automatic system. You learn how to draw things; how to do Jacquards but mainly on square pieces. The fourth course is called “Fully Fashioned and special”. The course is about learning how to program the material in two shapes in order to be able to do fully fashion patterning. So for example your sweater is made from different pieces knitted together. This course helps you learn how to do this jigsaw puzzle inside the program and be able to create a sweater which needs to be link together in the edges. The is meant to go deeper into the programming. You also learn how to program with the combination of the automatic and manual system or how to do colour arrangements. This is a very interesting course because it is going beyond making simple patterns but also very intensive because you learn a lot of things in those two weeks. The fifth course is called “Knit and Wear” where you learn the programming of three dimensional shapes. You learn how to knit some certain basic shapes but you also learn how to knit everything in one go. So you learn how to knit with no seams. It’s all about three-dimensional knitting but if you say that you want to make a star shape with five arms that’s not possible. Its either a jersey or a jersey with different shoulders or it’s a hat.

And usually there are those basic things that you can change. The sixth and last course is called “Stamping out” and they learn you how to program things that are not based in basic shapes. After this course you are able to program your own shapes and that is even more complicated.

The people who attend the courses are usually people who work with the machines because they already work in a company that have knitting machines.

In the end of the course you get such a paper that you attended the course. Whether or not you understood anything is not their concern because you are not tested in the end of the course. If you shut up and don't understand anything is fine by them. You go there for a course it's not like a school where they care if you understood anything or not. You go there because you want to learn something. They provide you with the courses and the tools but when you go back to your job then you need to start learning it because the examples they use in the courses always work when they do it. They do it in a certain way and when you do it maybe there are ticks here and there that don't work with your software and you can get stuck. You have to figure out on your own how to do it according to the way you did it during the trainings. Especially with the second course there is so much to learn that you have to start using it to keep up and remember how it works. For instance I do not do a lot of knit and wear but when I don't have a lot of clients I go back and quickly program again this very basic shape. Just to be able to see if I still remember how to do it.

These courses are the only courses that Stoll provides. But they have a very good helpline that you can call when there is a problem with the program. You can send it [the program] to them and they can correct it or they can say do this or that. But sometimes you just talk with the person and if you don't understand something you also have a book that you get from your trainings. But it's not that always very easy and helpful.

-Jan Willem Smeulders, Industrial knitting Operator (Technician),
Textielmuseum Tilburg

At Stoll I followed two trainings (basic knitting - CMS). Next March I will follow the programming training. It is quite complex and the trainings are necessary. To me, it is impossible to work on a Stoll machine without knowledge."

- Suzanne Oude Hengel, Footwear Designer

-MECHANICAL PROBLEMS

Even though the knitting machines have also seen a breakthrough through the years, they still continue to unfold different problems. Knitting machines in the simplest terms; are machines that push needles to do a linear motion in high speed over and over again. Although the way that needles will go up and down are not only determine precise mechanical movements but also determined by the software that controls them. Therefore, a lot of things can go wrong along the way. Failure in knitting is very frequent and makes people be even more critical on how they will use the machines in a way that it reduces the percentage of failure.

"Stoll has been working on with mechanical machines until the 80's. After that they introduced computer operated machines. The difference is that they replaced the mechanical selection of the needles with some electronic type and the machine was controlled by a very basic computer programme. You needed to load a strip of cardboard with little holes and then later on you had to load the programme on the computer and then you could let a jacquard pattern run. It worked quite well but there were many limitations. But if you compare it to the mechanical machines it was a breakthrough because it had 10 times more possibilities than what the previous machines were offering. But the memory of that machine was 128 gigaByte which was nothing compared to now. And then from there on the software improved and the memory of the machines improved. Here in the museum we have one new machine which has quite big memory and then we have two machines that are around 15 years old. They have improved memories but sometimes we run into the problem that we hit the maximum amount and then there is a trick that you can split the programming into sections and reload the programme into the machine with a floppy disk or a usb or online. But the newer machines they all have larger memories and we do not run into problems about the memory anymore.

Machines break all the time. Sometimes the machines run for six weeks without any problems and then we have six weeks with only problems. It's because the machines are mechanical equipment. Metal pieces that can break, electronic pieces that can fail, there are magnets that can be less magnetic; there are all kind of stuff that can go wrong. If you are very careful and you produce only basic things and not very challenging for the machine then of course your machine is likely not to break so often. But here in the museum in the way that we do it, for example that we knit with materials that are not straightforward and sometimes stiffer than the machine really wants then your machine will break more often. Sometimes there are things that happen that you can not foresee and you really need to stop and fix it. There is always something that will break."

-Jan Willem Smeulders, Industrial knitting Operator (Technician),
Textilmuseum Tilburg

I use my own yarns with all of the projects that I am doing because I do not want to destroy the yarn feeding system that I have established in my machine. Because my biggest problem even if I use my own yarns is the tension that sometimes is getting out of hand.

-Thijs Verhaar, Industrial knitting Operator (Technician), Knitwear Lab

-THE ESSENTIAL ROLE OF INDUSTRIAL KNITTING OPERATORS (TECHNICIANS)

It is known around the textile industry that people who can operate the knitting machines (both from the programming and machinery perceptive) obtain very high hierarchy and power. Not only because they know the ins and outs of the machines and the different functionalities and tricks that can be applied but also because it is a job that can be done after having years of experience in the field. Knitting takes years for people to be learnt. Most knitting operators (technicians) have at least 25 years of experience and knowledge and they still sometimes can not figure out on their own how to create things.

If someone wants to create a knitted wearable (whatever that is) in a high quality, they have to contact a factory or someone who has a machine and pay them to make it. Even sometimes technicians will reject to work with people if they want to work with yarns and

techniques that technicians don't want to work with. This is due to the fact that they are afraid that their machines will break.

Therefore knitting is also a very closed and elitist technology. It does not allow new people to engage to such technology and explore the different possibilities that easily. Another barrier is that the only way that you can even see a knitting machine is by going to a museum (like the Textilmuseum in Tilburg) or by visiting a factory. It is more possible nowadays to have an access to a highly expensive and precise industrial 5-axis cnc machine or a high quality 3d printer or even a laser cutter than being able to even see a flat-bed knitting machine knit a clothing.

- INDUSTRY 4.0

New concepts from the maker community want to open up knitting innovation. Kniterate [which is a concept from the same person who made the OpenKnit concept] for example wants to target makers and makerspaces and allow them to openly make pieces of clothing (it can also be shoes) in their own way without depending on technicians or industrial knitting producers. His goal is not to totally revolutionize the knitting industry but rather open up the space for people to experiment with knitting machines.

On the other hand; Stoll despite being dismissive about giving the machines to the people and the internet of things (IoT); in 2016 in BSTIM (the european knitwear fair) in Igualada, Catalonia, Spain they presented their latest creation of CMS technology specifically targeting students and small studios. [Hunter (2016)]. This release acted as a response to the concept of Kniterate and the DIY version of it, the Openknit.

***“Our baby CMS202 HP B machine was originally conceived with the shoe market in mind. But we now see really good potential in schools and colleges such as the London colleges, colleges in the fashion capitals and elsewhere,”
Most students learn on domestic knitting machines where there are limits on gauges and of course jacquard limits, in that only single bed float jacquards can be produced. Our ‘baby’ machine of course has two needle beds and will be available in a wide range of gauges. We can produce all of the well known knitted structures on this machine.***

“We are also seeing good interest from designers and yarn manufacturers for prototyping and production of smaller items. And of course we also see good possibilities with our traditional knitwear manufacturing customers for the production of collars, trims and accessories,” [Hunter (2016), Stoll interview April 2016]

“People can make whatever machines they like. Everyone is free to do whatever they want. We are not interested in those type of homemade machines...”

The Internet of Things concept is an example of worthless value. There are so many bad products and services that are connected to each other that there is no value in it. I think that the Internet of things will somehow collapse because it's just a lot of useless products connected to each other. ”

- Stoll, Industrial Flat-Bed knitting machine producers
(November 2016)

Against that straight forward move of releasing the CMS202 HP B; Stoll's CEO Andreas Schellhammer in his interview about what Industry 4.0 means for the company he said **“is all about automation of knitting factories in order to achieve superior efficiency, speed and flexibility. A key pre-requisite for that is the networking of all flat knitting machines in a bi-directional way. With our new “Production Planning System” (PPS) our customers are able to comprehensively control, plan and optimize their production. As a result, for example, they will become more responsive to the increasingly shortening collection cycles of fashion companies ...”** [Knitting Industry (2016)]

This indicates that industrial knitting producers do not drastically see a future where their machines can be used outside the factory sector. Efficiency, speed and flexibility have always been subjects for development of knitting machines since the industrial era. Then the questions that arise are:

- Do we need to produce in large quantities in order to sell in large quantities? [Tomico 2017]
- Do we need to have faster more efficient machines ?
- Is there real demand from people wanting to buy clothes that are pretty much the same with one another?

-CREDIBILITY AND TRUST

Throughout the interviews and different meetings with stakeholders; an obvious aspect was that there is a huge lost of trust and misinformation between the different stakeholders. Even by trying to verify information said by one stakeholder about another for an event or a topic that both of them were present or discussed the information was misrepresented. Even further due to the high competition between the people who own knitting machines, it seems that by spreading rumours about the projects they are doing is somewhat how they survive.

“We are working with a company called Kniterate they are developing a desktop 3d knitting machine and we are helping them develop a template for the footwear patterns that they want to make. Because it is fairly complicated for people to use the programming software.”

-Slem, Innovation and Training Institute for Footwear Design

“When did they said that? Because they haven’t reply to any of my emails for a month now and the last time we talked they didn’t seemed to care about it. So, yeah I don’t know why they said that we collaborate. ”

-Gerard Rubio, Kniterate

Another important topic is that the so called progressive transformative projects that are trying to “change” the industry and the way that personalised wearables are produced; instead of solving some problems (especially regarding the trust) they end up being one more catalytic reason why people stop wanting to collaborate with one another. Even if they collaborate with one another the collaboration happens under unfavourable conditions and the results are not remotely close to ideal.

An interesting example of such a thing was about the Dutch project “The girl and the Machine” which was presented in the Dutch Design Week 2016. This project has some very disturbing topics that need to be addressed. First is the fact that the project is called the “girl and the machine” which is false because the owner does not own a machine. Secondly, the project states that the sweaters alongside with being measured to fit, they are also locally produced which is also false. The first samples were made in the Netherlands but after the demand for the product increased they ended up being produced in Spain. Lastly, what is more disturbing is that despite the hard statements that the product is changing the industry and the production; there is nowhere in the site of the project

where you can find with what machines, with what companies and who are the people involved in the project aside from the founder.

The credentials of such projects are non-existent or they are hidden behind the names of the designers. So, it is understandable that technicians or people with machines are very selective to the collaborations they are doing.

5. INITIATING MULTI STAKEHOLDER OPEN INNOVATION

If only one conclusion should be drawn from the analysis of the barriers that cost innovation to be disturbed, that is the lack of collaboration in a multi stakeholder industry and the rise of the idea that innovation can move forward only from the momentary acts of individuals working on their own.

Each party of stakeholders is developing their own opinions, wishes and visions regarding the future, according to the set of expertise and interests they have. When projecting those wishes into a more societal and participatory stage all together they seem to mismatch, fail or even be completely opposite to one another. That's because the development of such visions happen in a individualist and monumental stage where one's opinions are only valid and the rest are hidden under the carpet.

In order to succeed we have to move from a top down approach to more of a bottom up approach. By setting all stakeholders in the table and creating a system of common communication. All the stakeholders are valued by their expertise and their contribution to the project not by their name or who they are. Projects emerge or different design concepts emerge from win win partnerships between expertise and expectations. That's how the collaboration is set. We move from "I do this and I am interested in that to we. Its about sharing ownership. Its an inductive process. The interesting thing about going from products to services is that all the people in the room are discussing and providing new ways of working or new possibilities for their companies. Actually they are doing it because they will be involved in the result. They are not coming with ideas because they have to or because its cool. Because its their project. [Tomico (2014)]

Lastly, projects with multiple stakeholders require constant need for relevance for each and every stakeholder to motivate them to participate and keep working on the project. [Marina Toeters] In the end of the collaboration a physical product or a service needs to be deployed in order not only to create a return investment but rather set the

motivation for next collaborations to be initiated. Therefore brands can be the stakeholders that plays the role of the “glue” that bridges the world between design research and production and deployment of such products and services that were created inside this collaborative stage.

6. DESIGN PROCESS

-MATERIAL EXPLORATION

Taking a shoe apart - Ouside look



Taking a shoe apart - Inside look



Taking a shoe apart - Soles



Taking a shoe apart - Cut in half



Samples made with Circular knitting Machine



1.



2.



3.



4.



5.



6.



7.



8.

1. - 2. Sample given from TextielMuseum Tilburg

3. - 4. - 5. Exploration of diffrent yarns

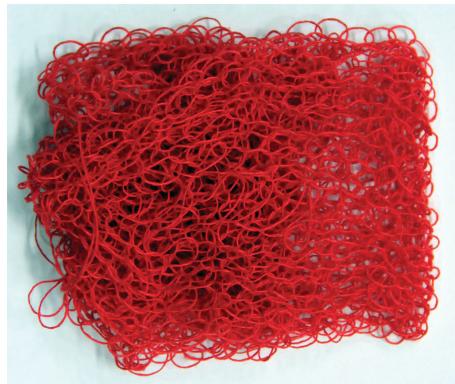
6. - 7. - 8. Applying heat press plastic to samples from TextielMuseum Tilburg



9.



10.



11.



12.



13.



14.



15.



16.

9. - 10. - 17. - 18. 19. Creating flat pieces in circular knitting machine

11. - 12. - 15. - 16. - 17. - 20. - 21 Exploration of different yarns and colours

13. - 14. Applying heat press plastic in combination with other material to samples from TextielMuseum Tilburg



17.



18.



20.



19.



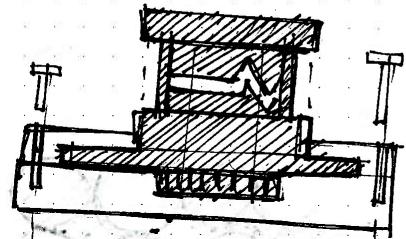
21.

Samples made with Flat-bed knitting Machine



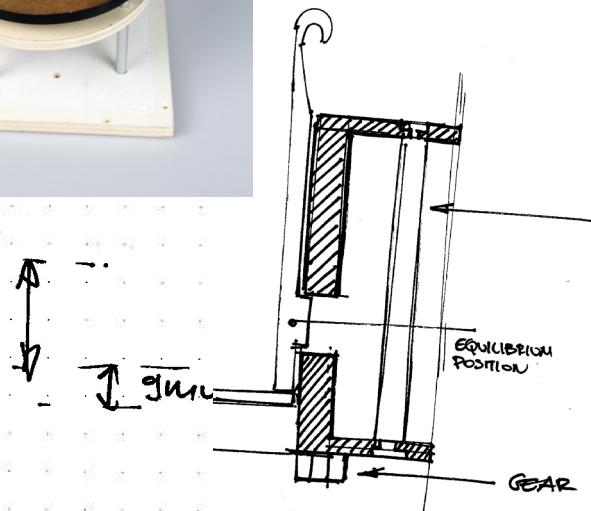
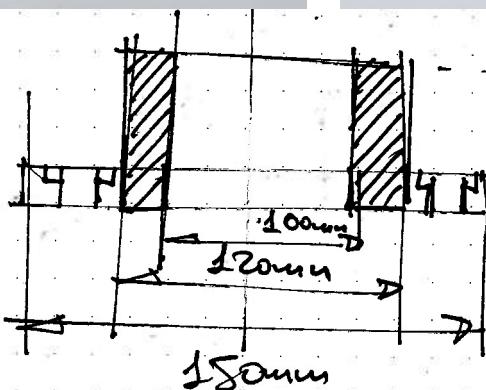
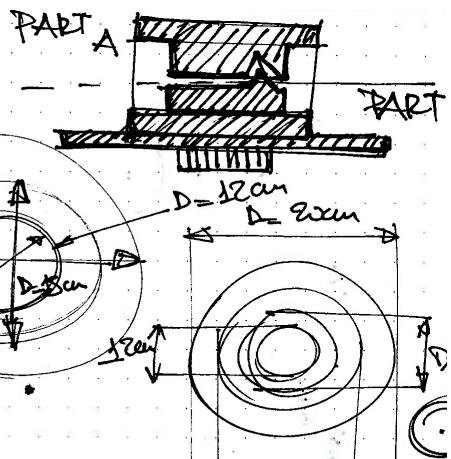
-PHYSICAL PROTOTYPING

Circular Knitting machine prototype

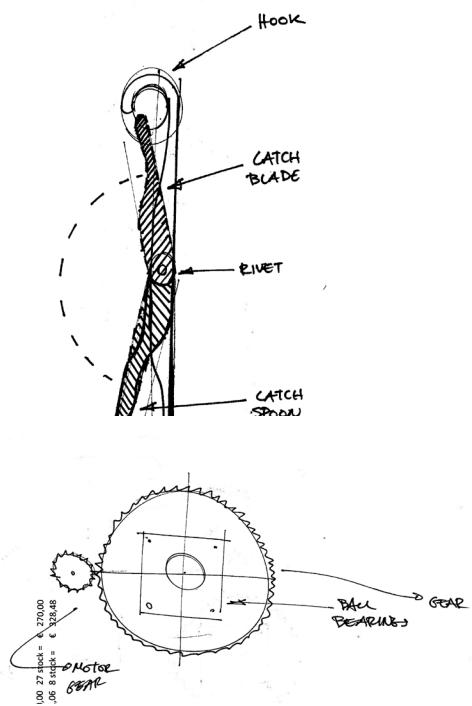
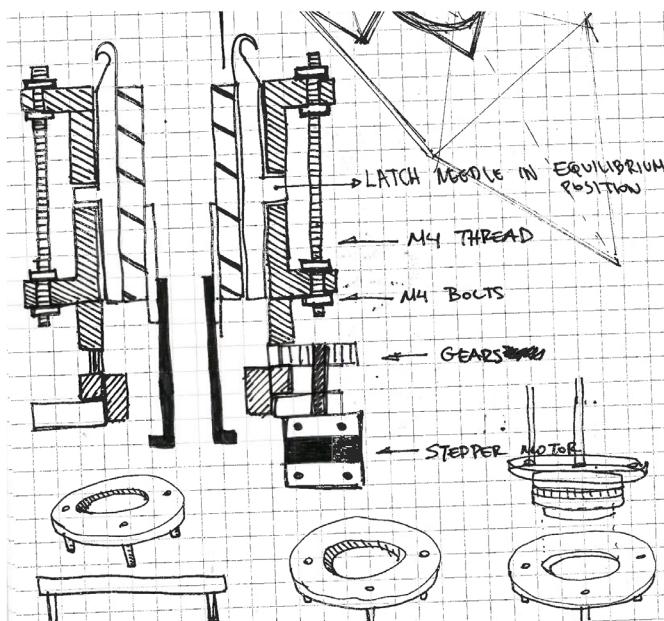
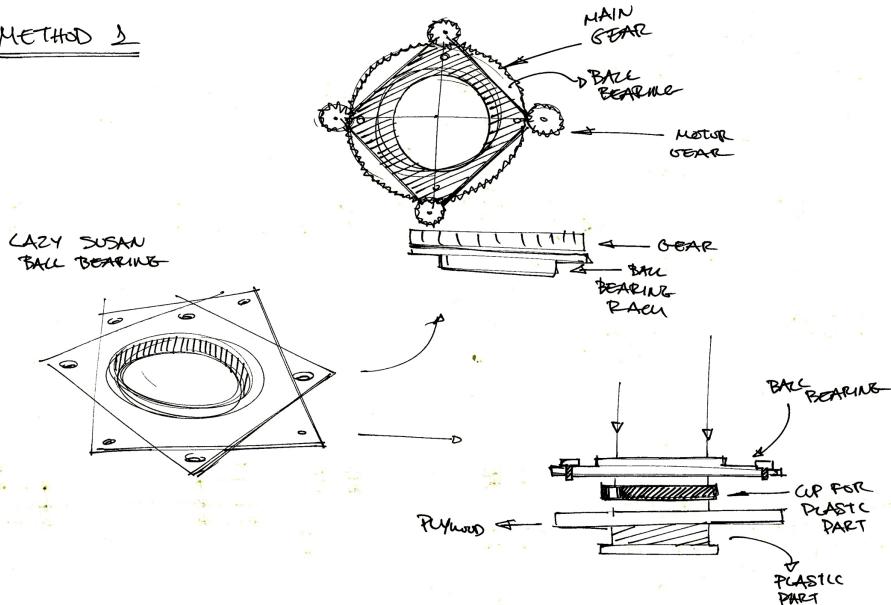


$D = 32\text{cm}$, $R = 6\text{cm}$

Neoprene ring

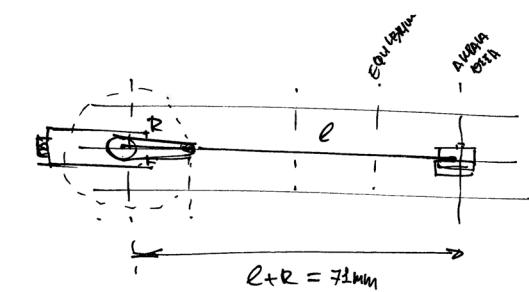
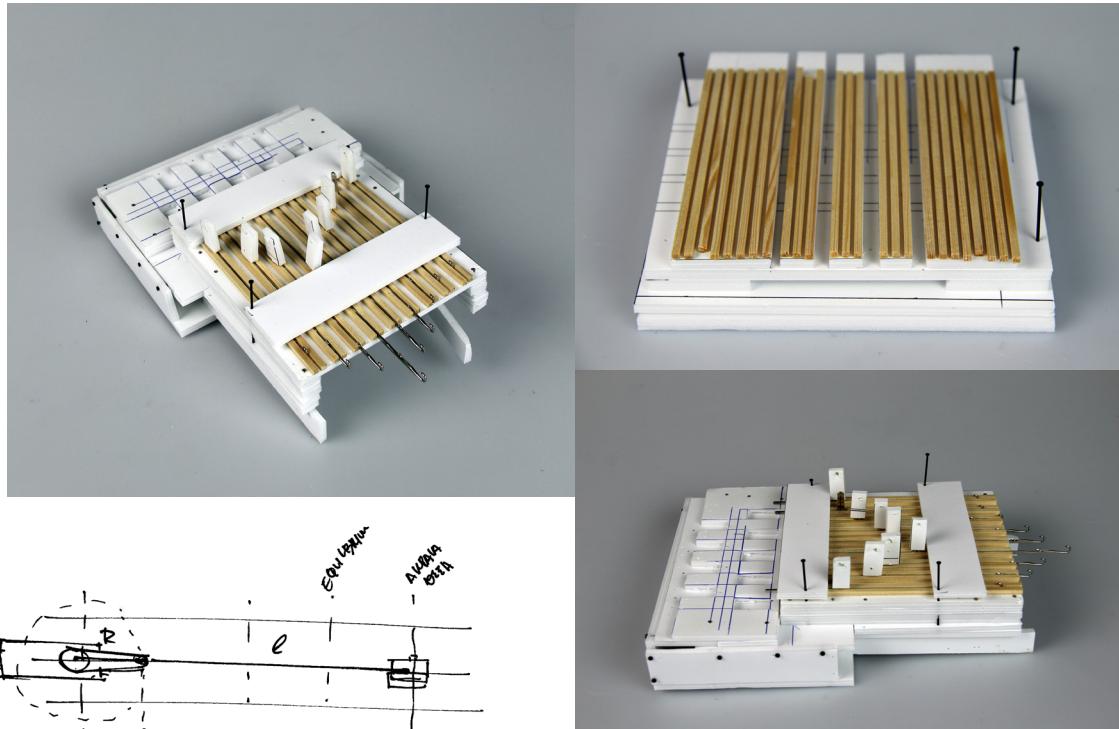


METHOD 3

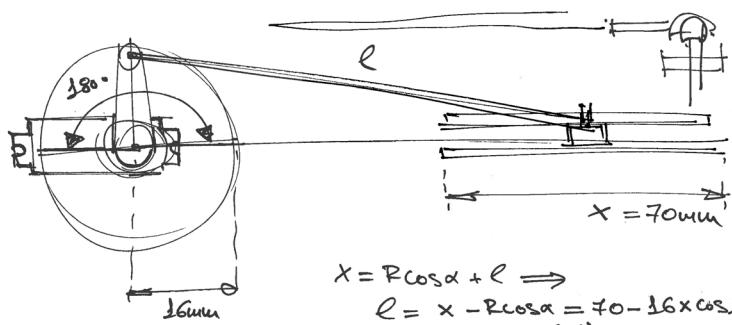


Flat-bed Knitting Machine 1.0

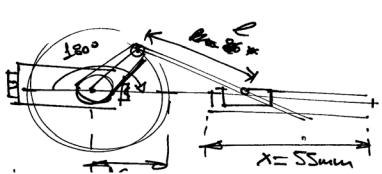
Main Goal of the prototype: to understand the construction and mechanics involved



$$l + R = 71\text{mm}$$

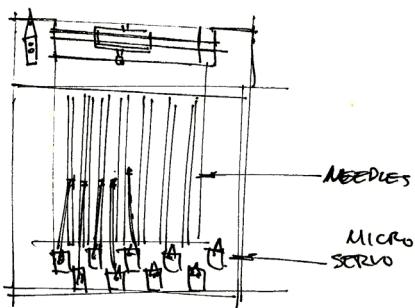
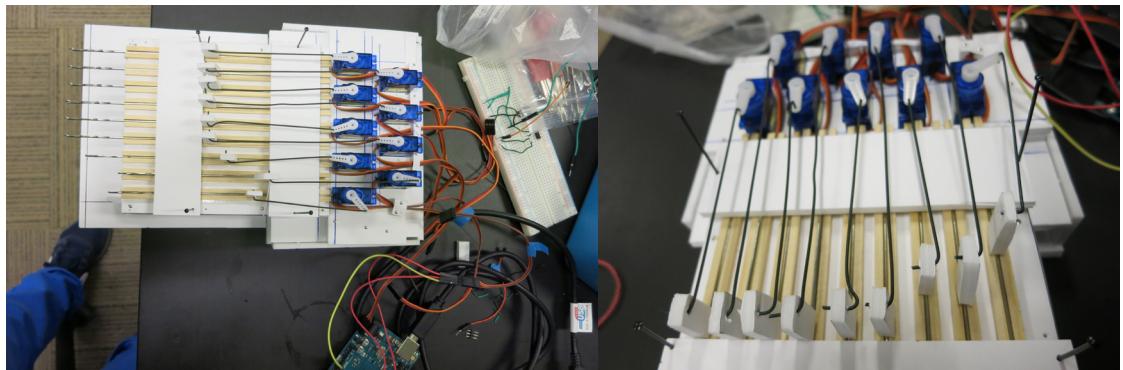


$$x = R \cos \alpha + l \Rightarrow \\ l = x - R \cos \alpha = 70 - 16 \times \cos 18^\circ$$



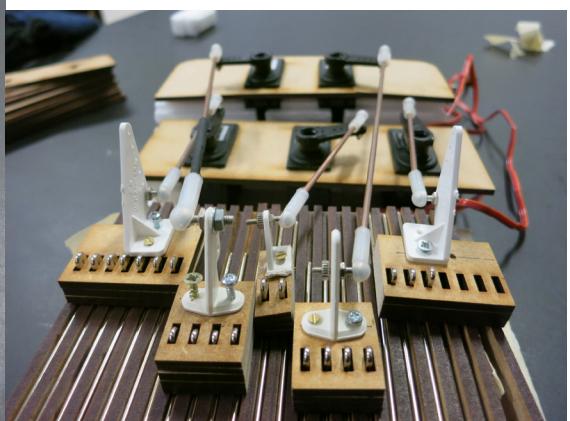
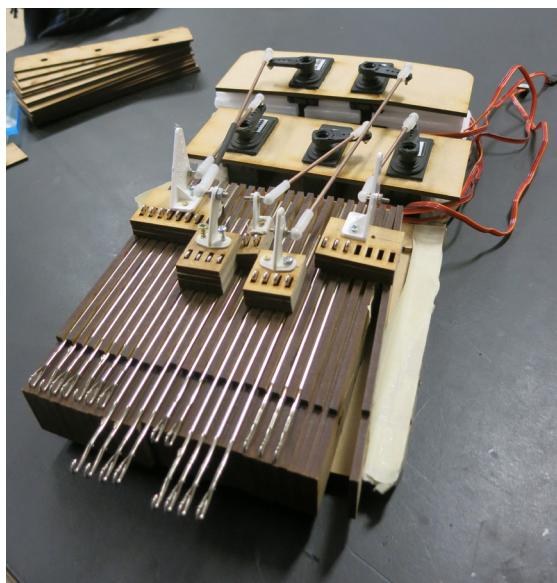
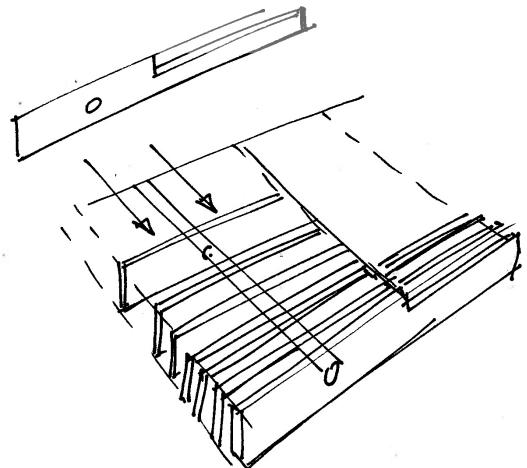
Flat-bed Knitting Machine 2.0

Main Goal of the prototype: make needles move and find a more efficient way to do it



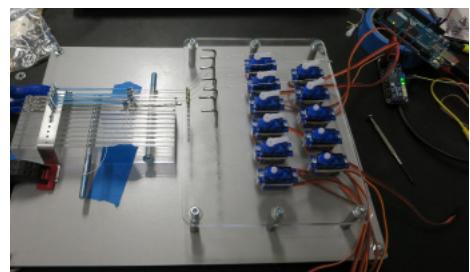
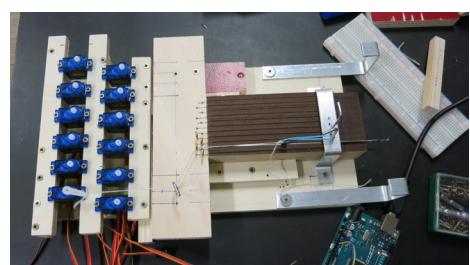
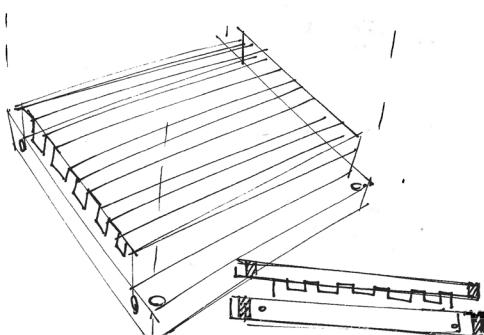
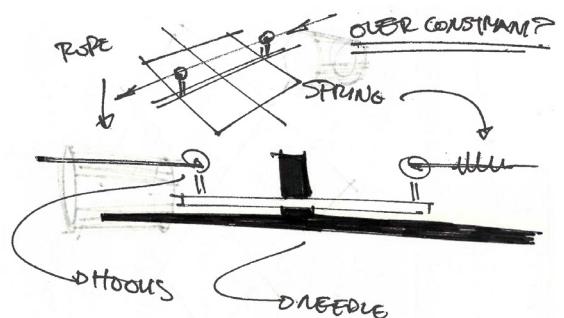
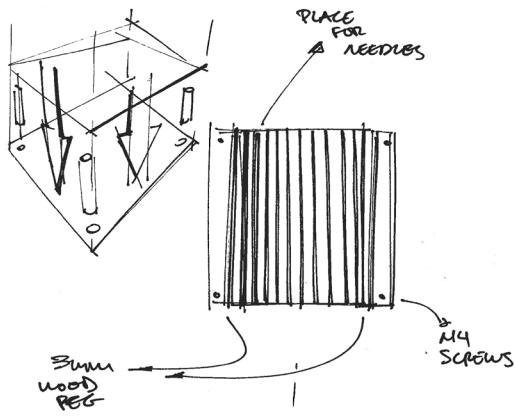
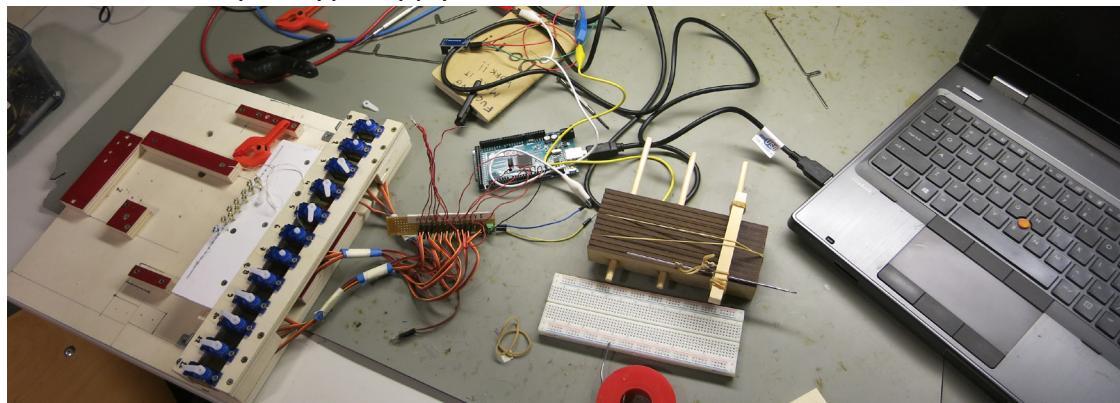
Flat-bed Knitting Machine 3.0

Main Goal of prototype:
full range of motion of the needles



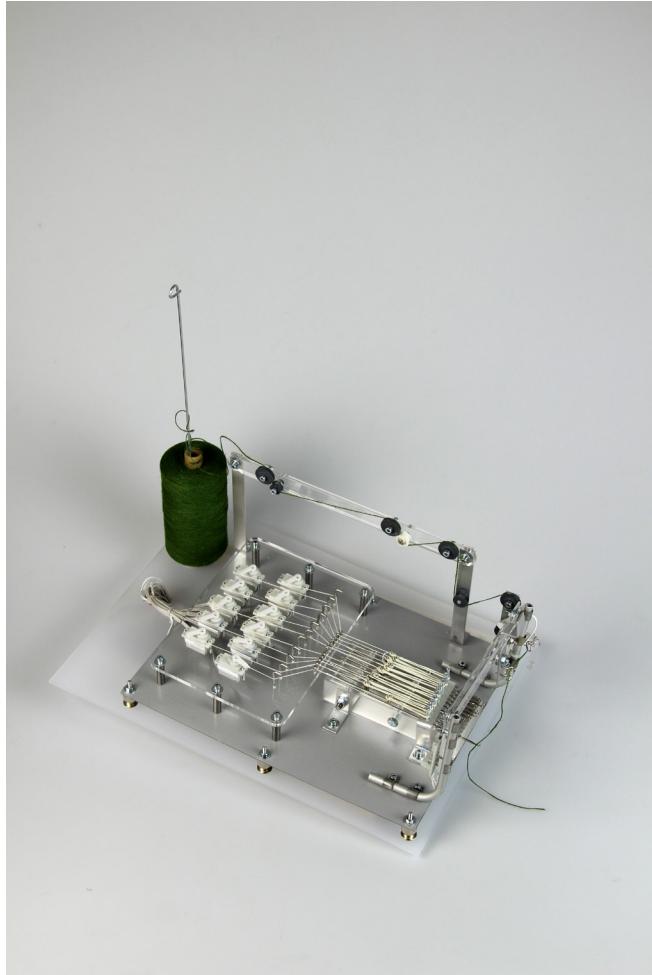
Flat-bed Knitting Machine 4.0

Main Goal of the prototype: apply exact kinematic constraints



Flat-bed Knitting Machine 5.1

Main Goal of the prototype: small adjustments to the mechanism



Final Prototype

The only code used during the construction of the prototype was the pre-existing Servo library from Arduino

7. ACKNOWLEDGMENTS

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10. APPENDIX

The stakeholders that were involved in the project are:

- *Slem, Innovation and Training Institute for Footwear Design*
- *Gerard Rubio, Kniterate*
- *Stoll, Jorg Hartmann, Head of Fashion and Technology*
 - Peter Berner, Director of Development Design System*
- *Jan Willem Smeulders, Industrial knitting Operator (Technician), Textielmuseum Tilburg*
- *Marina Toeters, Fashion Technologist*
- *Thijs Verhaar, Industrial knitting Operator (Technician), Knitwear Lab*
- *Suzanne Oude Hengel, Footwear Designer*
- *Mathieu Hagelaars, Footwear Designer (Studio Hagel)*
- *Helen Kirkum, Footwear Designer*

Due to the incredibly long interviews and transcribed audios you can contact me at:

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