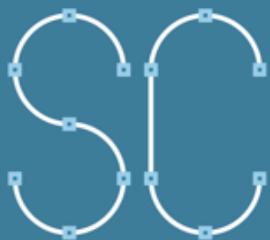


3D-printed future of fashion business



by ShareCloth

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Welcome

This whitepaper is addressed to a wide readership: designers, who want to learn more about fashion 3D printing, entrepreneurs, journalists, and regular geeks.

Our goal is not to promote the new methods of clothes manufacturing, but to present a short and accessible extract about development of the garment industry's new focus area, production of clothes with the help of technologies at all and 3D printers in particular.

This paper includes extensive research and industry expertise, author's forecast and potential solution. Though, since futuristic products are hard to predict, this could be one of potential ways the industry will unfold in which the author believe the most.

All numbers and facts are taken from open sources, and we try to cite all of them at the bottom of each page.

Executive summary

Fashion business as we know it has been evolving for the last few centuries. Today, the majority of garment production takes place far away from the sales locations. Because of this long-distance supply chain, it takes between 4 and 6 months to get from the drawing of the dress to its delivery to the stores. The extensive supply chains create not just the managerial and economic problems, but environmental hazards as well, because overproduction and inability to easily recycle the majority of garments put a strain on the environment. Fashion industry today is the world's third largest polluter.

On the other hand, 3D printing's potential for the fashion business is clear even today, and it grows with every year. Experts agree that in the next 5-10 years we can expect radical changes in garment manufacturing cycle and the whole supply chain.

Research predicts explosive growth of the 3D printing equipment market, which is set to reach \$23 bln in 2020, while the service market is expected to grow to \$50 bln by 2025.

Manufacturers of 3D printing materials estimate that 3D-printed fabrics will become available within the next 3-5 years. Materials identical to leather will be available within a year, while the flexible biodegradable plastic is available even today.

Global challenge



Aggressive retail merchandize is the key of fashion business,
source: [Depositphotos.com](https://www.depositphotos.com)

Fashion business today is experiencing one of its greatest upheavals since the moment it started to become a global affair.

LONG SUPPLY CHAIN

The extremely long and risky chain of supply, which can't be radically transformed within the framework of existing (analog) paradigm of the fashion market.

Today, apparel stores are forced to order the new collection half a year before it ships (and is produced), while the fashion brands have to work with an even longer cycle: in order to get pre-orders 6 months prior to shipment, they have to actually produce the apparel collection to show the clients.

AGGRESSIVE RETAIL AND RETURNS

After receiving the collection, which was ordered half-a-year ago, the retail stores use all the available methods to sell it. Anything goes: advertising, discounts, free delivery and free returns for 365 days after the purchase, and much more.

The outcome is familiar to anyone who follows the business of fashion: statistics show that online shops have 25-50% of returns⁵, while offline retailers have 8%⁴ of returns. The resulting competition inside the fashion business is the competition of supply chains, investments and advertising budgets, and not the competition of design, which was initially meant to solve the client's problems, not create them.

JUST IMAGINE:

25% of all chemicals are used in fashion production³

10% of all carbon dioxide is generated by the fashion industry³

11% of all pesticides and 24% of all insecticides are used in industrial cotton growing²

70 mln trees are felled each year for production of fabrics such as viscose.

70 mln barrels of oil are used each year to produce polyester, the most popular fabric of contemporary mass market clothing, which takes more than 200 years to decompose².



A GOOD EXAMPLE OF SUSTAINABLE BRAND

«*Patagonia, a major retailer in casual wear, has been selling fleece clothing made from postconsumer plastic soda bottles since 1993. This recycling process takes clear plastic bottles made of polyethylene terephthalate (PET), melts them, and reconfigures them into fibers that can be woven into fabrics and other applications. The company estimates that between 1993 and 2006 it saved 86 million soda bottles from ending up in the landfill. Patagonia also recycles its cotton T-shirts through Italian company Calamai Functional Fabrics. According to Trailspace.com, an outdoor gear information site, recycling cotton saves 20,000 liters of water per kilogram of cotton, a water-intensive crop.*»

OVERPRODUCTION AND LOW SUSTAINABILITY

The long supply chain and low marginality have created another dead-end strategy of mass market fashion, overproduction.

Each year, we produce 150 bln units of clothing². This would be enough to provide 20 garments to each person living on the planet. Statistics show that about 21% of all garments remain unworn¹ or are thrown out brand new. Every year, an average US resident throws out 70 lbs (31 kg)¹ of textile garments.

The majority of these garments are hard to recycle and easily salvage because chemical dyes and artificial materials are used in the process of manufacturing.

But such is the economic reality of contemporary supply chain. For the fashion corporations, the profit from overproduction (cost per item, avoiding risks from shortage, inflexible size chart) is much greater than the risks of failing to satisfy the demand. This puts a significant strain on the environment, and makes the fashion industry the world's third largest industrial polluter after oil and gas.

ANALOG WORLD

Whatever computer or other innovative solutions offered by vendors and developers, the necessity of transporting the fabrics, trims and finished products invariably leads to the situation, in which the logistics, customization, return or recycling of the purchased garment have to follow the rules of the “analog world”.

This is why we believe in the future potential of digital fashion, on-demand production and, in particular, 3D-printing clothes production that, with time, can become a notable alternative to mass production and global sourcing.

¹ [US National Center for Biotechnology information](http://usncbi.org)

² [Forbes.com](http://forbes.com)

³ [Huffingtonpost.co.uk](http://huffingtonpost.co.uk)

⁴ [NFR 2015 Retail Report](http://nfr.org)

⁵ [Whiteboardmag.com](http://whiteboardmag.com)

3D printing of clothes

The active development, cost-cutting and market penetration of 3D printers make them one of the most promising instruments for the fast-paced development of local manufacturing. Moreover, 3D printer design can solve the core problem of sourcing: you won't have to search for the right fabric with the right print and qualities, as the printer will impart the necessary properties in the process of printing the fabric.

Successful resolution of this essential problem will enable the full-scale move from the analogue part of the garment manufacturing process to the digital format. It will be sufficient to send the necessary data, which we call a digital package or an improved techpack, if you will, in order to start manufacturing the garment: the digital package will contain the garment pattern, and the fabric's

qualities and design. The rest will be done by the printer.

OVERVIEW

Since the start of 3D printing's explosive development, the idea of fashion industry's transformation has been on the minds of both the futurists and hi-tech adherents. In our blog posts, we've also regularly mentioned 3D printing as one of the key technologies for the industry.

But 3D printing innovations have been a subject of intense discussion for seven years already, and yet there's been no dramatic transformation of the fashion market. So when will these changes finally come about? We are doing this primarily because recently we've noticed a trend towards acceleration of this niche's development.

THE PAST

As it usually happens with innovation, the first attempts at 3D printing, dating back to the late

1970s, didn't seem promising and were rejected by the corporate leaders of that time. Thus, the 3D printing technology would develop off the radar, and only entered the mass market in the late 2000s. Several distinct 3D printing technologies, such as the Power bed, Light polymerization, and Extrusion, began to be used by companies that required swift prototyping of parts and other engineering projects. The latter of the mentioned technologies, the method of "printing" successive layers to create 3D models, made a mass-market breakthrough, and by 2009 it went from being a hi-tech lab technology to being a household one.

THE PRESENT

Over the last five years, the cost of a 3D printer fell from \$20,000 to \$1,000-2,000 or lower, and this created the impetus for an extensive DIY movement of people who manually assemble 3D printers. Thus, the printer itself stopped being an innovation or an exclusive right of the large corporations.

This was the moment when fashion appeared somewhere on the horizon. The idea is that with the advent of 3D printing everyone could manufacture his own clothes independently, instead of using the fruits of labour of a thousand seamstresses working in some sweatshop. Such approach would be much more expedient and sustainable.

See for yourself: right now, the clothing item spends six months travelling from the fashion designer's sketch to the fashionista's wardrobe. 3D printing allows the



1986, prototypes of SLS 3D printer

consumers to download (buy) the design from the brand's website and to immediately begin the item's printing. Of course, today the printing of one dress would require 50-100 hours of printer's work, but this number continues to decline with every day as the speed of printing is gathering pace.

The successful breakthrough in the sphere of 3D printed clothes will come after overcoming what seems to be the final barrier — the material that will be used by the 3D printer for such operation.

Contemporary 3D printers print objects from flexible plastics that resemble the mixture of plastic with rubber or neoprene. But this is just the beginning. There have been recent attempts to "print" a fully functional fabric, and they will definitely continue. These technologies and products demonstrate that the market is still in its infancy, and that radical transformations are "just around the corner."

MARKETS ALREADY AFFECTED BY 3D PRINTING

Medicine

Medicine as a market has started using 3D printing ahead of everyone. The use of 3D printers and 3D bioprinters enables creation of implants and prototypes out of different materials, which are accepted by the human organism.

According to different estimates, by 2019, the market of medical 3D printing will be valued between \$966 mln and \$2 bln.

Aerospace/Aviation/ Automotive

Prototyping and industrial production of parts for the aerospace, aviation and automotive (and other machinery) industries no longer seems like science fiction.

While all of the automotive producers use 3D printing for speedy and precise prototyping of parts, certain companies and Formula 1 race cars use 3D printing for customized and commercial vehicles.

The new level of additive manufacturing was demonstrated by the Airbus concern, which used over 1,000 3D-printed parts in its new aircraft Airbus 350 XWB.

It should be noted that according to PWC calculations, 3D printing can enable the aerospace industry to save up to \$3.4 bln on spare parts on the annual basis.

Footwear and accessories

Manufacturing of footwear, its specific parts and customizable insoles for everyday use, sports or specialized tasks is one of 3D printing's fastest growing segments.

Among the global brands, the 3D printing technology is used in manufacturing of insoles and soles by such companies as Under Armour and Adidas.

Inclusive fashion

Disability is an emerging \$8 Trillion Market according to Inclusive Fashion + Design Collective Foundation.

The development of the inclusive fashion stems from the technological progress and appearance of new materials and approaches to design. 3D design with subsequent direct printing, precise virtual simulation and fast customization of garments significantly expands the solutions available to this very important fashion segment.

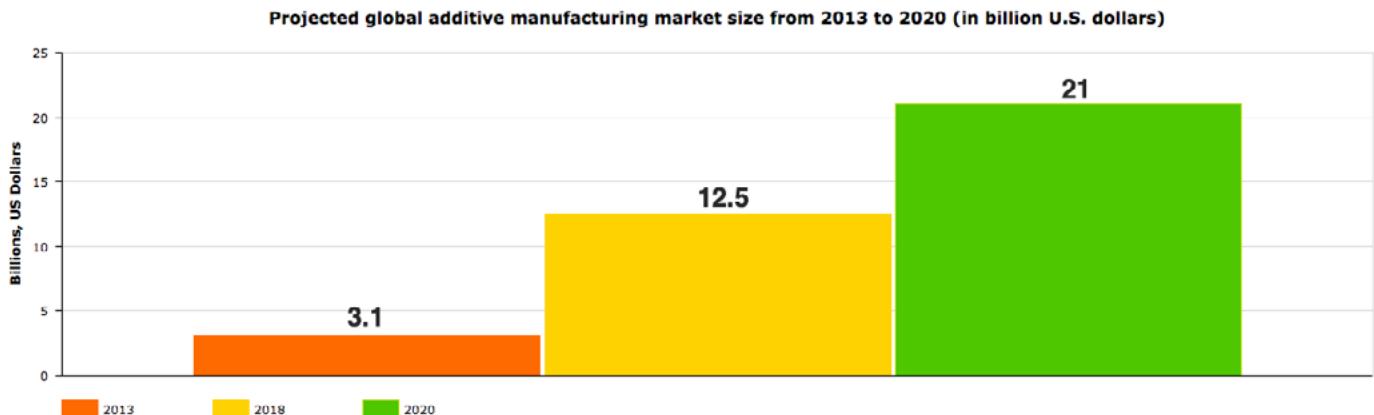


3D printed insoles by Wiiv

²<https://www.statista.com/statistics/284863/additive-manufacturing-projected-global-market-size/>

³<https://www.statista.com/statistics/315363/global-market-for-3d-priting-and-services/>

«Between 2016 and 2030, the global additive manufacturing market is set to shift from prototyping to mass production of parts and accessories. By 2030, it is expected that additive manufacturing technologies will enable companies to produce finished products on a large scale². »



Source: <https://www.statista.com/statistics/284863/additive-manufacturing-projected-global-market-size>

THE FUTURE

“[McKinsey](#) predicts that additive manufacturing could have an economic impact of \$550 billion annually by 2025. There are many applications for architecture, automotive, aerospace, engineering, biotech (human tissue replacement), fashion, footwear, jewelry, eyewear and many other fields.”

Global additive manufacturing market size estimated to 3.1 bln in 2013 and expected to grow to 21 bln in 2020.

And global market for 3D printing, materials & associated services is

expected to reach \$50 bln in 2025.

The development of 3D printing and its influence on the fashion industry are making greater strides than may seem at first glance. In the coming months and years, we should expect a lot of incredible news about materials/fabrics and products from the 3D apparel printing industry.

Everything speaks in favour of this hypothesis, from the demands on the significantly transformed global economy, which requires new solutions for speedy and inexpensive manufacturing and recycling of apparel, to the

innovative brands that promote and sell 3D fashion even as we speak.

We believe that the young brands have the biggest window of opportunity as their products can have both a dramatically different design and a radically new retail model. What if a new brand, which appears on stage in 2017 to take over the global capitals of fashion, no longer needs to worry about sewing the garments...

In this section we present a cross-section of products, technologies and challenges of the existing market of 3D-printed clothes.

IN OWN WORDS

How do you expect 3D-printed fashion will evolve in the next 5, 10 years?

In the next 5 to 10 years 3D there will be competitively priced 3D printed clothes available for sale around the world. Currently most clothes are made from woven textiles that are sewn together or knit from yarns. In the near future non-woven materials that are 3D printed will be a third type of apparel manufacturing that will grow rapidly as the technology improves.

Sylvia Heisel, owner of Heisel Studio, heisel.co



Danit Peleg photo, 3D project for olympic games

THE INDUSTRY BENEFITS

a) Cost savings on import and logistics

Statistics show that in 2015, import of garments into the US was valued at \$97 bln.

Development of 3D printing and local garment manufacturing will enable dramatic cost savings on import, and will lead to re-thinking of logistical costs, since the seller will be able to print the garment from cloud at a print center located near the customer, thus avoiding many logistical steps.

b) Less returns

According to the research done by the University of Regensburg, the top two reasons for returns of garments purchased online are either “size wasn’t right” (52%) or “the garment was damaged” (27%). Transition to customizable

sizes in printing clothes on demand will enable significant reductions in returns due to problems with size or defects in quality.

c) Faster production of collections

Today, production of a new garment collection lasts 4 to 6 months, taking into account the need to source the fabrics, manual production and globalized logistics. Removal of these steps will enable designers and brands to put out new collections 3-6 times faster.

d) Increasing business profitability

The aforementioned steps will enable the fashion business to increase its profitability as a whole, and the same is true for e-commerce, as it will no longer have the storage and delivery costs. They will also reduce the risks of investments and bulk buying,

which will no longer be necessary.

DESIGN&DESIGNERS

As you would expect with a new technology, 3D printing of clothing gravitates towards contemporary design and mostly intricate shapes, which do an excellent job demonstrating all the potential and promises of such design, accessible for production at home.

Israeli designer Danit Peleg, who had first used 3D printing for her graduate collection for Fashion Design degree, is one of fashion printing’s most prominent advocates. The hallmark of Danit’s products are the reliance on primitive home-use 3D printers that use the FDM (fused filament fabrication) method and the style of her collections, which bring 3D-printed clothes closer to the pret-a-porte format.



3D printed coat by Heisel studio



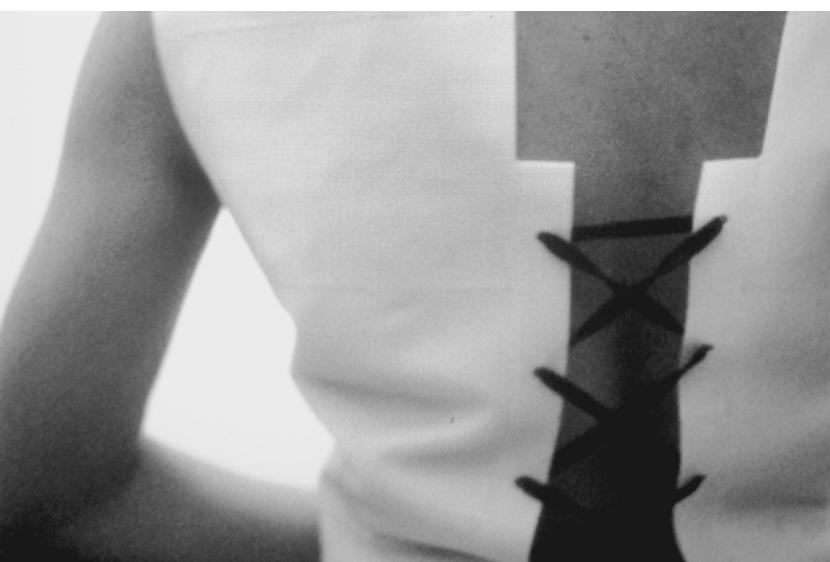
Necklace by MadLab.cc



Julia Koemer, Voltage dress for Iris van Herpen



Neri Oxman, Wild Biomorphic Spacesuits Designed to Survive Hostile Planets



3D printed dress by Heisel studio



Iris van Herpen design at the runway

IN OWN WORDS

How do you expect 3D-printed fashion will evolve in the next 5, 10 years?

«I think we will see more and more 3D printed fashion, but it will look differently than today. I feel like with this project I tinkered the future - it took 2000 hours to print the collection so it's not something that can be done easily. The filaments I produced are flexible, but they are not like cotton yet. I'm sure in 5 years we will have more innovative filaments and printers so I believe it's only a matter of time until we see better printers and more wearable materials.»

How 3D-printed fashion expansion would change traditional supply chain and production model?

If the technology does improve significantly, then yes, this could be the future of the fashion industry. The consequences are huge anyone could design clothes and manufacturers will turn to a printing farms. This will make- less shipping costs, more personalization, and most importantly the democratization of design - anyone could design. Just like a viral video, you could see a «viral t-shirt» that someone designed and that everyone is suddenly wearing.

Danit Peleg, 3D designer, danitpeleg.com

Media's attention was also drawn to the projects of Danish designer Iris Van Herpen, whose futuristic runwalk shows were noted by the global fashion magazines. In her work, Iris used more complex, industrial methods of 3D-printing.

Mass market brands are also paying attention to 3D printing, using the new technologies to achieve new heights in functionality, design and weight. One of such innovators is the American brand



Neri Oxman, *Wanderer'*



Under Armour's sneakers with 3D-printed sole

Under Armour, which created new design, sole and insoles for their now-legendary 3D-printed trainers.

Today, many progressive designers and brands manufacture clothes, shoes and accessories using different methods of 3D-printing. Despite conventional wisdom and forecasts on the rate of technology development, all of the experts agree: 3D-printed clothes and shoes are the next step towards customization and sustainability that will change the model of production.

PRINTERS AND MATERIALS



Pic 4.13 comparison of home and industrial printer, Stratasys Objet500 Connex3

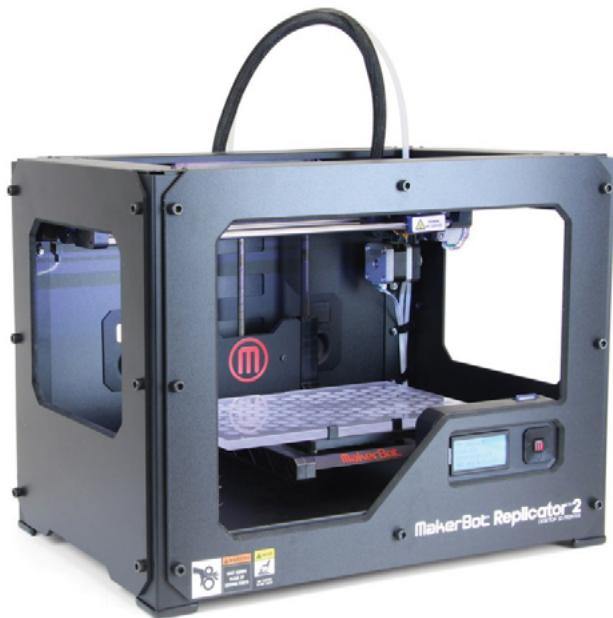
The number of 3D printer models available on the market is impressive. Even in selecting a home-use device you'll be faced with a great number of models that use different printing methods.

SLA

3D printers that use the method of stereolithography achieve greater accuracy and speed in printing intricate details, which is why they are usually used for industrial well-detailed prototyping. Such printers are used to prototype parts for the machine-building industry and in other similar areas.

SLS

The futurist items of Danish designer Iris Van Herpen, which caused quite a stir in the media, are created using industrial method of laser sintering. Such method entails the use of large volumes of liquid, which hardens in layers and then undergoes laser sintering. The final "printed part" requires subsequent cleaning and final touches, which in our opinion is harder to fit into the framework of a "home-use" 3D-printer, but they should be available in the near future.



FDM printer for home or education purpose

In addition to Iris Van Herpen, such 3D-printing methods are also used by other brands, like Pringle of Scotland, which in 2015 showcased printed items based on nylon.

free the designers from the need to work with different kinds of fabric to achieve different look & feel qualities. Another factor in favor of this method is its low cost, as FDM printers are the cheapest 3D printers around.

FDM

As for the fashion industry, we believe in the potential of FDM-type printers, which create the product through additive manufacturing and require no special technical skills to operate. This approach resembles traditional printers used for printing documents, because the material is gradually sprayed over the surface through the nozzle. The material is fed into the printer in a solid form with the help of a bobbin, and in the process of melting it's applied to the flat surface, creating the necessary forms, structures and patterns.

This allows for variations in thickness, flexibility and other qualities of the canvas. Thus, we believe in the potential for R&D of fabric-printing 3D printers that will use additive manufacturing to



Dita von Teese dress



Dress made from filaflex filament in dynamic by DanitPeleg.com

“During the next month Recreus will launch three new filament one of them: Filaflex 70A, ULTRA_SOFT elastic material similar touch as Silicone perfect to print insoles, fashion etc. Cotton filament will be expect in less than 5 years, but leather filament is underdevelopment we will have prepared for 2018!! ;)"

Ignacio Garcia, CEO of Recreus – a producer of flexible filaments and tools for 3D printing

Since Dita von Teese's legendary 3D-printed dress was made in 2012 with the help of hard plastic materials, the market has seen an inflow of flexible plastics that guarantee significant durability in case of stretching.

The best materials used for 3D printing of clothes, shoes and accessories by FDM method include FilaFlex, WillowFlex and NinjaFlex. Their effective and spectacular uses are regularly showcased by 3D fashion designers: they are used by Danit Peleg in her collections, these

materials also help to create shoes, insoles and accessories.

Moreover, their use also helps implement the principles of sustainability, because they are created out of biomaterials on the basis of corn and sugarcane. Therefore, the natural recycling of such product won't take more than a few months.

Flexible PLA plastic belongs to the first group of materials that can be used in manufacturing of clothing, but the real breakthrough in at-home 3D-printing of clothes will require the invention of

printable fabrics. We forecast such technological innovation within the next 3-5 years.

Several young companies are working on this as we speak, and the first samples of “printed” fabric were presented by Electroloom startup in 2015.

USER EXPERIENCE GAP

The right materials are not the only missing link required for successful adaptation of 3D-printed clothes: contemporary science of design doesn't even have a chapter on designing for 3D-printers. Therefore, even a “hip” designer who uses a computer to make his models is completely divorced from 3D-printing. Creation of three-dimensional objects requires the use of relevant 3D design software such as Autodesk 3D Max, Maya, 123 or open-source solution Blender. But even this isn't enough, as these programs lack the instruments for working with the clothing item's fit or cut.

As of now, there was no software solution that would permit the designers to design and shape 3D-printed clothes.

Consequently, in addition to innovations in the sphere of 3D printing filaments, the development of digital paradigm requires software that would bring the three-dimension clothing design and 3D printing industry to the single denominator.

“As the variety of materials available to print in 3-D become more extensive and less expensive, both free open-source and proprietary clothing designs will be widely available online in as little as 10 years,”

Ray Kurzweil, Google's director of engineering, Source

Conclusions

1. The experts agree that 3D printing will transform the manufacturing model and the supply chains of the fashion business, and that the transformation of the \$200-250 bln garment manufacturing market will begin within the next 5-7 years.
2. 3D printing will bring speed, flexibility and decentralized production, enabling the transition from the raw material to digital business model, foregoing long term investments, the global logistics, purchase of materials and commodities.
3. High-speed on-demand printing of clothing is one of the key missing elements required for dramatic improvement and increase in profitability of online and offline retail, and transition to lean manufacturing and fully digital supply chains.

What is ShareCloth



Editor ShareCloth is a cloud-based software that was created specifically for fashion designers and that enables transformation of traditional design knowledge and skills into 3D-printed product without the requirement of mastering complicated specialized programs.

The designer can turn any traditional flat dress-pattern into a three-dimensional model that's required by the 3D printer software in order to print the

garment. He can change the design and structure of the model, try it on a virtual tailor's dummy or a body 3D scan, and prepare the garment for print.

Why is this important? The use of such holistic but simple solution, which straddles the border of traditional and 3D-printed fashion designs, provides some excellent opportunities for a wide range of designers, who don't want to delay using innovation in their work any longer.

ShareCloth develops cloud-based products to create and manage the exact virtual samples of clothes, and markets them to garment producers. The company has been developing the technology of digital fabric simulation, apparel 3D-rendering and SaaS solutions since 2013. In March 2017, the company is presenting its new product, the desktop editor for 3D printing of clothes.

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