

The metaphorical stitching of the architectural and fashion disciplines

An insight into the history of fashion and architecture collaboration and the modern influence of the 3D printer.

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Abstract

This research paper delves into the convergence of 3D printing technology within architecture and fashion, examining significant collaborations and innovative advancements in these fields. Commencing with a historical overview of notable architectural and fashion designs, the timeline serves to contextualize the subsequent case studies. These case studies exemplify the fusion of technology, nature, and architecture, featuring collaborations such as Iris van Herpen and Daniel Widrig's 3D-printed Fossil Top, Francis Bitonti and Michael Schmidt's dress for Dita von Teese, and Zaha Hadid's collaboration with United Nude to create the Flames Shoe. Through meticulous analysis, these case studies illustrate how interdisciplinary collaborations transcend traditional design processes, highlighting the transformative potential of such endeavours. Furthermore, the paper explores the redesign of the Naturalis Biodiversity Centre in Leiden, where architect Michiel Riedijk and fashion designer Iris van Herpen seamlessly integrated biomorphic panels into the atrium design, symbolizing the interconnectedness of art, science, and creativity. By examining these collaborations and innovations, this research paper aims to deepen our understanding of the role of 3D printing in shaping the future of architecture and fashion. It also acknowledges the contributions of notable pioneers such as Dr. Hideo Kodama, Chuck Hull, and Carl Deckard, who have played crucial roles in advancing essential 3D printing technologies.

Keywords: Fashion, Architecture, Collaboration, 3D printer,

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Introduction

The collaboration between fashion and architecture is not a novel concept; throughout the history of human creativity, the two disciplines have been intertwined expressions of cultural identity and technological advancements. Especially nowadays, with designers such as Iris van Herpen, the boundaries between fashion and architecture have become increasingly blurred. Iris van Herpen is a Dutch fashion designer renowned for her avant-garde creations which are the epitome of fashion and technology fusion, often incorporating techniques such as 3D printing and laser cutting, which are also prevalent in architectural practice. Drawing inspiration from structure and form, her designs exemplify cross-disciplinary exploration.

First, this thesis will seek to explore the historical relationship between architecture and fashion, tracing their intertwining evolution over four specific periods: 1970-1990, 1990-2000, 2000-2010, and 2010-2020. By examining and explaining the key designers from both disciplines and identifying prominent collaboration projects in the respective time, this thesis aims to link these cases to the central architectural and fashion movement of said time and see how they influence each other.

Further understanding of each period will be gained through case studies, analysing the key elements of the designs from both architecture and fashion and explaining how both professions influenced this design. Adding to the already existing works of architecture and fashion, this thesis will add the impact of 3D printing technology. Despite the already existing literature on the topic of architecture and fashion collaboration such as Hanisch, (2006), Castle & Pawley (2000), Moh (2005), Hodge, Mears, & Sidlauskas, (2006) and Fausch Singley, Macleod, & Wigley, (1994), much is rather outdated and limited in scope, primarily covering conceptual collaborations or store design for specific fashion brands. There is a notable absence of research on unique, tangible creations or architectural marvels resulting from these collaborations. This knowledge gap has become more pronounced since the introduction of 3D printing technology over the last two decades.

To address this gap, this thesis will delve into contemporary collaborations between fashion designers and architects, shedding light on how 3D printing has revolutionized their creative processes and output. By examining recent case studies and innovative projects, this research aims to uncover the true impact of 3D printing on the convergence of fashion and architecture, providing valuable insights into the future trajectory of these industries.

With the emergence of the 3D printer, a revolutionary turn has occurred, profoundly impacting both architecture and fashion. This technology offers new possibilities for design exploration and collaboration in the field, by investigating pivotal moments in the past and present and assessing the influence of the 3D printer in recent designs, this thesis will structure and further elaborate on the history of architectural and fashion collaborations and the recent influence of the 3D printer. This will be accomplished by attempting to address the following primary research question: How has the advancement of 3D printing technology influenced the collaboration of architects and fashion designers, and how has the use of a 3D printer impacted these collaboration designs over the last 30 years?

To develop a cohesive framework and support the thesis, it will be organized around several sub-research questions that support the main question. Questions about the Technological development of the 3D printer are: What is the timeline for the creation of the 3D printer and its main innovations and advances during the last 50 years? What advances in material science were made during the development of 3D printing's applications and how has the technology's industrial use changed over time? How has the development of the 3D printer contributed to the design possibilities of both the architect and the fashion designer and their possibility to collaborate?

Lastly, there will also be questions answered about the case studies linked to the use of the 3D printer. These are as follows: How did the architects and fashion designers effectively integrate the use of 3D printing into their designs? In what way does the use of the 3D printer impact both the look and the function of the final design? Is it still possible to identify and analyse separate influences from each field in the final design?

1: The history of fashion and architecture

Imagine yourself walking down the busy streets of the 1970s, when brutalist architecture met the avant-garde fashion of that period. High concrete buildings offered a striking contrast to the expressive clothing used by the fashion industry. However, they did go hand in hand, as concluded in a review by Ottone (2021) brutalist architecture happened to be a mirror reflective of the youth's disenchantment. They embody the failure of noble ideals like social housing and of a Western world that had fooled itself into resurrecting more communitarian and less individualistic after World War II. Ottone (2021) even states that instead of fleeing the cities and their run-down working-class neighbourhoods, where buildings once representing hope now stand neglected, the post-punk youth embraced the concrete brut aesthetic, turning it into a structural element of an artistic rebirth. The collaboration between architecture and fashion tells a story full of inventions, creativity, and mutually beneficial cohesion within the history of design evolution.

This time in history signalled the start of a new age in which fashion designers and architects collaborated on groundbreaking projects and shared ideas. This chapter follows the parallel paths of fashion design and architecture to shed light on the dynamic timeline that developed between 1970 and the present. It explores the fascinating collaborations that arose at the meeting point of these two fields, from the design of thin, minimalist skyscrapers to the introduction of avant-garde creations on fashion runways and plenty in between, as can be seen in Figure 8. Within this timeline, three distinct sections emerge, displaying the most iconic architectural, fashion, and collaborative designs. This suggests that some designs may not overtly exhibit characteristics of both fields but serve instead to provide a contextual backdrop for the era in which the collaborations exist.

It can be stated that, as can be seen in Figure 8, the first period doesn't span 10 years like the other three periods. This deviation arises from the scarcity of available sources detailing collaboration between architects and fashion designers before 1980. Nevertheless, this extended period encapsulates a remarkable era marked by advanced technology, the prominence of postmodernist architecture, and the dominance of Punk in the fashion industry, so there is a strong likelihood that collaboration and influence existed at the time, but none has been documented or investigated.

1970-1990

Even though there had not been a lot of collaboration documented, this time, as previously noted, was the peak of postmodernism and the Punk Movement in Architecture. Starting with a famous design from the 1970-1990 period is the Centre Pompidou in Paris France, often associated with the high-tech and postmodernist movements. According to Kramer, (1977), the Centre is recognized as one of the most remarkable architectural achievements, even considered the most radical modernist structure in Paris. In his article in the New York Times, he even included a depiction of Paris' skyline, with the Centre standing out as a large, distracting building amid the city's landmarks, as can be seen in Figure 1. Anticipating that the now-renowned Centre would be regarded on par with iconic structures like the Eiffel Tower and the Arc de Triomphe.

A New Arts Center in Paris to Open Amid Raging Controversy



The unorthodox design of the new Pompidou Center, upper right, has led one critic to call it "an architectural Ektar Xerox," but a more serious issue is raised by its purpose

Figure 1 (the unorthodox design of the new Pompidou Center Red Crooves 1977)

Maro Kiris (2021) argues its vibrant contrasts, playful use of colours, symbols, and imagery, embodying a postmodern aesthetic. Notably, the exhibition of technology and the intentional separation of functions and construction components are distinctive features. Despite varying opinions on its design, the Centre Pompidou stands as a globally recognized, iconic architectural landmark that marked the beginning of a new era in Architecture.

Continuing the trajectory of radical designs in the 1980s, the fashion designer Vivienne Westwood emerges as an important figure. Aligned with the introduction of punk, Westwood's creations echo the rebellious spirit of the era. As articulated by Hochswender (1989), Westwood, who was once a Punk, embodies an image indicative of British fashion—simultaneously frumpy and rebellious, with an anarchistic undertone beneath a well-tailored façade (Hochswender (1989), p. 57). In both architecture and fashion, the spirit of that time was to stand out and differentiate from the existing designs and society. Something both the Centre Pompidou and the colourful garments of Westwood did.

In conclusion, the period between 1970 and 1990 witnessed significant cultural and creative movements, notably postmodernism in architecture and the emergence of the punk movement in fashion. The Centre Pompidou in Paris exemplifies the radical architectural designs of the time, embodying postmodern aesthetics and marking a shift in architectural discourse. Similarly, fashion designer Vivienne Westwood rose to prominence during this period, reflecting the rebellious spirit of punk through her creations. However, despite their contributions to their respective fields, documented collaborations between architects and fashion designers, such as Westwood, remain scarce during this era. Therefore it can not be stated with certainty that there have been collaborations between architects and fashion designers between the 1970s and 1990s.

1990-2000

Moving on to the more recent period of 1990-2000, in contrast to the earlier years, collaborations come to light, The Guggenheim Museum in Bilbao, Maison Hermès in Tokyo, and Alexander McQueen's NO.13 fashion show in 1999 are iconic expressions of design innovation during their respective times. The Guggenheim Bilbao, designed by Frank Gehry, stands as a symbol of deconstructivist architecture, breaking traditional moulds with its fluid forms and titanium exterior. In 1999, the year the museum was constructed, Hoge (1999) even wrote: "It looms outsized at the end of a street of unremarkable masonry, a shimmering object that looks as if it just landed there after a trip from its own planet" Due to its unconventional shapes and contrasting design in relation to its immediate surroundings, this building stood out as a distinctive and unique design in its era, a distinction it still maintains today Although the design does not stem from a direct collaboration between architects and fashion designers, it nonetheless exhibits influences from the clothing industry. Its flowing curves evoke imagery reminiscent of textiles billowing in the wind as can be seen in Figure 2, imparting a sense of fluidity and modernity that was revolutionary for its time.



Figure 2. The Guggenheim Museum Bilbao, Bourgeois 2005)

Similarly, one of the more memorable collaborations of the period, the Maison Hermès in Tokyo, designed by Renzo Piano in collaboration with Fashion giant Hermès, highlights a harmonious blend of modernity and cultural sensitivity. This design will be further elaborated on in the next chapter.

Regarding the fashion developments in 1990-2000, Alexander McQueen's NO.13 fashion show in 1999 disrupted the norms with its theatrical presentation and avant-garde designs. "The show was a tour de force, which ended with Shalom Harlow in a white bouffant dress, spinning on a turntable like a ballerina on a music box while being attacked by robotic arms that sprayed black and blue paint into her clothing and skin. It seemed the designer's way of saying that beauty and innocence are fragile and in constant danger of being destroyed" (Shiro, 1998). This fashion show, doubling as a performance art piece, paved the way for more progressive thinking and ushered in new developments in the realm of fashion as can be seen in Figure 3.



Figure 3 Alexander McQueen NO.13 fashion show spring summer, McQueen 1999)

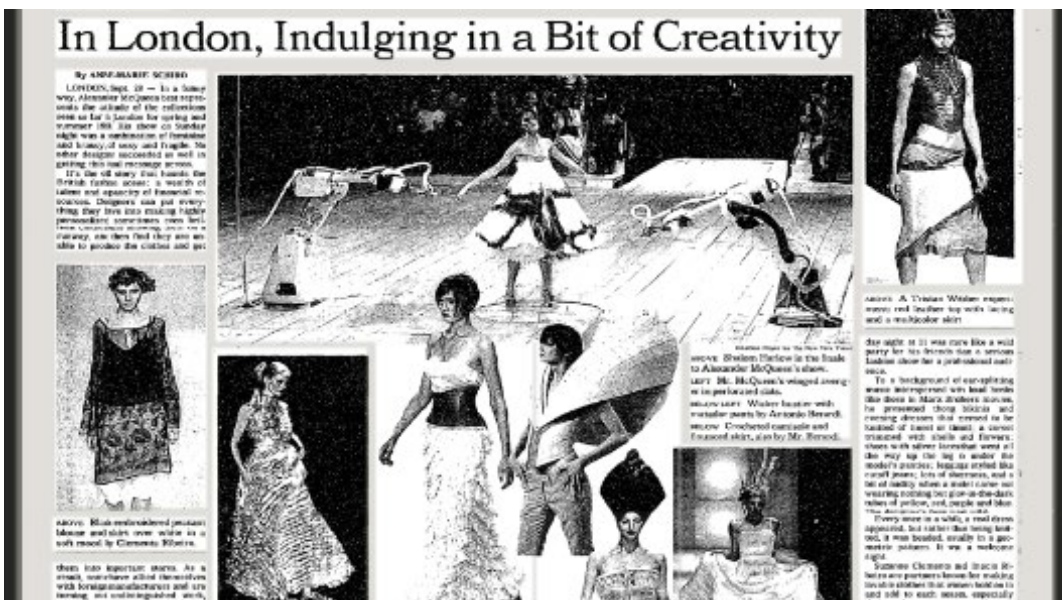


Figure 4 In London, Indulging in a bit of creativity, Shiro, 1998)

The incorporation of groundbreaking technology, such as robotic spraying arms, was revolutionary during that period. Adopting design methodologies more commonly associated with the automobile and painting industries, McQueen established a pioneering approach that would influence future years to come, even headlining a New York Times article written about the fashion show as can be seen in Figure 4.

Commonalities between Fashion and architecture in this period lie in their groundbreaking use of materials, pushing the boundaries of form and function. During the late 20th century, these landmarks and designs were prominent for challenging conventions, embracing a dynamic fusion of tradition and modernity, and setting new standards for architectural and fashion excellence. However, during this period, official collaborations were sporadic, ranging from occasional designs for flagship stores to similarities in design or runway shows where both professions influenced each other, rather than embodying true collaborative designs.

2000-2010

The early 21st century however witnessed significant shifts, characterized by the rise of high-rise buildings, debates on fast fashion versus sustainable clothing, and the exploration of parametric design. During this era, collaborations extended beyond traditional store designs to include pavilions, shoes, and limited-time exhibitions, displaying a dynamic fusion of architecture and fashion in fields that expand that of both architecture and fashion.

A prime example where the discussion about sustainability arose was the last fashion show of Alexander McQueen his career. A shoe from this collection can be seen in Figure 5 as the 'Armadillo' boot. The Museum of savage beauty (2009) describes the design as if he created a form entirely without apparent reference to the natural anatomy of the foot, the scaly surface of designs rendered in python skin invoking the armoured shell of the animal after which the shoe was named. This also marks a shift in functionality, it no longer only serves one function, the shoe, but the shoes also become part of the fashion. Here, we see designers shifting more towards creating innovative forms and shapes, departing from strict adherence to established styles or functions. This trend is notably prevalent in the later works of Iris van Herpen.

McQueen used ordinary materials like paillettes creatively, hinting at the idea of the shoe having scales similar to those of an armadillo. This homage to nature not only recalls notions of sustainability and durability but also demonstrates his imaginative reimagining of common materials.

The collaborative work chosen for this era is the Prada Epicentre in Los Angeles, a design also further elaborated on in the next chapter.

2010-2020

In the past decade, a distinct evolution in design has set it apart from the earlier years. The advent of the digital age and technologies like laser cutting and 3D printing have expanded the realm of possibilities in both architecture and fashion. Notably, fashion designers are now engaging directly with architecture, exemplified by figures like Virgil Abloh, creator of the fashion brand OFF-WHITE and artistic designer for the men's clothing line of Louis Vuitton. As highlighted by Kornblatt (2022), Abloh's background includes training in civil engineering at the University of Wisconsin and architecture at the Illinois Institute of Technology. This intersection of disciplines underscores the contemporary landscape where designers traverse diverse fields, leveraging technological advancements for innovative collaborations in both architecture and fashion.



Figure 5 The Armadillo Boot by Alexander McQueen, the museum of savage beauty, 2009)

The integration of data science in both architecture and fashion design has revolutionized both professions, enabling the creation of designs previously unimaginable. From the iconic curves seen in architectural masterpieces by Zaha Hadid to the groundbreaking futuristic creations of fashion designers like Iris van Herpen as can be seen in Figure 6 and Figure 7. These innovations have been made feasible by newly developed technologies such as the 3D printer and computer-aided programs. Moreover, this technological advancement has provided a common ground for collaboration between the two fields, offering a solid foundation for the design process to flourish.



Figure 6. Heydar Aliyev Center, Binet, Baan, Hayes, & Hufton + crow, 2012)



Figure 7 The shift souls' collection, look NO. 15, van Herpen, 2019)

To summarize, the history of architecture and fashion resembles two distinct routes gradually converging and, in recent years, intertwining into one cohesive story. It's like two rivers moving towards a common goal, with each discipline affecting and enriching the other. The rebellious essence portrayed by Vivienne Westwood in the 1980s, as well as Alexander McQueen's avant-garde manifestations in the late twentieth century, paved the way for a rising collaboration of architecture and fashion. Over the last 10-15 years, this convergence has gotten increasingly bigger, mirroring the progressive merging of previously different streams. Architects and fashion designers can now collaborate in a continuous interaction, with each influencing the other's design language and

finding common ground to work together on both architecture and fashion design due to the use of design techniques such as computes and 3D printers that make it possible to create an interdisciplinary design process.

The metaphorical stitching of various disciplines represents a visible unity in which the fabric of design development is seamless and connected. The last decade has seen an apparent collaboration, representing a collaborative journey towards new possibilities and uncharted territory. The ongoing convergence of architecture and fashion forms a cohesive narrative of shared innovation, creativity, and inspiration. Both disciplines share the common goal of using their designs to protect and shield people as either a façade or a garment, providing a unifying factor where architects and fashion designers can find common ground.











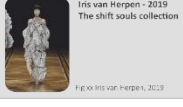
	1970 - 1990 High tech architecture Postmodernism Punk	1990 - 2000 Deconstructivism	2000 - 2010 Fast fashion vs sustainability High rise Parametric Minimalism	2010 - 2020 Parametric Technology
Architecture	 <p>Centre Pompidou - 1977 Renzo Piano, Richard Rogers and Gianfranco Franchini Fig. xx, images, 2014</p>	 <p>Guggenheim Museum (Bilbao) - 1992-1997 Frank Gehry Fig. xx Bourgeois, 2005</p>	 <p>Burj Khalifa - 2010 Skidmore, Owings and Merrill Fig. xx Abaza, 2014</p>	 <p>Zaha Hadid, Heydar Aliyev Center - 2012 Fig. xx Breet, Baar, Hayes, & Huber + crew, 2012</p>
Collaborations	<p>Non available where there was a direct collaboration so far</p>	 <p>Maison Hermès, Tokyo - 1998-2001 Renzo Piano assisted by Bohlin Cywinski Jackson and Takenaka Corporation Fig. xx Where in Tokyo, 2001</p>	 <p>Prada Los Angeles Epicenter by Rem Koolhaas and Ole Scheeren - 2004 Fig. xx OMA, no date</p>	 <p>Off-White Flagship Store Miami - 2018 Virgil Abloh, together with AMO, research centre of OMA Fig. xx OMA, 2018</p>
Fashion design	 <p>Time Machine Collection in Fall/Winter - 1989 Vivienne Westwood Fig. xx Lij, Jan, 2008</p>	 <p>SS99, NO. 13 - 1999 Alexander McQueen Fig. xx McQueen 1999</p>	 <p>Spring/Summer 2010 collection, ENCYCLOPEDIA OF COLLECTIONS: PLATO'S ATLANTIS Alexander McQueen Fig. xx, The museum of savage beauty, 2009</p>	 <p>Iris van Herpen - 2019 The shift souls collection Fig. xx Iris van Herpen, 2019</p>

Figure 8 Historical timeline of Fashion and Architecture, Vermeer, 2024)

2: The collaboration of Fashion and Architecture: case studies

In any city's bustling streets, architectural designs silently reveal stories of invention and history, with each project a tribute to the then-limitless possibilities of design and technology. However, amid the hustle and bustle of city life, how often do we take the time to look at these buildings and uncover the stories hidden in the window shops, façade, and materials? Each building and garment contains a story that begs to be told, one of innovation, collaboration, and historical and cultural significance.

This chapter delves into these narratives, attempting to comprehend the underlying design decisions and the unique possibilities they provide. The purpose of studying the previously mentioned flagship store case studies where architecture and fashion met is to provide a more in-depth understanding of the intricate processes involved, showing the design process, benefits, and potential of these collaborative efforts. By studying these stores through the lenses of design principles, materiality, spatial composition, and cultural context, this chapter aims to gain a better understanding of their relevance.

Maison Hermès Tokyo (1998-2001)

In the late 1990s, a significant collaboration occurred between fashion giant Hermès, the Renzo Piano Building Workshop, and Rena Dumas, as shown in Figure 9, resulting in a remarkable architectural design in Tokyo. The design was completed between 1998 and 2001 and, as stated by Hanish (2006), symbolizes the popular topic of semi-transparency at that period. Situated in the hectic streets of Tokyo, the building's design stands out from its surroundings. Although Tokyo is primarily a collection of screaming advertisement signs and traffic lights, this structure appears quiet and calm according to Hanish (2006). Something more of an opinion rather than a fact.



Figure 9 Maison Hermès, Time Out, 2018)

The building's exterior is constructed from 13,000 450 mm glass bricks; this material and construction decision follows the prevalent architectural trend of the time, while also creating a distinct visual appeal. Given Japan's high earthquake risk, the bricks were built in Florence, Italy, to endure earthquakes and fires by absorbing shock in the seals between the glass bricks. They are tempered glass with a polish that makes them translucent rather than transparent, hence the nickname for the building: Japanese Lantern. (RPBW, 2006)

According to Hanish (2006), this building represents the brand Hermès' motto, which is supposed to stand for tradition and wit, and the company that designed it can now say the same. The incorporation into the urban surroundings emphasizes the collaboration between architecture and fashion, with the design serving not only as a practical space but also as a statement piece in the urban landscape. It may be argued, however, that by including this translucent façade, the building itself has become a screaming neon advertisement for the company.

Furthermore, the relationship between the façade and its surroundings is more than just aesthetics; it represents a deeper blend of tradition and innovation. Drawing inspiration from traditional Japanese architectural elements such as Shoji or Fusuma, the paper walls commonly found in traditional housing, the building reflects both culture, architectural technology, and the fashion designer's somewhat forward-thinking goals in this case, which is to sell products. All made possible because, with a semi-transparent façade, it is easier to see all the available goods as seen in Figure 10.



Figure 10 Maison Hermès, Rena Dumas Architecture Intérieure, 2014)

This design fits into the timeline when the collaborations were more sporadic, ranging from occasional designs for flagship stores to similarities in design or runway shows where both professions influenced each other, rather than embodying true collaborative designs. However, they took the cultural aspects of Japan into account and created a functional design for the client, but also a unique design that would suffice as a stand-alone design.

To summarise, the partnership between Hermès, the Renzo Piano Building Workshop, and Rena Dumas generated a stunning architectural design for its time, embracing the then-trend of semi-transparency while intertwining Hermès' traditions. The building's existence is subject to debate because, during the day, it appears quiet and calm, but at night, as shown in Figure 9, it turns into something it is supposed to resist. Aside from its visual attractiveness, the building acts as a practical demonstration for the company, combining functionality, architecture, and new technical advancement in a single design.

Prada epicentre Los Angeles (2002-2004)

Another key design for its time is the Prada Epicentre, designed by OMA in collaboration with Prada in 2002-2004. The Prada Epicentrum, situated at 343 Rodeo Drive in Los Angeles, epitomizes the avant-garde collaboration between a fashion powerhouse and an architecture firm known for its forward-looking designs, or as Hanisch (2006) calls it, the fashion Earthquake, designed to evoke seismic symbolism. A statement a non-writer about fashion and architecture might not understand or recognise as it may initially appear as a large, featureless white block protruding from a somewhat transparent exterior.

The building's classic facade conceals an interior that redefines traditional retail spaces. Within the building, a double flight of stairs serves both as a display for fashion pieces and as a circulation element, drawing inspiration from architectural landmarks like the Spanish Steps in Rome or the Grand Staircase in Garnier's Paris Opera. The large stairs where you can sit and walk may appear to be overused now, but in the early 2000s, it was practically groundbreaking.



Figure 12 Garnier's Paris Opera, Evans, 1905)



Figure 13 Spanish steps Rome, Bruce & Lundberg 1855)

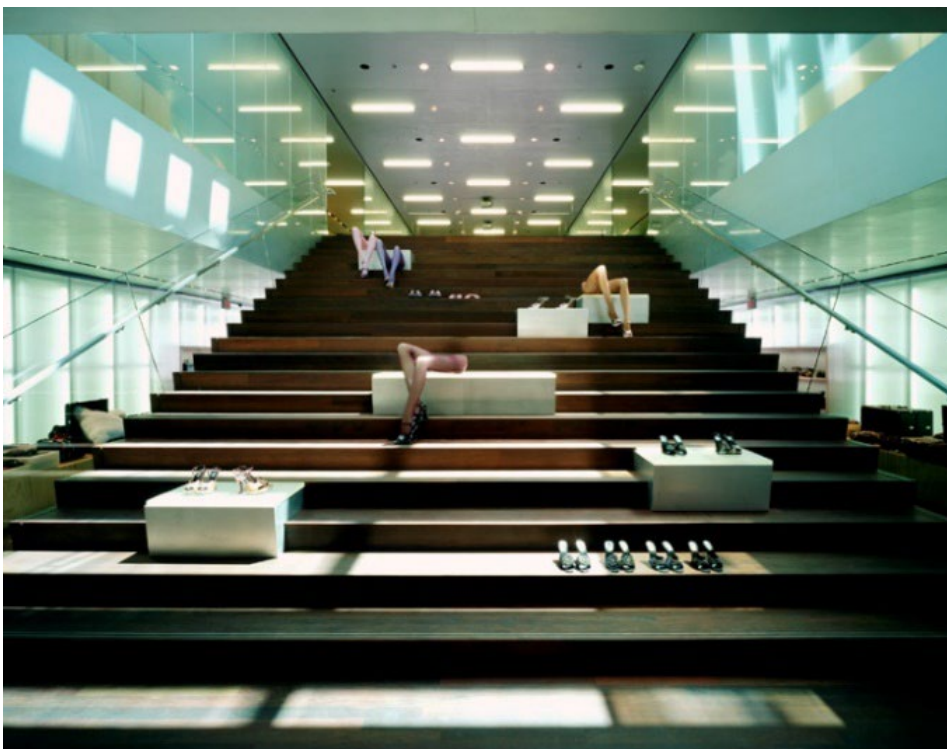


Figure 11 Prada Beverly Hills, Kugler Ning Lighting, ND)

The walls are crafted from a proprietary material called Sponge, developed exclusively for Prada, further exemplifying the brand's commitment to innovation. Additionally, the hovering aluminium box above the entrance, also partially constructed from Sponge, adds a futuristic element to the design. OMA (2002) sheds light on the concept behind the project, emphasising its research-driven approach to shopping experiences and the integration of new technologies like a website, LED screens and cameras. Collaborating with industrial, computational, and interaction designers, OMA aimed to create a space that not only exuded exclusivity but also embodied the dynamic and enigmatic essence of the Prada brand. This multifaceted collaboration extends beyond the facade, encompassing the entire interior design of the store, highlighting the collective expertise of the collaborators involved, all made possible by the new technologies of the 2000s.

As shown in Figure 14, this façade is dominated by stark white and black tones, employing only straight lines to create a sleek aesthetic. This design approach epitomized simplicity, favouring clean lines and functionality over ornate embellishments, thus encapsulating the essence of minimalist architecture favoured at that time.

In conclusion, the Prada Epicentre, a collaborative design project between OMA and Prada, redefines retail space with an avant-garde design and innovative interior. These unique elements such as the Sponge material highlight Prada's commitment to pushing the boundaries of innovation and drive to work together on new designs. Ultimately, the Epicentre stands as a testament to the transformative power of collaboration, shaping contemporary retail environments with its dynamic and exclusive ambience.



Figure 14: Prada in store Technology, OMA, 2002)

OFF_WHITE flagship store Miami (2020)

In the heart of Miami's shopping centre, USA, stands a testament to collaboration and innovation in architecture and fashion: the OFF_WHITE flagship store. Designed through a partnership between OFF_WHITE founder Virgil Abloh and OMA's research arm AMO, this space at 127 NE 41st Street is a fusion of design abilities.

What sets apart this store is the hands-on approach of Abloh, drawing on his background in civil engineering and architecture, he crafted its unique elements, including a striking semi-transparent façade made of polycarbonate adorned with the brand's iconic white cross logo. This facade, a stark departure from neighbouring structures seen in Figure 15, invites curiosity and sets the stage for what lies within.

Inside, flexibility dominates. With movable walls and a bi-floor layout, the space adapts effortlessly to the brand's motto of flexibility as well, reflecting a dynamic approach to retail. Beyond mere commerce, Abloh envisions the store as a hub for cultural exchange and events. By retracting the secondary facade, a public space emerges, ready to host gatherings and engage the community.

Blending Abloh's background with AMO's expertise, the store has concrete floors, ideal for Miami's warm climate. Steel shelves, black and white marble, and corrugated metal walls finish the interior, while tubular ceiling lights add an industrial touch. Every piece of furniture is mobile, also adding to the sense of adaptability and flexibility the brand represents.

What sets this collaboration apart is its vision beyond mere retail. Abloh aimed to integrate the brand's motto with the architecture, creating a holistic OFF-WHITE experience. The lines blur between the fashion designer's touch and the architects' contribution, displaying the seamless fusion of creativity. While the flagship store's primary goal remains sales, it transcends its commercial purpose. It becomes a symbol of collaborative innovation and progressive design, redefining the concept of a retail space.



Figure 15: OFF_WHITE facade, Miami Design District, ND)



Figure 16: Interior OFF_WHITE store, OMA, ND)

3: The introduction and history of the 3D printer

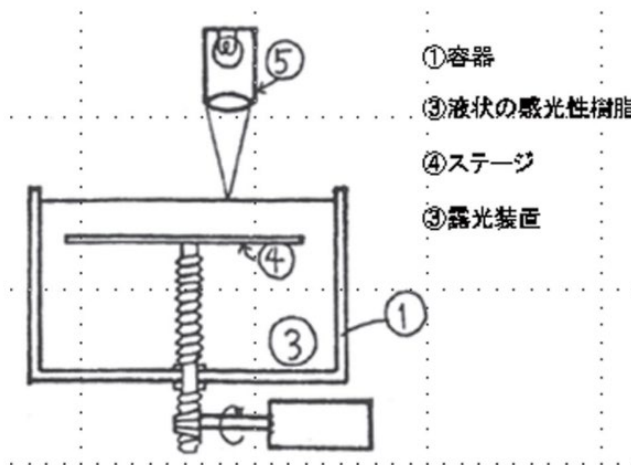
Similar to previous collaborations where novel technologies were custom-made for the designer's clients, a well-established technology now steps into the realms of fashion and architecture.

This chapter digs into the remarkable integration of 3D printing technology in architecture and fashion, shedding light on how it has transformed design possibilities and material research. 3D printing began as a prototyping tool in the 1980s and has now evolved into a versatile medium, providing new creative opportunities.

We explore the history of 3D printing, from its early experimental phases to the widespread availability of commercial-grade devices. This historical overview serves as context for the subsequent case studies, which display important cooperation between architects and fashion designers and the use of the 3D printer in those designs.

These case studies demonstrate how 3D printing technology has altered design processes, allowing architects and fashion designers to push the limits of conventional methods. We look at how this technology enables the merging of diverse aspects from both professions, resulting in new and visually appealing works.

The history of 3D printers is one of invention and technological advancement, particularly in the last decade. Dr. Hideo Kodama developed the prototype in 1981, using UV light to harden resin and stack layers. According to the Institute of Electronics, Information, and Communications Engineers (ND), using holographic technology was the only way to construct a 3D model in the 1980s. The holographic technology provided 3D views, but creating holograms for non-existent objects necessitated the use of replication equipment and numerous sophisticated calculations. That is why Kodama discovered a strategy, that by regulating the intensity, duration, and exposure area of light, he could manage the process of hardening the liquid polymer in a simpler approach, as shown by his first sketches and first 3D printed model in Figures 17 and 18.

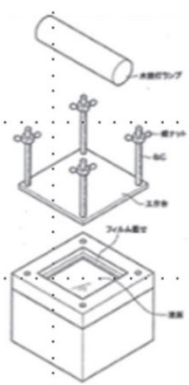


The basic equipment of the three-dimensional printer

① Receptacle ② Liquid photohardening polymer ④ Stage ⑤ Exposure equipment

Figure 17. First Sketch of the concept of 3D printing, Kodama, 1981)

(マスクを用いた光造形)



The first model, a house, fabricated by the 3D printer

Figure 18 First 3D printed Model, Kodama, 1981)

After that Chuck Hull patented stereolithography (SLA) in 1986 (Ultimaker, ND), which is widely considered the origin of the contemporary 3D printer. He designed UV lamps for a living, which is how he came up with the notion of using UV light to cure photopolymer. He originally made plastic pieces for tables and found the procedure of injecting the plastic into the moulds tedious; nevertheless, he connected one and two and discovered that instead of producing a mould, he could manufacture the object itself by layering small layers of plastic on top of one another. In other words, this was the identical method that Kodama discovered two years ago. However, by labelling it Stereolithography and employing UV light, he was able to file for a patent and is now widely acknowledged as the creator of the 3D printer. (Ultimaker, ND)

Later Carl Deckard licensed SLS technology, which marked another milestone for the 3D printer. Deckard, who graduated from the University of Texas in 1988, used a laser to turn powder into a solid substance. Shortly after, in 1989, Scott Crump developed FDM (Fused Filament Fabrication), a method of layering items using thermoplastic material. Modern filament printers' function by extruding plastic via a small opening, allowing them to make any shape they desire.

Over the next decade, 3D printers were mostly developed for industrial uses, including aerospace, automotive, and healthcare. Dr Adrian Bowyer founded the RepRap Project in 2005, inventing a 3D printer that can produce its own plastic parts, allowing for self-replication. The expiration of 1980s patents led to the formation of MakerBot in 2006, which commercialized printer programming by selling the software to create printers and models for them.

Today, 3D printers are available for as little as 200 euros, with rapid advancements seen across industries ranging from architecture to fashion. The main types of 3D printers are filament printers, which can use plastics and similar materials, and resin printers, which work by curing resin using light, similar to the original designs for the 3D printer.

This general background will serve as the foundation for the case studies that follow, in which a 3D printer was employed as the primary source of construction in a collaboration between fashion designers and architects.

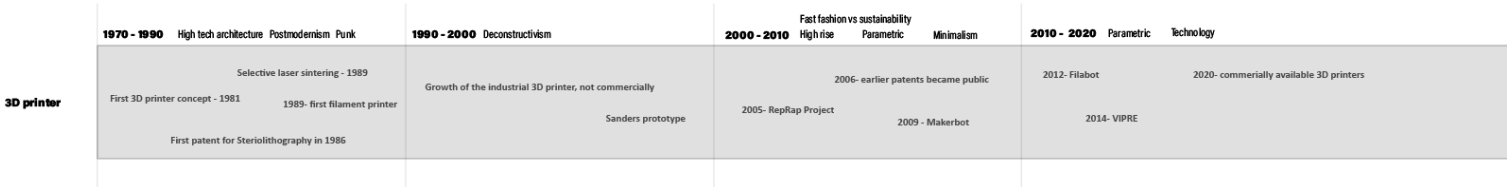


Figure 19: History timeline of the 3D printer, Vermeer, 2024)

Look NO. 16 (2011)

Iris van Herpen is a Dutch haute fashion designer famous for her innovative work and recognizable designs. She combines fashion and technology and gets her inspiration from nature and architecture. She includes new techniques and methods such as 3D printing and intricate handwork.

The collaboration between Iris van Herpen and architect/designer Daniel Widrig birthed an extraordinary piece: the 3D-printed Fossil Top, look NO. 16 on the runway, which debuted on said runway in 2011. This avant-garde garment is a testament to their shared fascination with the intersection of technology and nature and was, and still is, revolutionary for its time. This top was created during the early phases of 3D printing, which is why a solid polymer material was used. However, this choice aligns perfectly with the inspiration behind the design, resembling the solidity of a fossilized stone.

The top features a captivating interplay of forms, resembling a skeletal structure or fossil brought to life. Mirrored spirals adorn the top, forming a triangular shape that elegantly accentuates the model's features, with additional spirals tracing the contours of her shoulders and arms. The design, meticulously crafted with 3D printing technology, exudes a sense of otherworldly elegance.

Van Herpen's signature blend of innovation and organic inspiration is evident in the top's intricate details. Each curve and contour reflects a harmonious fusion of technology and nature.

From the top's elongated silhouette to its strategic placement of openings, every aspect of the ensemble evokes a sense of wonder and intrigue. It transcends the boundaries of traditional fashion, offering a mesmerizing glimpse into a realm where art, science, and nature converge.

In essence, the 3D-printed top is a masterful creation that embodies the creative synergy between Iris van Herpen and Daniel Widrig. It stands as a testament to their shared vision and relentless pursuit of innovation, captivating audiences with its ethereal beauty and groundbreaking design. This design highlights the vital role of 3D printing technology. Unlike handmade creations, where the human touch is evident, this piece wouldn't be achievable without 3D printing. It's a testament to how this technology opens up possibilities beyond traditional craftsmanship.

As van Herpen expresses in the interview (Herpen, 2012), she avoids creating new images based solely on existing ones. This design marks her first venture away from handmade creations, influenced by factors including co-creator Daniel Widrig. Both form and shape draw inspiration from nature and an understanding of form, proportions, and composition. The top alone required 168 hours to print, highlighting time as the collaboration's most crucial element. Unlike the fast-paced nature of the fashion industry, Van Herpen prioritizes the development of new techniques, allowing time for innovation and welcoming external influences through collaborations.

In summary, the collaboration between Iris van Herpen and Daniel Widrig produced the remarkable 3D-printed top, a testament to their shared passion for blending technology, nature, and architecture. This avant-garde garment transcends traditional fashion boundaries, displaying its innovative spirit and meticulous craftsmanship. It serves as a beacon of their relentless pursuit of creativity and collaboration, inspiring future generations of designers.



Figure 20: Capriole Collection, NO. 16, van Herpen, Dy Vo, ND)

Dita Von Teese, 3D printed dress (2013)

In the world of fashion, where innovation often intertwines with glamour, couture typically thrives on exclusivity. However, since the late 2000s, the advent of cutting-edge technology like 3D printing has ushered in new possibilities. Notably, Francis Bitonti and Michael Schmidt created a fully 3D printed dress for the burlesque dancer Dita von Teese, a pioneering work representing the transformative potential of the material. Bitonti, drawing from his architectural background, views fashion akin to architecture, equating the production of a garment to creating a building facade—aiming to fabricate a second skin.

The dress, composed of 3000 unique moving pieces and adorned with 12,000 Swarovski crystals, though resembling a recycled tyre at first glance, signifies a departure from traditional couture. Schmidt (2013) acknowledges the controversy surrounding its elevation of design, emphasizing its nod to traditional Hollywood glamour, accentuating von Teese's hourglass figure visible in Figure 21. The use of the 3D printer allowed for a shape impossible to achieve by human hands, tailoring it uniquely to von Teese's body and ensuring lightweight, rigid, and sculptural characteristics unattainable manually.

They collaborated with the architect Francis Bitonti to develop a 3D computer model of the dress they planned to design for von Teese. They were able to sculpt the design over the shape of von Teese's body by creating a model comparable to a construction one, visible in Figure 22.

Another contention raised here is whether it's the design or the manufacturing process that lends uniqueness to the dress. During that period, the 3D printer could only produce rigid nylon materials, necessitating the use of a second, more flexible material for assembly. Overcoming these persistent limitations required designers to innovate, often incorporating additional materials for flexibility and wearability. Schmidt foresees the evolution of 3D-printed clothing to embrace organic attributes such as breathability, dyeability, and flexibility, ensuring that garments transcend being mere fashion statements to become practical and wearable for everyday use.



Figure 21: 3D printed dress designed Specifically for Dita von Teese, Francis Bitonti Studio Metalocus, 2013)

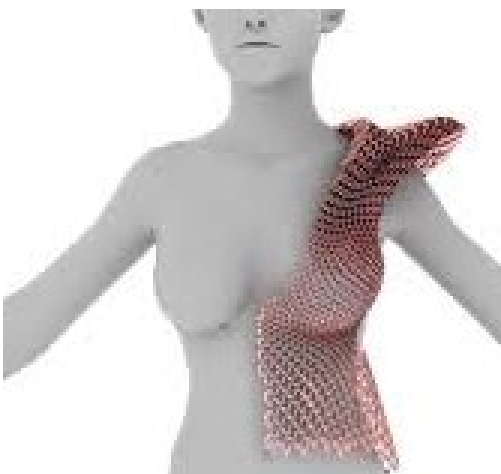


Figure 22: Modelling the Dita von Teese Dress, Bitonti, 2014)

Reflecting on the broader history of fashion, Schmidt's transition from a punk rock enthusiast to a New York-based fashion designer underscores a departure from conventional norms. "By embracing new technologies like the 3D printer, Schmidt epitomizes a rebellion against societal norms, reminiscent of punk's ethos, and challenges established fashion paradigms" (Archive on Demand, 2015)

The collaboration between the fashion designer and the architect highlighted a unique fusion of software expertise and shape design, which significantly influenced the capabilities of 3D printing. Despite the printer's inherent limitations, they ingeniously transformed these constraints into functional solutions

tailored to the demands of their era.

In the end, the cooperation between fashion designer Michael Schmidt and architect Francis Bitonti demonstrates 3D printing's transformational potential in the world of haute couture. Their unique approach challenged conventional conceptions of garment construction, using cutting-edge technology to produce a game-changing outfit for Dita von Teese. They illustrated how 3D printing may transform the fashion industry by pushing the limits of design and production processes and opening up new possibilities in materiality, form, and wearability. This partnership demonstrates the importance of interdisciplinary collaboration and innovative thinking in defining the future of fashion.

The Flames shoe (2015)

The Flame Shoe, a collaborative piece by Zaha Hadid and the esteemed shoe brand United Nude is another collaboration design piece that epitomizes the fusion of architectural brilliance and cutting-edge fashion design. Inspired by Hadid's iconic organic forms and United Nude's commitment to innovation, this high heel embodies a captivating blend of style and functionality. Drawing from Hadid's architectural aesthetic, the Flame Shoe showcases sweeping curves and dynamic shapes reminiscent of waves, exuding boldness and elegance. Its sleek lines and sharp points make a striking statement, encapsulating the essence of both the architect and the shoe brand.



Figure 23: Flames by Zaha Hadid for united Nude, United Nude, ND)



Figure 24: Flames by Zaha Hadid for United Nude, Designboom, ND)

The concept of the shoe originates from the flickering of a flame, hence its fitting name, the Flames Shoe. These flames are visible as protruding elements that drape themselves around the foot.

The footbed is ergonomically crafted to provide support to the ball of the foot. However, given the steepness of the heel, one might question its effectiveness in practice. The material utilizes Selective Laser Sintering in Hard Nylon and a newly developed soft rubber type. This combination enables the creation of a shoe that remains flexible and wearable. This marks a significant evolution since the creation of the 3D-printed dress for Deeta von Teese two years prior. Only 50 pairs of these shoes have been created given the time-consuming process of creating the shoe.

United Nude's dedication to innovation shines through in the Flames Shoe, crafted using state-of-the-art 3D printing technology. Finished with luxurious suede and leather, it combines modern manufacturing techniques with premium materials, enhancing its allure and ensuring a refined finish. However, as can be seen in Figure 24, when looking at the shoe in harsh lighting, one can still see the texture of the printing levels that is the result of the 3D printer.

This design by Zaha Hadid and United Nude is part of a collection of five collaborations between architects and designers where they all used a 3D printer. Other participants included Ben van Berkel of UN Studio as an architect, Ross Lovegrove as a product designer, Fernando Romero as an architect, and Michael Young as a product designer. (United Nude, 2015) The idea behind the Re-Inventing Shoe Project, as it is called, was to experiment and push the boundaries of rapidly evolving techniques.

This collaboration seamlessly blends elements from both architecture and fashion. While serving as a fashion statement, a closer examination reveals the structural integrity and functionality characteristic of architectural

design. Notably, the heel, without ground contact, maintains stability, demonstrating a clever fusion of form and function. In essence, the Flames Shoe represents a harmonious union of architectural innovation and forward-thinking fashion design. Its distinctive silhouette and meticulous craftsmanship offer a unique footwear option for those with an appreciation for bold and distinctive style.

In conclusion, the Flame Shoe stands as a remarkable collaboration between Zaha Hadid and United Nude, blending architectural brilliance with fashion design innovation. Inspired by Hadid's organic forms, the shoe's sweeping curves and dynamic shapes evoke boldness and elegance. Crafted with cutting-edge technology and premium materials, it represents a pinnacle of creativity and craftsmanship. Despite its limited production, the Flame Shoe offers a unique statement piece for those seeking bold and distinctive style. With its seamless fusion of architecture and fashion, it embodies the spirit of experimentation and pushes the boundaries of design, something that could not have been done without the aid of the 3D printer.

Naturalis Biodiversity Centre Leiden (2019)

A more recent collaboration between an architect and fashion designer is the redesign of the Naturalis Biodiversity Centre in Leiden. According to Giele (2019), the addition to the existing structure was intended to inspire a massive sensation of nature. Architect Michiel Riedijk designed an atrium that connects the older to the new and modern structures to make space for new research halls.

In the new design, horizontal white frieze bands around the new exhibition halls' exterior produced a sense of monumentality. Within these bands are panels designed by fashion designer Iris van Herpen, emphasizing the architect-fashion designer collaboration in a building rather than a garment as seen before. The underlying concept for the design was biodiversity, which is important to both the client Naturalis and several of van Herpen's collections. This allowed both parties to find common ground in the two designers and the client's themes.

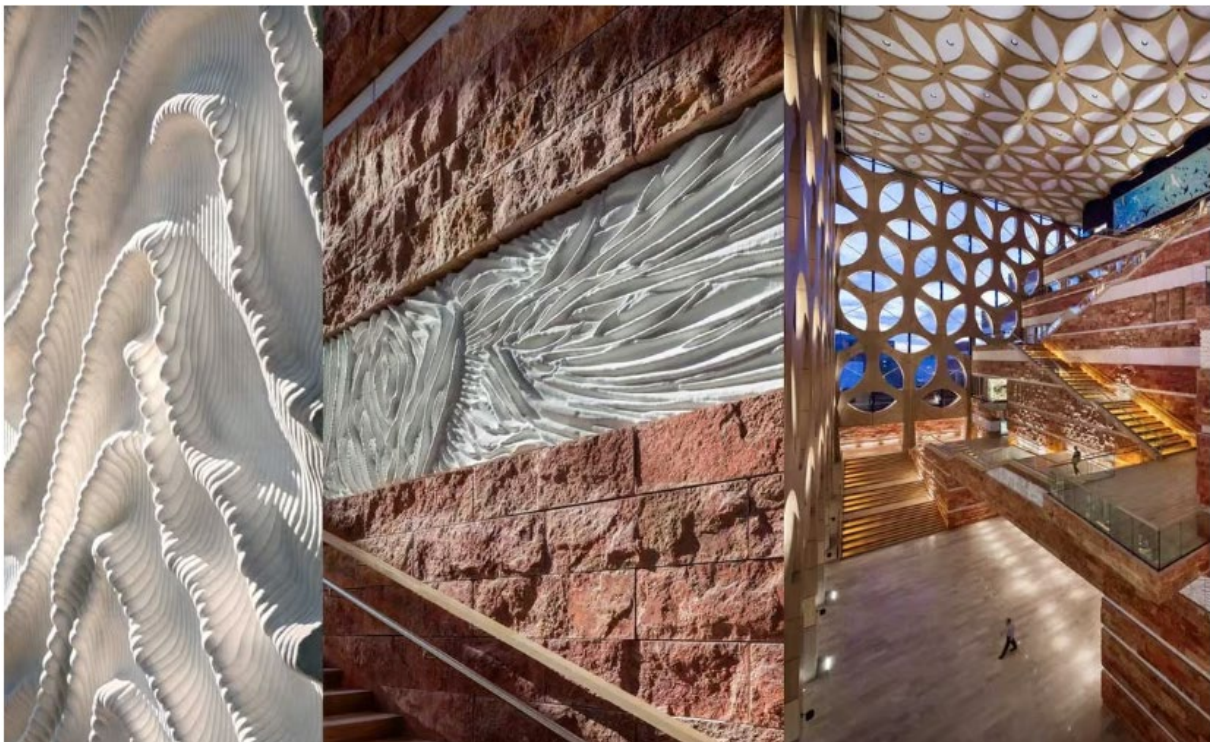


Figure 25: Naturalis Museum, Scagliola & Brakkee, 2019)

The design, which spans nearly a kilometre, includes 263 panels created using a unique technology. A 3D printer distributes sand and marble aggregate into forms that resemble erosion features in rocks. Each pattern has three distinct panels, with the third fading into an overlapping one. Four overlap panels form a chain between two panels, resulting in 13 distinct panels. This pattern resembles a fingerprint, which adds a natural touch.

Technically, this design is a fusion of two distinct techniques. The 3D printer collaborated with a concrete mill to create the base for the shapes. The design process was primarily digital, with established rules for panel form due to feasibility constraints. The space between waves in the panel had to maintain a specific distance (50 mm) to ensure ample strength for self-support. Depth considerations aimed to prevent standing water within the panels.

Hibex, the concrete company, leveraged the digital model to fabricate a mill for the mould. This entailed a comprehensive digital collaboration among the architect, designer, and construction company which can be seen in Figure 26.

Looking at the panels from a distance, the façade looks like a section of the earth, with each layer symbolising a different time with fossils and history. The white concrete bands form a stark contrast with the red, rough

natural stone imported from Iran. Vissering (2019) highlights these contrasts as a nod to the work of Iris van Herpen herself. She still played with fabrics and pleats, but now it's carved in stone.

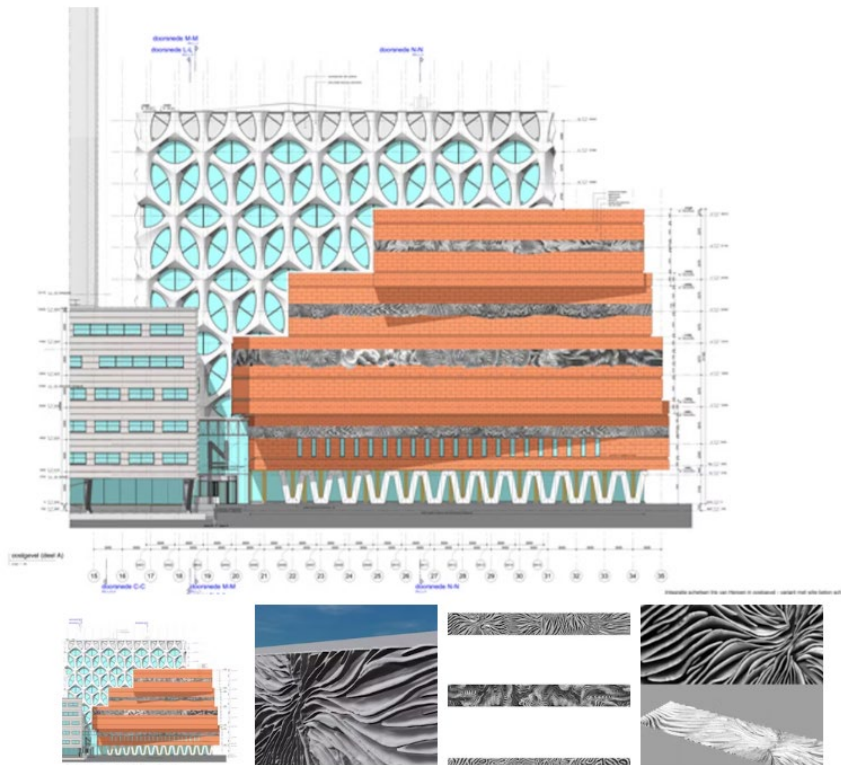


Figure 26: Parametrische reliëfstructuur, Vissering, 2020)

According to Guntlisbergen (2019), Iris van Herpen claims in a recorded interview: "These three-dimensional biomorphic patterns intertwine the inside and outside of Naturalis, like the archaeology of a dress." She drew inspiration from Gian Lorenzo Bernini's early works and his ability to depict fabrics in marble. Developing new techniques and materials can be a time-consuming endeavour, as Iris van Herpen has emphasized in her approach to innovation. She has expressed a willingness to invest time in the development process, noting that if she doesn't take the time to explore new materials, no one else will.

This design marks van Herpen's first large-scale architectural project, having previously collaborated on clothing with other architects. In this case, it's not just a collaboration between architects and a designer; the museum itself heavily influenced the design. Van Herpen drew inspiration from the numerous fossils present in the museum. She emphasizes that every aspect of both architecture and fashion aims to foster understanding and discovery on a conceptual level, both in terms of materials and technically.

This collaboration merges nature and monumentality themes, seamlessly integrating the designs of both the architect and fashion designer. It offers a platform for both professions to shine, as the multidisciplinary design process incorporates van Herpen's ideas from the outset, ensuring they fit organically within the context they're intended for.

In conclusion, the collaboration between architect Michiel Riedijk and fashion designer Iris van Herpen in the redesign of the Naturalis Biodiversity Centre in Leiden represents a groundbreaking fusion of architecture and fashion. By seamlessly integrating van Herpen's biomorphic panels into Riedijk's atrium design, the project transcends conventional boundaries and blurs the distinction between art forms. This innovative approach not only creates a visually stunning space but also symbolizes the interconnectedness of nature, science, and creativity. Through meticulous digital collaboration and technical precision, the designers have crafted a space that serves as both a monument to biodiversity and a testament to the power of interdisciplinary collaboration. This project not only exemplifies the evolution of van Herpen's creative vision but also sets a new standard for collaborative design in the realms of architecture and fashion.

Conclusion

In examining the intersection of architecture and fashion, we delve into a realm where creativity knows no bounds. From iconic landmarks like the Maison Hermès in Tokyo and the Prada Epicentre in Los Angeles to innovative retail spaces like the Off-White flagship store in Miami, the collaborative efforts between architects and fashion designers redefine traditional notions of design and functionality.

These collaborations transcend mere practicality, embodying the ethos and identity of the brands they represent while pushing the boundaries of innovation. The Maison Hermès's semi-translucent façade and the Prada Epicentre's avant-garde design showcase a harmonious blend of architectural elements and fashion sensibilities, symbolizing a commitment to tradition and innovation.

Similarly, the Off-White flagship store in Miami, designed by Virgil Abloh in collaboration with OMA, represents a modern approach to architectural and fashion collaboration. Abloh's unique background in civil engineering and architecture enables him to infuse Off-White's distinctive aesthetics into the store's design, creating a dynamic space for cultural engagement.

Moreover, the integration of 3D printing technology into architecture and fashion has ushered in a new era of design possibilities. From the 3D-printed dress for Dita von Teese to the innovative panels at the Naturalis Biodiversity Centre, these case studies illustrate the transformative potential of 3D printing in both industries. By combining expertise in software, shape design, and materiality, architects and fashion designers are pushing the boundaries of creativity and redefining the future of design.

In conclusion, the collaborative efforts between architecture and fashion represent a fusion of creativity and innovation, resulting in spaces and garments that transcend mere functionality to become cultural landmarks. As technology continues to advance and interdisciplinary collaboration flourishes, we can expect to see further exploration of innovative design solutions that blur the lines between art, science, and design, shaping the future of architecture, fashion, and beyond.

The advent of 3D printing has unlocked new avenues that were previously inaccessible without the aid of computer-aided programs. With the ability to utilize intricate forms, mathematical algorithms, and streamlined communication, collaboration between architects and fashion designers has become more seamless than ever before.

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