

3D Printing; The Future of Innovative Shapes and Materials in Women Fashion Design

Dr. Nessreen A. Elmelegy¹

¹PhD, Associate Professor.

Faculty of Applied Arts, Damietta University, Egypt

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Abstract: 3D Printing is an emerging trend since the last few years. It is literally used to print from simple objects like toys to an intricate and complex object like a house. In fact, every field of design has adopted 3D printing as it transforms the ideas into tangible objects in no time through an easy and quick process and lesser materials for construction. The industry of fashion design, in no doubt, has adopted this method for making of apparels. 3D printed fashion is slowly being adopted by designers due to ease of construction, innovative products and high-end results. Many fashion designers and companies have used 3D printers to create all sorts of fashion items such as Jewelry, shoes, bags, and dresses. The 3D Printing has given fashion designers great motive to create innovative shapes and use innovative materials since it is a valuable technique to explore very exciting ideas in fashion design. 3D printing technology is now commonly available in the collections of designers and brands which participate in world's leading Fashion weeks in Paris, London, New York, and Milano fashion week. Spearheaded by renowned fashion designers, like Iris van Herpen, Janne Kytanen, Danit Peleg, Michael Smith, and Francis Bitonti.

The shape is the fundamental framework of the garments on the body or the general state of the piece of clothing without adornment. Shapes can lead the eye movement based on the lines direction. Different kinds of shapes in fashion design are designed to flatter different bodies and also create dress codes for certain events or occasions. Shapes can be taken into an advantage and alter the appearance of body silhouettes to create a graceful illusion. It is a fundamental consideration in fashion design, it can determine the first impression of the design. People will notice the shape of the design before they examine the material or the details of the design.

Materials in fashion design are one of the key elements, it plays a great role in the appearance and the visual effect of the design; it can give the design the bulky or the slim look depending on the type of materials are using in the garment whether it rough or smooth materials. In the last few years, new technologies provided the fashion industry with new invented materials to be used in fashion design. 3D Printing technology is one of the new technologies that enrich the fashion market with new advanced materials for fashion design. Since 2013 there was an expansion in the production of 3D printed garments as a type of combination between the traditional craftsmanship and the new technology. Recently, it is possible to print garments, shoes, accessories using the 3D printing technique. Many fashion designers have used 3D printing technique with advanced materials to create innovative designs with innovative shapes. So, this research will discuss the 3D printing in fashion design in terms of the innovative shapes are created and new materials are used. The present

research is aimed to draw attention to the diverse use of this new technology in fashion design. The research will also explore the impact of using 3D printing – as an advanced technology- in the future of the sculptural shapes and the use of the advanced materials in Fashion Design. The advantages and disadvantages of 3D printing in fashion design. Also how fashion designers applied the 3D printing technology in their collections, to draw the attention to this innovative technology and how can it helps to enrich the Fashion market.

Index Terms: Fashion Design, 3D printing in Fashion Design, Advanced materials in 3D printed garments, Innovative shapes in 3D printed garments.

INTRODUCTION

Fashion design is a unique combination of silhouette, construction, fabric, and details that distinguishes a single fashion object from all other objects of the same category or classes. [1]

Fashion is a worldwide market that works on various levels to reach everybody from people who are following fashion to the individuals who simply buy a dress as a need for the regular day. The range and extent of fashion is tremendous, from a lavish high fashion outfit made by hand in Paris atelier to the T-shirt produced using mass production in China. [5]

Fashion can be a difficult industry to work in, but also a very interesting field especially when we work with an innovative technology as the 3D Printing technology. Nowadays, since Fashion is changing rapidly, so there is a need to bring new technology and new innovative ideas to fashion design. The need for change in fashion and style has always led the way to execute the creative ideas in different directions.

3D printing is a novel approach to produce objects in a new and innovative technique. Birtchnell and Hoyle determine that 3D printing offers an alternative to the worldwide consumption and production system in some key areas that impact upon material poverty. [1]

3D printers have been utilized regularly in fields, such as health, dentistry, automotive, architecture, etc., particularly since the start of the 21st century. Because of its fairly high cost and deficient material choices, 3D printers are normally utilized by architects and specialists to fabricate models and picked up considerably for final result manufacturing when plastics and metal materials began to be utilized as input materials. [28]

3D printing has been in development for two decades back with the good effort of science and engineering being done at universities, national labs, and within corporate research labs. In 2009, few years back, 3D printing was moderately new in fashion design, and because of its high expenses was just available to medium and high-level markets. Anyway, this innovation led to an expansion in the innovation of fashion designers because of the speed and immediacy of advanced technology. Since the 3D Printing is still uncommon on the Egyptian fashion industry; so that, the researcher shows some of international fashion designers' collections who depended on 3D Printing techniques, and computer software to create their amazing fashion collections, to draw the attention to this innovative technology and how can it helps to enrich the Fashion market. [4]

Material and Method

Shape is the fundamental framework of the garments on the body or the general state of the piece of clothing without adornment. Shapes can lead the eye movement based on the lines direction. Different kinds of shapes in fashion design are designed to flatter different bodies and also create dress codes for certain events or occasions. Shapes can be taken into advantage and alter the appearance of body silhouettes to create a graceful illusion. It is a fundamental consideration in fashion design, it can determine the first impression of the design, people will notice the shape of the design before they examine the material or the details of the design.

Materials in fashion design is one of the key elements, it plays a great role in the appearance and the visual effect of the design; it can give the design the bulky or the slim look depending on the type of materials are using in the garment whether it rough or smooth materials. In the last few years new technologies provided the fashion industry with new invented materials for fashion and 3D Printing technology is one of the new technologies that enrich the fashion market with new advanced materials for fashion design. [3]

3D Printing

we can simply define 3D Printing as it is the action or process which we use to create a physical object from a three-dimensional digital model, typically by laying down many thin layers of a material in succession.

Also, 3D printing is the technology to print a product where the material will be printed layer by layer to make the 3D product. The product is designed as a digital file using CAD and send it to the printer. 3D printing has been produced in 1983 by the American creator Chuck Hull. The 3D printers are presently accessible for industrial and semi-professional use. The 3D printing innovation permits the development of solids in different structures, as per the information sent to the printer. [6] [7]

In the 2000s, the 3D printing went through many developments, the cost was so high but starting from 2010 the costs decline, it became available to print a product with a cost less than a thousand dollars. And since 2012, many fashion designers started to use 3D printing in their collections. 3D printing technology has also been used in fashion designers collections as conceptual or prototyping pieces not as commercial designs. The 3D Printing tech is known as Laser Sintering. This is a procedure by which parts are fabricated layer by layer using a fine nylon powder. Progressive powder layers are spread over each other and, after each layer, a laser beam scans the surface and binds together (sinters) the powder involved in the design. The rest of the powder is effortlessly cleaned or brushed away when the machine completes the process. This innovation is utilized to make a wide collection of items in all life fields, as equipment, tools, lamps, jewelry, and garments. This procedure enables designers to create designs that would be unimaginable some other way. [13]

3D printing is rapidly and significantly changing the fashion industry. Up to a couple of years prior, the capacity to print in 3D was saved for substantial organizations and specific experts that could bear the cost of costly hardware. Since 2004, the cost of a 3D printer has started to dropped from over \$15,000 to marginally under \$1,000, which became more affordable for designers to use this technology to create their innovative collections. At present, 3D printing has opened a new field of creation in Fashion Design. Garments, accessories, bags, glasses, watches, and more can be made by using CAD (Computer Aided Design), and the suitable materials. The number of fashion products manufactured using 3D printing has likewise been expanding in the current years. Designs made by using the 3D printing technology is now commonly available in the collections of designers and brands which participate in world's leading Fashion weeks in Paris, London, New York, and Milano fashion week. Spearheaded by renowned fashion designers, like Iris van Herpen, Janne Kyttanen, Danit Peleg, Michael Smith, and Francis Bitonti, this innovation-based approach will surely make strides each other day. All things considered, the "3D Fashion Show" held as a major aspect of the "3D Print Week" in New York uncovers the situation of 3D printers in the fashion business. [28]

Normally, the designs created using the 3D printing technology show a stiff and sculpture shapes, but recently, the new technology allows designers to create flexible structures that adapt movement to the designs as shown in the below designs.

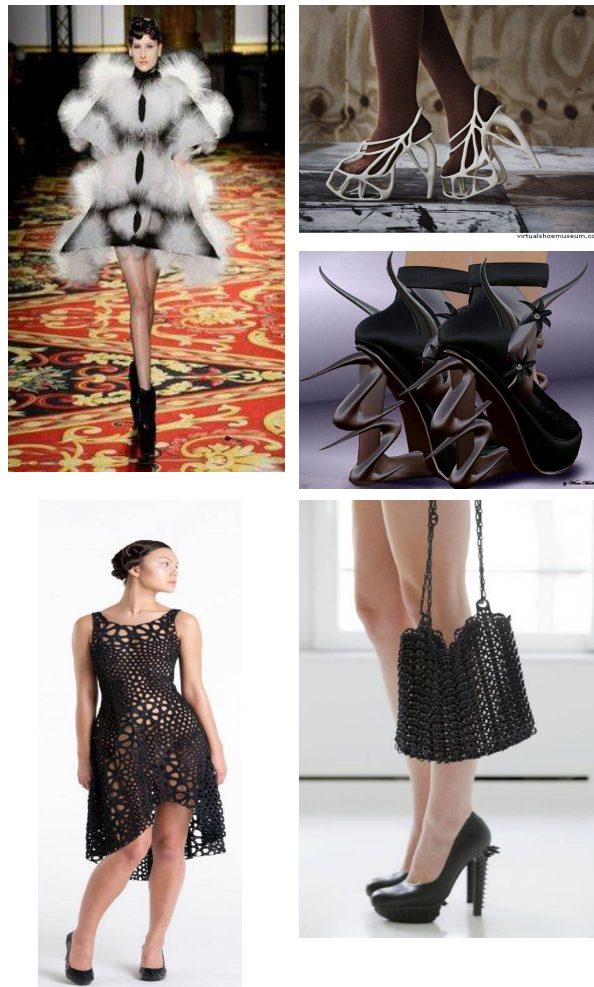


Fig 1: 3D Printing between the sculptured and the wearable designs.

Types of the 3D Printing in fashion design

There are five types of 3D printing methods that exhibit great potential in fashion design, including Stereolithography (SLA), Selective laser sintering (SLS), Fused Deposition Modelling (FDM), Material Jetting (MJ), and Binder Jetting (BJ).

Stereolithography

SLA is a quick prototyping process. It can produce products from 3D CAD (Computer Software files) in only a couple of hours. They do this by converting liquid plastic into solid 3D objects, layer after layer. The plastic is first warmed to transform it into a semi-fluid material, and afterward, it solidifies on contact. The printer builds every one of these layers utilizing the ultraviolet laser. The print cycle proceeds along these steps, building 3D objects from bottom up.

Selective laser sintering

SLS The technology of SLS & SLA is quite similar in regards to speed and quality. The main difference is with the materials used, as SLS depends on powdered substances, while SLA depends on liquid resins. In SLS printers they use high power CO2 lasers to combine particles together to create the required design. Different types of Materials can be used such as nylon powder, ceramics, and even glass.

Fused Deposition Modelling (FDM)

This type of printer uses the thermal plastic materials for 3D printing. It's an innovation that can make precise subtle elements and boasts an excellent quality to weight proportion. Before the FDM printing process starts, the producer has to slice the 3D CAD data (the 3D model) into multiple layers using certain software and send it to the printer to print it on layers.

Material Jetting (MJ)

This technology of 3D printing is mainly used for dental and Jewelry industries, after uploading the CAD file to the printer, it starts to add the molten wax to the printer aluminum platform in controlled layers using spouts that move equitably over the required build area. When the warmed wax lands on the build plate it starts to cool down and become solid. The MJ is the best and easiest technology for jewelers to create their collections.

Binder Jetting (BJ)

BJ is the 3D printer which use two types of materials to build the product: a powder-based material (usually gypsum) and another material to work as a bonding agent which work to attach (bond) the powder layers together. After the printer finishes the first layer, the build plate will move down to allow for the next layer and so on. This process repeats until the required product printed.

The most popular materials used in BJ printing are: Ceramics, Metals, Sand, and Plastics. [9] [23]

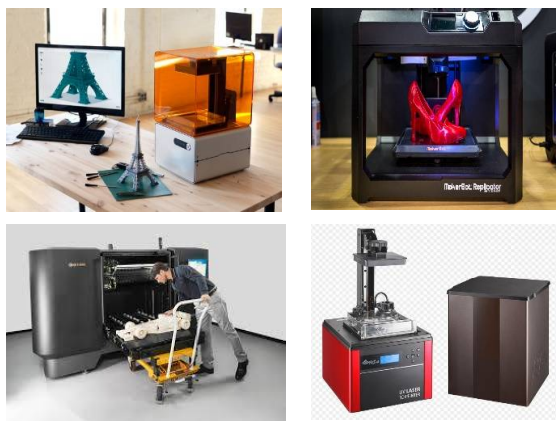


Fig 2: Sample of 3D printers.

The steps of 3D Printing technology

Whatever the strategy a 3D printer utilizes, the entire method is nearly the same. Researchers recognize 8 steps to complete the printing process:

Step 1: Create a 3D model on a computer-aided design software (CAD), the software will give us a clear vision and information about the design and the materials with simulation of the design, in this step we can change in the file of the design till we reach to the required design.

Step 2: Convert the format of the 3D model in CAD to STL (standard tessellation language) which is the format initiated especially for 3D printing systems.

Step 3: Copy the STL file of the design to the computer which operating the 3D printer.

Step 4: Setting up the device to be ready for printing, which include adding or refilling the materials which the printer will use in the printing process. That also means put a tray as a base or adding some material as a water-dissoluble support.

Step 5: It is an automatic step, the 3D printer will print the product, and the thickness of the layers is around 0, 1 mm each, it can be thicker or thinner according to the design and the materials used. The time of the process can be several hours to few days. We have to check the printer while working to avoid any errors.

Step 6: Remove the printed object from the printer carefully to prevent any damage in the product.

Step 7: Sometimes after finishing the 3D printing process, the product will require some

post-processing as removing the rest of the powder or the water-soluble supports.

Step 8: Finishing all the process and the product is ready to use. [11] The below pictures show the steps of the 3D Printed dress of Dita Von Teese designed by Michael Schmidt and Francis Bitoni. [24]

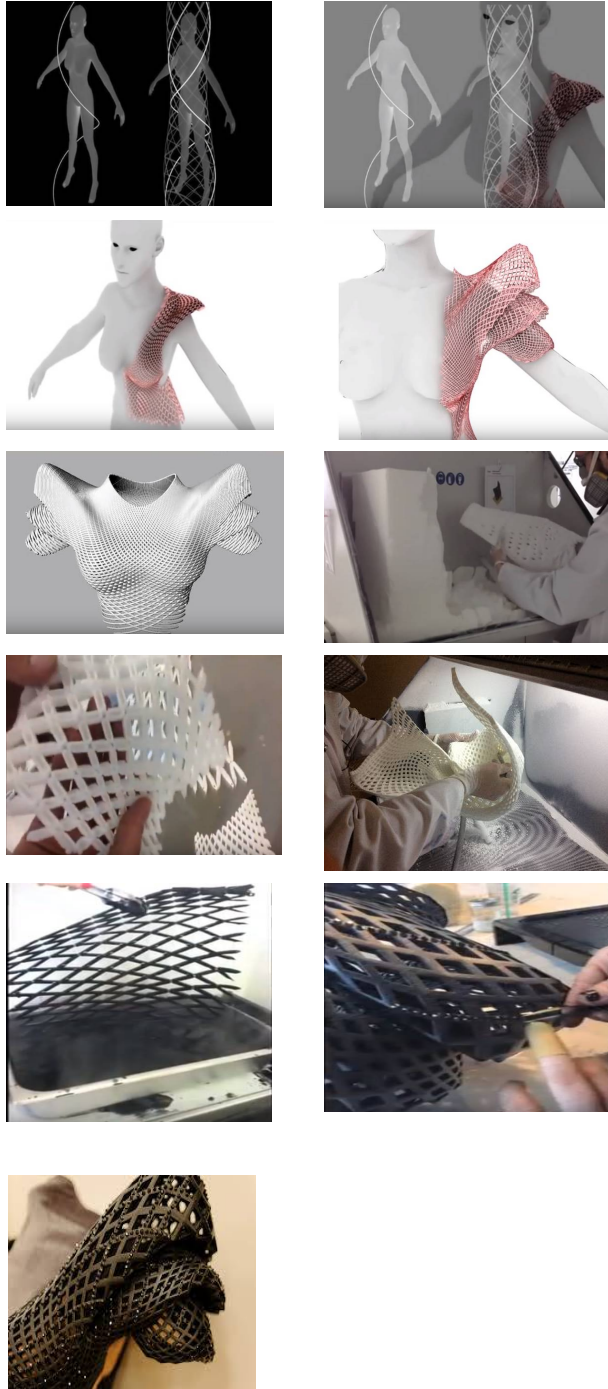




Fig 3: Steps of the 3D Printing dress of Dita Von Teese by Michael Schmidt and Francis Bitoni.

Materials for 3D Printing

We cannot ignore that there are limitation in the materials which used for 3D printing, since the materials used for garments should be flexible, comfort and absorbent, but the materials are used in 3D printing still away from the mentioned property requirements.

The materials used in 3D printing are not absorbent materials, we cannot treated as popular fashion materials since we cannot wash, iron and press it, and also it cannot be sewn. So there is a need to develop the rubber-like materials used in 3D printing to meet the fashion textiles requirements. [29]

The raw materials most often used for the printed items and for the high-class semi-professional 3D printers are PLA (or Poly Lactic Acid, is made from organic material), ABS (short for Acrylonitrile Butadiene Styrene, is an oil-based plastic) among other materials as glass polyamide, epoxy resin, wax and even metals like titanium, silver, steel and nylon. ABS is normally used in Lego toys. It is not heavy material, solid, tough and resistant. It can be recognizes with a smell of hot plastic while printing. PLA is made of corn starch and some more renewables. It is safer than the ABS since it can be printable at lower temperatures, and it is biodegradable, PLA is environmentally materials but not as solid and resistant as ABS. Those sorts of printers process the thermoplastic polymers in a type of strings by softening and expelling them through a spout to the printing place (combined fiber creation). With modern printers, it is additionally conceivable to utilize metal, ceramics or fossil and materials reasonable for the thermosetting procedure. [26] [10]

Despite the fact that, it isn't conceivable to create materials appropriate for sewing using 3D printers today, the current accomplishments in printing with material items are imperative improvements to solve this issue. Having been examining on surfaces joining 3D printer innovation and the materials utilized with material items, Laura McPherson and Mark Beecroft are finding a way to produce fabrics we can wear in our day to day life. Having utilized woven textures and 3D printers in a mix, specialists expressed that their point is to realize new methodologies with the utilization of old and new technologies together. [28]. Shapeways organization (2015) used a printing innovation from the utilization of lasers and powder cementing, and different procedures created with the utilization of templates, which as a last outcome, help the designers to print using aluminum, bronze, gold and different materials. [25]

In 2014, McPherson and Beecroft have been working on sewing the two-dimensional world of knitting with 3D printing in their investigation of technical crafting, which is trial in its nature, offering a new explanation to both old and new innovation. By incorporating 3D printing into the world of fashion fabrics, great development and flexibility are conceivable in the wide range of fabrics made. Since the two worlds have a tendency to be thought of as harder materials (3D printing) and softer materials (knitted fabrics), the mix of the two types with specialized making opens the way to another innovative materials for fashion. [15] [2]



Fig 4: knitting with 3D printing.

An example of the combination between textiles and 3D Printing technique is the fabrication had developed by Cube. In this project the fabric will be the base and the 3D Printer prints 3D pieces to be on the surface of the fabric as shown in fig. (5). [22] [27]



Fig 5: Fabrication had developed by Cube.

3D Printing and Sculptured shapes in Fashion design

Basically, the 3D Printing technology helps us to create innovative sculpture Fashion, Some of the international fashion designer are using the 3D printing technology to create their collections of garments and accessories.

3D Printed sculptured fashion by Iris van Herpen

Iris van Herpen is the fashion designer who is playing a great role in reciprocity between craftsmanship and innovation in fashion and technology. She is forcing the fashion to the extreme inconsistency between magnificence and renovation. After finishing her study in Fashion Design at ArtEZ Institute of the Arts Arnhem and interning at Alexander McQueen in London, and Claudy Jongstra in Amsterdam, Iris van Herpen begins her own fashion label in 2007 in Arnhem, the Netherlands and shows her first unique collection at the Amsterdam Fashion Week. Iris van Herpen is a revolutionary designer who is not afraid to break fashion norms. She is a designer who combines craftsmanship with innovative techniques and materials to achieve the movement in her designs.

When the geometric concept came into fashion, the designers started to create designs without thinking a lot about the wearability and the model's mobility on the catwalk. But Iris Van Herpen is one of the fashion designers who are working to create designs which achieve creativity and elegance and in the same time wearability of the designs.

In 2010 Iris van Herpen collaborated with London architect Daniel Widrig and digital manufacturers' .MGX by Materialise, to create her first 3D printed project 'Crystallization' which is inspired by shell structures, and 3D printed from white polyamide. She showed her first 3D printed design at the runway at the Amsterdam Fashion Week.



Fig 6: 'Crystallization' top by Iris Van Herpen 2010.

And in 2011 she showed the collection 'Escapism' using the 3D technology. The Project "Escapism" was a development of the earlier collaboration between Iris Van Herpen with architect Daniel Widrig and digital manufacturers' .MGX, to create dresses with lightweight and flexible 3D printed materials via using selective laser sintering (SLS) in Polyamide. This collection was showed at Paris Fashion Week. The collection showed the possibility of using advanced digital design techniques and computer-aided manufacturing in the realm of haute couture fashion design. The Project worked in increasing the limitation of 3D printing keeping in mind the end goal to build the wearability of the fashion collection. The dresses are made out of bunches of fiber-like components with limited diameters. The fineness of the printed lines of the texture makes the general outfit lightweight, fashionable and takes into consideration the cost of it. [19]



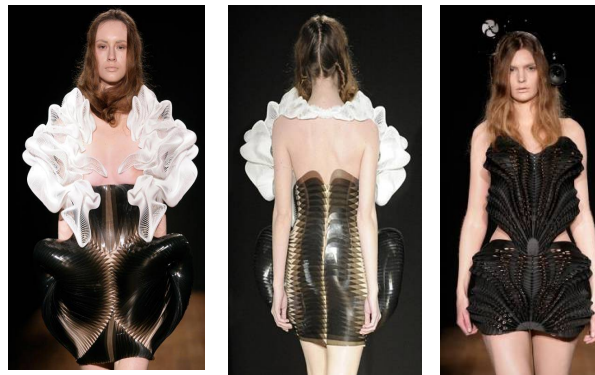


Fig 7: 'Escapism' by Iris Van Herpen 2011.

A final piece for 2011, played an important role in the exhibition titled "The New Craft", at the Centraal Museum Utrecht, and in Paris known as the Skeleton Dress, Iris Van Herpen collaborated with architect Isaïe Bloch to create this unique masterpiece. In the Skelton dress the designer highlighted the construction and the structural forms of a skeleton. In January 2012, in the Paris Haute Couture Week, Iris Van Herpen showed her MICRO collection, the "Cathedral", printed from SLS technology in polyamide and sculptural details.

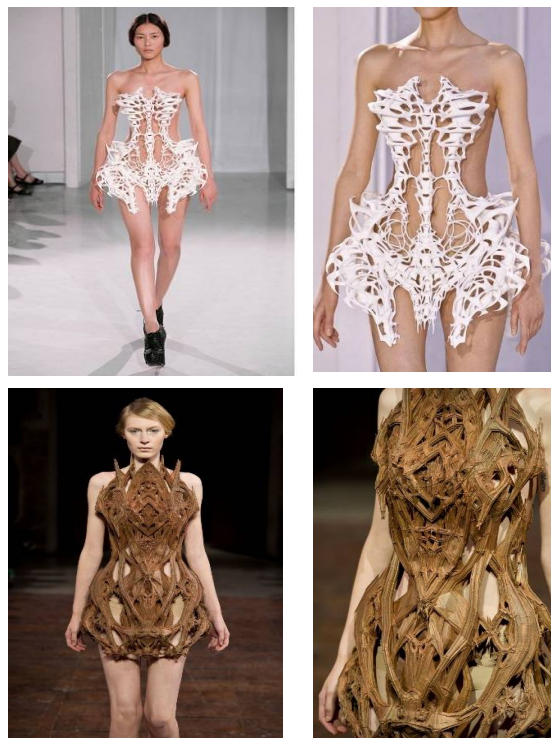


Fig8: Skeleton Dress 2011 and Cathedral dress 2012 by Iris Van Herpen.

In 2012, Iris Van Herpen collaborated with architect Julia Koerner for her Autumn/Winter 2012/2013 collection "Hybrid Holism", in this collection, she explored - for the first time- mammoth stereolithography (a 3D Printing process using a big printer and a liquid resin). The result was a 3D printed collection with liquid appearance, where she blended creativity and technology together in a technique never seen before in fashion industry. [13]



Fig 9: Autumn/Winter 2012/2013 collection – Hybrid Holism by Iris Van Herpen.

In 2014, Iris Van Herpen showed her collection “Biopiracy”, in this collection she showed a dress made of laser sintering and rubber and she coated the dress with silicon to give it a flexible, glowing finish. After her hard work she succeeded in achieving the flexibility and movement to the design. [25]



Fig 10: Biopiracy dress and Magnetic Motion dress by Iris Van Herpen 2014.

In her collection “Lucid” for Autumn/ Winter 2016, Iris Van Herpen collaborated with 3D artist Niccolo Casas and architect Philip Beesley to create a collection featured with 3D-printed dresses and holograph-like fabrics. Two sculpture dresses out of her collection were implemented using the 3D printing technique. In the two sculpture dresses which she called it “Magma dresses”, Herpen & Casas tried to explore the active interactions between the body and garments through the use of technology, they combined the 3D-printed materials with traditional craftsmanship, all the components of the two dresses are unique —The Magma dresses made of the flexible thermoplastic polyurethane (TPU) material to create a fine web with 3D printed polyamide elements, one of the Magma dress made from around 5000 - 6000 printed pieces which stitched together to create the final design. Iris Van Herpen as usual played with the shape and direction of the designs based on the body's position and movement. [14] [8]

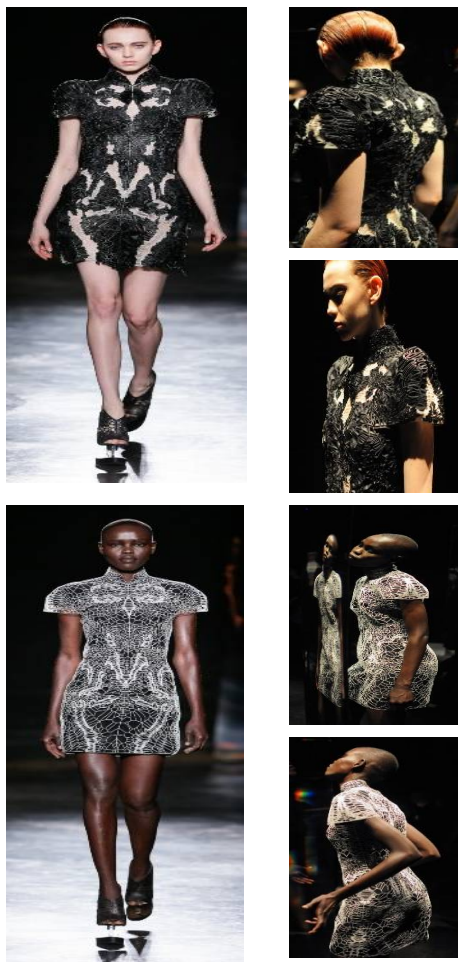


Fig11: Magma dresses from the “Lucid” collection Autumn/ Winter 2016 by Iris Van Herpen.

Another group of designs of Iris Van Herpen from different fashion shows, using the technology of 3D printing, using unusual innovative materials to create garments with innovative sculptured shapes. This designs showed in the fashion weeks or as a solo exhibitions.





Fig 12: Group of designs of Iris Van Herpen using the 3D printing technology in fashion design.

3D Printed sculptured fashion by Noa Raviv

In her collection “Hard Copy” 2014; fashion designer Noa Raviv collaborated with Stratasys; one of the biggest companies of 3D printers in the world, to create some pieces in her innovative collection.

Noa Raviv has combined 3D-printed elements into ruffled and pleated clothes and created designs with asymmetric silhouettes with fractured look. Raviv designed materials with misshaped grid designs creating visual illusion over the texture. Also, she used 3D printed elements to create so complicated shapes. Silhouettes of the collection inspired from the classical Greek sculptures; she used the classical art in a so innovative ideas. Printed copies incorporate seven dresses including high contrast ruffled fabric in a grid design that gives these designs big and unique shapes. The 3D printed pieces made from layers of ribbed polymer in black, white and sheer tones. When she spoke about her collection, she explained that she translated the lines into textiles to create optical illusion in her collection. [18] [20]





Fig 13: Noa Raviv 3D printed designs from “Hard Copy” collection 2014.

3D Printing and the wearable Fashion

In 2000, it was the time for the first wearable dress using the 3D printing technology which was the Black Drape Dress, produced by Jiri Evenhuis, in collaboration with the Janne Kyttänen. This dress is made by stacking thin layers of polyamide powder and laser sintering (SLS technology) to deliver a material quickly. Nowadays, the dress is exhibited as a part of MoMA's collection in the Museum of Modern Art. [25]



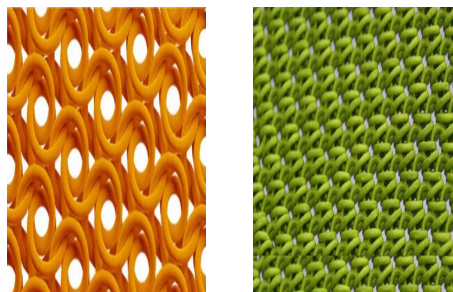


Fig 14: The Black Drape Dress & samples of the 3D printed textiles designed by Jiri Evenhuis and Janne Kyttanen.

Wearable 3D printed fashion by Danit Peleg

Danit Peleg is a Fashion designer who has figured out how to use 3D printing technology to design, excellent, adjustable, wearable and washable collection, a considerable number of designers have attempted unsuccessfully. The greater part of endeavors have been unique cases like Studio Bitonti's dress for Dita Von Teese, or the 3D printed Parametric dress for Lady Gaga by XO studio. Danit, then again, has succeeded to create wearable 3D fashion. The collection of Danit Peleg is a stunning example of outstandingly creative work. The designer designed a collection of 5 pieces manufactured using a specialized material called FilaFlex with 9 months of innovative work, over 2000 hours to print, every piece of the outfits assumed control 400 hours.

Danit Peleg attached the output of A4 paper size together to create outfits looking like lacework. The most surprising issue of these collection that the outfits gives the impression of the normal wearable fabric. [21]

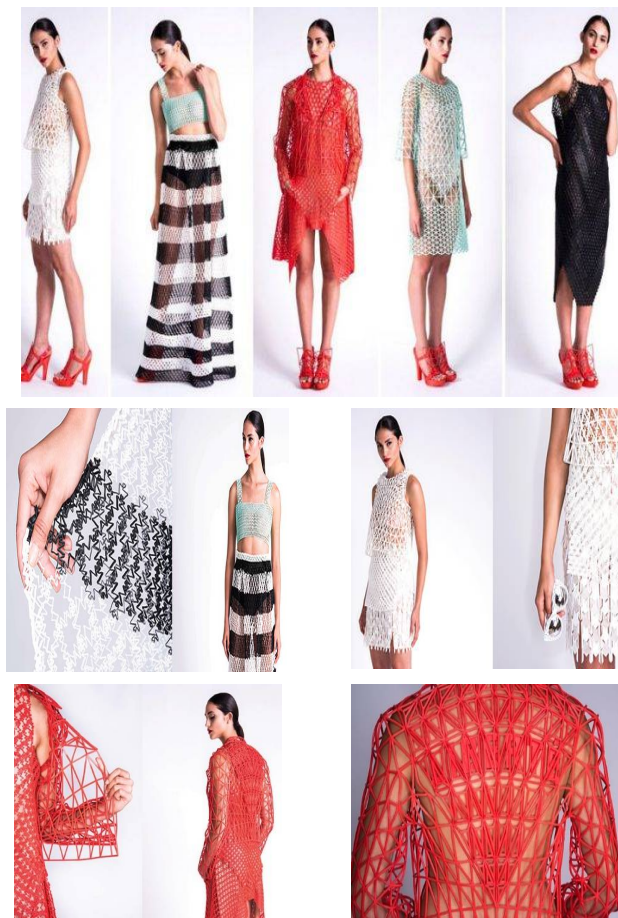




Fig 15: Fall 2017 collection by Danit Peleg.

As she explored different experiments with 3D printers, she settled on Witbox and realized that she required a group of printers to influence things to work. Advance investigation drove her to work with form tech organizations everywhere throughout the world, as Gerber Technologies, Nettelo, and a body scanning Software Company to make each piece fit flawlessly. In any case, there was the issue of materials. Most 3D polymers are hard and that is the reason that considerable number of 3D printed attempts have been excellent however more sculptural than useful. When she joined with Recreus and started utilizing their FilaFlex materials, she was at long last ready to print garments that were delicate and achieved the required movement with the body. Not long after in the wake of displaying her achievement, it circulated around the world.

In 2016, continually her achievements in 3D Fashion, Danit Peleg created her second collection "Birth of Venus" using the same technique of the 3D printing, to create 5 pieces nude color dresses. The American snowboarder Amy Purdy's wore one of the designs in the 2016 Paralympic Opening Ceremony in Rio de Janeiro. The dress worn by Amy Purdy was a piece of the collection "The Birth of Venus". It was printed utilizing a delicate, bare shaded fiber FilaFlex, a TPE thermoplastic elastomer base polyurethane made by Recreus, which allow movement for the wearer. Peleg utilized similar strategies she had utilized in her past undertakings; the dress was altogether 3D printed and was made with the help of Gerber Technology. Peleg was so motivated by what she was really going after, that she has outlined a full gathering of five looks. [17] [30]





Fig16: “Birth of Venus” Collection by Danit Peleg.



Fig 17: Amy Purdy Wears 3-D-Printed Dress at Paralympic Opening Ceremony 2016.

Nowadays , the 3D printing technology allow the sneaker brands as Nike, Adidas, New balance and others to print their products with the possibilities of customization, this technology would allow the brands companies to specify the needs of each customer and print the shoe according to this needs. Also the 3D printed outsole designed with low pressure and more flexibility which will enhance the performance of the shoe. According to Adidas; the 3D printing technology will allow companies to produce printed sneakers on a large scale, the plan will be to ship around 100,000 pairs of sneakers by the end of 2018. [16]



Fig18: 3D printed sneakers.

3D Printing and the innovative Sculptured accessories

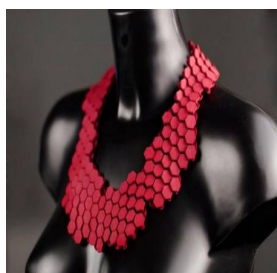
As the 3D printing technology allows the fashion designers to create so complicated and innovative garments, it allows them also to create innovative accessories. Many materials are used for the 3D printed accessories , it can made of glass polyamide, nylon, epoxy resin, wax, gold, sterling Silver, steel, brass and

bronze. As an example, Maison 203 Studio is one of the most specialized companies in 3D printed fashion items, in 2015 with the using of selective laser sintering (SLS) technology, the designers of the Maison 203 Studio created a collection of 3D printed handbags, they used Nylon as the main material of the collection. Since the company established their business, they designed many collections of 3D printed fashion accessories. In their collections the designers of Maison 203 tried to provide their collections with flexibility specially the necklaces as it has to fall on the body in a comfortable way. [12]



Fig19: Collection of designs made by Maison 203 Studio.

Many fashion designers are using the technique of 3D printing to create innovative collections of sculptured fashion accessories, using a wide range of materials as glass polyamide, nylon, epoxy resin, wax, gold, sterling Silver, steel, brass and bronze as shown in the below designs.



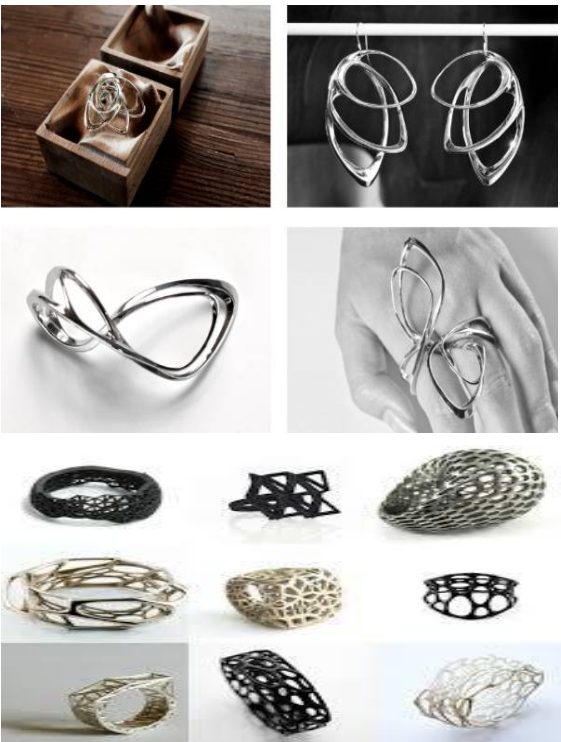


Fig20: Collection of 3D printed sculptured fashion accessories.

The Advantages & Disadvantages of using 3D Printing in fashion design

In time that there are a lot of advantages of using 3D printing technology in fashion market but still there are some disadvantages of using it , which need more work and research to find solutions for it. [28]

ADVANTAGES	DISADVANTAGES
- Best alternative technique for construction of haute couture garments. - Requires less time and resources for the rapid prototyping. - Produces high end and unique designs. - Adds perfectly elaborate and high details to the dresses that can't be accomplished by hands. - Helps save environment by reducing the need to obtain natural	- Use of plastic can cause health problems. - Tailors and seamstresses would be in a job crisis due to their works being replaced by machines. - Products can be counterfeited and it will be hard to tell the difference with the original. - Garments are not always suitable for daily/regular wear. - Disposal of garments will create environmental issues as plastics are hazardous and non-biodegradable.

fibers and using single manufacturing operation.	- 3D printers are expensive and cannot be afforded by an average person.
- Economically feasible for designers are they can cut down cost of production.	- Skills like tailoring, draping, paper pattern making etc. will be futile.
- Suitable for small scale fashion/jewelry designers for the production of their inventory.	- Designers will be lethargic.
- Suitable to create literally geometric shaped garments.	- The time required for creation and costs restrict the possibility of large-scale manufacturing.

RESULT & DISCUSSION

Fashion is changing rapidly, so there is a need to bring new technology and new innovative ideas to fashion design. It became a fact that, almost every day a new development is published regarding the field of fashion design and impressive investments are made to this end. Fashion is a luxury activity, and with the use of 3D printing, designers today are afforded the luxury of new exploration, new materials, and new technology adding progress to the fashion industry. It's fascinating to perceive how fashion technology can stand next to each other with hand-made Haute Couture, requiring a similar sort of time and care. In 2016, the Metropolitan Museum displayed the Manus X Machina show which investigated the excellence and craftsmanship of fashion design made using technology beside those made by hand using the craftsmanship and equipment, to draw a light to the importance of combining fashion and new technology together.

The huge technological revolution in industry help fashion designers to create innovative collections. Also, the use of the computer software and the incredible advances it has brought is one of the techniques in which technology is working to improve, develop and innovate the fashion industry. 3D printing technology has been around for a considerable length of time, as far back as the 1980s to be exact. Architects, engineers and industrial designers have all used 3D printers to develop layers by layers to create prototypes and models. However just over the most recent couple of years has there been quite a bit of an enthusiasm in using 3D printing due to being more affordable and the accessibility of home printing. The most surprising thing about 3D printing is that this area is developing incredibly fast although its introduction was a few decades ago. Technology of the 21st century is shifting towards the "new generation" era where a lot of new inventions are produced with functions to facilitate the life of an average human being. In fact, every new products are designed to reduce our workload i.e. every new invention are to make our lifestyle easier day by day. The digital revolution wasn't just limited to specific fields, it can be seen in terms of fashion too. 3D printing is the technology to create unique designs with high quality, with 3D printing there is no design limitation, we can change in the design when it is still a design in the CAD and make any required customization before starting the printing process. There are five types of 3D printing methods that exhibit great potential in fashion design, including Stereolithography (SLA), Selective laser sintering (SLS), Fused Deposition Modelling (FDM), Material Jetting (MJ), and Binder Jetting (BJ), and in 3D printing designers have to only input the specifications into the printing machine and click on print as the machine does rest of the job. 3D printing is mainly used in haute couture style of garments as it produces high end dresses with intricate details.

3D printed fashion gathered a lot of attention when Dutch designer Iris van Herpen launched her 3D collection of dresses in 2010, the collection was followed by many other collections designed by Herpen and exhibited in fashion shows and solo exhibitions around the world. Followed by Herpen, few other fashion designers launched their own designs from 3D printing. Collections are often results of collaboration with arts, technology and architecture. Over the most recent couple of years, the capacities

of 3D printing innovation have produced much exchange and media introduction in the industry and academia. Over the most recent couple of years, 3D printing has been investigated in fashion markets in garments, footwear, and accessories by pioneers as Iris Van Herpen, Noa Raviv, Danit Peleg and others. Some sportswear brands as Nike, Adidas, New balance and others used the 3d printing technology to print sneakers. The market of 3D printing in fashion industry are increasing as it is considered as new advanced technology which allow designers to bring new ideas to the fashion market. The quickly developing and progressing in using 3D printing in designs reflects the need for new advanced approaches in the fashion market. Since there is lack of absorbency in the materials used in 3D printing such as glass polyamide, flexible plastic, epoxy resin, wax and even metals like titanium, silver, steel and nylon; So there is a demand to enhance the properties of this materials to meet the property requirements of fashion textiles. The materials used in 3D printing are not absorbent materials, we cannot treat as popular fashion materials since we cannot wash, iron and press it, and also it cannot be sewn. There is a need to develop the rubber-like materials used in 3D printing to meet the fashion textiles requirements.

The future research in 3D printing should concentrate on enhancing the properties of the materials used in 3D printing to be more flexible and absorbent to create wearable garments.

CONCLUSION

3D printed fashion is being adopted by designers due to ease in construction, less cost of production and high end results. However, in the fashion cycle of clothing it will exist as a fad i.e. face a fall in the near future with its rise mainly due to the fact that it isn't a practical wear and can exist in haute couture only. Moreover, the use of plastic can be dangerous to health (especially the skin) and environment as well i.e. disposal of the garments will be difficult due to the fact that plastics are non-biodegradable products. 3D printing may become a relief to designers who specialize in haute couture garments but it can be a disadvantage because the ease of obtaining fast and perfect end results with less effort will only make them lethargic. In addition, skills like tailoring, cutting, draping etc. will be futile and specialists will face job crisis. But in the case of jewellery, 3D printing will face steady success as it can be used as a practically and is worn occasionally.

REFERENCES

- [1]. Birtchnell, T. & Hoyle, W., "3D Printing for Development in the Global South: The 3D4D Challenge", Basingstoke, United Kingdom: Palgrave Macmillan, 2014.
- [2]. O'Neal, Bridget, "3D Printing and Knitting Converge: Technical crafting brings new dimension to apparel", 2014,
content/uploads/2017/01/NADASBAS_AND_CILEROGU_The_use_of_3D_printers_in_fashion_design_for_different_models_and_sizes.pdf.content/uploads/2017/01/NADASBAS_AND_CILEROGU_The_use_of_3D_printers_in_fashion_design_for_different_models_and_sizes.pdf.
- [3]. Eundeok Kim, Ann Marie Fiore & Hyejeong Kim," Fashion Trends, Analysis and Forecasting", Bloomsbury Publishing Plc, 2011.
- [4]. Ferrity, C.," The impact of 3D printing on the fashion industry", 2017. Retrieved from URL https://www.taylorwessing.com/download/article_fashion_3d_printing.html
- [5]. Harriet Posner, "Marketing Fashion", Laurence King Publishing, second Edition, 2015.
- [6]. Hausman, K. & Horne, R.," 3D Printing For Dummies", John Wiley & Sons, Inc., ISBN 978-1-118-66075-1, Hoboken, 2014.
- [7]. Hoffman T., "The many dimensions of 3D printing", PC Magazine 91-100, 2015.
- [8]. Howarth, D.," Iris van Herpen uses 3D printing and magnets for fashion collection", 2017. Retrieved from URL <https://www.dezeen.com/2014/10/01/iris-van-herpen-magnetic-motion-spring-summer-2015-fashion-collection-3d-printing-magnets/>
- [9]. Y.venkateswararao, k.sujana. "a novel stability indicating rp-hplc method development and validation for the determination of clopidogrel in bulk and its dosage forms." International Journal of Pharmacy Research & Technology 9.2 (2019), 1-11.
- [10]. Abdul Qader, O.A.J., Sukmasari, S., Doolaanea, A.A., Abdul Rahman, M.N., Ismail, A.F. "The effect

of incorporating *Baccaurea Angulata* extract on rheological properties of various gelling polymers(2018)", International Journal of Pharmaceutical Research, 10 (2), pp. 246-250.

- [11]. <http://www.niccolocasas.com/LUCID-1>
- [12]. <https://3dprint.com/22901/knitting-3d-printing-textiles/>
- [13]. <https://fashionunited.uk/news/fashion/fashion-technology-forecast-2018/2017123127410>
- [14]. <https://inside3dprinting.com/news/paralympic-opening-ceremony-featured-a-3d-printed-dress-by-danit-peleg/41102/>
- [15]. <https://www.designboom.com/design/noa-raviv-stratasys-hard-copy-fashion-collection-3d-printing-israel-08-25-2014/>
- [16]. <https://www.dezeen.com/2011/03/04/escapism-by-daniel-widrig-iris-van-herpen-and-mgx-by-materialise/>
- [17]. <https://www.dezeen.com/2014/08/21/noa-raviv-hard-copy-fashion-collection-grid-patterns-3d-printing/>
- [18]. <https://www.forbes.com/sites/westernbonime/2017/09/10/danit-pelegs-beautiful-fashion-tech-must-haves-for-fall-2017/#605ba3413a9b>
- [19]. <https://www.sculpteo.com/blog/2016/01/27/making-wearable-3d-printed-clothes/>
- [20]. <https://www.tandfonline.com/doi/full/10.1080/17543266.2016.1223355?scroll=top&needAccess=true>
- [21]. <https://www.youtube.com/watch?v=J4zGFdKfU1U>
- [22]. Kuhn, Renato & Minuzzi, Reinilda de Fátima, "THE 3D PRINTING'S PANORAMA IN FASHION DESIGN", *Moda Documenta: Museu, Memória e Design*, ISSN: 2358-5269 Ano II - Nº 1 - Maio de 2015. Retrieved from URL http://www.modadocumenta.com.br/anais/anais/5-Moda-Documenta-2015/02-Sessao-Tematica-Design-Moda-e-Cultura-Digital/Renato-Kuhn_Moda-Documenta2015_THE-3D-PRINTING_S-PANORAMA-IN-FASHION-DESIGN_BILINGUE.pdf
- [23]. L. N. Partschi, S. Vassiliadis and P. Papageorgas, "3D Printed Textile Fabrics Structures", 5th International Istanbul Textile Congress 2015: Innovative Technologies "Inspire to Innovate" September 11th -12th 2015 Istanbul, Turkey.
- [24]. Sculpteo.com, "3D Printing Fashion and Textile: Get 3D Printed Clothes thanks to 3D Textile", 2017. Retrieved from URL <https://www.sculpteo.com/en/applications/textile-industry/>
- [25]. [28] Serdar Egemen Nadasbaş, Birsen Çileroğlu, "The use of 3D printers in fashion design for different models and sizes", *Global Fashion 2016*. Retrieved from URL
- [26]. http://gfc-conference.eu/wp-content/uploads/2017/01/NADASBAS_AND_CILEROGLU_The_use_of_3D_printers_in_fashion_design_for_different_models_and_sizes.pdf
- [27]. Sun, Danmei; Valtas, Agita, "3D Printing for Garments Production: An Exploratory Study", *Journal of Fashion Technology and Textile Engineering*, 2016. Retrieved from URL <https://pureapps2.hw.ac.uk/ws/portalfiles/portal/14475677>
- [28]. Tarmy, J., "The Future of Fashion Is 3D Printing Clothes at Home", 2016. Retrieved from URL <https://www.bloomberg.com/news/articles/2016-04-15/3d-printing-is-poised-to-bring-haute-couture-into-the-home>