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Figure 1: illustration made for my graduation collection.
In 2014 I did an internship at Blue Loop Originals, a small denim label that focuses on innovations in recycled cotton products. During my time there I visited the brand’s main supplier of recycled material. Here, old denim was unraveled and new yarn was spun from the second hand cotton fibers. But in addition to recycling second hand garments and textile waste, a big part of the factory’s business was to destroy companies’ overstock of products. Hundreds and hundreds of kilograms of never worn clothing, with price and hang tags still attached, were in the best scenario, either separated according to their material group and then recycled, or in the worst scenario, burnt. Overstock garments and sample pieces that had in some cases not even seen a store, let alone being bought or worn.

I was shocked when I saw hundreds of pairs of perfectly fine shoes being shredded in their boxes and piles and piles of clothing waiting to be burnt. The fashion industry’s carbon footprint is tremendous compared to other industries - second only to the oil industry (Sweeny, 2015). Ever since this experience, finding sustainable ways of working has been one of my main driving forces when creating clothing. In my eyes, the time has come to change the fashion industry from within by changing the approach to the design process and the sampling machinery. The use of virtual prototyping instead of traditional prototyping may result in reduced product development cost, less inventory risk and textile waste.

Virtual prototyping and sampling have the power to change certain traditional aspects of the fashion industry. By showing computer generated imagery (CGI) with high resolution, customers can get a feeling of the garment on the body without a single centimeter of fabric having been used, and size sampling can simply be done by adjusting the avatar the clothing is displayed on. Three dimensional simulations have been the industry standard in many other design disciplines like product design or architecture for almost thirty years. The time to adopt this technique for fashion design has come.

The combination of new technologies and crafty techniques within the fashion world has always fascinated me and played a big role in my own design work. In addition to modern day techniques, my work often reflects on social injustices and pinpoints ethnic minorities that live alongside societies but are often forgotten or completely neglected. Previously I have drawn inspiration from a community of Hasidic Jews in Brooklyn, New York and gang culture in North America. For my graduation collection I want to give attention to an ethnic
minority in Canada, the Inuit. Throughout the centuries, sustainability has been one of the cornerstones of their society. Minimizing waste and respecting the ecosystem has made it possible for them to survive in the harsh environment they live in, the Arctic, for over 4000 years.

In this paper I will argue how virtual prototyping is as good for decision making as regular prototyping, and is furthermore more environmental friendly, less wasteful, and can create a much more sustainable fashion industry. By making my graduation collection “NEMSIS”, solely in a virtual environment, I will point out the advantages of this technique, but also acknowledge the challenges that arise with it. Drawing inspiration from the costumes and traditions of the Inuit, my collection will combine the newest technological development in sustainability with an ancient old ecological lifestyle of a repressed ethnic minority, to demonstrate that it is time for the fashion industry to change.

Virtual prototyping in the industry

The acceptance of 3D virtual prototyping in the fashion industry has not yet happened to the same amount as it has in other design disciplines like architecture or product design. But what are the advantages CGi can have compared to well-tried design work flows?

First, the amount of sample pieces that have to be made in the fashion industry right now is enormous. There can be up to 13 stages of samples until the final garment is in store, excluding numerous samples for salesmen and showrooms for big brands (Fasanella, 2011). These sample pieces are in some cases sold at outlets, some are given away to employees, but a big percentage is not wearable because trimmings like buttons and zippers are missing, so they are thrown away. Talking to a senior product developer at Tommy Hilfiger, I learned that for one wash style of jeans, 70 sample pieces are made on average. This number could be reduced drastically if only fit and wash samples were substituted by virtual prototypes. If the company would introduce virtual show rooms, the number could even be cut down to about 5 samples per style. That is a breaking 7,2% of the original 70 pieces.

Second, cost and time efficiency are a major plus on the side of virtual prototyping. By taking physical samples out of the production chain, manufacturing and multiple shippings of the sample do not apply anymore. Changes can be made quickly and data can be shared on a cloud. That brings down the cost of product development.
While there are obvious advantages, many companies still grapple with a fundamental issue. Industry internals are asking the same questions over and over again, but the key one usually is: can virtual prototypes be good enough for decision making? Cases published by brands like Adidas prove that they are. Global sportswear companies in particular have embraced the technology and have moved onto a 3D platform (Lewis, 2004). Adidas has been working with virtual prototyping software for almost ten years and they stated that their worldwide sample pieces have been cut down from about 3 million to 500,000 items since (Loeffler, 2011). This is due to depicting virtual samples in their buying catalogues and by using Computer Generated Imagery (CGI) in some parts of their online shops (Loeffler, 2011).

Customers ranging from mid-size to large apparel businesses with a turnover above US$50m generally have the most to gain from implementing 3D systems (Landau, 2015). For instance, Calvin Klein has just started using 3D rendered images for their store and window concepts instead of having prototypes shipped and taking photographs of them in an arrangement (Fleming, 2015).

There is a third way in which virtual prototyping is being used by companies in the fashion industry. As sustainability has become increasingly important as a marketing tool, companies are trying to decrease their carbon footprint. Virtual prototyping can function as a valuable tool for companies that do not want to educate their customers on environmental matters when making a purchase. Brands that do not see sustainability as a fitting unique selling point for their brand identity can offer their customers this new technology, while also reaping the benefits of the sustainable advantages. This creates a different approach to a target market of young urbans who do care about the sustainable impact of the goods they buy, but are not interested in old fashioned approaches to “green” fashion.

As these examples have shown, virtual prototyping can have a major impact on the sustainability of the fashion industry and can help reduce the waste created by the production chain.
Advantages and obstacles when designing with virtual prototyping software

As explained in the first part of this paper, there are some clear advantages for virtual prototyping regarding sustainability. However, designing with it can present a whole different set of advantages and disadvantages.

On the one hand, software like Clo3D offers quick visualization of garments on an avatar. All patterns have to be made with a separate program, in this case Lectra Modaris. Paper patterns and cutting of fabric are redundant as everything only exists in data. That makes it easy to take your work anywhere, geographical restriction is of the past.

Making a first virtual prototype with all corresponding patterns takes almost as long as making it out of real fabric and sewing it. But once you have the garment base in the 3D software on an avatar, changes can be done very quickly and patterns change according to your changes on the 3D garment. This makes it easy to track adjustments in the process of garment development (See Fig.2) Tryouts in colors and prints are done with 2 clicks, which makes it easy and quick to see how print designs work on a body. Especially placement prints are easy to arrange on the pattern and on the body (See Fig.3)

On the other hand, fabric simulations are quite hard to estimate. There are many different settings to influence the drape of a virtual fabric, but the behavior in movement can only be seen once the garment is animated on the avatar. This process is time consuming as an animation of one garment takes about 30 minutes. If you however animate several garments as an outfit at the same time to see how they look in composition, it can take up to 10 hours for the computer to calculate the “fabric behavior”. This faces one with the need for excellent technical equipment, which is expensive.

While I am in favor of new technologies and like to teach software to myself, I know from fellow students that the way of working in virtual prototyping software can be excruciating. That is why I would argue for the need of earlier education for this way of working in the fashion industry. There could potentially even be a whole different education branch focused on virtual fashion design and prototyping.
Figure 2: Hood development done in Clo3D, from basic hood to lose fit and finally to a sporty hood with zipper. 7 stages of prototyping were done in about 4 hours.

Figure 3: Tryouts for print placement around the leg.
I have always challenged myself to implement new technologies in my work. At the same time, I see it as a necessity to give my work importance by pinpointing social injustices that happen to ethnic minorities around the world. My graduation collection draws inspiration from the First Nations in Canada, in specific, the Inuit.

During an exchange semester in Toronto, Canada last year, I made a friend who had native roots and took me to the Torontonian native center to get me acquainted with his cultural background, the Inuit. Especially the aboriginals’ adherence to traditional rites and old customs and their close bond to the environment and sustainability were astonishing. Inuit use all parts of a harvested seal or caribou. The meat is consumed, the skin is used to make insulated clothing, and bones are carved into artwork or turned into tools. What is considered unfit for human consumption feeds the dogs (Freeman, 1998).

Being one of the oldest native people, the Inuit are a secluded ethnic minority group who have led a lifestyle unexposed to western fashion trends until the late 50s of the last century. Due to extreme weather conditions in the arctic, the Inuit have developed a unique costume that consists of up to ten layers of different animal skins, caribou and seal in particular (See Fig. 4). Even in their choice of footwear the Inuit have to be creative. Thus they wear up to 7 layers of shoes, with double layered furs to the out and inside (Athropolis.com, 2016). At the same time the Inuit have to make sure to stay warm but still be able to move freely when going out for hunts and while traveling (See Fig. 5).

After having been a semi nomadic people for more than 4000 years, they were forced into settlement by the Canadian stewardship in the 1960s, by making it illegal to not be registered with a fixed address (Smith, 2007). About 25 communities were created after the Second World War in the northernmost territory, Nunavut.

The forced settlement confronted the Inuit people with quite some obstacles. They were used to travel with the seasons and hunting grounds, so they did not know how to build houses, did not have professions or sufficient education and the import of goods like food and building materials turned out to be extremely expensive. Because of the rough weather conditions in the area, fresh vegetables and fruit are exclusively being imported by either ship or aircraft, which marks comestible goods up by up to thousand percent (Prestwich, 2016).

Because of low perspectives for future jobs and a high unemployment rate in the area, crime statistics are extremely high. The number of homicide cases in specific is much (Léséleuc and Brzozowski, 2006) higher than anywhere else in Canada. If Nunavut were a country, the homicide rate per capita would be higher
Figure 4: Inuit family dressed in fur coats (S. Curtis, 1929)

Figure 5 below: Inuit out on the hunt, dressed in fur layers ("10 Interesting Facts About Eskimos")
Figure 6: Model Alessandra Ambrosio wearing a native american headdress at the Coachella festival in California. She caused a public outcry with this picture she posted on social media captured: “Becoming more inspired for coachella with this amazing native american headpiece #feathers #festival #coachella #inspiration #foreveronvacation (Smith, 2014)

Figure 7: leggings with Inuksuit print and hidden message
than in the US and on the same level as in countries like Nicaragua and Haiti, which are classified as third world countries (Statcan.gc.ca, 2015). So what causes these extraordinarily high crime rates in a first world country like Canada?

Looking at the Inuit’s history, the predominant frustration can be linked to the people’s inability to lead the semi nomadic lifestyle their ancestors and people had been used to for more than 4000 years. By forcing the family tribes into settlements, the Canadian government took people’s natural understanding of purpose. The inability to move, both literal and figurative, can have severe impact on a person’s physical and mental well being (Sarris, 2008). By neglecting the right to continue their nomadic lifestyle to the Inuit, the Canadian authorities have made themselves accessory to the miserable state the territory is in today.

Speaking from my own experience, I can not imagine what it would be like to be geographically nor physically restricted while your nature tells you otherwise. I have lived in 5 different countries within 10 years and have moved house more than 15 times. I would consider myself a modern day nomad. At the same time, I am constantly looking for physical challenges and can never stay still, neither physically nor mentally. Stagnation would be one of the worst punishments I could imagine.

I see it as a necessity in my work as a fashion designer, to address social injustice within neglected ethnic minorities and to make my collections a mouthpiece for them. By doing so, I hope to raise awareness and inform people about injustices that are happening alongside their first world society.

When taking foreign cultures as inspirational paradigm, cultural appropriation should be taken into consideration. Cultural appropriation is “[a] term used to describe the taking over of creative or artistic forms, themes, or practices by one cultural group from another. It is in general used to describe Western appropriations of non-Western or non-white forms, and carries connotations of exploitation and dominance.” (Oxfordreference.com, 2016). A known example for cultural appropriation would be white, wealthy, upper class girls wearing traditional native headdresses to the music festival Coachella in California, which is a yearly reoccurring phenomenon (see Fig.6). That counts as cultural appropriation because they literally take the native’s traditional head dress which was only worn by the oldest and most honorable members of a native tribe (Hardin, 2013) and bring it out of context by purely using it for a superficial manner of adornment.
Contrary to that, using the Inuit’s social situation and mistreatment by the authorities as the main point of inspiration for my graduation collection, I am aiming at raising awareness for their matter and not just stealing symbols and techniques from them to use them in an out of context, superficial manner. Every point of inspiration has been translated for the purpose of the collection. The only literal resemblance is the use of Inuktitut\footnote{Inuktitut is the Inuit language (Dictionary.com, 2016)} for prints. But there is a hidden message concealed in the words that appear abstract to western eyes (See Fig.7). Only people who are able to read the language will be able to decrypt them, which is aiming at empowering the minority and giving them a feeling of superiority.

The graduation collection is titled NEMESIS. This is derived from having an arch-enemy, something that has to be fought against for as long as one lives, without having a perspective of losing or winning. An obstacle for which there is neither an obvious nor a concealed solution (Cambridge Dictionary, 2016). The title perfectly encaptures the situation the Inuit have been living in for the past decades. They have to live in confinement without the perspective of being released from it without losing their family bonds and heritage.

It also describes the feeling I have when looking at the future of the fashion industry. The lack of implementation of new technologies that could solve certain problems the industry is facing, like the flooding of the market with fast and cheap fashion and the resulting sustainability crisis, is making me question my standpoint within the industry. The ready to wear sector has not undergone big renovations - or on this analogy, movement - for decades and innovations are deemed too time consuming to implement in the fast paste money machine that the fashion industry has become (Waddell, 2004).

Through my own frustration with the fashion industry and taking the inspiration by movement into account, the collection is loosely based on a sports wear appearance. It takes on sporty elements in choice of fabrics like breathable
polyester and mesh, style elements like hoods and oversized fit and sportswear inspired print placements. Panels that hide pockets are finished with flat cover stitches in bright colors. Glued pockets and seams make the collection functional.

Layering

The collection consists of 8 outfits that each contain several layers of garments. This is inspired by Inuit dress behavior. The outfits are set up out of three interchangeable layers. The first is a tightly fitted, highly technical sportswear layer, that is mainly made from technical high performance fabrics such as different polyurethanes, breathable mesh and thin stretch cotton. Partition seams allow for a skin tight fit and sportswear finishing like flat cover stitches provide comfortable wear and movement. Seamless knitted body suits grant the wearer with high comfort during movement (See Fig.8). Polyurethanes like nylon and polyester allow sweat transportation to the outside and keep the wearer's body temperature regulated. Mesh is inserted in panels to provide extra ventilation.

The second layer, which is inspired by athleisure², covers the wearer up but allows for the spectator to see the first layer, by using partly see through fabrics like chiffon and sheer mesh with big holes (See Fig.9). Sportswear aesthetics, fitted hoods, rib knit hems and sweat combinations, are of significance for the sportswear appearance. The athleisure layer is made from sheer materials like cotton and silk chiffon and, in contrary to that, sweater jerseys and windbreaker material. Athleisure currently very much focuses on providing the wearer with a maximum level of comfort, which is mainly achieved through soft and warm materials, but also by ensuring the protection against cold weather.

The third layer, the outside shell, consists of puffed jackets and coats with big shawl collars and hoods (See Fig.10), which are inspired by the round silhouette of the Inuit. The big and bold silhouette and the puffing allow for thick fabric structures that are a good match for arctic temperatures. The fabrics are mainly polyester nylons in different qualities.

² Athleisure refers to casual clothing — like yoga pants, sweat pants, and hoodies — that are designed to be worn both for exercising and for doing (almost) everything else (Webster, 2016)
Figure 8 - 10: examples of garments of all 3 layers. The image on the left top shows a seamless knitted bodysuit, the top right image shows an oversized tshirt with mesh insert and the image on the left bottom shows an example of a puffed coat with shawl collar.
Figure 11 and 12: virtual prototype of puffed coat with incorporated backpack. Inspiration is drawn from Figure 12, an Inuit woman carrying her infant in the enlarged hood of her jacket (Inuit Mother With Baby, 1903).
Innovations in the collection

The puffed coats of the third layer are inflatable, which means that they can either be worn “unpuffed” or can be inflated by the wearer by blowing air into air chambers through a small pipe that is attached to the lining of the garments. In an unpuffed state, the garment will protect the wearer from humidity and wind, but the level of inflation determines the isolation of the garment. This comes in handy when there are changes in the activity of movement and the body needs to be temperature regulated by the outside. Looking at nomads, sudden changes between settlement and a low activity level and traveling and movement with high activity levels are common. By providing air puffing, the same garment can be worn in different surroundings and for different activity levels.

Also inspired by the nomadic lifestyle of the Inuit are backpacks that are integrated into the puffed coats and jackets. These derive from the historic practice of Inuit women to carry their infants in the enlarged hoods of their coats (See Fig. 11 and 12). Having their hands free to carry belongings and to chase the dogs while traveling was vital to the Inuit way of life.

Color scheme and prints

The use of colors throughout the collection is inspired by arctic landscapes. Base colors are hues of blue which derive from ice caves and icy landscapes from the arctic (See Fig.13). Bright accent colors like neon green, pink and highly saturated purple are inspired by images of the northern lights (See Fig.14) which can only be seen high up in the northern hemisphere.

Research into prints in the sportswear sector concluded in the usage of graphical placement prints that follow the principal of high contrast, black on white and white on black. Instead of using a company's name or logo, Inuktitut writing with its special lettering functions as an eye catcher. By using the letters as placement prints in several sizes and due to the inability to read them, the prints function as an abstract but graphically bold statement. Apart from the placement prints, all over prints with graphically abstracted lightning and northern lights are applied on several layers. By mixing craft and printing techniques, such as paneling, topstitching and layering of all over prints and placement prints, a feeling of depth is achieved.
Figure 13: Ice cave in the Arctic (“Eyegami | Ice Cave”)

Figure 14: Image of the Aurora Borealis, the Northern Lights, which can only be seen high up in the northern hemisphere (“Northern Lights Or Aurora Borealis Explained”, 2016).
This paper highlights the growing problem of unsustainability in the fashion industry. The fashion industry has not changed in over 50 years, when ready to wear had one of its peaks and global businesses started outsourcing production to countries with cheap labor. Prototypes and samples have since been produced without care, because they have become so cheap. But in order to save our planet from literally drowning in garbage in the future, industry professionals will have to start thinking differently and take action rather than sticking to old industry standards that might have worked 20 years ago. One of the solutions would be a shift to the use of virtual prototyping.

By making a virtual collection, I want to show that change can be made. By providing convincing 3D simulations of garments, the industry can change tremendously towards a more sustainable business model and a higher time and cost efficiency. Garments do not have to be shipped around the world multiple times anymore, but information can be exchanged online. Variations in fit, colors and print design can be achieved quickly. However, virtual prototyping also has its obstacles. The long animation and rendering times of the outfits and the need for expensive equipment and educated personal is holding back the adaption of this new technology.

I have chosen the Inuit as inspiration for my graduation collection because I am driven to raise social awareness for the injustice they have found themselves in since the Canadian stewardship forced them into settlement in the 1950s. Not being able to live their ancestor's semi nomadic lifestyle anymore resulted in frustrations that lead to shockingly high numbers of homicides and unemployment (Léséleuc and Brzozowski, 2006).

The collection is stylistically loosely based on the Inuit’s appearance and expresses their need for movement throughout their 4000-year history. In addition, it also conveys my own sentiments as a modern day nomad. The goal of the collection is to empower the wearer and encourage him to move freely.

This paper and my collection have shown that the disadvantages of virtual prototyping are being outweighed by the benefits and that the CGI is precise enough to be used for decision making in the fashion industry.

A pervasive feeling of change in the fashion industry right now can stimulate young professionals to persuade their desire for implementing technology.
“Any technology is the attempt to advance the way we deal with circumstances. Getting there requires imaginative minds that reassess assumptions and conventions – not only to innovate but also to identify creative ways of applying technology to other sectors.” (Adidas group, 2014)

In other words: if we never change, we will never move forward. The time has come to make the change now, for the sake of our environment and our personal and professional future.
Books


Images


Articles

- LEWIS, J. (2004) 3D software launch in Oz. ragtrader, (May), p.9

Documentaries

Websites


