Textiles and Architecture

Woven into Dimensions of Temporality, Craft, Drapery, and Technology

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Abstract

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Textiles play an important, but often unacknowledged role in architecture. They have been closely associated with flexibility, texture, weaving, impermanence, moldability, mobility, lightness, and wrapping. However, textiles are merely perceived as finishing materials or applied ornamentation in buildings. Their narrative though has been prominently shifting from a temporary dialogue to a cardinal story; penned to be read with multiple versions. This thesis investigates a more comprehensive integration of textiles in architectural design, primarily through case studies that demonstrate important dimensions of fabrics—Temporality, Craft, Drapery, and Technology—to state their advancing relevance in contemporary architecture. Leveraging the methodology of qualitative and quantitative study, this thesis evaluates the integral role of textiles in design, contributing towards tapping their full potential in architecture thereby providing a concrete narrative and strengthened understanding for future exploration.



Fig.a. Iterations of Textiles, Art, and Architecture

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Dedication

I am dedicating this thesis to my family goddess, **Shree Shantadurga**
with highest regards and love

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1.0. Chapter 01: Introduction

1.1. Abstract

Textiles play an important, but often unacknowledged role in architecture. They have been closely associated with flexibility, texture, weaving, impermanence, moldability, mobility, lightness, and wrapping. However, textiles are merely perceived as finishing materials or applied ornamentation in buildings. Their narrative though has been prominently shifting from a temporary dialogue to a cardinal story; penned to be read with multiple versions. This thesis investigates a more comprehensive integration of textiles in architectural design, primarily through case studies that demonstrate important dimensions of fabrics—Temporality, Craft, Drapery, and Technology—to state their advancing relevance in contemporary architecture. Leveraging the methodology of qualitative and quantitative study, this thesis evaluates the integral role of textiles in design, contributing towards tapping their full potential in architecture thereby providing a concrete narrative and strengthened understanding for future exploration.

1.2. Aim and Objectives

Aim: To explore the potential of textiles in design and to redefine their relevance at the intersection of art and architecture.

Objectives:

- To study the relationship between attributes of textiles and built forms
- To understand the evolution of textiles with respect to the built environment
- To investigate the potential of textiles as an important material in architecture

1.3. Problem Statement

The thesis delves into questions like—what are the parameters that integrate built forms with fabrics? What kind of relationships are developed when textiles meet the realm of architecture? How are these relationships perceived and interpreted by end users? This thesis investigates these questions through a systematic analysis of the particular characteristics of textiles and the roles they play when closely integrated with buildings.

1.4. Research Methodology

The research methodology revolves around a theoretical framework of dimensions that set the outline for this thesis. Delving into both qualitative and quantitative study, the thesis investigates the importance of textiles in art and architecture. Qualitative study focuses on background research, which looks into three components, namely; (i) the evolution of textiles in architecture from being the earliest form of shelter as tents to their transition into tensile structures, (ii) the varied relationships between textiles and architecture to understand how this integration is perceived and received by end users, and (iii) the attributes of textiles as a potential paramount material in art and architecture. Qualitative study further explores the nature, behavior and relevance of textiles through case-studies that demonstrate four architectural projects in detail under every dimension and are supported by illustrative design examples to present a variety of textile iterations that are comforting, surprising and informative towards the potential of the material in art and architecture.

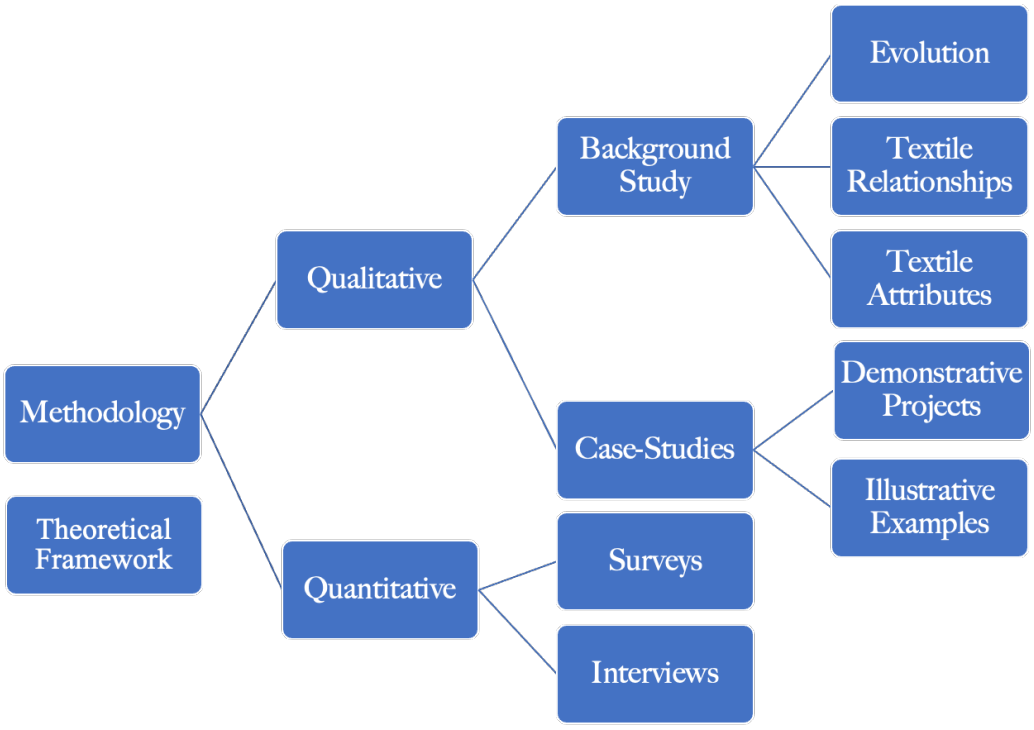


Fig 1.1. Hierarchical chart presenting the research methodology

Quantitative study further strengthens the thesis argument by delving into surveys and interviews thereby broadening the understanding of this intersection between textiles, art and architecture. The survey targets an audience of architectural as well as non-architectural backgrounds to comprehend the value of textiles in their life and how they perceive textile architecture. On the other hand, the interviews involve design professionals who've closely worked with the material in order to gain insights into the practical possibilities of textiles when merged with architecture. While the survey helps shape up the parameters of textile and architectural integration, the interviews help engage with the local weaving communities, who are an essential part of this collaboration between the two fields of textiles and architecture. A hierarchical methodology becomes the key to a thesis that navigates through the past, present and future of textiles and architectural intersection.

1.5. Literature Review

It is essential to understand the difference between key terminologies that are often referred to in this thesis in order to comprehend the context of those terms as well as to state the theoretical scope of this thesis. The thesis revolves around an important word called *textile*. According to the Cambridge Dictionary, a *textile* is a cloth that is woven and made by hand or machine. According to Collins Dictionary[1], a *textile* is any fabric produced by weaving, knitting or felting and can be woven or capable of being woven. In the context of this thesis, we define *textile* as—a three-dimensional product of craft that can be woven, knitted, warped or felted by combining strings or fabrics. According to the Cambridge Dictionary[2], a *fabric* is a cloth or material for making clothes or covering furniture. According to Collins Dictionary, a *fabric* is a cloth or other material produced by weaving together cotton, nylon, wool, silk, or other threads. In the context of this thesis, a *fabric* is a two-dimensional piece of cloth composed from woven strings and covers or wraps a space/object/structure/sculpture. As for a *string*, according to the Cambridge Dictionary, a *string* is a piece of strong, thin rope made by twisting very thin threads together, used for fastening and tying things. According to Collins Dictionary, a *string* is thin rope made of twisted threads, used for tying things together. In the thesis context, a *string* is a one-dimensional thread that can be flexibly stretched or suspended, can tie or bind things together, and can be woven into a fabric or a textile.

[1] https://www.collinsdictionary.com/us/dictionary/english/textile

[2] https://dictionary.cambridge.org/us/dictionary/english/fabric

Material keywords: *Textile, Fabric, String*

As for deciphering the varied techniques pertaining to textiles, the thesis defines the widely used processes that act at the intersection of textiles and architecture. According to the Cambridge Dictionary, *weaving* is the act of making cloth by repeatedly crossing a single thread through two sets of long threads on a loom. According to Collins Dictionary, *weaving* is the art of crossing threads, cloth, long plant stems or fibers over and under each other. In the context of this thesis, *weaving* is the process of creating an overlapped, rhythmic composition through the combination of two or more materials by interlocking them together. According to the Cambridge Dictionary, *drapery* is a cloth hanging or arranged in folds. According to Collins Dictionary, *drapery* refers to a covering, clothing or hanging arranged in loose folds. In the context of this Thesis, *drapery* is a projection or a fabric composition, which includes folds and layers. *Draping* however is a technique of using fabrics to cover or layer an object, inducing rhythm and fluidity to the composition. Moving on to the technique of *knitting*, Cambridge Dictionary defines it as a process of fabric being connected by yarn or threads into joined rows. According to Collins Dictionary, *knitting* refers to the act of forming a fabric by looping a continuous yarn. In the context of this thesis, *knitting* is an act of composing fabric or a textile by looping threads or yarn in a continual manner.

Technique Keywords: *Weaving, Knitting, Draping*

Drape Architecture:

The thesis also addresses terms like *Drape Architecture*, which refers to a characteristic of architecture that imitates the act or impression of drapery through the style of folding, wrapping or covering a structure or space in fluid geometry. It inherits and portrays attributes of a draped fabric in architecture.

Woven Architecture:

It refers to an architecture that generates facades, which are either woven (like textiles) or create an illusion of being woven or are inspired from the pattern of weaves.

Craft and Duality:

The thesis also focuses on the skill and state of textiles in architecture. For instance, according to the Cambridge Dictionary, *craft* refers to a skill and experience, especially in relation to making objects. Collins Dictionary believes *craft* to be any activity or job that involves creating things skillfully by hand. In the context of this thesis, *craft* refers to creating a weave, knit, knot, warp, weft in order to produce a composition or joinery by hand or machine (latter often termed as digital craft). Duality however refers to the state of combining two different things as per the Cambridge Dictionary. According to Collins Dictionary, *duality* refers to a situation in which two opposite ideas or feelings exist at the same time. In the context of this Thesis, *duality* refers to the co-existence of two diametrically opposite or stark ideas/states at the intersection.

Keywords: *Drape Architecture, Woven Architecture, Craft, Duality*

2.0. Chapter 02: Background Study

2.1. Textiles and Architecture

At some point in our life, we have held onto a piece of textile close to our heart because, it either (i) reminded us of our loved ones, (ii) has been passed on to us as a part of a cultural or family heirloom legacy, or (iii) has a childhood memory attached to it. This clearly shows that textiles are cognitive in nature. They enrich our thoughts, memories and most importantly, senses. There is a sense of familiar association when built forms include textiles—be it as an elevational façade, a structural component, an art installation, as interior furnishings, as wall tapestries or as a functional element. Textiles are the only prime material that we wear on ourselves. As for metal armors, we only wear them as shields to guard us, not to comfort us. As for textiles, we know exactly how the material feels, its texture, and its familiar essence. And this is exactly why if textiles prominently craft a built space, it becomes an associative, approachable environment. However, like we wear stone and metal as ornaments, similarly in architecture, textiles have been reduced to finishing materials or ornamentation. This thesis investigates a more comprehensive integration of textiles in design and portrays its relevance in contemporary architecture to further tap their potential as an important building material.

The background research investigates the evolution of textile integration in architecture and its reinterpretation in modern times. The ability of architecture to stem from its past and borrow from its surroundings paves the way for the development of relationships. These textile and architectural relationships set an outline for perceptions and relativity. The background study also delves into the varying textile attributes that are compatible with architecture from the past, present and future and allow it to expand its possibilities within the built environment.

2.2. Historical Evolution

Some of people's earliest shelters were tensile structures made with animal skins or textiles. Tents have been considered as the earliest form of man-made architecture.[3] This means that textiles have acted as shelters since architecture was conceived. The figure depicts a timeline that shows an evolution in tent prototypes from the Early Mammoth tent to Asian Yurts, Roman Army tents, Arabic Bedouin tents, famous American teepees, right up to geodesic domes. This clearly indicates the ability of textiles to create varying geometries owing to their inherent qualities and property of tensility.

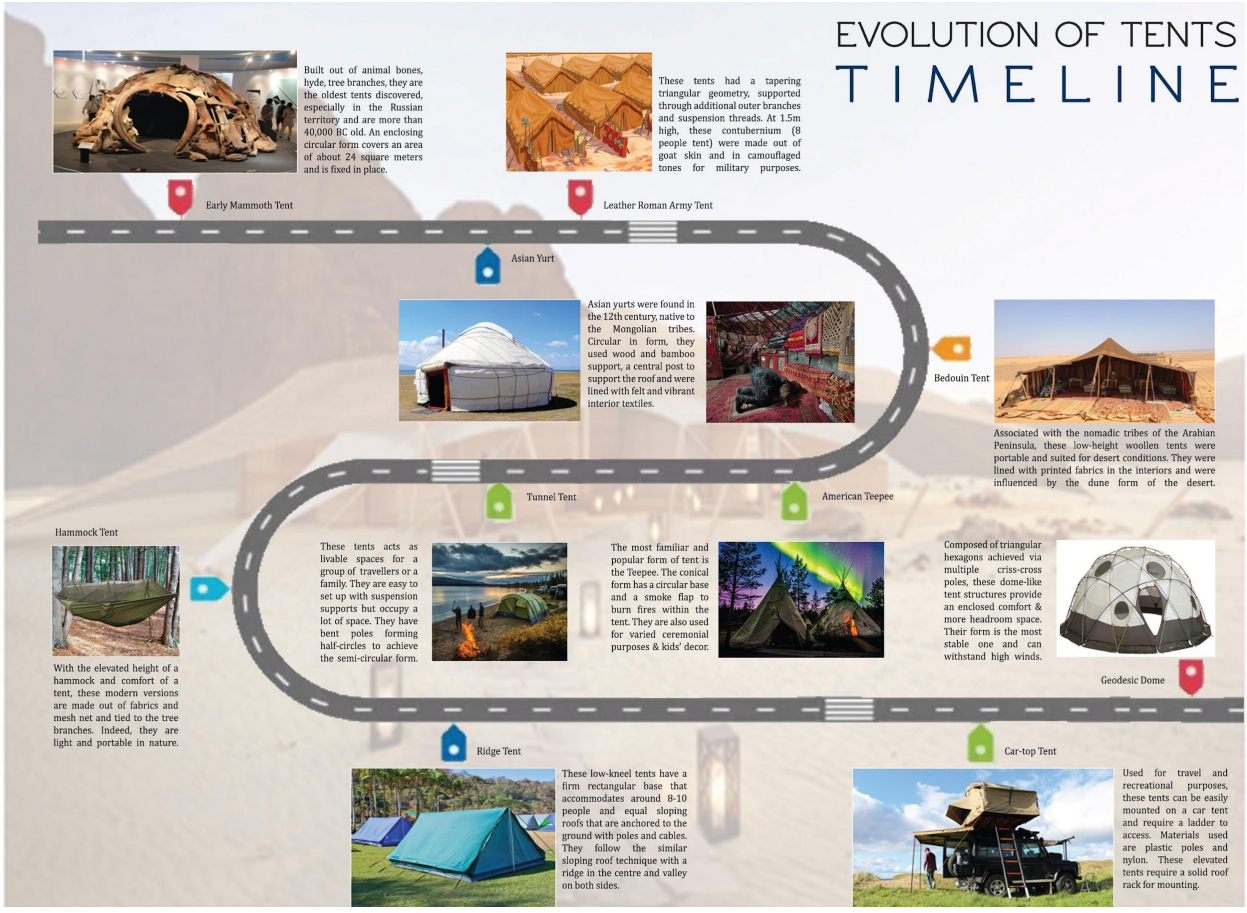


Fig 2.1. Timeline showing evolution of tents

[3] https://www.nikwax.com/usblog/the-history-of-the-tent-infographic/

Tent Architecture

Influenced by the existence of tents in different regions, architects have taken the concept a notch higher and realized tents into habitable spaces on a larger scale, as illustrated by the examples. From being a tent shelter[4] to a tent structure[5], there is a character of durability and permanence that starts to shift perspectives about textiles being a temporary material.

a) *Superpausee Macro Tent* by Vous Architecture & Design, France, 2019

As an ode to camping, this built form is a portable, light superimposition of two Canadian tents, wherein the traditional timber of a remote cabin is replaced by steel tubes and suspensions. Double tenting ensures efficient insulation and waterproofing. A split-level construction, it opens up to the forest views. Its combination of pitched roofs and tensile structure suggest an intersection of a cabin and tent.



Fig 2.2. Double-tented Superpausee structure



Fig 2.3. View from meshed floor nook

[4] https://www.designingbuildings.co.uk/wiki/The_history_of_fabric_structures

[5] https://www.archdaily.com/979422/tents-an-architectural-language

b) Circus Tents

Circus tents have long used textiles in various forms, colors, and prints. The fabrics are stretched over central masts and staked over perimeter poles to maximize interior space. Circus tents have typically been circular, although designers have started to experiment with variations looking at the stretchable property of textiles.




Fig 2.4. and Fig 2.5. Variations of a circus tent

c) *Garage Screen Cinema* by SNKH, Moscow

In an attempt to highlight the temporary nature of the pop-up cinema outside the Garage Museum of Contemporary Art[6], a tensile structure by SNKH reflects an inverted Bedouin tent form with steel exoskeleton supporting a PVC membrane that wraps the steel framed skeleton to depict the nomadic nature.




Fig 2.6. Reinterpretation of a Bedouin tent into a modern day museum of Garage Screen

[6] https://www.archdaily.com/946782/garage-screen-cinema-snkh-studio

2.3. Textile Relationships

Associating with a thought, object, space or person stems from how we interpret them. As rightly mentioned in Gadamer's *Truth and Method*, "Interpretation always involves a relation to the question that is asked of the interpreter". A person who seeks to understand must question what lies behind what is said[7]. This is exactly why it is essential to comprehend the relationships that thrive between textiles, art and architecture. Derived from numerous architectural examples and the functions infused by textiles into the built forms, **the four prime relationships are—Aesthetic, Cultural, Structural and Sculptural**.

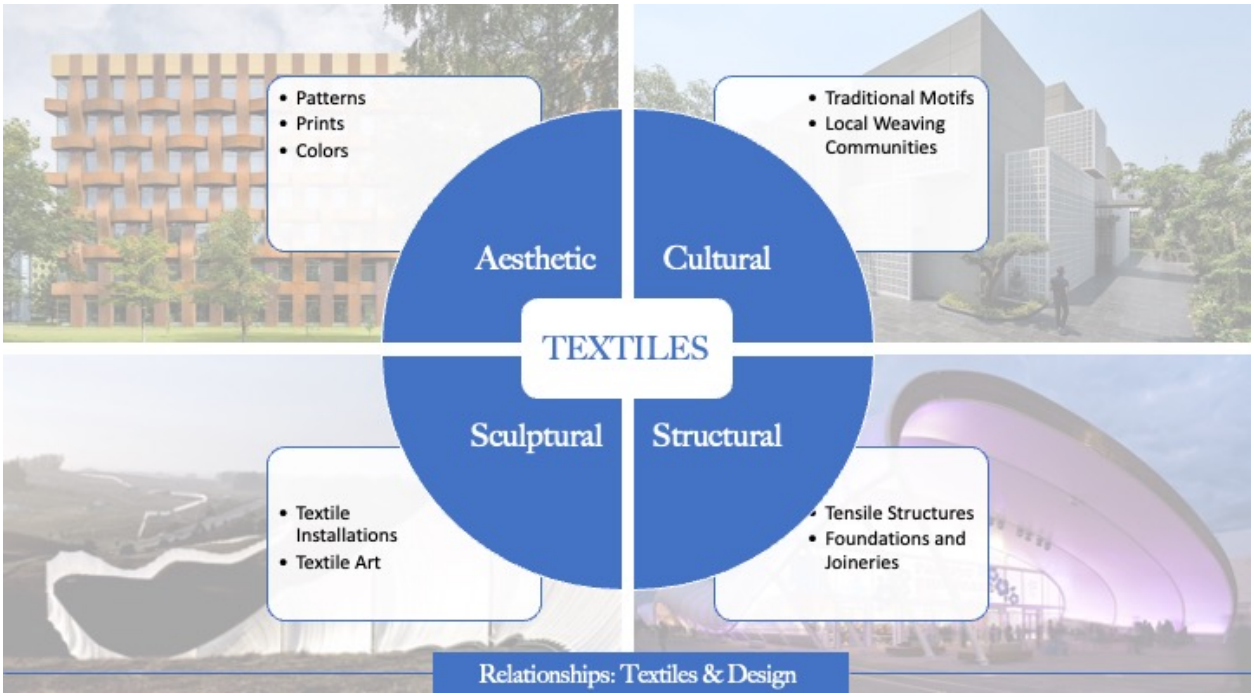


Fig 2.7. Illustrative chart showing relationships between textiles and architecture

A common thread binding them all is the Gestalt theory of Interpretation. The theory revolves around the concept that we see things as whole and not in parts[8]. The relationships that constitute

[7] Gadamer, Georg Hans. "Truth and Method", 1960 (Page 333-337)
[8] Heidegger's Reflections on Gestalt: Establishing the Truths

the interplay between textiles and architecture appear to be cohesive in functionality, meaning the relationships overlap at times and produce varying perspectives. Wrapped as a weave, the intertwining component of a fabric ironically drapes a structural façade in stability and a touch of tapestry elegance. Textiles are generally associated with being elegant and delicate and yet they have acted as a strong, durable structural facade screen. This reflects on the thought that the tangible aspect of textiles might have a completely different possibility from its intangible counterpart. The relationship between textiles and architecture is synonymous to the equation between time and human beings. There's inter-dependency, there's correlation, there's evolution in the way the two fields have merged over the years and similar to time, a textile weave runs in a continual manner, creating meaning. When textiles intersperse with architecture across functions, aesthetics, scales, cultural diversity and time—an era of woven architecture is born.

2.3.1. Aesthetic Relationship

Being the most prominent relationship of all, the aesthetics of a structure or space resonate first with a familiar cognition or in this case, with the character of textiles. How built forms are perceived externally formulate a base for changing narratives that either reveal the interior in alignment with the exterior or entirely surprise with the enclosed elements. The aesthetic relationship is defined by—Patterns, Prints and Colors—originated from textiles. We have known textiles to beautify interior spaces in furnishings, rugs, wall tapestries or privacy screens. Identifying them and witnessing their weaves, imprints and hues on a structural façade or within a composition is the most conversant way of association with textiles. Furthermore, an element of illusion also comes into play when certain structures project a woven façade but are structurally and materially far from it, thereby sticking to the aesthetic domain.

Origin

Before looking at the correlation between buildings and textile components, it is essential to study the origin of this connection and how it came into existence. While the world believed that putting blocks together led to architecture, a German architect, Gottfried Semper in the 19th century introduced a concept that everything in this world originated from knots, including nature itself. He was the first person to predominantly find a connection between textiles and architecture and spread awareness about it through his book, *The Four Elements of Architecture,* 1851. The weaving knots have also been considered to inspire the wooden joinery techniques.

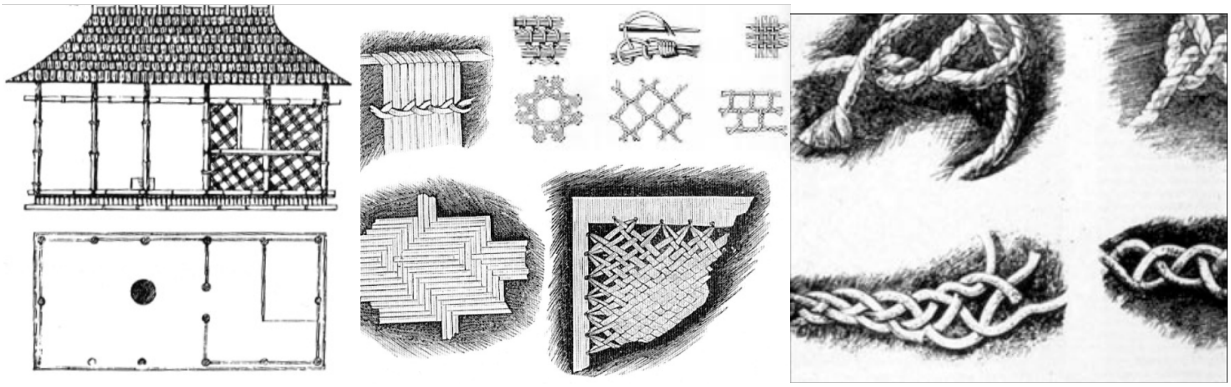


Fig 2.8. Knots, weaves and plaiting patterns, Semper. *"The Four Elements of Architecture",* 1851.

In an article titled, *"Of Blocks and Knots: Architecture as Weaving",* 2013, The Architectural Review,[9] author Tim Ingold decodes the concepts of Semper's book, which insists that the threading, twisting and knotting of linear fibers were among the most ancient of human arts, from which all else was derived, including both building and textiles. 'The beginning of building', Semper declared, 'coincides with the beginning of textiles.' And the most fundamental element of both building and textiles, he thought, was the knot. The author puts forth a question that further fuels this thesis argument, ***"Is making a matter of building up or of carrying on?"***

[9] https://www.architectural-review.com/essays/of-blocks-and-knots-architecture-as-weaving





Fig 2.9. Basket-weave elevation Fig 2.10. Solomonic columns Fig 2.11. Twisted brick columns in Kerala

Figure 2.9. displays an elevational facade of Carrieres Centrales by AT-BAT-Afrique, Casablanca, 1953[10]. Designed to be an experimental residential community by a group of post-colonial architects, the white-washed structure displays a bold basket-weave elevation. The structure isn't interwoven through materials, nor uses fabrics and yet resonates with the weaving pattern through the staggering element of balconies, stacked one above another. The stacking also results in a voluminous space, effective ventilation and functional shading.

Figure 2.10. reflects upon the impressions of twisting ropes as seen in the Solomonic columns from the Romanesque era. The columns were used as aesthetic elements in entrance gateways.

Figure 2.11. shows twisted brick columns that support the verandah canopy in a traditional South Indian house. Since South India has always had region-specific weaving communities, this aesthetic rendition of twisted columns, echoing the twisted threads may be an ode to them.

In all these ancient examples of textile iterations within a built form, it is observed that the elements are extroverted in nature and are imposed on the outer facades or gateways or outer courtyards to first interact with the users through their aesthetic recognition.

[10] https://www.thepolisblog.org/2012/07/adaptations-of-vernacular-modernism.html

Patterns

The most ubiquitous and widely used weaving patterns namely, plain weave, twill weave, satin weave and basket weave have found their way into the architectural setting in the form of façade treatment. This is where Rosenau's Representation theory comes into picture. The question is how close to reality is the adopted representation? How are the users perceiving it? And what was the intention to present an evolved version of an original presentation again? Each of the following examples replicate textile patterns using solid building materials. They demonstrate that the aesthetic identification of textiles in a built form is so evident and direct that even if the material itself isn't fabric, the elevational derivatives can be traced back to their textile origin.

a) *Aspen Art Museum* by Shigeru Ban Architects, United States



Fig 2.12. Exterior view showing plain weave casing

This public structure is rendered with a façade treatment that observes a plain weave pattern, made out of a composite material Prodema: amalgam of resin and paper. It has been encased between a dual-sided veneer, offering an exterior wooden woven screen that interjects with the natural light to create dramatic patterns in the interior spaces.



Fig 2.13. (L-R) Plain weave; Play of light through woven facade; Front elevation of casing

b) *Ferrum I* by Sergei Tchoban, Russia



Fig 2.14. Impression of a woven facade ornamenting Ferrum I building in Russia

With a prominent horizontal presence, the structure communicates through its rigid textile frontage. *Ferrum I,* derived from the Latin name of Iron, is a testament to the former industrial area on which the seven-story commercial block presently resides.[11] Besides that, the name also

[11] https://tchobanvoss.de/projekt.php?id=549&lang=DE

indicates the materiality usage of CorTen steel with *Ferrum I* being the first building in Russia to use it for sculptural purposes. While the CorTen steel members in *Ferrum I* are durable and light-weight as means of projected facades, they punctuate a massy, heavy look. This continual projection of dominance and strength contributes to an intimidating structure as opposed to a welcoming one (an inherent quality of textiles). A strong geometric composition encompasses the commercial block in a plain weaving technique wherein each member is strategically overlapped onto the other, being functionally independent while aesthetically cohesive. Three-dimensional, corrosion resistant CorTen steel strips are arranged in a flat and protruding fashion, rendering a rustic texture through their red-patina finish.



Fig 2.15. Emphasis on the CorTen steel strips replicating a plain weave in elevation

Seen at the top of the structure are aluminium panels in gold, bordering the entire building in a compounding manner. According to the architects, the theme of the structure revolves around the belief that, ‘Rust on the outside, gold on the inside’. Our brains have registered over the years how a plain weave looks and the moment we come across a similar pattern, we instantly relate to the association interpreted. Does that mean interpretation drives representation? While the former solely remains attached to the architect, the latter varies with varying user opinions.

c) *Keiun Building* by Aisaka Architects, Tokyo

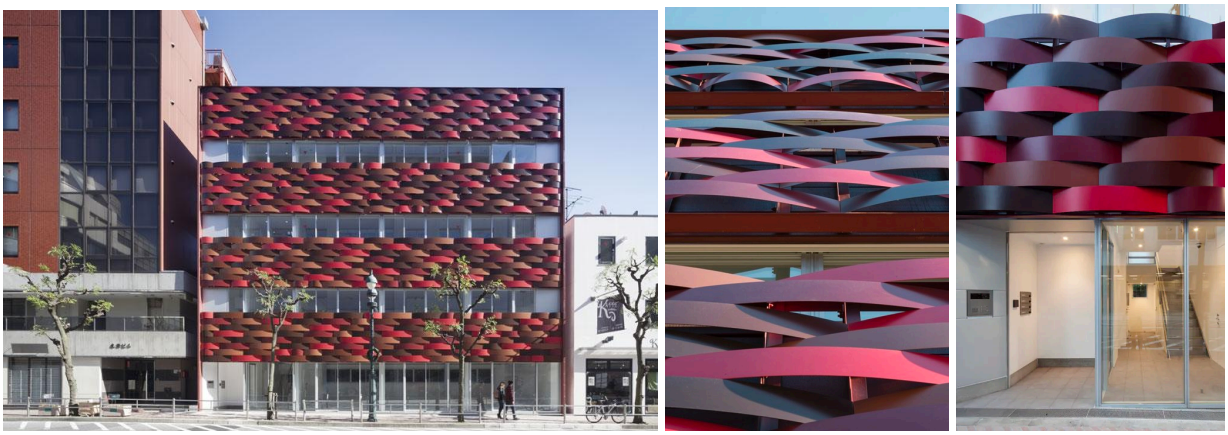


Fig 2.16. Woven facade in warp and weft technique and auspicious hues (elevation and detail)

Portraying a basket-weave elevation, the structure uses curved and arched strips of aluminium combined with steel brackets that hold them in position to a skin of autoclaved aerated concrete panels. Inclined towards horizontality, the structure is balanced by its cuboidal verticality.[12] While a screen of ribbon-like layer paints the road and railway frontage street in crimson hues, the horizontal glass slits echo Le Corbusier's ribbon windows from the Modernism period. The basket weave elevation that's inspired from the 'warp and weft' weaving method, infuses vibrancy by incorporating auspicious Japanese shades namely *Akane-iro, Ebichairo, Hiwada-iro, Bengara-iro* and *Kuri-iro.*

[12] https://www.dezeen.com/2015/02/23/aisaka-architects-keiun-building-red-basket-weave-facade-tokyo-office-block-japan/



Fig 2.17. (L-R) Auspicious Japanese colors used in the aluminum ribbons; Facade detail

These undertones also resonate with crimson brick colors as well as the fire hues. To add to that, the weave used in the elevation resonates with the traditional Japanese bamboo blinds, fondly addressed as *Sudare.* While the arched form lends a ribbon-like pattern, establishing an aesthetic relationship of textiles to architecture, a cultural essence also engulfs the built form.



Fig 2.18. Keiun Building as seen from the street, giving an ode to the former Fire Street

Prints



Fig 2.19. (L-R) Wooded House, Wales; The Garnet Hill Mural Project, Glasgow 1977; Amsterdam Noordstrook Block A

When enriched with prints, textiles become richer in quality and character. Native to every region, the prints originated can be unique, informed, inspired or overlapped. Forms and motifs seen in the fabrics are often replicated in interior finishing alongside furnishings. Taking that crossover further, the above images depict the textile prints onto a structural elevation. Figure 2.19. depicts a Wooded House in Wales, which is layered with tiles, engraved in floral and geometrical motifs, reminiscent of the *Saree* borders in India; the Garnett Hill Mural Project, 1977 in Glasgow that incorporates a stone clad façade infused with geometric and abstract textile prints and assembled in the form of fabric swatches; the façade of Amsterdam Noordstrook Block A by Mecanoo Architects, which uses different shades of brick, clad in weaving patterns to look like imprints thereby infusing vibrancy. Apart from these examples, there are multiple other structures that use printed patterns like—chevron, scroll, floral, checks, geometric, scales, tartans, ogee, ikat, paisley, Greek key and the likes of it.

Colors

Undoubtedly the highlight of the textile industry, colors are the driving force for creative manifestations. Colors are not just important for the way they either make a structure stand out or blend in but are essential for their vitality towards cultural and religious significance. Additionally, colors play a huge role in altering human psychology. They can either calm a person down or add to their hyper behavior. In such cases, when users recognize certain hues borrowed from textiles, they instantly relate to the meaning of those colors and a sense of acceptance thrives from within. Environmentally too, colors behave differently to changing climate. There have been structures around the globe using subtle, soft, warm, cool or bold hues that either resonate with the context or are a form of experimentation.



Fig 2.20. Textile imprints on the facade of Ecuador Pavilion Milan Expo, 2015

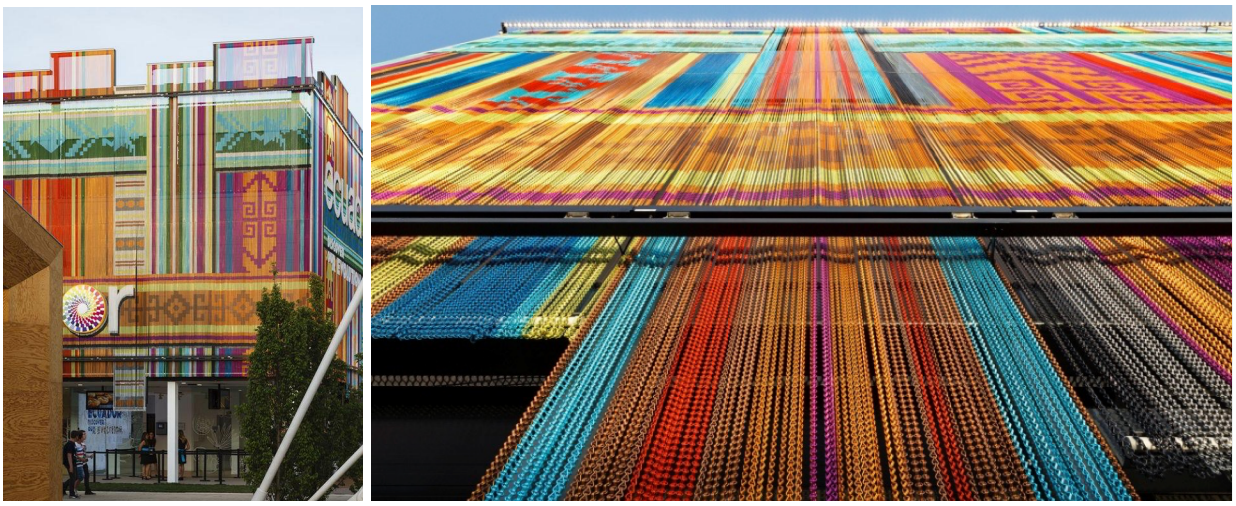


Fig 2.21. Aluminum strings crafting a textile tapestry in colorful hues

Colorful threads and tapestries have widely been used for art installations or in interiors but incorporating them as a façade treatment establishes a direct connection between architecture and textiles. Figure 2.21. shows the Ecuador Pavilion Milan Expo, 2015[13] by Zorrozua y Asociados. As a testament to the cultural heritage of the country, a graphic façade; almost a tapestry has been crafted and inspired from the multicolored fabrics of the Otavalo region. The elevation uses the KriskaDECOR paneling system, induced with anodized aluminium curtains, leading to chromatic emphasis, stemming from a core textile value.



Fig 2.22. Prints, patterns and colors coming together to fashion this textile composition

[13] https://www.archdaily.com/770638/ecuador-pavilion-expo-milan-zorrozua-y-asociados

2.3.2. Cultural Relationship

Driven by culture, the relationship can be context specific or concept specific. It involves not just structures that formulate their base over textiles but also engages with region-specific weaving communities and textile organizations. It is essential for a structure to sync with its surrounding site and echo the cultural and historical essence of the place. Inducing culture into a built form involves collaboration of a community, which is a relevant factor in the success story of architecture. A combination of case-studies and interviews unveils a tangible and intangible equation between textiles and architecture.

a) *18 Screens House* by Sanjay Puri Architects, Lucknow, India



Fig 2.23. (L-R) Exterior view; Dramatic light play from lattice screen; *Chikankari* fabric motif

As the name suggests, the residential structure has been conceptualized from cultural threads with 18 perforated screens. These striking laser-cut screens are composed of block-like patterns derived from the local, Lucknow *Chikankari* fabric motif that is evidently used in fashioning traditional outfits for women. In India, while some regions are known for their food, heritage, finance, or tourism, Lucknow is known for its fabric. The textile industry in this region is a representation of its multiple weaving groups and native prints. The screens thereby replicate those fabric motifs to

infuse an interesting interplay of light and shade, filter noise from the arterial road and also help in ventilation. The screens are functionally efficient as a structural component, culturally conceived and aesthetically relatable.

b) Weaving Communities across the World



Fig 2.24. Weaving communities using different techniques across the globe

For ages now, several weaving communities across the globe have been fostering and nurturing their traditional craft of weaving by hand. Every weaving community has had their own presence and trademark, representing their region on a world map. Countries like India, New Zealand, Indonesia, Mexico, and Africa have been rich in textile industry that is infused with handwoven techniques, and traditional prints. Seen in the image (L-R) are weavers indulging in the Kashmiri Kani Knitting; weavers using vernacular methods of dyed yarn tying to create a Pochampally Ikat pattern; Zinacantan weavers from Mexico employing a unique technique of weaving that works on the backstrap loom method; Māori weavers from New Zealand who have also been known for their lashing techniques of tying ropes in building construction; and the Varanasi weavers using the *charkha* method of sewing and knitting. Textiles are rooted to the local essence and native people of a region. Architecture too strives to be region and community specific in order to adapt with the climatic conditions and cultural practices of the locals. It is therefore important to bridge a cultural relationship between textiles and architecture for a collaborative design presence.

c) *Trendloom* by Aadyam Handwoven and India Craft Week, India



Fig 2.25. Cover for the Trendloom Forecast book by Aadyam Handwoven

Conceived as a noble art-oriented initiative by Birla, Aadyam Handwoven caters to select weaving communities from parts of India namely, Varanasi, Kutch, Kashmir and Kochi. They collaborate with these communities to create textiles in varied weaves, prints, fabrics and colors and promote them on a global scale within the architecture and interior industry. The revenue generated from this initiative is used to uplift the local, endangered weaving groups. The Trendloom initiative is a joint collaboration between Aadyam Handwoven and India Craft Week, who act as a middle-men connection between the produce (weaving community), the result (built forms) and the promotion (design retail industry). It is a forecast that documents trending themes and captures the simplicity of crafts to establish a relation between vast tradition and contextual modernity. The motive is to foster a self-sustainable ecosystem of local weavers, architects and the design retail industry.



Fig 2.26. Textiles from different regional weaving communities of India displayed at the exhibit

In an interview with Aadyam Handwoven's lead advisor Manish Saksena for ELLE Decor India, he states that, "Engaging in a constant dialogue with varied audiences, we realized that a substantial lot relegates handloom to esoteric on one hand and inapt on the other. In view of this, we strongly felt the need to bring out its intrinsic relevance and benefits in today's time. The inherent origin of handloom is timeless and beyond the dictates of any trend. This is exactly what defines its unscarred beauty! However, it keeps evolving with lifestyle patterns. We chose the term Trendloom—an oxymoron, as a property to emphasize the aspect of 'forever in trend'. We believe that handloom is not a whim or a transient fad, it is instead a way of life. Lifestyle trends around us further inspired us to interpret handlooms for end use in interiors. Our endeavor has been to dialogue with contextual concerns and choices faced by humanity at large as well as to exhibit synergy with handloom."[14]

[14] https://elledecor.in/article/5-questions-with-aadyam-handwovens-lead-advisor-manish-saksena-on-newly-launched-trendloom-forecast/

2.3.3. Structural Relationship

Buildings that use fabric as the base material for structural components like walls, roof, floor or construction support members establish a direct relationship with the realm of textiles. Whether it is borrowing wooden joineries from basic weaves (as discovered and studied by Gottfried Semper) or inventing twisted columns influenced by the twisting of warped threads, all of this has pushed the architectural industry towards immense innovation. Materials like Fiberglass, suspension cables, mesh nets, PTFE, Teflon replicate the fluidity and delicacy of fabrics while still offering structural stability. These juxtapositions of textile elements have strongly shaped architectural forms, and technologies. The examples below belong to the tensile architecture[15] realm and use either coated fabrics or meshed fabrics to achieve an all-weather protected, column-less space, making way for a sculpted, fluid geometry.

a) *The Cloud* by Jasmax Architects, Auckland, New Zealand



Fig 2.27. Structurally molded ETFE facade with white PES roof for a cultural and exhibit center

[15] https://www.archdaily.com/887462/tensile-structures-how-do-they-work-and-what-are-the-different-types

Perched along the harbor of Queens Wharf, the tensile structure is 600 feet long. 30 identical steel trusses as part of the prefabricated components are placed at varying intervals and angles to achieve a column-free space. Designed on a portable, temporary basis, the built form hosts exhibits and tourist attractions. A fluid geometry is achieved through a sculpted white PES roof that's coated with PVC. The geometric structure is dressed with glass walls and ETFE. [16]

b) *Noble House* by Greg Noble Architects, Great Barrier, New Zealand

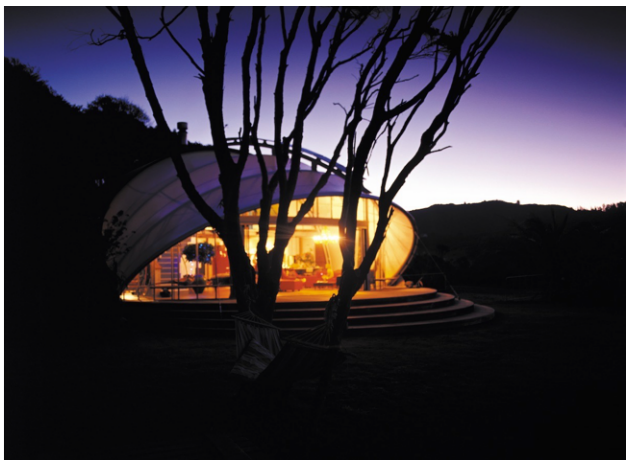


Fig 2.28. Noble house as a beacon of light

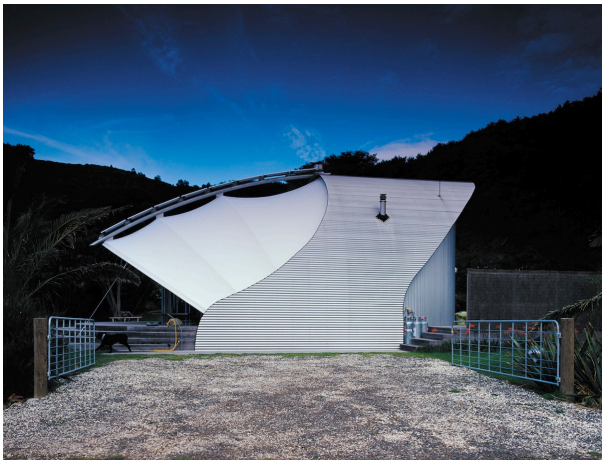


Fig 2.29. Side elevation of the PVC tensile membrane

Located on a quaint island in the Great Barrier, the architect's own house resonates with a shell-like form and looks out to the coast. A steel frame with elliptical shell-like curves holds the PVC tension membrane in place, which provides an all-weather protection and invites abundant light. Textiles are ruled by tensility and hence can be expanded or stretched under stress. [17]

[16] https://architecturenow.co.nz/articles/the-cloud/

[17] https://www.structurflex.com/projects/noble-house/

2.3.4. Sculptural Relationship

Whether it traces back to the numerous drape-like sculptures from the Renaissance era or addresses diverse and unique sculptural installations by artists around the globe, there's a temporary as well as reflective relationship that exists between textiles, art and architecture. Art is the prime component here to bind the two fields. Sculptural installations use the flexible, light-weight, folded, molded and portable character of fabrics and create architecture that merges with the landscape, interacts with users, attaches a symbolic relevance and adds a landmark value to a space by altering its current state.

a) Drapery Art

The art of drapery found its way prominently in the Italian Renaissance era, wherein sculptures and paintings depicted drapery of varied kinds. The sculptures were draped to add elegance and softness to the voluminous, monumental and rigid structures. Drapery also signified a certain level of opulence, which is why focus was pinned on fabrics. The art and effect of drapes was crafted in materials like stone and plaster, with utmost precision and layering. The impact of textile drapery in art and architecture has been profound and across scales.



Fig 2.30. (L-R) *Moses* by Michelangelo, 1513 in Renaissance era; *Veiled Virgin* by Giovanni Strazzo; Still life drapery; Draped sculptures in the Medieval era

b) Fabric Art Installations by Christo and Jeanne Claude

Christo and Jeanne Claude[18] created numerous sculptural installations using fabrics and techniques of drapery. They believed in reinventing perspectives of viewing a familiar structure or urban space. This aligns with the Gestalt Interpretation theory[19] that advocates going over the same content again and again to identify and unravel newer observations. This represents being in a situation bounded by a changeable horizon. With their temporary installations that took years and sometimes decades to conceptualize and set up, they worked towards uplifting spaces and achieving such difficult and precise compositions. They have formulated varied installations across regions and scales that have created history for a momentary period and generated fascination amongst the common public. Having believed in the freedom of design, they chose fabrics as their base material, especially nylon to be flexibly layered, molded, wrapped and stretched. Installations like Valley Curtain, The Gates, The Floating Piers, Wrapped Coast, The Pont Neuf, Running Fence and others have transformed structures and horizons with the incorporation of fabrics. What was perceived of them earlier changed overnight with a piece of fabric that was added to the equation. This makes us wonder how long does it take before the perceptions become perishable?



Fig 2.31. (L-R) Running Fence; The Pont Neuf; Wrapped Coast textile installations

[18] https://christojeanneclaude.net/
[19] https://www.britannica.com/science/Gestalt-psychology

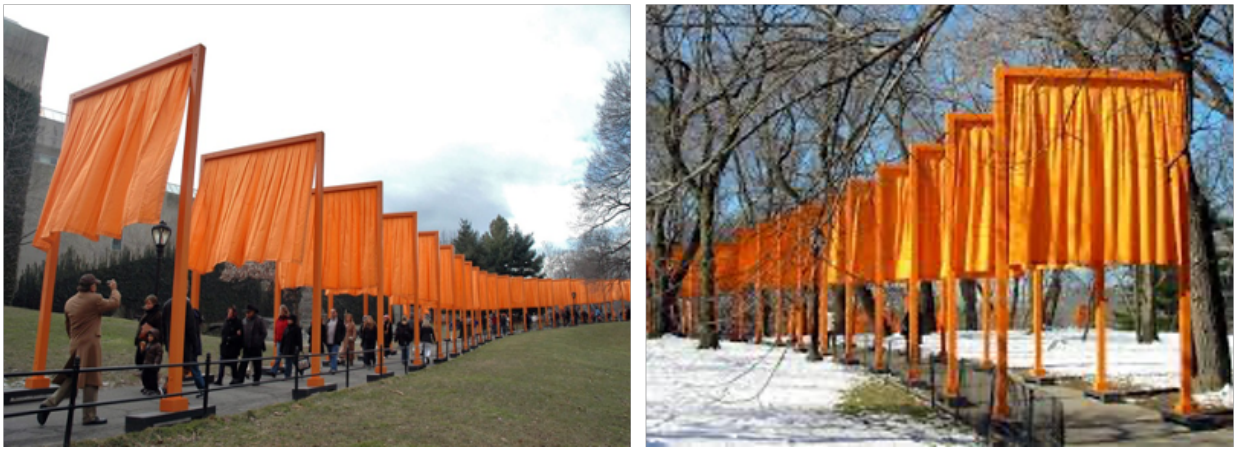


Fig 2.32. The Gates by Christo and Jeanne-Claude, Central Park, New York, 2005

Conceived for almost 26 years, The Gates opened to the public in 2005 and turned out to be a successful art installation. The idea was to change the fabric of everyday places, in this case, Central Park and let users experience a journey through interactive, sculptural art. Anchored on steel bases, vinyl poles stood draped by saffron fabric that swayed, unfurled and added fluidity and a golden hue through its translucent material. 7,500 gates stood 16 feet tall for 16 days.



Fig 2.33. (L-R) Translucent saffron fabric adding a golden hue; Artists Christo and Jeanne-Claude

Textile Installations

Numerous textile installations have been taking place across the globe wherein spaces are dressed in fabrics, and viewers are offered an opportunity to experience and explore them. Although temporary, the installations gather limelight, essential for the domain's upliftment.

a) Nila X The Art Lab Studio: *Corona Quilt Project*

The Corona Quilt Project[20] has been conceptualized by artist duo Dia Mehhta and Neha Modi in collaboration with The Art Lab Studio. The textile-oriented project has been displayed at Nila House in Jaipur. Based on the concept, 'Stories of Healing in Cloth', the public art installation celebrates the textile based historical ecosystems of Rajasthan. As means of community engagement to generate revenue for the weaving groups that were affected during the pandemic, the installations advocate the thought through seminars as well. Seen in Figure 2.34. are multiple 75" squares in the form of patchwork, each handmade by over 200 artisans displaying varied textile techniques, across Rajasthan, depicting culture.



Fig 2.34. Various scenes from the textile installation setting at the Nila House in Jaipur

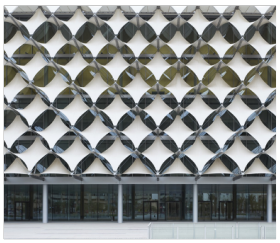
From weaving to block-printing to knitting, the fabrics embellish the interior spaces as tapestries and enhance them in a traditional, crafty essence. The rich fabrics depict tenderness for healing.

[20] https://www.platform-mag.com/art/the-nila-x-corona-quilt-project.html

2.4. Textile Attributes



Dynamic Nature



Flexibility



Moldability



Portability



Woven



Wrapping



Light-weight

Textiles singularly as a material have the ability to be woven, wrapped, molded or stretched. They are light-weight fabrics that acquire portability. This very portable character makes them suitable for the production of either prototype-based architecture or refugee architecture. In both these cases, the development of textile forms is cheap, adaptable and easy to transport. The flexible nature of textiles renders a dynamic quality wherein they are capable of shape-shifting their form, unfurling, swaying with the wind and cascading like drapes.

Textiles can provide shade, comfort, character and identity to a built form. They can alter perspectives of looking at a structure or landscape by incorporating one of their attributes. While textiles do require to merge with other building materials to stay anchored in place, they are the primarily active material that complete a composition and change narratives.

2.5. User Survey

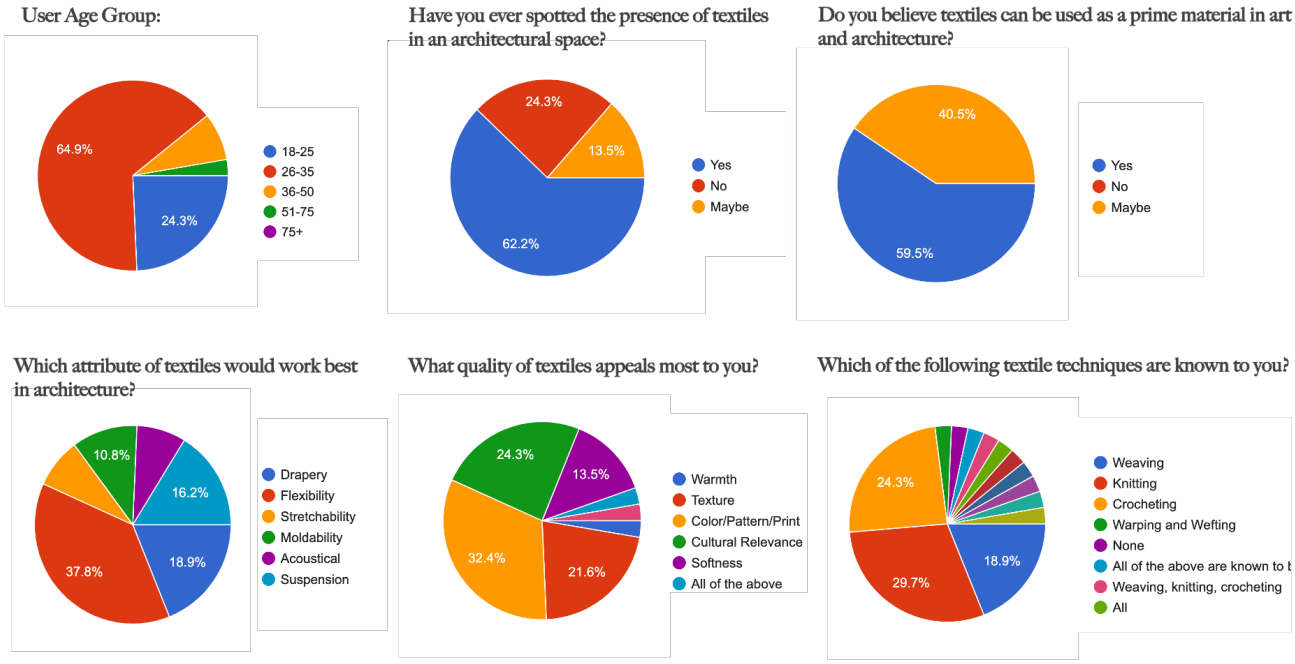


Fig 2.35. Pie chart diagrams showing the results of the conducted user survey

As a part of quantitative research methodology, a user survey was conducted to understand the association of end users with textiles as well as built environments. It was a week-long survey that urged participants to think about their interactions with textiles, whether in the form of a memory, a privacy element, a plush setting or as ornamentation. When asked about what textiles mean to them, most participants responded as identity and comfort.

The results of a survey study conducted with 50 users from architectural and non-architectural backgrounds defined their understanding of textiles and architecture, what attribute appeals to them, the techniques of textiles known to them and their awareness of this intersection between textiles and architecture. The perceptions and opinions helped derive the parameters of evaluating textiles and architecture.

3.0. Chapter 03: Theoretical Framework

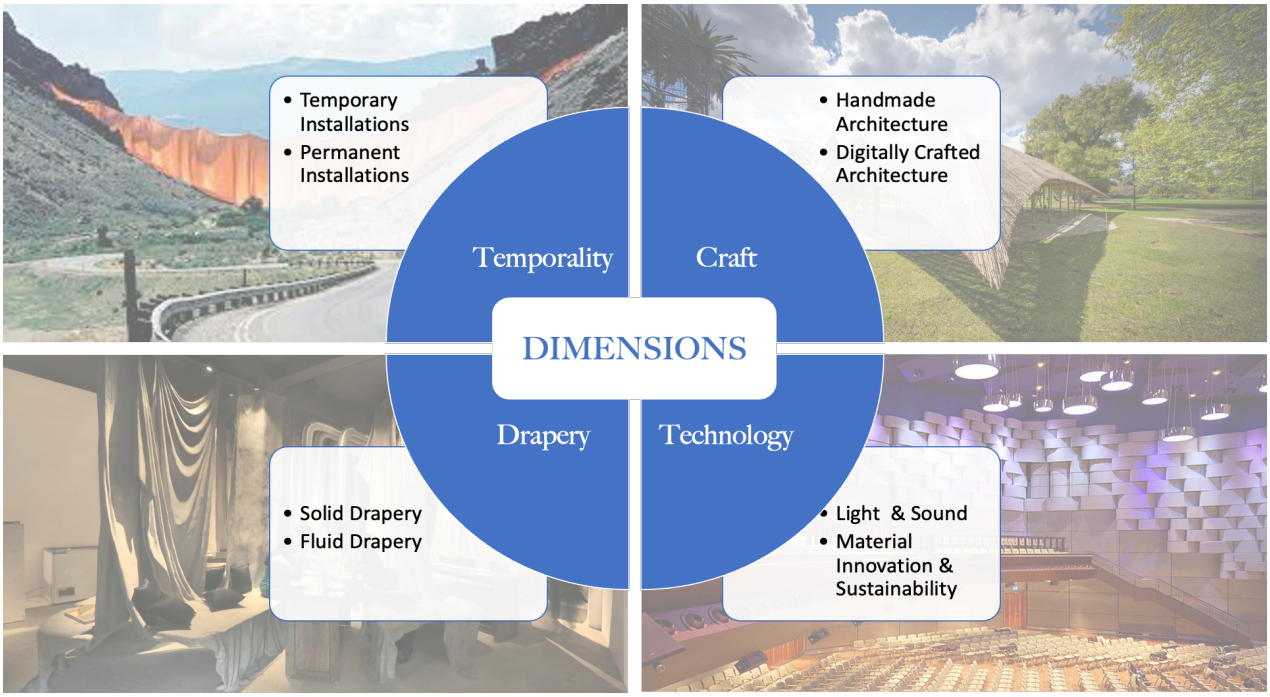


Fig 3.1. Theoretical framework of dimensions outlining the thesis

The user survey helped formulate the parameters of evaluating textiles with respect to art and architecture. Almost all the users spoke about how they hold on to a piece of textiles, which hinted at the temporality of the material. The cultural aspect of textile seemed most appealing to the users, which reflects upon the idea of craft. The most relatable portrayal of textiles to the end users is its curtaining and providing privacy, which directly relates to the art of drapery. The thesis is predominantly outlined by a theoretical framework of four dimensions—Temporality, Craft, Drapery, and Technology. The dimension of temporality looks into the durational timeline of textile installations and their impact within that said timeframe. The dimension of craft studies the craftsmanship of structures in collaboration with the textile communities. The dimension of drapery focuses on the proportions and relations of a body (human or structure) and the fabric (garment or textile) that drapes around it. The dimension of technology looks into the future potential of textiles with respect to innovative technologies and materiality.

3.1. Dimension of Temporality

3.1.1. Introduction

Any matter in its existing form and through its evolution has had a long-standing relationship with time. Similarly, the equation of textiles and architecture too has witnessed a transitional chronicle of design manifestations. And while the potential of textiles in design continues to be evaluated on multiple parameters, let's address the intersection of fabric, art, and architecture through the lens of temporality—a framework woven in time and space.

It has been observed that there are some designs that stand the test of time, narrating a story of their existence and adaptation. These designs constantly reinvent themselves to continue being valued. Examples of this category could be heritage structures or iconic designs that have been associated with generations and act as a symbol of art and architectural movements in time. And then there are designs that are crafted with a temporary objective, in an attempt to fascinate people, to let them wander through the experience, to broaden perspectives, for experimentation, or to attach relevance to the ongoing social, cultural or political scenario. Even though they exist for a short duration of time and are eventually going to be taken down, they leave back—a long lasting impact, a memory, a sense of association. Examples of this category could be exhibitions, installations, set designs, makeshift structures, and the likes of it.

It is often believed that textiles solidify time; they weave time and freeze it into an artistic memento to be revisited time and again. And this has been reiterated even in fantasy tales like '*The Wheel of Time'*, wherein 'warp and weft' have always been linked to time portals. This very dimension of temporality studies the relationship between textiles, art, and architecture through the medium of demonstrative case-studies; each with a varied duration of existence, and illustrative examples that depict the scope of temporal interplay offered by textiles.

Demonstrative case-studies include a balance of two permanent textile installations and two temporary textile installations. Case study 01 portrays a textile playground of *Rainbow Net* in Japan, conceived as a permanent interactive environment within a solid environment. Case Study 02 delves into a symbolic textile installation of *Impatient Optimist* in Seattle that is suspended as an extroverted sculpture between two solid buildings, is far from tactility and yet acts as a permanent element of connectedness. Case Study 03 shifts to an ethereal, temporary installation called *Graced with Light* in San Francisco's Grace Cathedral, assembled for a music festival. This string art installation holds a symbolic value and is interactive in its purpose. Case study 04 talks about an interesting composition of another temporary installation, Lumen in MoMA's courtyard in New York. Envisioned for a music festival, this summer installation experiments with materiality and technology while alternating between its temporality.



Fig 3.2. (CW; L-R) *Rainbow Net; Impatient Optimist; Graced with Light; Lumen*

3.1.2. Case Study 01: *Rainbow Net* by Japanese artist, Toshiko Horiuchi



Fig 3.3. Textile environment fostering an interactive play area for the kids

Conceived as a playful and colorful composition of interwoven nylon threads, *Rainbow Net* by Japanese artist, Toshiko Horiuchi MacAdam renders Sapporo's Takino Suzuran Hillside National Park in an interactive temporality. Employing the techniques of knitting and crocheting, the fiber artist took around three years to curate this vibrant piece of textile by hand. Acting as a tactile medium for a kid's play area, it offers an interesting, curious and joyous experience to the children who love to sway, swing, jump, explore and curl up in this textile bubble. Suspended from an intertwined wooden structure, the textile installation creates a soft, protected environment within an environment. The upbeat spirit of this piece combines with the warmth of wood and offers a sensory experience, wherein the kids can touch, pull or tug a string and even feel the textile weaves as they crawl through the installation. Unlike the temporary setting of most of the installations, *Rainbow Net* has been crafted with a permanent vision.



Fig 3.4. Kids crawling through the woven textile are able to touch and feel the texture



Fig 3.5. The textile composition is suspended from all sides and anchored to a wooden encasing

Talking to a magazine portal, My Modern Met, the artist explains that she specializes in, “creating large, interactive textile environments that function both as imaginative and vibrant explorations of color and form, at the same time as providing thrilling play environments.”[21]



Fig 3.6. (L-R) A dangling, soft textile assortment within a wooden cocoon; Artist weaving the textile art

The case study illustrates that textiles have the potential to be explored variably in a way that their natural characteristics can add a lively, qualitative and rhythmic weightage to an otherwise solidified space/structure. In this case, the nylon threads have been molded, stretched, knitted, suspended and deformed into different forms to develop a geometric, sculptural installation. Even the encompassing wooden shell symbolizes an interlocking weaving pattern that resonates with the internal textile capsule. Colors, patterns and flexibility of textiles come together to produce this light-weight, mesh-like arrangement that’s entertaining, safe and secured in place.



Fig 3.7. (L-R) Interior of the textile bubble; Exterior of the textile assortment

[21] https://mymodernmet.com/vibrantly-colored-crocheted-playground/

3.1.3. Case Study 02: *Impatient Optimist* by Janet Echelman, Seattle, 2015



Fig 3.8. Textile sculpture suspended from the two structures of Bill & Melinda Gates

Unraveled as a free-spirited and floating aerial net sculpture, the 'Impatient Optimist' by Massachusetts-based artist, Janet Echelman represented a beacon of light and hope, upon being unveiled on February 10th, 2015. The curating process took about two years, and the sculptural installation went on to grace the courtyard between two buildings of the Bill & Melinda Gates Foundation in Seattle. Spanning 120 feet long, 80 feet wide and 40 feet in depth, the organic composition, made out of ultra-lightweight polyester fibers and nylon threads has been suspended from the two neighboring structures. This work of textile art has certainly added a layer of dynamism to its associated architecture. While the aerial sculpture doesn't offer tactility and physical interaction, it does communicate visually.

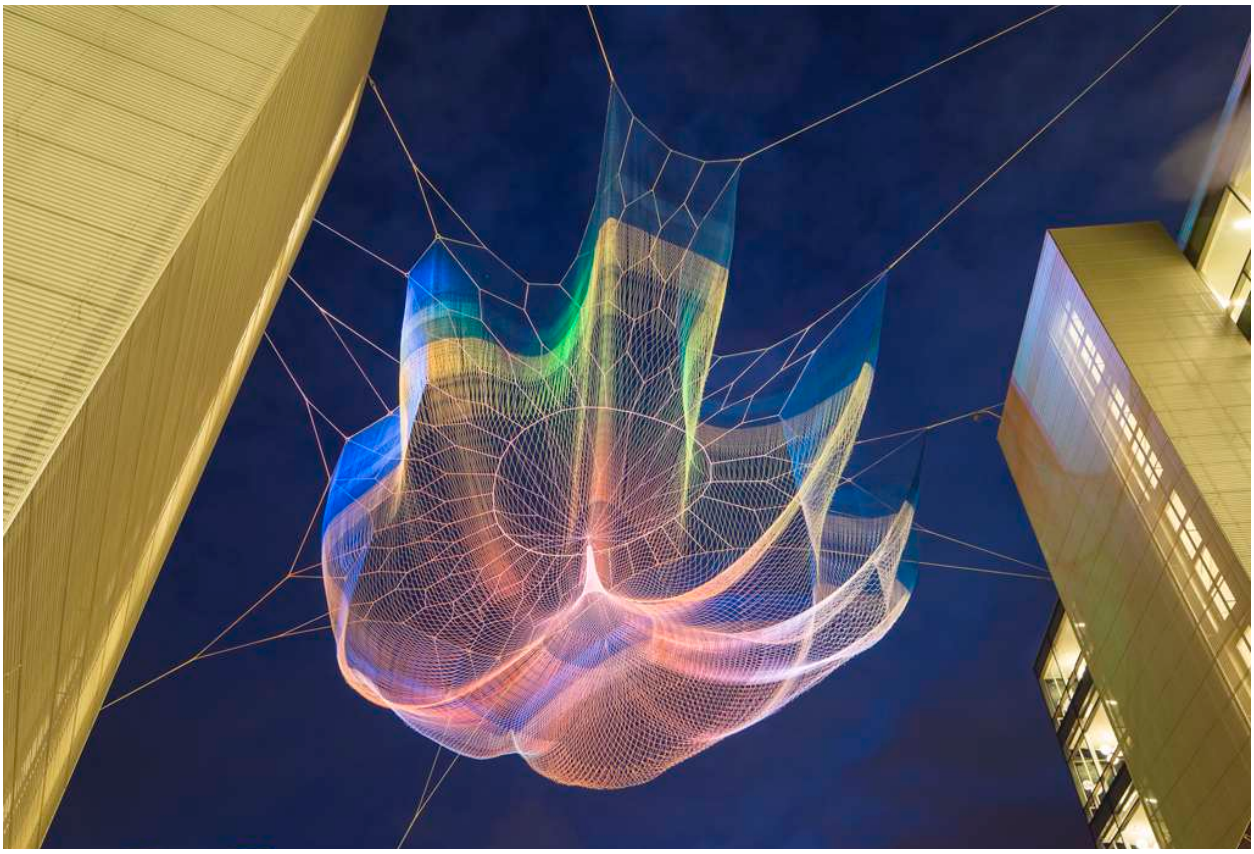


Fig 3.9. Luminescent aerial sculpture creating patterns with its textile materiality

Bill & Melinda Gates Foundation describe it as an ephemeral artwork that, “becomes an immense, iridescent jellyfish hovering above the campus and shifting in the breeze.” While it is suspended and anchored in place from all sides, its textile materiality allows it to shape-shift and create formative dances with the wind. During the day, the sculpture appears as a thin network of threads, calmly settled in place. At night though, it captures the LED lighting projected from below and displays it in a rhythmic pattern on its skin. As the light beams interact with the threads, the sculpture prominently starts to contort into different forms thereby revealing its unsettling, impatient side. The sculpture puts itself out there to be viewed and approached from varied vantage points. This characteristic resonates with the work of the foundation towards health and wellness. It lends an extroverted demeanor to the inward facing buildings. We can see that the textile here is subjected to being pulled, stretched, deformed, and suspended in thin air. Similar to the Rainbow

Net, this aerial sculpture too has been envisioned as a permanent installation. Vanguard Seattle states, “Impatient Optimist is at once local and global, light and resilient, artistic and scientific. In place of divisions and oppositions, “Impatient Optimist,” like the Gates Foundation, builds bridges seeking to connect and collaborate. The permanent installation is an impressive and wonderful addition to the city landscape, reflecting the roots of the Gates Foundation here in Seattle. Drawn from the very identity of the foundation itself, “Impatient Optimist” embodies its namesake, looking skyward, across the world, to envision the dawn even in darkness and strive for a better tomorrow.” It is essential to note the fact that in order to echo the concept of building bridges and existing at intersections, textiles are employed as a medium. Echelman believes that the sculpture has a particular relevance to the setting, because “the number of knots alludes to the notion that the work of a single foundation member can affect a million lives.”[22]



Fig 3.10. Textile sculpture shape-shifting its form in the day

[22] https://www.gatesfoundation.org/ideas/media-center/press-releases/2015/02/impatient-optimist-sculpture-unveiled

3.1.4. Case Study 03: *Graced with Light* by Anne Patterson, San Francisco, 2015



Fig 3.11. String art installation adding an elegant touch to the voluminous cathedral

The free-suspended string installation imbues the Grace Cathedral in an illuminated glow. *Graced with Light:* The Ribbon Project[23] was launched in March 2013 with a durational vision of four months for a music festival. Due to its subtle but meaningful interactive quality, it became popular enough to be extended four times and ran its course till February 2015, for almost a year. The cathedral is donned with colorful strings of crimson and blue, suspended from the ceiling. Community members and visitors conversed with the installation by writing messages and wishes on the ribbons, in a symbolic hope that they will ascend straight up to the heavenly power as indicated by the linear, uninterrupted composition. This project has been assembled by hand by the artist and members of the Grace Cathedral in San Francisco, California.

[23] https://www.annepatterson.com/graced-with-light



Fig 3.12. Strings of red and blue shades add a subtle vibrancy to the muted cathedral

The selection of a fabric string for the execution of this project focuses on an interesting choice of material that has the ability to add vibrancy and spirit to the concrete cathedral as well as a touch of softness to its intimidating structural volume; an explicit trait of textiles. Strings as a material also have a continual meaning to them, which reflects on the continuous temporality of this installation. The strings can be looped, intertwined or converted into any other composition to keep their purpose going. The strings have messages written on them that emulate an intangible quality of always existing and being passed on. So, while the tangible temporality lived on for almost a year, the intangible temporality continues to live on.

3.1.5. Case Study 04: *Lumen,* MoMA's PS1 Courtyard, New York by Jenny Sabin Studio



Fig 3.13. Stretched and dangled textile assortment of Lumen covering the MoMA courtyard

Stretched over the courtyard space at MoMA in New York, *Lumen* by Jenny Sabin Studio uses a cellular lumen fabric (a poly thread material) to wrap the space in a poetic motion. The otherwise static space has been punctuated in movement, which aligns with the rhythmic movement of people during the music festival for which it has been designed. Curated for MoMA's 2017 Young Architects Program, this kinetic canopy was envisioned as a temporary, sustainable covering for the Warm Up music series, hosted by the museum during summer. It is interesting to note that the lumen fabric is composed of recycled photo-luminescent textiles that capture solar energy and convert it into light. The temporality of this textile assortment changes alternately between day and night. The presence of textiles and its ability to perform multiple functions alters the fabric of the courtyard, constantly offering new experiences to the users.



Fig 3.14. Top view of the Lumen fabric spanning over the MoMA courtyard



Fig 3.15. Textile canopy suspended from surrounding structures with mist installation for cooling

Like an act of metamorphism, the *Lumen* looks calm and playful during the day with the mist sprays attached to it as a medium of interaction and cooling during the summer. As night engulfs the courtyard, *Lumen* transforms into a futuristic sci-fi set as it is illuminated in glorious pink, purple and blue hues. The integration of technology and sustainability with the temporality of textiles is observed through this installation, successfully catering to each component. The textiles here are stretched, deformed, molded into a repetitive form, suspended, and left dangling for the visitors to interact with the material. This web-like installation is also supported by piercing circular frames on which ropes are diagonally woven thereby imparting a twisting pattern. The floor replicates the pattern of the canopy as an interplay of light and shadow carpets it. *Lumen* is robotically woven as a textile composition. Reason for a mechanical craftsmanship may account to the integration of technology as well as the prototypical typology of its pattern.

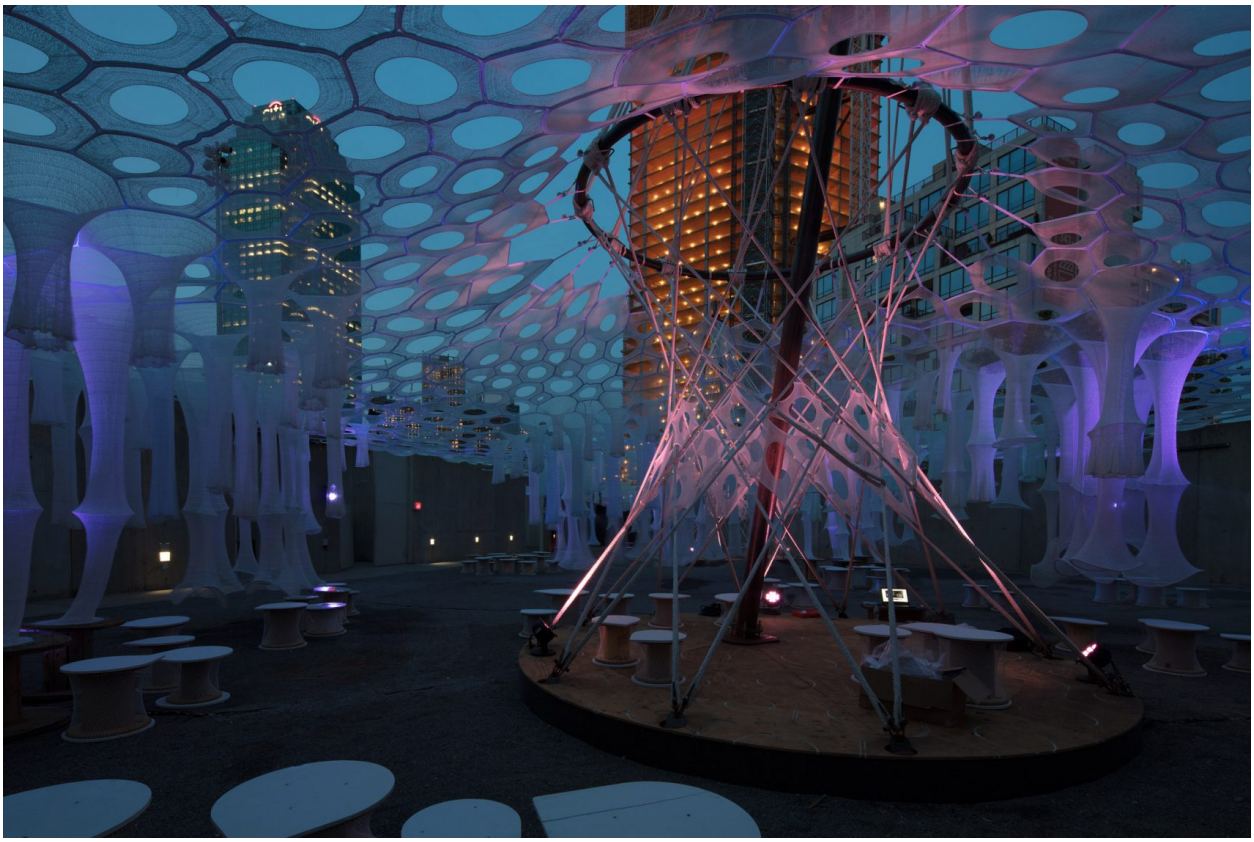


Fig 3.16. Lumen turns the courtyard into a futuristic, LED illuminated setting at night



Fig 3.17. Metal posts pierce through the textile canopy a dynamic character and support

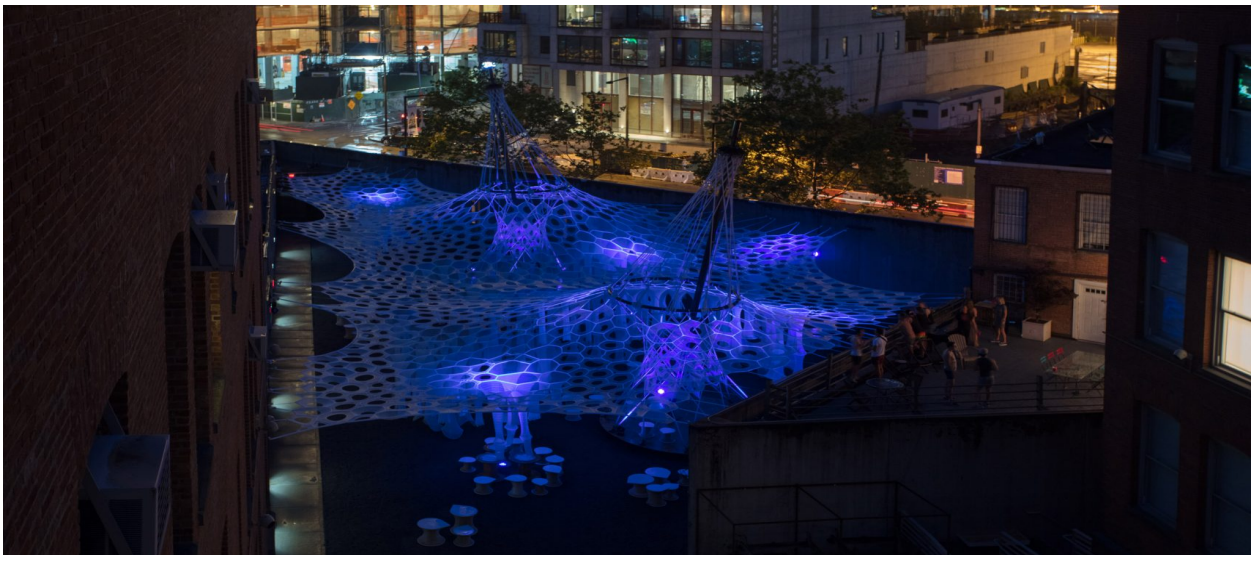


Fig 3.18. Lumen glowing at night in its organic, prototypical demeanor

The recycled, circular stool seating also aligns with the circular punctures in the illuminated textile canopy thereby encompassing all design elements in a cohesive installation. Courtyards are spaces that encourage gathering and to associate them with textiles (also accounting to tying and weaving) is definitely a smart, metaphorical concept.

3.1.6. Illustrative Examples

While case-studies are certainly closer to the lens of analysis and offer the scope for detailed research, illustrative examples act as supporting factors to further (i) strengthen an argument, (ii) demonstrate a variety of work, and (iii) present a collective approach. Working along the same lines, this research will now present examples of work across regions, techniques, concepts, and designers that have stretched the potential of fabric in relation to the dimension of temporality.

Example 01: *"Plexus No. 19"* Series by Gabriel Dawe, Como, Italy



Fig 3.19. String art adorning the muted, classical villa in impressions of soft light beams

Conceptualized as soft beams of vibrant light, this elegant yet impactful thread installation stands against a mellowed classical architecture of Villa Olmo in Como, Italy. Arranged by Mexican artist Gabriel Dawe, the colorful strings are secured in place by tying their loose ends between two central atriums. It projects an illusion of soft illumination space, breathing softness into a structured, disciplined style of classical architecture. It adds a lively spirit to the muted interiors.

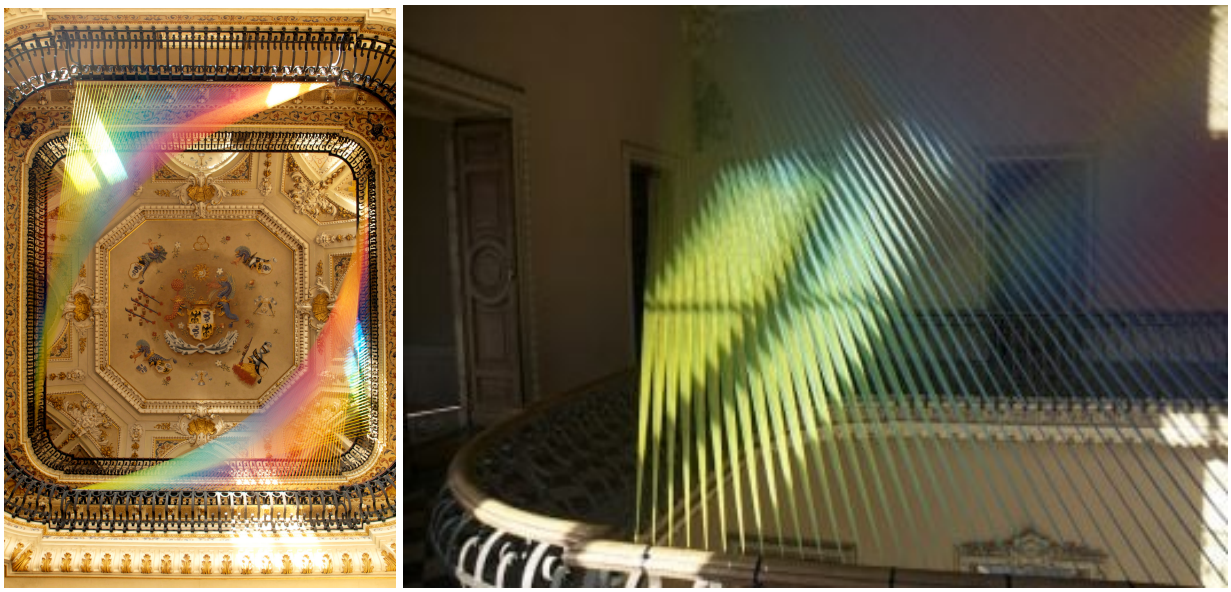


Fig 3.20. (L-R) Top view of the atrium adorned in strings; Strings interacting with light beams



Fig 3.21. View from below looking at the juxtaposition of ornamented ceiling against graceful strings

The composition aligns with the pointed arches of the structure. This string art installation is massive in its scale and adds an ethereal glow to the neoclassical ornamented setting. It is also interesting to know that this string artwork was commissioned in response to the preservation of the classical architecture style of the villa. Keeping the purpose at the forefront, this string art exhibit takes place every year for a temporary but continued period of time, wherein this modern form of art revisits to blend with its age-old roots. The artist has been mindful of the intricate murals and motifs donned on the ceiling and has therefore created a subtle, non-interfering but classic composition of string art that only accentuates the space without hampering its original character. Under the *Plexus* series, varied graphical, soft geometries can be witnessed in different spaces, enriching them.



Fig 3.22. Strings are arranged in a twisting, organic pattern rendering soft curves to a grid setting

Example 02: *Valley Curtain* by Christo and Jeanne-Claude, Rifle, Colorado, 1972



Fig. 3.23. Valley curtain transforming the landscape of Rifle Gap

Another marvel in the art and sculptural domain by artists, Christo and Jeanne-Claude, Valley Curtain has been perceived as an environmental art that changed the fabric of a landscape in Rifle Gap, Colorado. A huge community of students, artists and volunteers joined hands in a collaborative effort to install this sculptural textile art for a duration of 28 months. A project that took years to conceive, 28 months to assemble, stayed in place for just 28 hours. The temporality of this installation has not one, but many layers attached to it. It left an impact and a perception change for eternity. Again, an intangible and symbolic aspect of textile temporality comes into picture. The textile installation included 18,600 square meters of woven nylon, saffron-hued fabric that dangled in between the valley and was anchored with the help of rope and cable system, also derived from textile fibers. While some of their other textile installations include solid building materials for support systems, this project was predominantly textile oriented. The stretchability of textiles, its translucent quality of letting light pass through it and its rhythmic character of moving with the wind, all added to a rendition of this temporal, textile installation.

3.1.7. Conclusion

The Dimension of Temporality addressed four prime case-studies in both the temporary and permanent installation domains. It is evident from the case-studies that temporality of textiles varies according to the specific form of textile used (threads, meshwork, fabric, strings) as they are woven differently into a composition that can be tangible or intangible in nature. The temporality dimension shows that textiles have a quality that connects with the sensory response of a user. For example, textile compositions can be remembered through memory, visual, attachment, or touch. Remembrance equals to textiles existing in time thereby increasing their durational frequency. Temporality does not just account to a physical existence of a textile assortment, it also focuses on the impact, relevance and legacy left behind by that textile installation, which is cherished and felt for years to come.

The illustrative examples further support this argument wherein they transform the way we perceive a structure or a landscape by inducing textiles into it for a short duration of time. This involvement of textiles is responsible for replenishing an old structure, as textile converses with it in a new light. While textile installations are taken down after they've served their purpose, the perceptions they created, continue to build on. Additionally, tangibly too, a renewal quality is attached to textiles as most of these are either recycled or reused in a different textile installation thereby keeping their temporality alive and reinvented.

3.2. Dimension of Craft

3.2.1. Introduction

Associated with the art and skill of creation by hand, craft has been one of the most essential components of textiles, art and architecture. For ages now, strings and fabrics have been woven into textile pieces by molding time and culture in between palms. Similarly in architecture, when bricks were laid together by hand or when traditional lashing techniques were used—a built form was created. In either case, the process of intricate craftsmanship has been involved, leaving room for variation, hard work, and a touch of familiarity. Whether it's granny's carefully crocheted piece of textile or an age-old handloom hung as an interior tapestry—they're handcrafted with love and a personal touch. An American teepee, a Mongolian yurt or a Mughal Shamiyana, they are all a product of building and assembling by hand. That's right where architecture began. Depicting a cultural relevance and imparting a unique identity to each piece of textile, art or built form, the dimension of craft reveals a systematic story of time and progression as opposed to mass-produced outcomes.

While handcrafted skill might lack precision or be time consuming, it enriches the space in a raw, unique identity. The process of exercising this handmade skill involves labor thereby generating employment opportunities and uplifting local weaving and mason communities. A symbol of teamwork and coordinated effort for large scale projects is what resonates with the idea of craft. Through the dimension of craft, this thesis examines the intersection of handwoven textiles with handmade architecture, wherein traditional methods of construction are reinterpreted. Another domain of this dimension also explores the digitally/machine crafted framework of textiles into architectural spaces, focusing on the sensory, aesthetic and functional quality of this skilled intersection.

3.2.2. Case Study 01: *MPavilion* in Melbourne, Australia, 2016 by Bijoy Jain



Fig 3.24. The woven roof kneeling down to the ground with its tapered geometry on all four sides

Born out of a culturally responsive design, the MPavilion in Melbourne is considered to be the largest bamboo structure in Australia. It is interesting to note that while the pavilion is built to provide an uninterrupted space for gathering and interaction, the process of crafting it also revolved around the idea of collaboration. Realized as a temporary structure for four months, this pavilion is a classic example of handmade architecture. Resting on bamboo support is a woven fabric roof, made out of fibers and sticks from Karvi plant. Architect Bijoy Jain's work has always used local vernacular materials, and collaborative efforts that encourage community involvement. Similarly, to achieve a handmade textile roof, a community of weavers in India knitted the roof panels for four months and the panels were then installed and assembled on site. The bamboos have been tied together using the traditional Maori lashing method of knotting by ropes. An essence of culture

and local spirit is evident in the process of crafting this pavilion, which focused on providing a space for exhibits, conventions, lecture series and the likes of it.



Fig 3.25. A traditional Indian entrance tower is placed beside the pavilion

Stretching across spans on all four sides, the cantilevered roof expresses the soft, textured and moldable attributes of textile. From each corner, the roof is viewed as a tapered geometry, kneeling and bowing down to the ground in humbleness—rightly absorbed from the local spirit. Being fabric-oriented in nature, the roof provides a sense of comfort, a safe, protective shelter for the visitors gathered in huge numbers. While it stays true to the dimension of craft, it also inclines towards the dimension of technology. An overlap in functionality is witnessed when at night, the textile roof offers a platform to project a light and sound show.



Fig 3.26. Top view of the pavilion with an almost central skylight acting as a connecting portal



Fig 3.27. Gathering space of the pavilion in light and shade play imitating dyed textile textures

The roof uses skills of weaving and lashing to be tied together. Additionally, the roof invites an interplay of light and shadow, casting patterned impressions on the ground that are reminiscent of hand-woven dyed textiles when they are hung for drying. A vertical shaft opening pierces through the woven roof, connecting the sky to the earth as well as the well that's situated beneath it. Aligning with the verticality of the shaft is the traditional Indian entrance tower (*tazia*), whose original purpose is to be displayed as a welcoming element in temporary ceremonies.

In an interview in Dezeen, Jain reveals, "My objective has not just been to create a new building but to capture the spirit of the place by choosing the right materials, respecting the surrounding nature and working collaboratively with local craftspeople to share design and construction ideas." The architect's intention of envisioning a space to gather, think and reflect has been manifested through a creative connectedness wherein exchange of ideas is nurtured. Designed as a summer pavilion, the project was sponsored by the Naomi Milgrom Foundation, whose founder shares, "As a utopian space for the creative industry and community, MPavilion continues to challenge the way we see and engage with the world by encouraging design debate and cultural exchange."[24]

The unified roof has also been dressed in mud plaster, as an analogy of lifting the mud off the ground in a continuation of tying the earth and sky together. The space inbetween is the room that's left for tangible manifestations of community participation. And indeed, this is what handmade stands for—love, warmth, efforts, identity, collaboration, and culture—every aspect that textile as a material has the potential to offer.

[24] https://www.dezeen.com/2016/10/04/studio-mumbai-bijoy-jain-mpavilion-2016-completed-bamboo-wood-melbourne/

3.2.3. Case Study 02: *Fass School* in Senegal, West Africa, 2016 by Toshiko Mori Architect



Fig 3.28. A hand woven thatch roof similar to an asymmetrical skirt textile

Cocooned in an elliptical geometry, the *Fass School* in remote Senegal is an institutional oasis that focuses on providing shelter and shade for the students' educational space as well as the teacher's residence, which is housed within. Representing a variety of textile attributes, the structure's sail-like roof kneels down to the floor in an asymmetrical skirt pattern. Molded around the core of mud-brick walls, the bamboo and thatch roof is knitted together through elegant, handmade craftsmanship. Designed for secular education with a capacity of around 300 students, the inverted pitched roof sets the structure into a rhythmic, vernacular flow. It rises and lowers at different points throughout the curve, offering experiences in sectional geometry as well as behaving like a piece of textile. A continual character of linear, wavy lines is observed throughout the elliptical form resonating with crisp creases or subtle undulations on a textile piece. Similar to the *MPavilion* in Australia, *Fass School* too is dressed in local materials, traditional architectural form and humility as it bow downs to the ground. This pattern raises an interesting question: what is it about handmade craftsmanship that keeps it close to its roots?

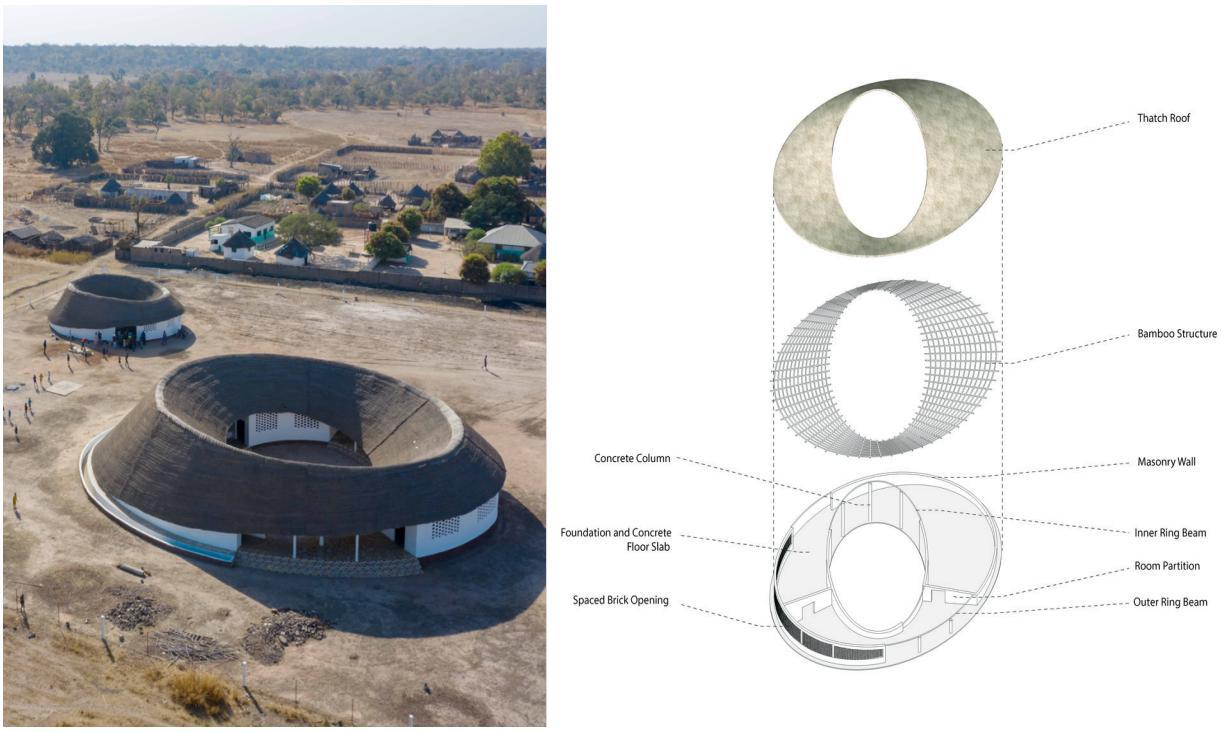


Fig 3.29. (L-R) Site view with two modules of the Fass School; Structural system



Fig 3.30. Hand woven thatch roof encircling the courtyard like the hem of a skirt in textile creases

Forming an internal courtyard like the hem of a skirt, the roof circumvents the structural form and renders an effect of being folded on the inside. It dips down to a level wherein the children can interact with its composition. All the classroom spaces open up into a common space that provides access to the internal, central courtyard.



Fig 3.31. Classrooms with perforated wall punctures opening out to the central courtyard

Within the classrooms, students can visually interact with the outdoors through the perforated openings that regulate efficient ventilation and face inwards to the courtyard. The walls too are painted white in order to reflect the extreme heat of the region and to contribute to the stack effect. Additionally, thatch as a local material also provides the much-needed insulation. The geometry of the structure allows for open curved corridors that provide easy access and efficient circulation between classes as opposed to linear, single-guided passages in conventional schools. The roof has also been tilted at specific angles to create a desired slope for the rainwater to be collected into the closest aquifer on site. Handmade architecture inherently has the quality to merge with sustainability for a functional design.

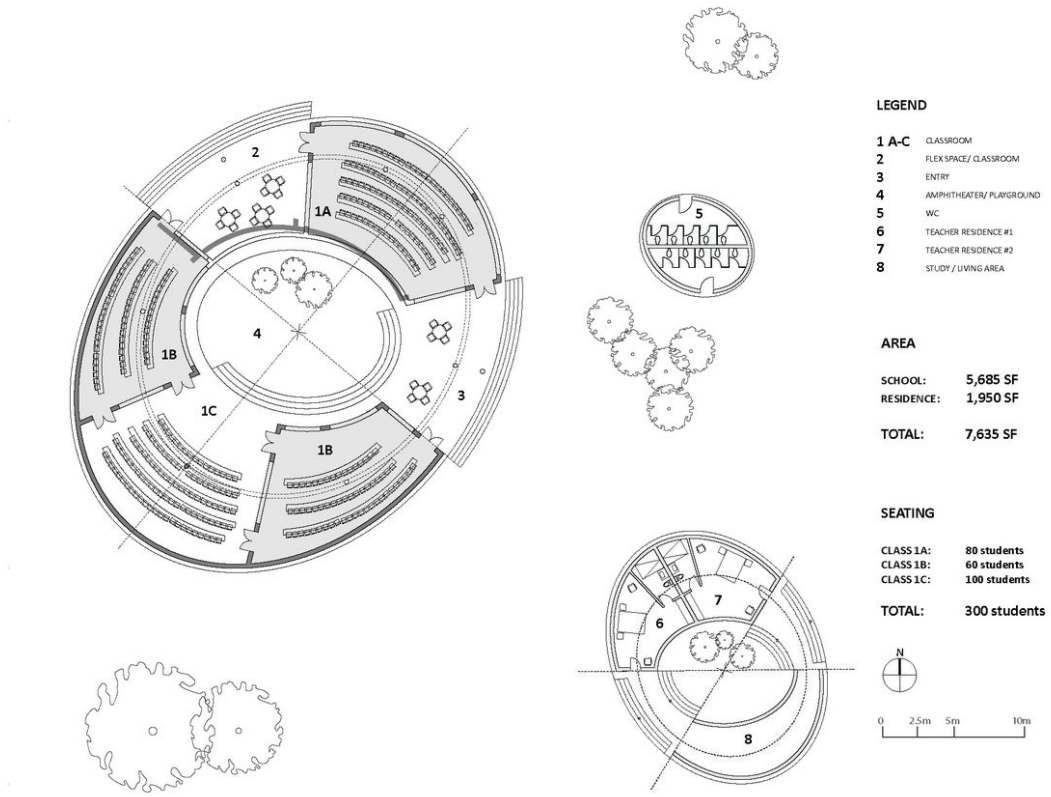


Fig 3.32. Floor plan showing the classroom layouts and a mix of indoor and outdoor spaces

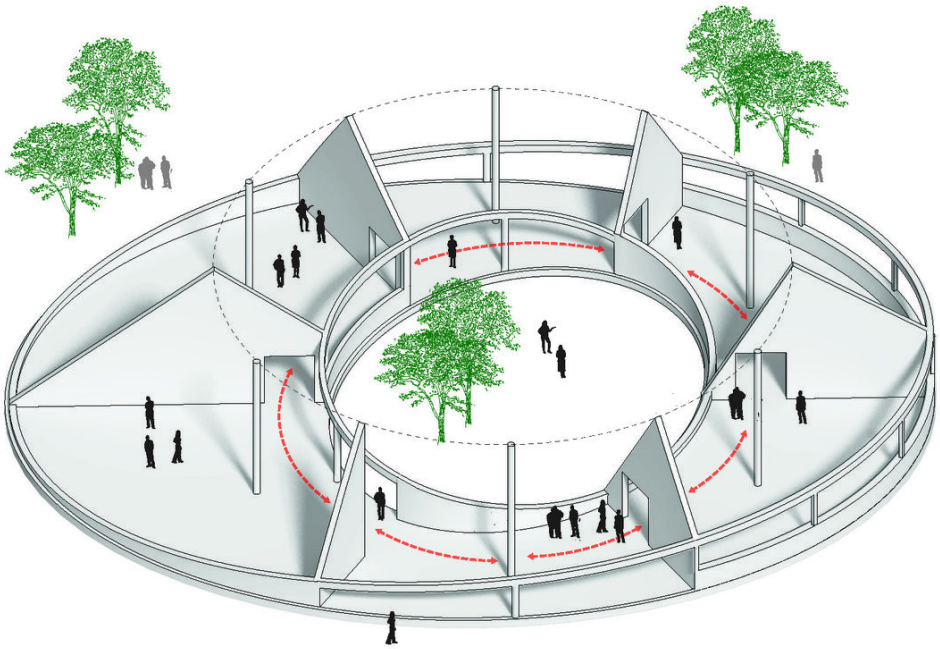


Fig 3.33. A 3D sectional model showing the internal division within the elliptical form



Fig 3.34. Sectional elevations showing the organic behavior and high-low points of the roof



Fig 3.35. Connecting foyer spaces extending out to the internal courtyard



Fig 3.36. Classroom interiors exposed to the warmth and texture of the woven thatch roof

The case study implies that textiles have implications that add to the essentiality of a structure. With just the incorporation of one textile-oriented roof, the *Fass School* acquired an identity, a cultural relevance, insulation properties, texture, comfort, rhythm and moldability. This relationship of a community to textiles is often conveyed through the comforting, textural and cultural properties of fabrics as also reiterated through the perspective survey.



Fig 3.37. (L-R) The low kneel roof imitating fabric texture; Internal courtyard

3.2.4. Case Study 03: *House of Book* by Olga Sanina and Marcelo Dantas, Madrid, Spain



Fig 3.38. Thin textile membranes merge together to create an expression of pages of a book

Unfolding a story of fluidity through an expression of book pages, this Madrid Book Fair Pavilion, also called as House of Book, is rhythm personified. Crafted by architects Olga Sanina and Marcelo Dantas, the temporary pavilion was created to make users experience the poetic essence of being inside a book and navigating through its pages. Often Portuguese architecture pays an ode to its textile roots and the sea, wherein textile knots were used for shipbuilding purposes. Taking a part of that inherent legacy ahead, Portuguese architects here have used digitally crafted, white textile panels and placed them in a series arrangement to generate a rippled page effect. The pavilion consists of a central auditorium space that is enriched with texture, muted tones, and kinetic movement. As wind sways through the pavilion space, the white panels (termed as tissues by the architects) produce patterns of dance to interact with the users. The pavilion certainly exhibits lightness and portability, another major textile attribute.

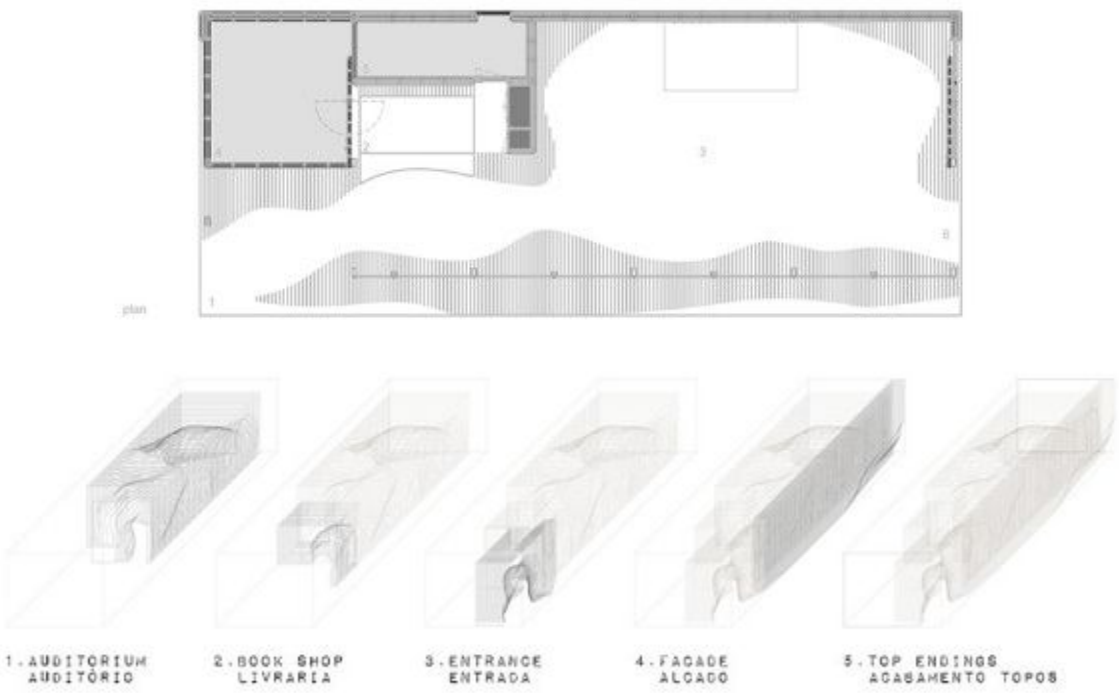


Fig 3.39. Floor layout (top) and modular iterations (bottom) for the textile structure

The advantage of being digitally crafted is the fact that multiple prototypes can be developed as rhythmic textile iterations, catering to specific scale and proportion of spaces. The pavilion uses multiple panels that are cut out to be of the same size and precisely placed along a planned route to achieve a desired pattern. A combination of opaque and transparent panels is incorporated in order to initiate an interplay of light and shade. The pavilion is placed at the intersection of opposing forces, such as,

a) Singularity and Entity

While multiple singular textile panels have been used to achieve a form, each panel acts independently and adds value to the geometry. It is only because every panel adds up to create a bundled effect of book pages, this pavilion stands true to its name and concept of inhabiting a book. Having said that, the installation of panels in a precise manner gives an impression of a cohesive, fluid entity that correlates to each other and acts in unison.

b) Clarity and Curiosity

While the transparency of textile panels allows one to expect what the interiors might look like, the space within is a series of exploration through a curious passageway that opens into a volumetric auditorium and reflects on the expanse of fluid geometry. Similar to a book that slowly unveils its mystery, the pavilion too takes its time to unravel what all is in store.

c) Similarity and Experimentation

During the conceptualization of this pavilion, a series of identical panels were crafted alongside a handful of unique panels in order to experiment with different angles and curves in a way that the composition feels like a floating tissue within a book. While some frames appear similar, some others are placed in a layering pattern, their different configurations adding to an interesting assembly of volume.

d) Inert and Movement

From the outside, the House of Book gives an inert idea, as if it is fixed in a place and is immovable. However, the textile panels supported on a metal frame contribute to a lightweight, portable structure, which can either be carried as a whole entity or be dismantled in parts and assembled again in a new location, thereby maintaining the continuity of its purpose. Additionally, when the wind isn't blowing, the pavilion stagnantly stands rendering visual fluidity. But, the moment wind passes through it, the installation begins to sway—each textile panel moving in sync with the rest of the composition. This physical, rippling movement is possible due to the usage of textiles as a prime material as opposed to any other firm material.



Fig 3.40. Layering of the textile membranes in the auditorium like fanning pages of a book



Fig 3.41. Pristine ambience in organic curves and soft folds

The blank, white canvas of this pavilion offers movement, lightness, poetry, mystery, rhythm, layered experiences, fluidity, and interaction—all through the use of positioned textile panels. The pavilion installation is infused in an ethereal glow of revelation, reiterating the fact that this book is certainly meant to be read as the pages offer way more than what the cover suggests.

3.2.5. Case Study 04: *King Fahad Library*, 2013 by Gerber Architekten, Saudi Arabia



Fig 3.42. Front elevation of King Fahad Library in filigree textile treatment

An assortment of geometrical compositions—square plan, rectangular elevation and rhomboidal presence, this structure is a testament to tradition meets urbanity. Enclosing the original library within is the newly built facade structure that acts as an urban screen to lend identity to the developing urban square around. A symbolic meaning also prevails as the original library is hidden inside like a central treasure of knowledge while the outer facade interacts with the modern context of the area. Reinterpreting the primitive, Arabian Bedouin tents, the architects have crafted this filigree textile facade in a rhomboid awning pattern[25], representing the Arabian culture. A contemporary, monumental character defines the built form that is wrapped in the subtle, soft textiles. Anchored on a steel cable structure, the white textile membranes are stretched to achieve a tensile outline, echoing the Middle Eastern patterns. Similar to a thread that's continuously woven to form a linear stitch, the textile rhomboids also cohesively tie all sides of the facade in a continual, linear fashion.

[25] https://www.archdaily.com/469088/king-fahad-national-library-gerber-architekten

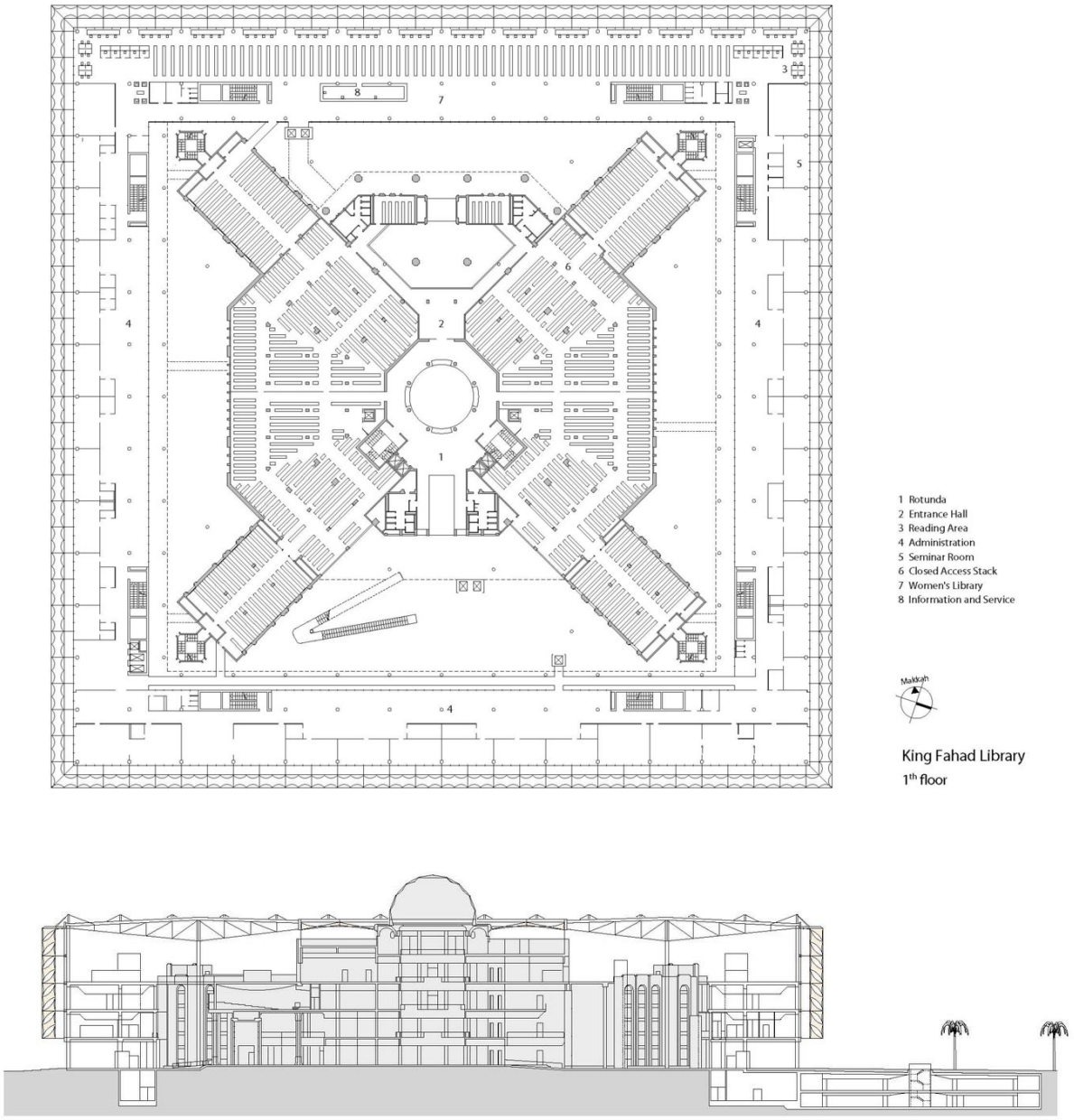


Fig 3.43. Floor plan showing the original library encased in cuboidal periphery (top); Section (bottom)

It is evident from the base layout and the sectional elevation that while addition of an external enclosure has transformed the aesthetic into a modern one, the internal structure still depicts a traditional architecture with a classical dome. Steel cable structures have been used throughout the elevation as well as parts of the roof to keep the internal and external treatment integrated.

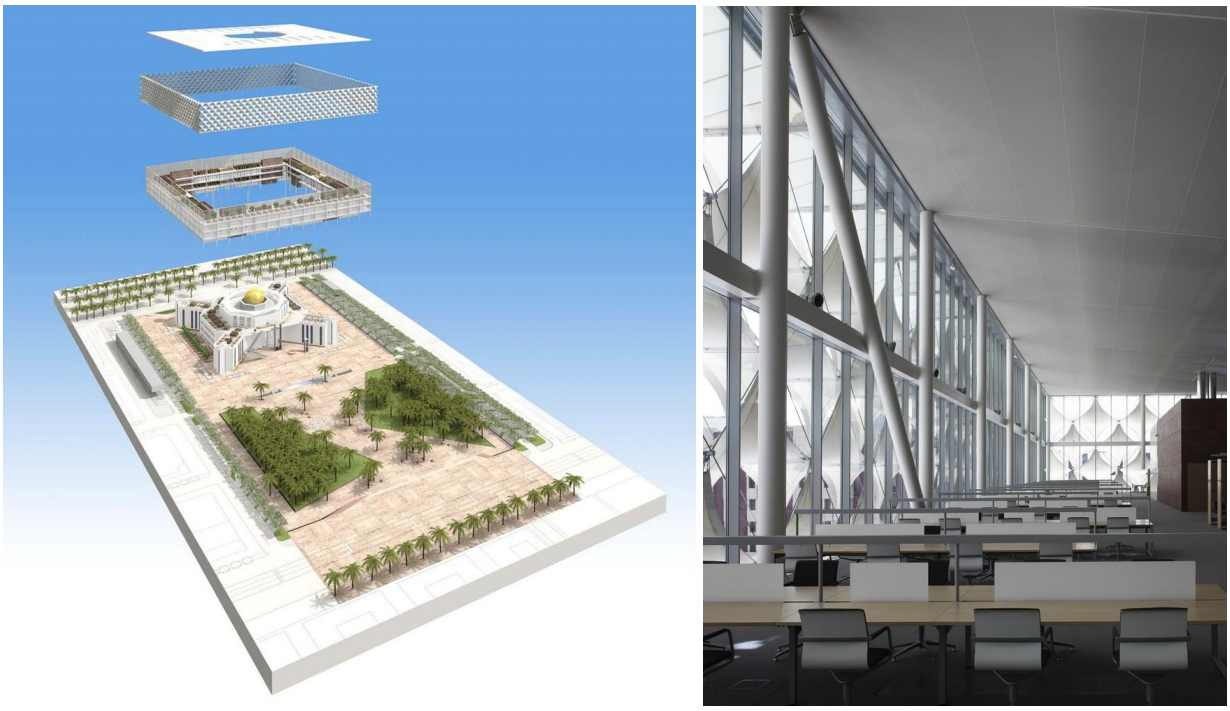


Fig 3.44. Perspective site model with structural encasing (left); Library interiors (right)

Arranged in a symmetrical fashion, the textile membranes impart an overlapping drapery effect when seen from the interiors, as if curtaining on the exterior. While a scenario of structural encasing (building within a building) is witnessed here, the softness and elegance of textiles personifies the original library building as a human body that's clothed with fabric; the latter signifying the new structural textile facade. The concept revolves around styling a culture with the use of internal and external buildings. Individual fabric pieces are digitally crafted to a specific size in order to maintain a precisely symmetrical composition.

Apart from the cultural relevance, the library works on a sustainable module that delves into energy consumption. The filigree textile facade also acts as a sunshade with a solar penetration of only 7 percent. Striking a balance between light and transparency, the textile membranes have been optimized and placed at specific orientations to follow the local sun path. This thereby

reduces the energy consumption. Additionally, textiles have an inherent quality of providing thermal comfort. The placement of these textile membranes has been done in a fashion that two opposing forces of concealing and revealing act at its intersection. The rhomboid awnings are alternately arranged so as to cushion and conceal in some parts and provide a glimpse to the exterior in other parts. This gives the impression of openness and lightness, making the structure approachable, just like textiles are approached, touched and felt. Furthermore, the roof textile membranes are punctured with skylights above common interior spaces, offering a layered ventilation (quite literally).



Fig 3.45. Textile membrane supported on steel cables and rods, revealing and concealing views

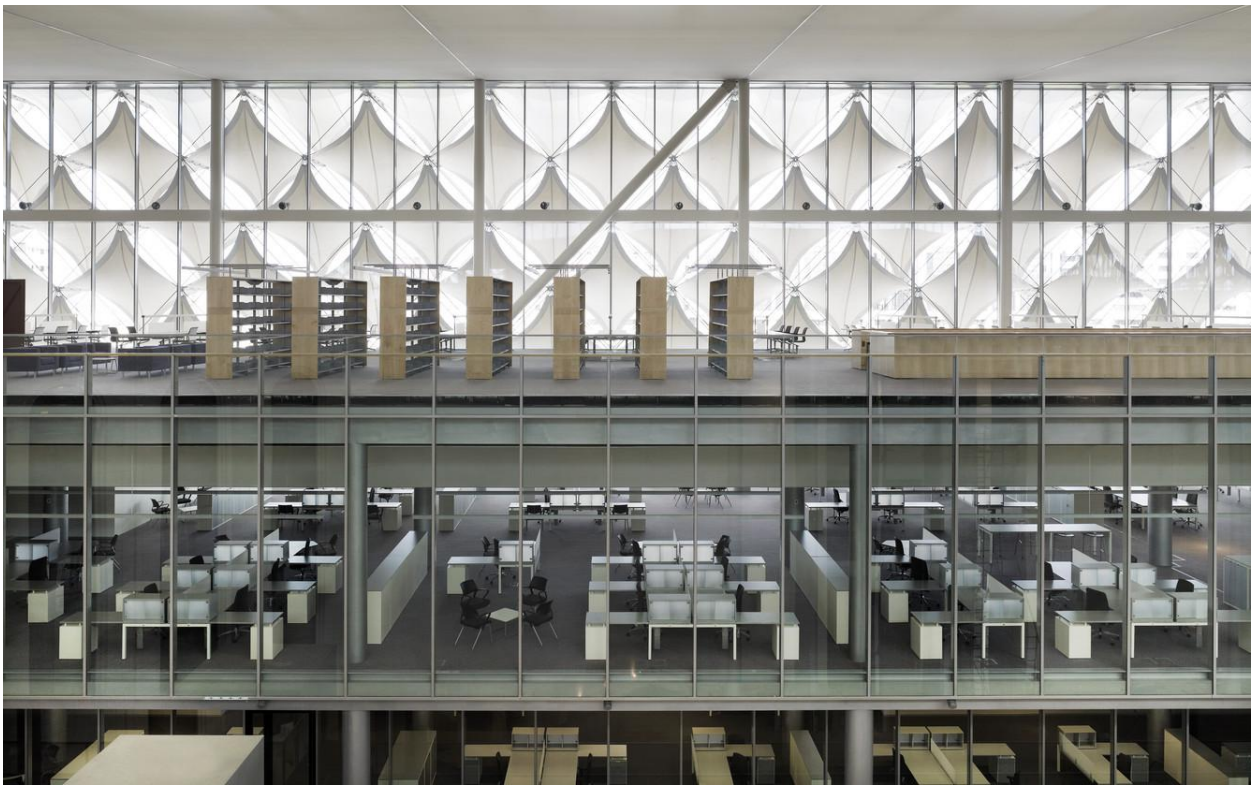


Fig 3.46. Library interiors looking out to a full-size soft, plush textile background

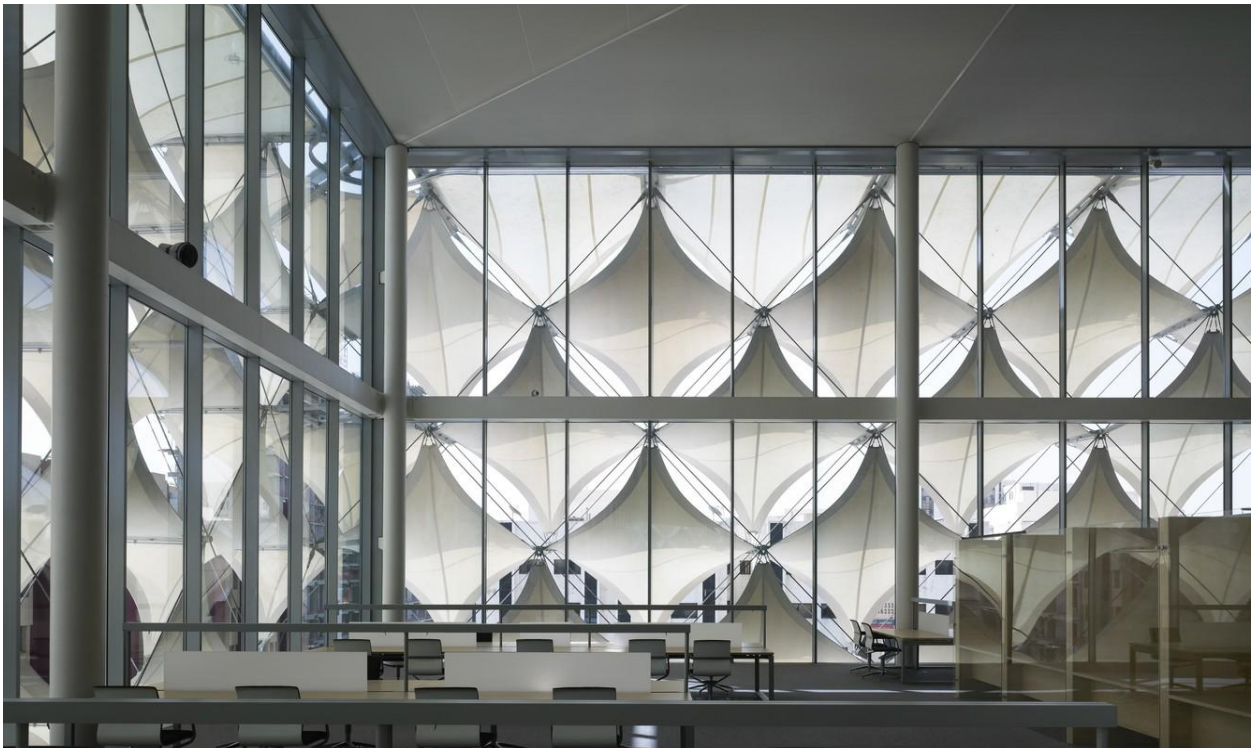


Fig 3.47. Textiles act as a cushioning and calming element within the library space

As for the internal spaces, the library-oriented areas are spread across all floors, with large, uninterrupted open-floor zones on the top floor to take advantage of the diffused light through the textile membranes as well as view through periodic skylights. The ground floor majorly consists of exhibit spaces, restaurants and a bookshop. Draped in fabrics, this library is a cultural bubble, cushioned by urbanity and setting an example for a local, iconic urban center.



Fig 3.48. Perspective view of the structure showing its' facade's angular geometry similar to the Bedouin tent (top); Arabic Bedouin tents as region-specific inspiration for the textile facade (bottom)

Folding, bending and stretching of the textiles creates multiple variations of a facade, when viewed from different angles. For example, when observed from a two-point perspective, the facade displays a continuous ribbon-like effect, adding a fluid rhythm to the structure. From a corner perspective, the sharp-edged yet delicate geometry resonates with the tapered angles of a traditional Arabic tent, staying rooted to the cultural aspect while providing a rich, contemporary aesthetic to the urban center.



Fig 3.49. King Fahad Library illuminating the surrounding urban square



Fig 3.50. Filigree textile facade imparting a rhythmic dynamism to the library structure

As mentioned by the architects to an online portal (ArchDaily), the textile facade transforms as it glows with changing colors, acting as a backdrop for light projections. This facet sees an overlap with the dimension of technology. The architects describe the library as the city's lighthouse, gleaming in a predominant luminous glow and serving as a focal structure in the newly developed urban plaza. While the structure and the landscape around it portrays a monumental presence due to their huge scale and proportion, the textiles on the facade soften the effect, enveloping the 1980s original library into a warm embrace. Aside from the facade's relation to the Arabic tents, it also pays homage to the traditional textile screens used in the Middle Eastern region. Raised on stilts throughout, the facade remains lit at night while the stilts are concealed in shadows—rendering the library in a floating band of rhythm and spatial interplay. Textile here has inhabited varied roles such as, an ornament that fashions the facade, an insulator that offers comfort, a cushion that provides protection, a screen that intersects with the indoor and outdoor, a curtain that conceals and reveals, and a catalyst that reinvents a cultural identity.

3.2.6. Illustrative Examples

While the case studies revolved around large scale projects that were either handcrafted or digitally crafted, the supporting examples look into small-scale projects such as installations as well as structures that use textiles as a cultural addition.

Example 01: *Windshape* by nArchitects, 2006, Lacoste, France

Built as a summer installation by nArchitects in collaboration with students at Savannah College of Arts and Design (SCAD), the *Windshape* is a woven piece of art, set in motion. Dancing to a rhythmic tune of the wind, the installation was commissioned by SCAD to host concerts, ceremonies and to act as a community meeting space. There's something comforting about gathering under a tent or being surrounded by an identical enclosure. Similarly, in the case of *Windshape*, two eight-meter-high pavilion structures integrate together on the terrace of a historic building, carving an ephemeral sculptural presence and displaying a symbol of connectedness.

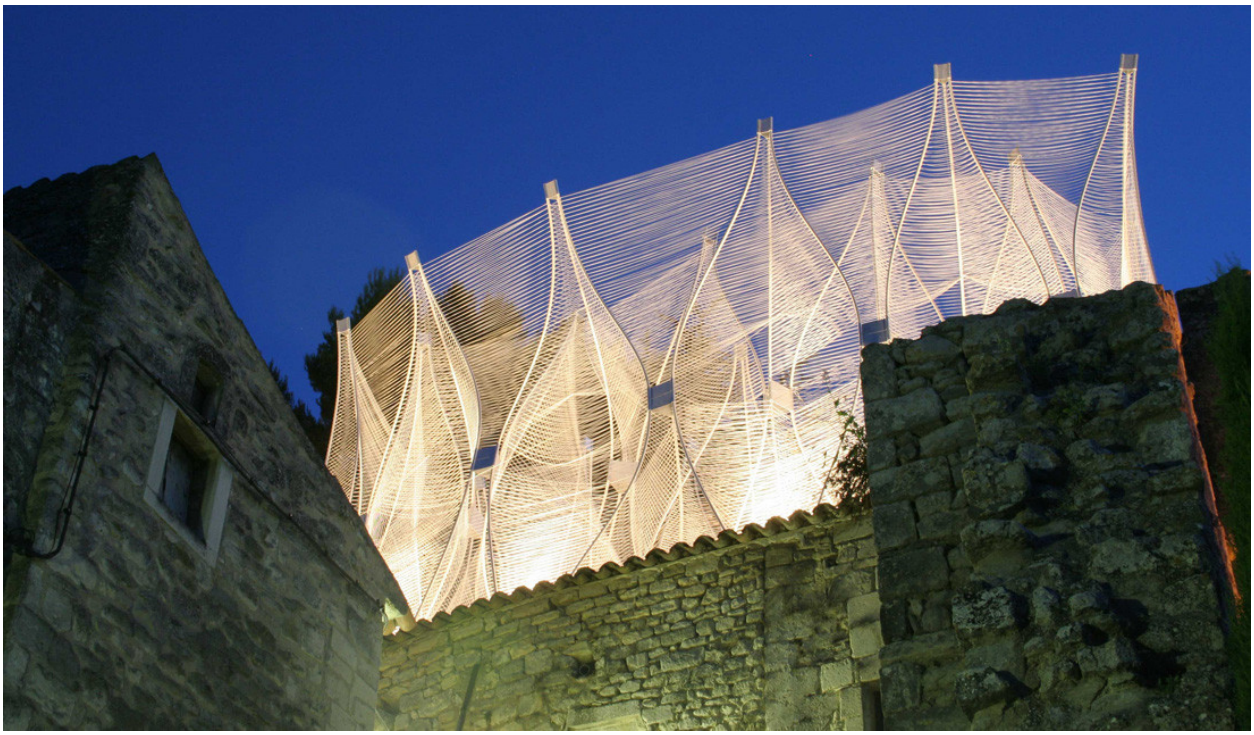


Fig 3.51. Windshape installation's organic form settled against limestone castle walls



Fig 3.52. A network of polypropylene strings hand woven around digitally crafted plastic poles (top and bottom)



Fig 3.53. Twisting and contorting of strings to create interesting textile iterations

An intricate network of polypropylene strings is woven around white plastic tubes and anchored by aluminium collars at junctions to achieve a geometry that resonates with the teepee architecture. At some places the strings are evenly spread out, at some others they become dense thereby lending a gradient character to the installation. As wind passes through the pavilion, the strings sway and twist, shape-shifting their form. From subtle oscillations to rippled mutations, the installation portrays a dramatic juxtaposition of the edgy, modern geometry to the surrounding limestone walled castles. The village of Lacoste has a harmonious blend of hard, rigid buildings coupled with soft, lush landscape. Through *Windshape*, the architects have attempted to reflect a mix of opposing landscapes into a single pavilion. And this yet again shows how textile is the chosen material to act at the intersection of opposite ideas.



Fig 3.54. Installation process of tying, twisting and weaving polypropylene strings

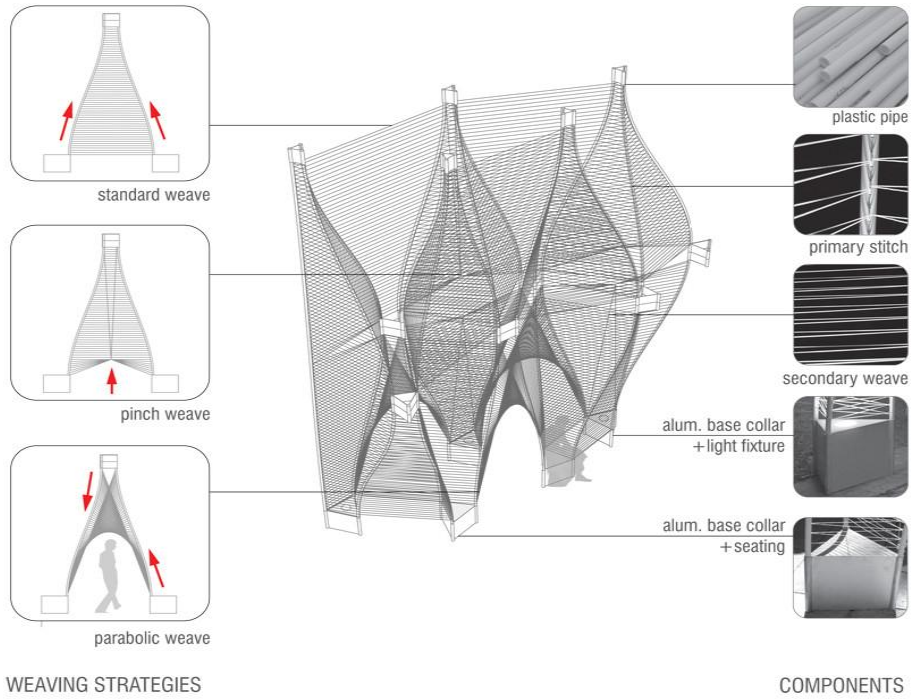


Fig 3.55. Form modulation process to replicate textile behavioral patterns

As seen in the figure above, various weaving and stitching strategies have been incorporated to create geometries that leave room for atrium punctures as well as archways and window openings. The whole purpose of this metamorphic pavilion is to establish an interactive connection between the indoor and outdoor environment, having mindfully known that the surrounding will always keep evolving. As for the complex yet delicate construction of this pavilion, both digital and handmade craft has been employed. The white plastic tubes have been digitally crafted to attain varied forms and have been grouped into tripods that can be bent or stretched. The polypropylene strings are however woven, stitched, and wrapped around digital configurations by hand, on the site itself, to maximize the tensile potential of textiles. Stimulating a rhythmic fluid movement to the pavilion, *Windshape* imposes dynamism to a static backdrop of heritage buildings in the vicinity. Additionally, at night, it transforms into a beacon of light and illuminates the building like a crown on the top.

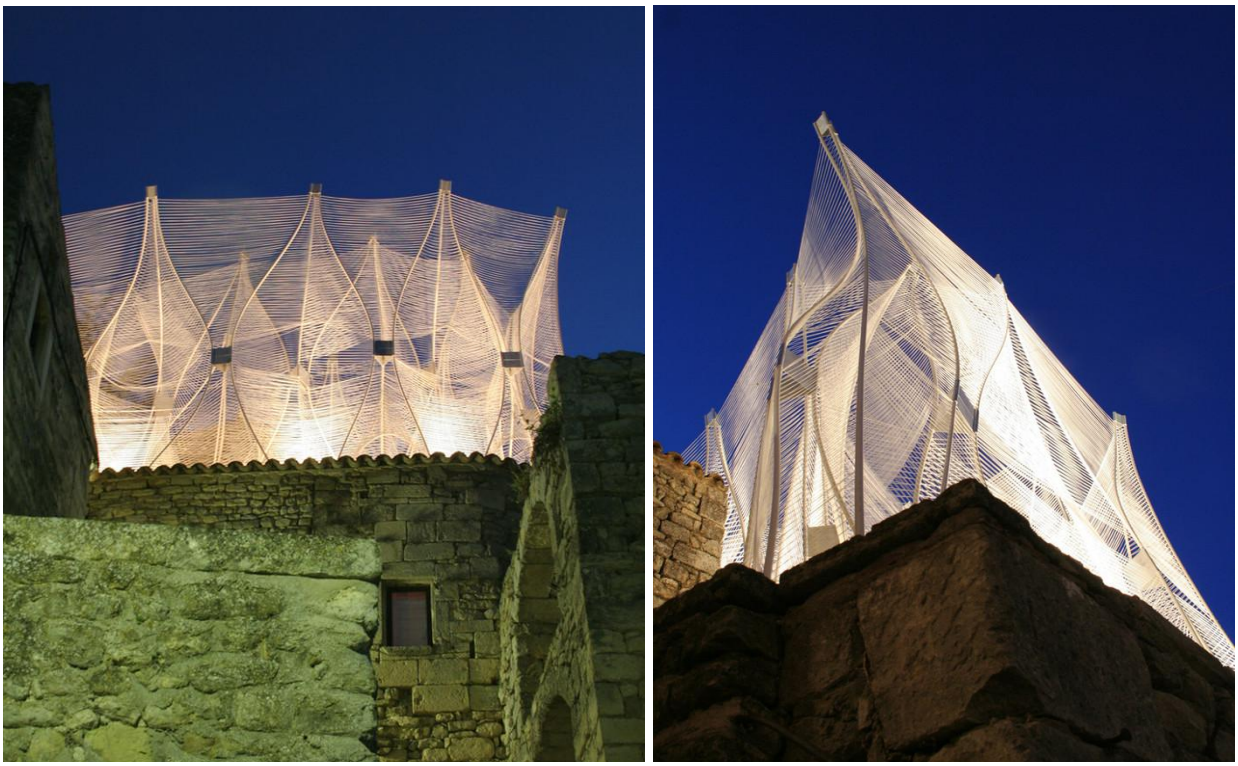


Fig 3.56. Windshape viewed as a crown of elegance on top of the classic stone structures

Example 02: *Te Māori Waiwhetu Cultural Centre* by Athfield Architects, New Zealand



Fig 3.57. Digitally carved panels depicting textile patterns from tukutuku textile panel prints

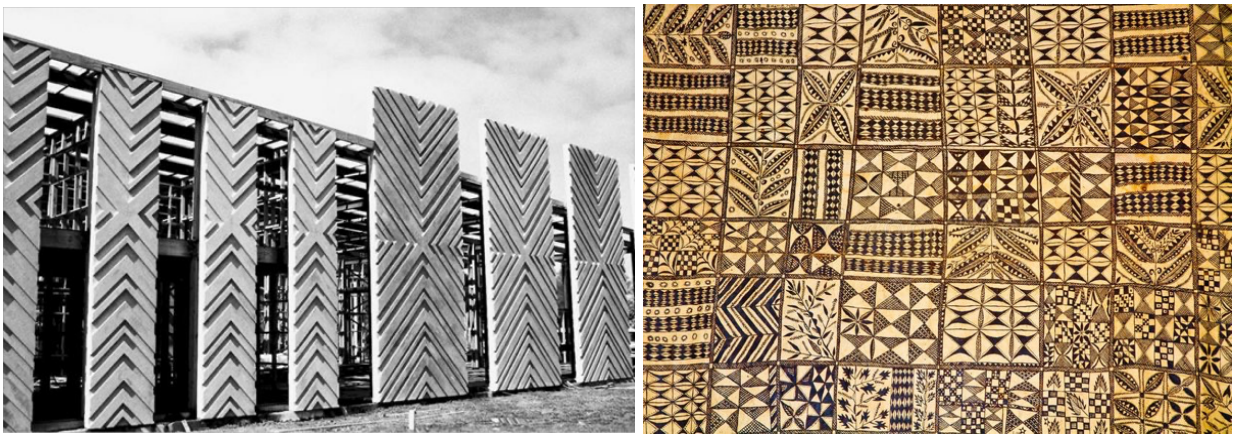


Fig 3.58. Detailed view of the panels with textile prints (left); Traditional textile prints (right)

Conceived as a civic building for community events, the structure is also tagged as a Repository of Treasures. The building on the external facade is donned with timber panels that are digitally carved in a repetitive pattern, which symbolizes the traditional *tukutuku* panels. These traditional panels are said to be imprinted with textile patterns, native to the region. Set along the north-south axis, the structure is ornamented with a ceremonial character reflected through the *tukutuku-inspired* timber panels, which lend a sense of movement and visual privacy to the structure. The building is used for community engagement purposes, another factor closely associated with textiles.

3.2.7. Conclusion

The dimension of craft delves into case-studies that are either handcrafted or digitally woven into textile architectural structures. The idea of craft revolves around community and culture. This is also what textiles echo. Handcrafted imbues an identity to a space or structure. Similarly, textiles also render an architectural space with their inherent attributes. This dimension reiterates the existence of textiles at the intersection of opposing forces, such as entity and singularity, inert and movement, identity and repetition.

Handcrafted architecture involves the curation of a unique design component such as the roofs of Fass School and MPavilion, both woven by a community of local weavers. The roofs are singular in nature and embrace an identity of their own. On the contrary, in digitally crafted architecture, for example the filigree textile facade in King Fahad Library repeats itself as a prototype in a continuous fashion.

Another aspect in the dimension of craft is that it revolves around retaining the purpose of textiles. In earlier times, textiles were seen providing shelter and comfort in the form of tents. Even now, in a more modern reinterpretation, tents are erected for ceremonial or gathering purposes. Tapping this quality of comfort and gathering people under the same roof, both Fass School and MPavilion focus on bringing the community together, cocooning them in a humble, low kneel roof that's woven out of a collaborative effort.

The dimension of craft attaches a cultural legacy and native spirit to a structure, which is intangibly carried on or passed on for years to come. This is how textiles connect past, present and future in a cycle. In MPavilion too, an opening in the woven textile roof pierces through to establish a connection between the earth, sky and the well beneath, creating a symbolic portal.

3.3. Dimension of Drapery

3.3.1. Introduction

The art of drapery dates back to the Indus Valley Civilization wherein a piece of cloth was used to drape the body. [26] This art gradually progressed into varied versions of drapery, both in the Eastern and the Western contexts. As a matter of fact, the Renaissance era used drapery to add texture to art and intricately carved sculptures. Whether we consider the multiple ways in which an Indian *Saree* can be draped or look at a Japanese *Kimono* or Western Gowns, drapery has existed everywhere. The art of drapery develops a relation with the human body or an object, accentuating its form further. Similarly, when architectural structures are wrapped in layers or employ the drapery art, a new dimension of dynamism enhances the built form. When a reflection of textiles and its qualities of flexibility, molding, layering, perforating, fluidity and movement are imbibed in structures, Drape Architecture is born.

Why is Drape Architecture essential?

Radiating a comforting essence, fabrics soothe the varied surfaces of an otherwise rigid structure. The most ancient forms of textiles used in architecture date back to the use of Bedouin tents, Mongolian yurts, American teepees and Indian *Shamiyanas* (ceremonial Mughal tents) to name a few. The evolution from tent to tensile forms has now extended its function to draping an entire built form with attributes of fabrics. As mentioned by Susanne Fritz, for Architonic, "Textile forms of habitation have a long history going back to Paleolithic times and represent an archetypal form of building which has endured to the present day. Textiles are light, easy to convert or dismantle, and they provide protection against wind, ultra-violet rays and rain." [27]

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[26] https://www.textileschool.com/4682/costumes-during-indus-valley-civilization/

[27] Using Fabrics in Architecture, Rethinking the Future - https://www.re-thinkingthefuture.com/fresh-perspectives/a6094-using-fabrics-in-architecture/

Offering a wide array of benefits, fabrics are inherently light-weight, durable, portable and flexible. Additionally, they reduce the urban heat island effect, require low maintenance, and add a creative domain of woven architecture to be explored. Drape architecture is required to test the potential of textiles further and experiment its existence in relation to fashion and culture. The concept also addresses the proportions and enhancements of a body (either human or a structure) with respect to the fabrics that wrap it in either fashion or architecture, subjected to overarching dialogues. Unlike other materials such as ferrocement concrete, metal, brick, tensile cables or stone, textiles are the only ones that we as humans wear or are draped in. It's as if we have known the touch, feel and essence of textiles and are aware of our interaction stimuli to it. Having been associated with textiles ever since we were born, the textile domain has an edge over other materials in terms of familiarity and sensory experiences.

The dimension of drapery specifically investigates fluid as well as solidified drapery. Architectural structures or spaces that are infused with fluidity and the quality is either inherent or generated by external factors thereby physically interacting with the user are a representation of fluid drapery. On the contrary, built forms that are induced with a visual rhythm or are derived from the character of drapes, symbolize solidified drapery; frozen in time and place. In fluid drapery, either the material itself is fabric or a different material is draped in a fashion to generate an actual movement. However, in solidified drapery, an impression of being draped is created to foster a sense of movement and rhythm. The thesis examines case-studies as well as illustrative examples in both these subdomains of drapery dimension to further test the potential of textiles at the intersection of art and architecture.

3.3.2. Case Study 01: *Bund Finance Center* by Foster + Partners, Shanghai



Fig 3.59. Draped layers of Bund Finance Center

Conceived as an arts and cultural center in the newly built financial district of Shanghai along the Bund waterfront, the three-level structure exhibits a character of dynamism within the complex. Designed by Foster + Partners and Heatherwick Studio, the multi-layered façade of the built form is reminiscent of an Indian Saree drapery. The structure consists of exhibit spaces, gathering venues and galleries that are partially concealed with the drape screens. The built form encourages interaction, imbuing a sense of community exchange. The purpose exactly aligns with the origin of a Saree. Apart from being a cultural garment, a Saree gave rise to experimentation, identity and variations that enriched the local weaving communities. This very exchange of fabrics, prints, patterns, textures and weaving techniques encouraged women of every Indian state to develop their own representation of a Saree.



Fig 3.60. Different drapery versions of cultural sarees in India

Attributes of an Indian Saree

The origin of the humble nine-yard drape dates back to the Indian subcontinent in the 5th millennium BC. Cultivated from cotton weaves, the Saree evolved over centuries to be made out of materials like nylon, silk, polyester, embroidery and the likes of it. Variations in block-work, prints, patterns and styles of draping have been representative of the native regions and culture. It is believed that the word Saree originated from 'sattika' meaning women's attire. [28] The evident attributes of a Saree constitute—flexibility, interconnection, seamlessness, multiple layering, lacework, perforations, fluidity, movement and wrapping. While it is seldom possible to find every aspect in a single built form, structures like the Bund Finance Center exhibit the prominent qualities of an Indian Saree thereby indulging in drape architecture.

[28] https://timesofindia.indiatimes.com/life-style/fashion/buzz/the-history-of-sari-the-nine-yard-wonder/articleshow/70277974.cms#:~:text=Sari%20might%20be%20a%20fashionable,BC%20in%20north%20west%20India.

Each screen is composed of suspended bronze tubes at varying heights thereby forming curved fold-like patterns that are the basis of wrapping a Saree. Similar to the garment, a central core reveals static and sturdy glimpses as the layering punctuates movement. A series of three distinct screens encompass the façade in an interconnected thread, similar to the different components of a Saree that fuse together for an aesthetic appeal. Although conceptualized as a reminder of open Chinese theater screens, looking out to the urban spaces, the structure resonates with the drapery of the East (South Asia: India). This overlap seems to have consciously traveled across regions over the past years synonymous to civilizations and culture. The textiles seemingly illustrate the extent of Eastern cultural diaspora. A seamless fluidity is infused in the built form as the bronze tubes respond to the swaying of the wind and create varying permutations. A single piece of Saree similarly can be molded, folded and draped into multiple permutations.

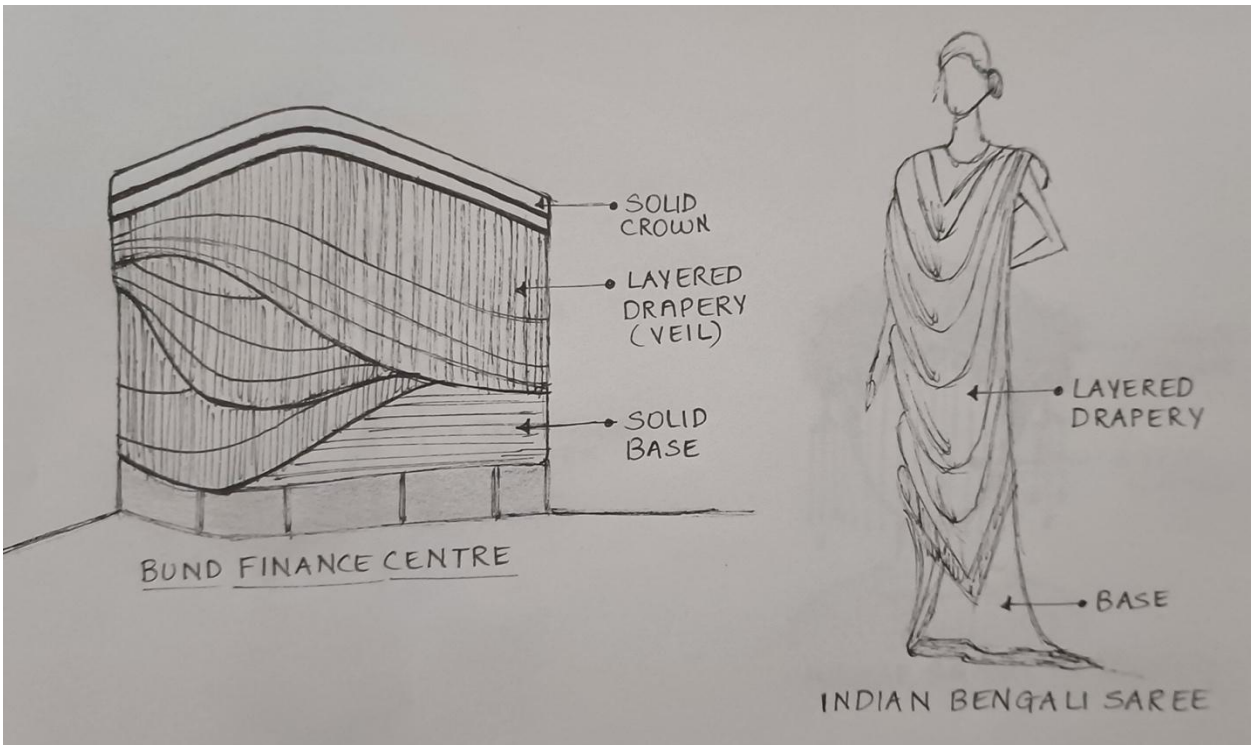


Fig 3.62. Illustration portraying correlation between the finance center building and Indian Bengali Saree

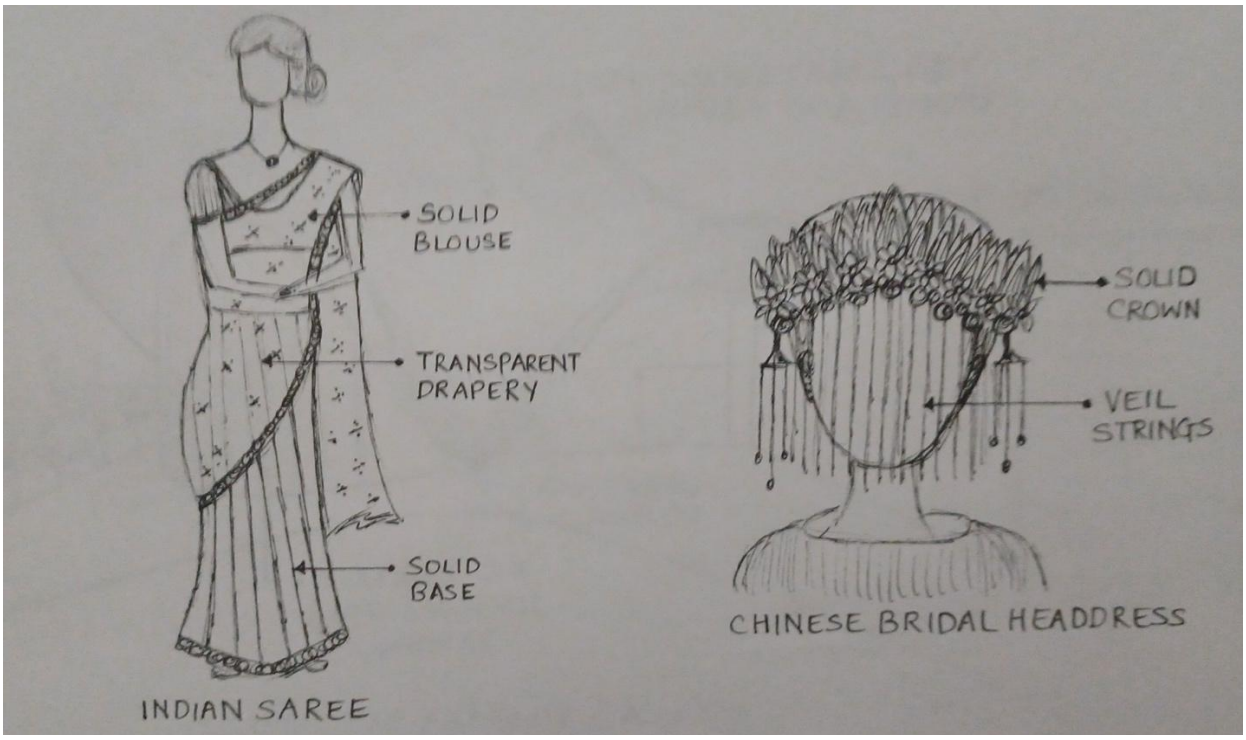
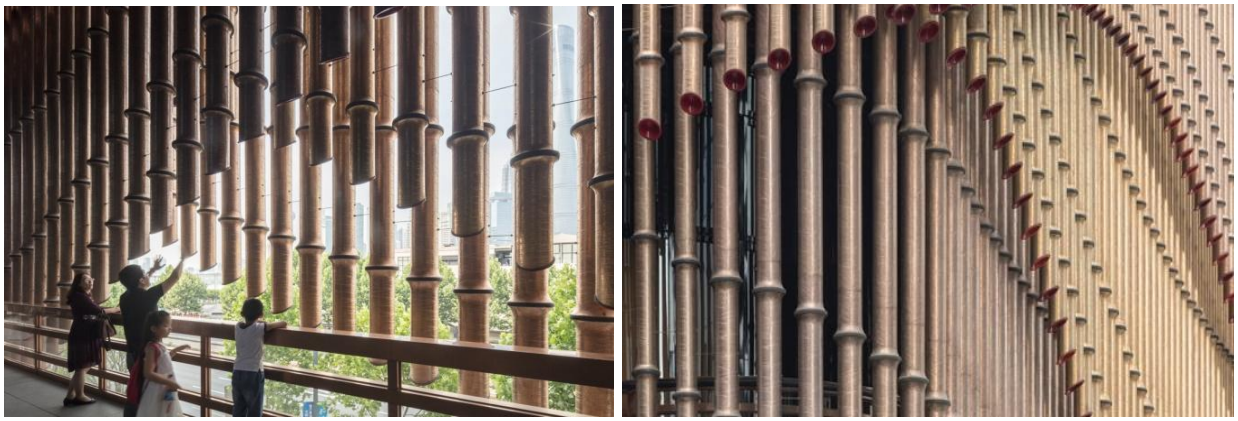


Fig 3.63. Illustration displaying relation of material between the building, Saree and Chinese headdress veil


Fig 3.64. Interior and exterior view of suspended bronze tubes as interactive screens

An article by Archdaily mentions, “A palette of crafted stone and bronze details gives the buildings a jewel-like quality. The edges of each volume are made of richly textured, hand-crafted granite and become slimmer as they rise, giving the impression of solidity at the base and transparency at the top.” [29]

[29] https://www.archdaily.com/881511/bund-finance-centre-foster-plus-partners-plus-heatherwick-studio

In case of a Saree too, the multiple layers at the bottom add a quality of opaqueness with each layer while the upper part of the garment portrays transparency, unless a solid fabric is chosen. As stated by the designers in Archdaily's coverage article, *"The building is encircled by a moving veil, which adapts to the changing use of the building and reveals the stage on the balcony and views towards Pudong. The façade is a veil organized along three tracks and made up of layers of 675 individual magnesium alloy 'tassels'—a reference to the traditional Chinese bridal headdress. The tassels range in length from around 2M to 16M so that as each track independently moves, the veil rotates with the tassels overlapping and producing different visual effects and levels of opacity."* Alongside the headdress reference, 'tassels' are also used in Indian Sarees, attached to either a waist belt or a blouse for a dangling aesthetic. Also, a distinct horizontal band, a jewel imbued belt (*kamarpatta*) also sometimes fashions a Saree outfit. It is clearly evident that inspirations from the Chinese components intersect with the attributes of an Indian Saree to create a cultural center that is a living example of Drape Architecture.



Fig 3.65. Components of tassel and waist belt in a saree



Fig 3.66. Interior and exterior views showing fluid drapery from different angles

Striking a balance between both aesthetic and functional relationship with the *saree* drape, the structure advocates as a model for Drape Architecture. It covers layering, form, structure, gradation and the actual movement of its components in accordance with the parts of a *saree*. It is also interesting to note that the typology of the building is that of a cultural center, which brings together a community. This aligns with the development of a *saree* and how it culturally originated differently while tying all communities together through its identity. While the material isn't fabric, the composition and fluidity of the structure stems from textile attributes.

3.3.3. Case Study 02: *Aichinger House Project* by Hertl Architekten, Kronstrof, Austria



Fig 3.67. Exterior elevation in pleated, anchored curtain

Built as a multi-level residence, this structure comprises two apartments, each on one level. A strong linear character punctuates the building that's wrapped in soft, pleated fabric from all sides. Exploring the potential of a textile skin in relation to the facade, the architects draped the built form with a light, grey toned fabric in a curtain-like manner. A curtain has been associated the most with the intersection of textiles and architecture since it is one of the most ubiquitous components of fabrics in the interior spaces. A curtain acts like a screen between the indoor and outdoor areas, imbuing a sense of comfort and protection. Similarly, a facade skin acts as an intermediate element between the interior and exterior of a building, serving multiple functions of aesthetic, cultural, or sustainable nature. Here, the architects have taken the concept of screens and privacy a notch higher by choosing a fabric material with an imbibed quality of protection and have clasped it onto the facade thereby directing it towards the function of a facade skin.



Fig 3.68. The textile skin is adjusted to suit the window and door openings

The textile skin is orchestrated in a specific fashion, forming diamond-like punctures to align with the window openings. From the interiors, it feels as if peeking into the outdoors through the external, elegant curtains. In an attempt to conceal the structure, the draped fabric makes the built form approachable and familiar. The vertical curtains break the monotonous linear geometry of the building. Apart from providing a strong sense of privacy, they also echo a sense of mystery that tags along with the concept of layering. Similar to a theater curtain that builds up suspense and excitement before it dramatically unveils the stage. However, unlike curtains in general, this textile skin doesn't have the ability to move, open or close. It doesn't advocate the movement or rhythmic qualities of textiles. What it focuses on are the qualities of stretchability, flexibility, softness, texture and comfort of textiles. The architects believe that the textile skin renders a metallic effect from a distance, making a striking appearance.



Fig 3.69. Textile skin anchored in place to restrict movement and render a curtain aesthetic

As seen in the images above, the textile skin is attached to the facade with the help of metal clasps that tuck in the curtain fabric and anchor them in place. The only bare minimum movement that takes place here is in the following situations:

1) The curtains can be densified or spread out through a motorized technology, handled by the residents. This helps control the level of diffused light and privacy.

2) The curtains can display a slight action of swaying at the passage of wind.

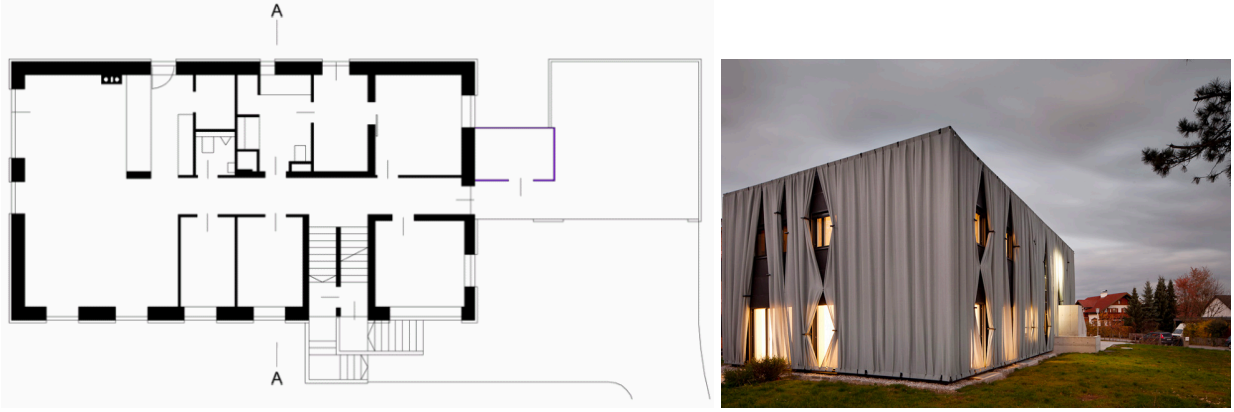


Fig 3.70. Floor Plan (left); Perspective view of fluid curtain-like drapery (right)



Fig 3.71. Aichinger House in soft, illuminated glow at night

At night, the entire Aichinger House glows like a beacon of light for the surrounding area. This case-study explores the possibility of employing interior textile functions to the external facades and takes advantage of the interchangeable intersection through an approach of relatability.

3.3.4. Case Study 03: *Serpentine Sackler Gallery* by Zaha Hadid, London, United Kingdom



Fig 3.72. Serpentine Sackler Gallery imbued in solidified drapery and passive dynamism

Realized as a tensile structure in fiber glass and PTFE coating, The Serpentine Sackler Gallery by Zaha Hadid Architects projects organic curves in a dynamic demeanor. Absorbing the floor kneel quality of a Kimono, the built form uses a roof that touches the ground level in alternate folds. Additionally, the roof resonates with the flappy full-sleeves that complete the T-section of a Kimono, a similar 'T-form' seen here as well. While the surfaces are devoid of prints or motifs prevalent in a Kimono, the lighting technology reflects unique patterns on the underside of the roof, adding a crafty character. While the core functional spaces have a horizontal presence, the proportion and expanse of the roof stretches over the verticality of the built form. This again aligns with the attribute of a Kimono. Similar to the glaze of a silk robe, the PTFE coating lends a smooth, shiny quality to the roof. Working as a cohesive, single entity just like a Kimono, the structure is free from multiple components and focuses only on a prime building.

Attributes of a Japanese Kimono

Derived from the Chinese Wu dynasty, the Kimono became a traditional silk robe in Japan and symbolized longevity and good fortune. Appealing as a single piece of cloth, the form is composed in a T-shaped outline with flappy, full-sleeves and a decorative belt that has evolved from an age-old obi-sash. It denotes fluidity, simplicity and cohesiveness. The most essential elements in a Kimono are its motifs and prints, symbolic of Japanese festivities, beliefs and traditions. The attributes of a Kimono include—unified entity, flowy nature, movement, horizontal bands, verticality, detailing, solidness and covering. While Drape Architecture expands with its flexible character, multiple structures continue to identify with the concept.



Fig 3.73. Variations in Japanese Kimonos; their wrapping patterns and multiple prints

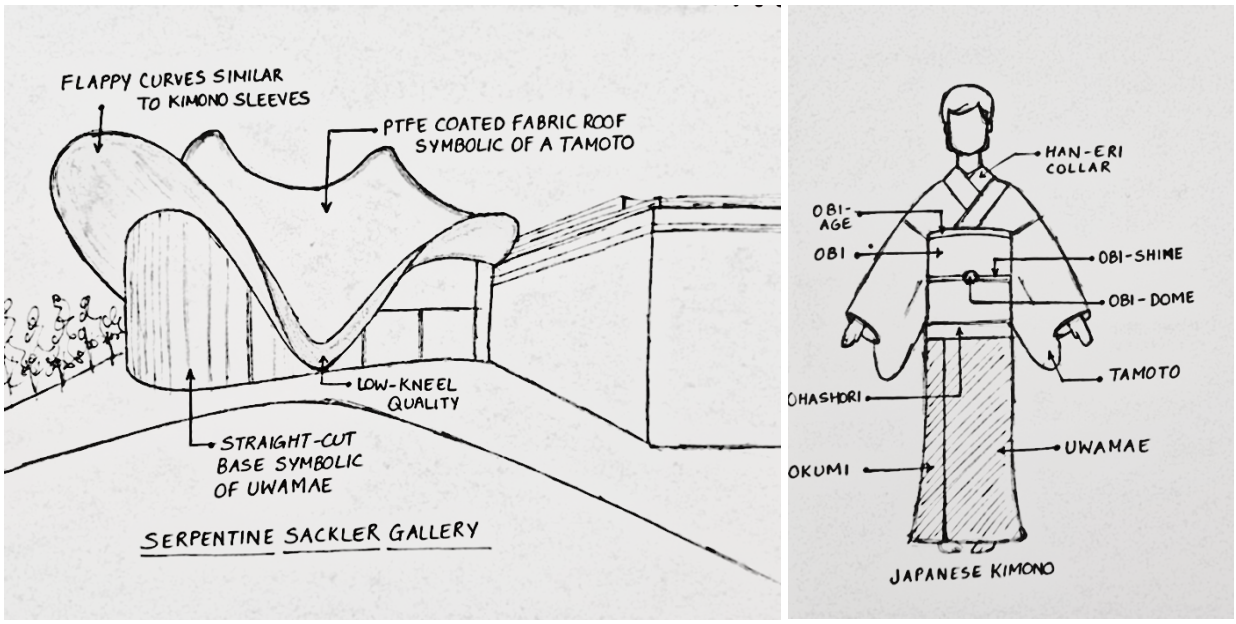


Fig 3.74. Illustrations showing correlation between the structure and a Japanese Kimono

A Kimono is fluid not just aesthetically but functionally too. This however, does not match with the sole, visual fluidity that the gallery renders. Fluted columns hold the structure together in the interiors, syncing with the belt's function to hold a Kimono together. Here, the aesthetic doesn't align with the horizontality of the belt but the purpose of interconnection echoes.



Fig 3.75. Structure showing the low kneel quality of the PTFE roof and light imprints on underside



Fig 3.76. The organic tensile roof is supported on fluted interior columns

As stated by the architects, *"The new extension feels ephemeral, like a temporary structure, although it is a fully functional permanent building. The tailored, glass-fiber woven textile membrane is an integral part of the building's load bearing structure. It stretches between and connects a perimeter ring beam and a set of five interior columns that articulate the roof's highpoints."* [30] A Kimono acts as a unified cloth of covering, representative of the roof that hovers above the glazed gallery below and wraps it in its embrace. The Serpentine Sackler Gallery represents a visual rhythm, it doesn't really have an actual movement going on. All the components are unmoving, set in a state of passive dynamism. Similar to the Bund Finance Center, Te Māori Waiwhetu Cultural Centre, and multiple other case-studies, the building typology in this one too is cultural—bringing people together under one roof—an inherent characteristic of textiles. It is also interesting to observe how a correlation can be made between a traditional garment of the East (Asia) to a structure from the West (Europe). This apparently hints at the fact that a Japanese Kimono seems to have influenced a global domain of fashion and architecture. Fixated in its position, unmoving, the Serpentine Sackler Gallery certainly holds its solidified drapery in place.

[30] https://www.archdaily.com/433507/the-serpentine-sackler-gallery-zaha-hadid-architects

3.3.5. Case Study 04: *Tease Me Cafe* by Vinu Daniel, Wallmakers, Kerala, India



Fig 3.77. A material innovation of *clothcrete* drapes this Kerala Cafe in visual fluidity

Responding to the challenge of a cramped space, the architects of Wallmakers revamped this Kottayam-based Cafe with a unique, wafer-thin material that surprised the South-Asian design industry. Instead of treading the established way of using walls or partitions for division of space, the designers explored the potential of merging cloth with concrete to create 'cloth-crete', rendering the cafe in draped folds. The idea revolved around privacy, aesthetic and comfort—all in one frame. Punctuating a unified essence, the solidified drapery of cloth-crete is suspended from the ceiling, extending as partition walls and then transforming into a seating space. This 695 SF cafe has been integrated with a sculptural art quality through the use of tousled drapes and their undulated, organic folds.

Wallmakers is known for working with waste/recycled materials and this time around too they picked '*Kora* cloth' (*Kora* in Malayalam means waste) as their base material, which is the cheapest available fabric in the market. They paired it with a mixture of cement grout and cement oxide coat to develop a one-inch-thick draped screen that sets the rhythmic and fluid theme of the cafe. For the seating, plywood pieces were placed at the desired height and cloth-crete was wrapped around them.



Fig 3.78. Storefront view peeks into the frozen drapery of the cafe

As a part of the research methodology for this thesis, a telephonic interview was conducted with Ms. Oshin Varughese, Associate Architect, Wallmakers on 24th Jan '23. The idea was to decipher the process of developing this material and to understand how it reacts to its surroundings and to find out if there were any challenges faced. When asked about the decision of specifically using fabric for partitioning, the architect revealed that it wasn't an initial choice. The idea struck when they were open to experimentation and saw the cloth lying around on the site for moisture retention purposes and that's when the permutations began.



Fig 3.79. Material experimentation process (left); Refined product of solidified drapery

Talking about fabric as a material, the architect shared, *"When we are using something that already has some properties of its own, we need not force too much of design onto it."* This thought right here says a lot about employing textile in design. Fabrics are fluid, moldable, stretchable, dangling and a work of sculpture in itself. They have the ability to induce art into architecture by simply existing in the most organic and unplanned way. Adding further, she says, *"The highlight of the project is the folds made by the cloth, which no matter how many times the person tries to design to make it look natural in 3D, the minute we try to push the cloth to look like that, it gets ruined."* The architect feels that throughout the process of crafting this cafe, they have been facilitators and just let the material design by itself.



Fig 3.80. Open kitchen within the cafe

The cafe has an open kitchen system, maintaining transparency and interaction within the space. The suspended pipes act as both exhaust as well as spotlights, adding a subtle interplay of light. Realized as an innovative concept of employing solidified drapery to optimally use the compact space has certainly resulted in an airy, light and sculptural cafe. There's a poetic quality that's imbued within this commercial space. Even the washbasin is draped in cloth-crete.



Fig 3.81. (L-R) Draped washbasin; Drapery as seating; Layered partition screens, Recycled furniture



Fig 3.82. Soft, elegant drapes are witnessed against a raw, unfinished furniture setting

Observing the artful drapery, it feels like it is going to sway at any given moment till we realize that the drapes are frozen in time and place. Similar to how textile freezes time in between the palms when being knitted. The drapery combined with the recycled tables attach a raw character to the cafe. However, once the users interact with the draped seats and lean against the cloth-crete[31] partitions, they experience comfort. On the art of exploration, the architect mentions that, *"We design from our limited creative brain. People are unwilling to try new things to experiment with material properties. However, new materials are both challenging and exciting."* Discussing the durability of the material, the architect revealed that the material composition has bare minimum reinforcement and is anchored to the ceiling to secure it in place. In fact, cloth-crete as a material recently went global when the architects were invited to display draped screens at the London

[31] https://www.designpataki.com/experimenting-cloth-concrete-tease-cafe-kerala/

Biennale in the Barbican Center Pavilion. Instead of using cement oxide, the designers added lime oxide to the mix to render a variation in the final product.

This shows that the designers are trying to tap the potential of fabrics in sculpting a space by expanding the characteristics of a merged material. Speaking of the solidified drapery, Varughese mentioned, “Art is very strong here. There’s no need to manipulate the folds in any way.” The drapery found here is also pretty similar to the drapery of a Bengali saree, which in fact is the eastern part of India while this cafe is located in the southern region. A healthy exchange of culture stemming from regional textile garments is evident in this case-study. The drapes are alluring for both physical and visual interaction. From the outside, the cafe looks like a black box with two openings framing the dramatic assortment of tousled drapes that envelope the customers in a comforting, private embrace.

Discussing the perspective of looking at textiles from a temporary angle in spite of its permanent potential, the architect believes that, “Any material if it’s not being widely used or if we are not able to resolve its issues and make it accessible to permanent structures, it simply remains as an art installation.” In this project however, textile breathed as a sculpted art form when paired with an architectural material in an interior space for a partition design function. This somehow also takes us back to the times when fabrics were used as dividing screens for the male and female seating chambers in an Indian palace court. And using fabrics as partition screens has also been one of the most familiar ways of user interaction with textiles as per the conducted survey. The case study strongly suggests that textiles and architecture can intersect without the former’s tactile (physical) attributes as even the visual and textural characteristics induce a soft, plush appeal, to which the human senses react in a way that a raw finished, condensed product feels smooth, flowy and approachable.

3.3.6. Illustrative Examples

Example 01: *Guangzhou Pavilion* by Say Architects, China



Fig 3.83. Theatrical curtain-like roof drapes this pavilion in poetic rhythm

Guangzhou Pavilion by Say Architects caters to a celebratory event space that has varied spatial components, all draped under one continuous dancing roof. The organic, u-shaped roof helps to block wind and fire owing to its geometry. The roof gives an impression of theatrical curtain drapes, and appears to be floating over a pristine white pavilion structure. Under the covered area too, the undulated roof generates an effect of a draped ceiling, symbolic for ceremonial events.

Example 02: *Barcelona Building Construmat Ephemeral Space* by Architect Josep Ferrando



Fig 3.84. Interior space showing the reverse functions of fabrics and structural components



Fig 3.85. Ribbon-like drapes accentuating the gathering spaces

Performing as pseudo walls and ceiling, the pristine white fabrics in this church render a plush, soft appeal and an essence of purity and enlightenment. The free-flowing drapes are secured in place in a ribbon-like pattern, leaving their other end loose. A layered drapery is witnessed through the central dangling assortment.



Fig 3.86. Geotextile sheets hung from the portal frames to imbue a charming drapery aesthetic

The rustic beams have been placed as furniture for seating while the comforting fabrics highlight the interiors as surface treatments. This interchange of functions and materials urges us to ask questions about shifting perspectives. The drapes are suspended from a height of 6M and are presented in the form of consistent panels made out of geotextile, an industry material. The space is envisaged as a temporary installation, which focuses on the position exchange of tensile (textile) and compressive (metal) materials. Mentioning to ArchDaily, the architects state, "Almost all spaces and almost all building materials work in two ways: they either hang, using traction, or they are stacked, that is to say they use compression. Two ways of working in which lighter elements, such as textiles, are contrasted with heavy elements, such as steel. The dialectic between what is light versus what is heavy, what is transparent versus what is opaque ... has always been present, and that is also what is meant to be conveyed with this intervention. "



Fig 3.87. (L-R) Series of geotextile sheets; Ribbon-like draped ceilings; Voluminous corridors

Example 03: *German Textile & Garment Industry* by Behet Bondzio Architekten, Germany



Fig 3.88. Staggered bricks composed to replicate textile creases, folds, and curves

Responding to the internal function of the textile block, the structure is composed of bricks oriented at different angles so as to create a gradient effect that renders drapery curves. A horizontal emphasis laces the rectilinear geometry of the industrial building that seems to interact through dynamism of shadows and brick projections. Here again, a character of solidified drapery is witnessed, linking the aesthetic to the function of the building.

Example 04: *Textile Academy NRW* by sop | architekten, Germany, 2018



Fig 3.89. Woven fiberglass PTFE fabric attached to a metal frame adds textural finesse

Designed as an institutional space for a textile and clothing industry, the cubic structure for the North Rhine Westphalia Textile Academy sits on a corner plot of an urban square in Germany. The rigid geometry of the cube is instantly softened by the 22,600 SF of woven fiberglass PTFE fabric that drapes the entire building in a delicate, veil-like character. Sheathed in a translucent quality, the individual textile panels are anchored by prestressed stainless steel framework that is lined along the periphery of the building at its top and base part. The textile is stretched and secured in place at both ends plus a vertical strip welding in between individual panels. While there is no scope for physical fluidity to take place, the material itself has a fluid characteristic that's solidified in place, tailored to the geometry of the built form.

Speaking of a textile skin concept, the designers mentioned to the Architectural Record that, “The structure was conceived in a certain fashion to show the many different ways textiles can be used.” The textile facade acts like an undulating membrane, which represents the expression of the building’s function; similar to a human body and a garment. The facade is also believed to be used as a background for art projections, overlapping with the dimension of technology.



Fig 3.90. Interior views showing the atrium and a conference room

The interior spaces look outwards through the central atrium as well as the irregular sized window openings. The textile membrane creates a filtered screen, a textured grainy effect when seen from the interiors. Textiles are breathable and generate filtered ventilation alongside diffused sunlight. A curved steel framework is clamped to the building elevation, on which the textile panels are fixed as flowing curtains with the help of steel cables. The textile skin adds a three-dimensional aesthetic to the otherwise two-dimensional concrete facade. Another interesting thing to note is that textiles, yet again exist at the intersection of two opposing qualities—the rawness of concrete is in stark contrast to the softness of fabrics and the rigid geometry of the cube is contrary to the fluid geometry of the fabric membrane.

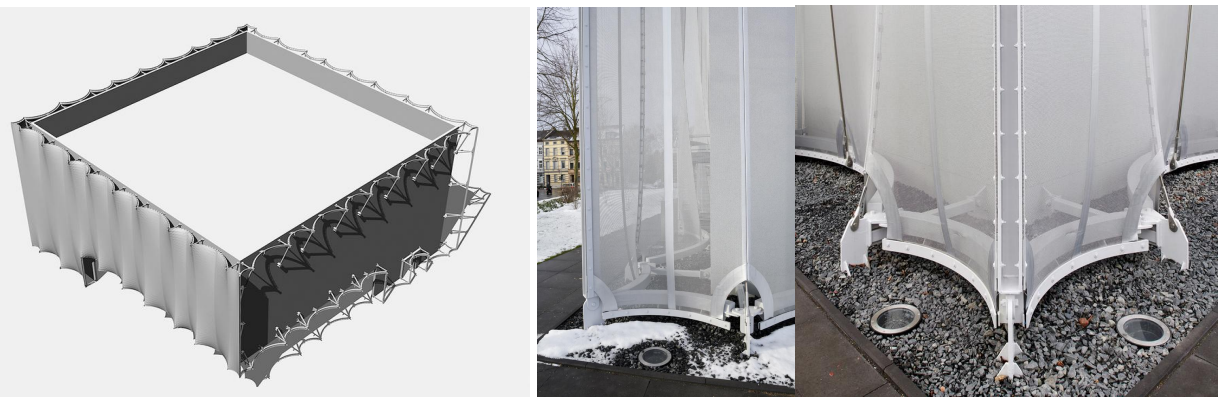


Fig 3.91. Structural representation model and textile anchoring details



Fig 3.92. Textile facade glows in subtle illumination letting the light fall over its organized drapes

A series of uplighters are embedded in the deck that peripheries the entire structure. At night, these lighting fixtures paint the textile facade in upward beams of soft light that gracefully make the fabric glow and highlight the subtle presence of the institutional building. This integration is also an encouragement to the textile industry, to show them the potential of textiles when merged with architecture, to push them to think of textiles as more than a fashion model or interior furnishing, and to project textiles on a larger scale for a long-term determined function.

3.3.7. Conclusion

The dimension of drapery investigated two case-studies each imbued in either solidified drapery or fluid drapery. A juxtaposition of opposing functions is witnessed here as textiles are solidified in passive dynamism. From a material like textile, tactile fluidity, folding and swaying is expected and then the material surprises by being frozen in time and space. While the visual fluidity remains intact, the tactility represents a solid composition. On the other hand, a solid material is composed in a drape-like pattern, stemming from textile roots and made to perform fluidity. It is interesting to note that while other building materials have to be orchestrated and designed specifically to induce fluidity in a built space, textile effortlessly does that by just existing. Textile is an art in itself, which drapes, folds and creases, creating design in the process.

The dimension of drapery also comes across inversion of textile's conventional functions in architecture. For instance, in Aichinger House, the common function of textiles to curtain the interiors is reversed onto the external facade, which is accentuated in curtain-like draped pleats. This is also reminiscent of Shigeru Ban's Curtain Wall concept wherein the boundaries between interior and exterior blurred away as textiles acted like a curtain screen. In Barcelona Construmat Space, the beam section members are placed as seating furniture and textiles drape the walls and ceilings of the space. This interchangeable and reversible quality of textiles encourages the development of shifting perspectives. Replicating the relationship between a human body and its clothing, drape architecture also treats a structure as a body, around which textiles are either physically or symbolically draped. How we interact with textiles as a material to our body proportion informs our senses to interpret a structure, its scale and its fashioned cover with respect to drape architecture. Elements of cognition, familiarity and texture play an essential role in drape architecture, which is exploring the potential of textiles.

3.4. Dimension of Technology

3.4.1. Introduction

The domain of architecture expands its scope of functionality when combined with technology. Architecture in today's world isn't only limited to making buildings or inhabiting spaces. Architecture has become this integrated module of experience that is driven by the advancement of technology. While materials like steel, concrete, bamboo, brick or stone are compatible with limited technologies, textile on the other hand displays a remarkable union of design when merged with technology. This dimension addresses four important types of technologies that condense with textiles to create architecture that actively dialogues with its users and site context. These four technologies are stated as follows:

Lighting Technology - Textiles have the potential to transform into large scale backdrops that project the technology of light and make way for an interactive and experiential medium. The translucent quality of fabrics lets the light beams converse with the interior as well as exterior spaces. Similarly, the opaque quality of textiles renders them to take a backseat and keeps the focus glued on the light projections.

Technology of Sound - Owing to the rich acoustic properties of fabrics, they can act as a paramount material to effectively reflect sound in a desired pattern. Whether applied in the form of wall panels or ceiling sound clouds or as sound insulation, varied fabrics like cotton, nylon, polyester, felt, or a mixture of fibers contribute towards the acoustics of a built form.

Structural Technology - Textile's inherent tensility, stretchability and lightness makes it suitable to be incorporated into structural technology of long-span columnless spaces, retractable roof stadiums/event spaces, parametric facades and portable structural prototypes.

Sustainable Technology - Fabrics are believed to be at the forefront of a sustainable architectural future. They leave behind a light footprint and are recyclable; two key aspects of sustainability. While their daylighting potential is well-known, textiles like recycled ETFE, PTFE, organic hemp, linen, organic cotton and many more have been serving as a prime material for construction as well as facade treatments. Textiles further consume minimal energy resources for transportation and fabrication thereby reducing the carbon footprint. Polyester fabrics coated with solar insulation or infused with photo-voltaic cells trap the solar energy and become a multi-purpose element. Textiles have a variety of untapped characteristics that contribute towards a sustainable scenario and regenerates a layered built form. Also, biodegradable fabrics serve their purpose and dissolve into the earth. Their flexibility helps them mold into a system, which automatically adjusts to the climatic conditions. The assembly of textiles doesn't involve any complex construction methodology thereby reducing the costs and machinery loads. Hence, textiles when paired with the technology of sustainability, can craft an eco-friendly architecture.

Permutational Technology - Apart from contributing to individual formats of technology, textiles can further synchronize with both sound and light to produce immersive projections onto building facades, within spaces, installations, exhibits and the likes of it. And in the process of doing so, they can retain their sustainable properties as well. The dimension of technology focuses on four distinct case-studies under each tech category, unraveling the relevance of textiles as a unified material that has multiple facets required to shape up a healthy, plausible future of architecture. Speaking of the future, the strongest presence of textile architecture is witnessed when we revisit the past; a place of answers and redirection. This dimension also focuses on the illustrative examples that put forth a case of textile-technology integration thereby bridging the gap between the past (material) and the future (technology).

3.4.2. Lighting Technology

Case Study 01: *DAR LUZ* Installation by Lars Meeß-Olsohn and Ali Heshmati, Germany

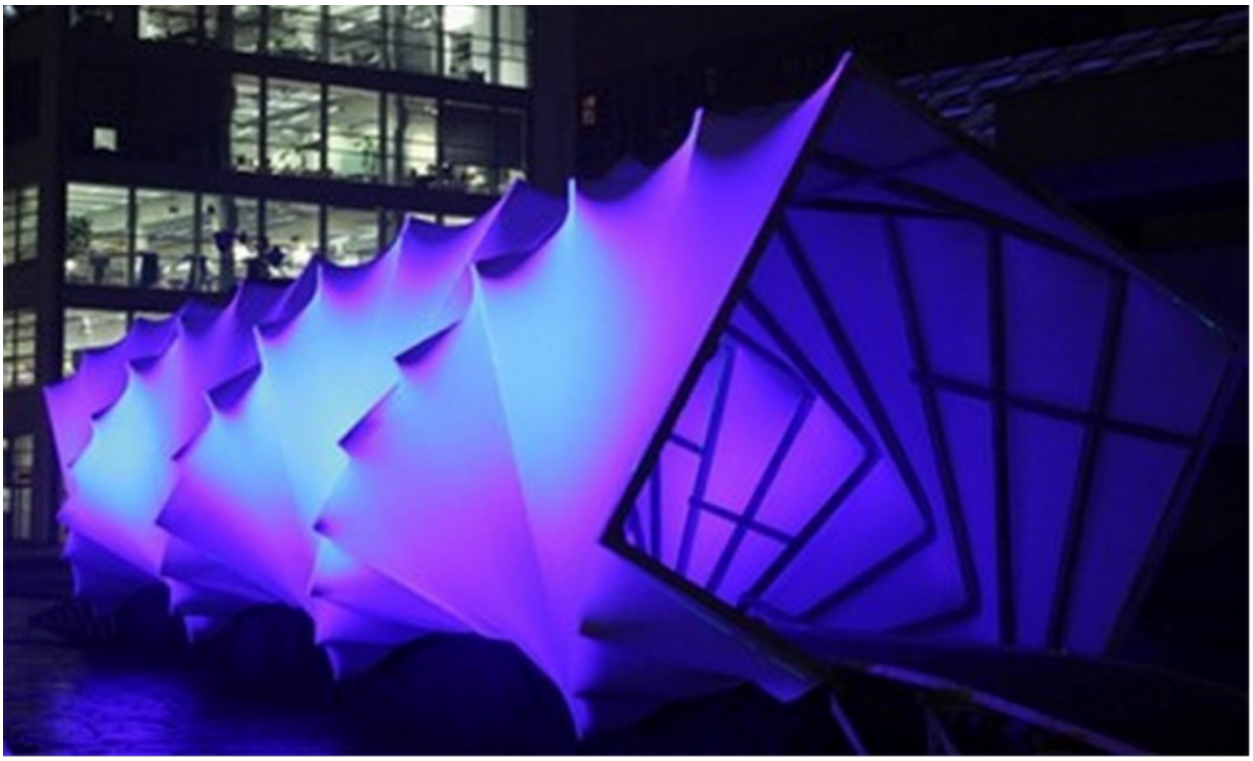


Fig 3.93. Textile skin wrapping a wooden installation and being a backdrop for light projections

Curated as an interactive light installation by Bettina Pelz and Tom Groll, DAR LUZ has been designed by Lars Meeß-Olsohn and Ali Heshmati. The idea revolves around creating a lighting art path wherein the users navigate through it and experience a dynamic light and sound show. A twisted, striking geometry is achieved by installing timber roof battens anchored to a wooden walkway that passes through the installation. The battens have been mounted at an angle of 15 degrees tilt with every frame that comes into picture. While the location and technology is set, the most essential factor is the display backdrop. In this immersive environment, textiles play a very important role as 150 meters of elastic, PVC coated Polyester fabric is stretched to mold as per the twisted form of the installation. This fabric wraps around the wooden frame and transforms into a clear screen for artistic light projections.

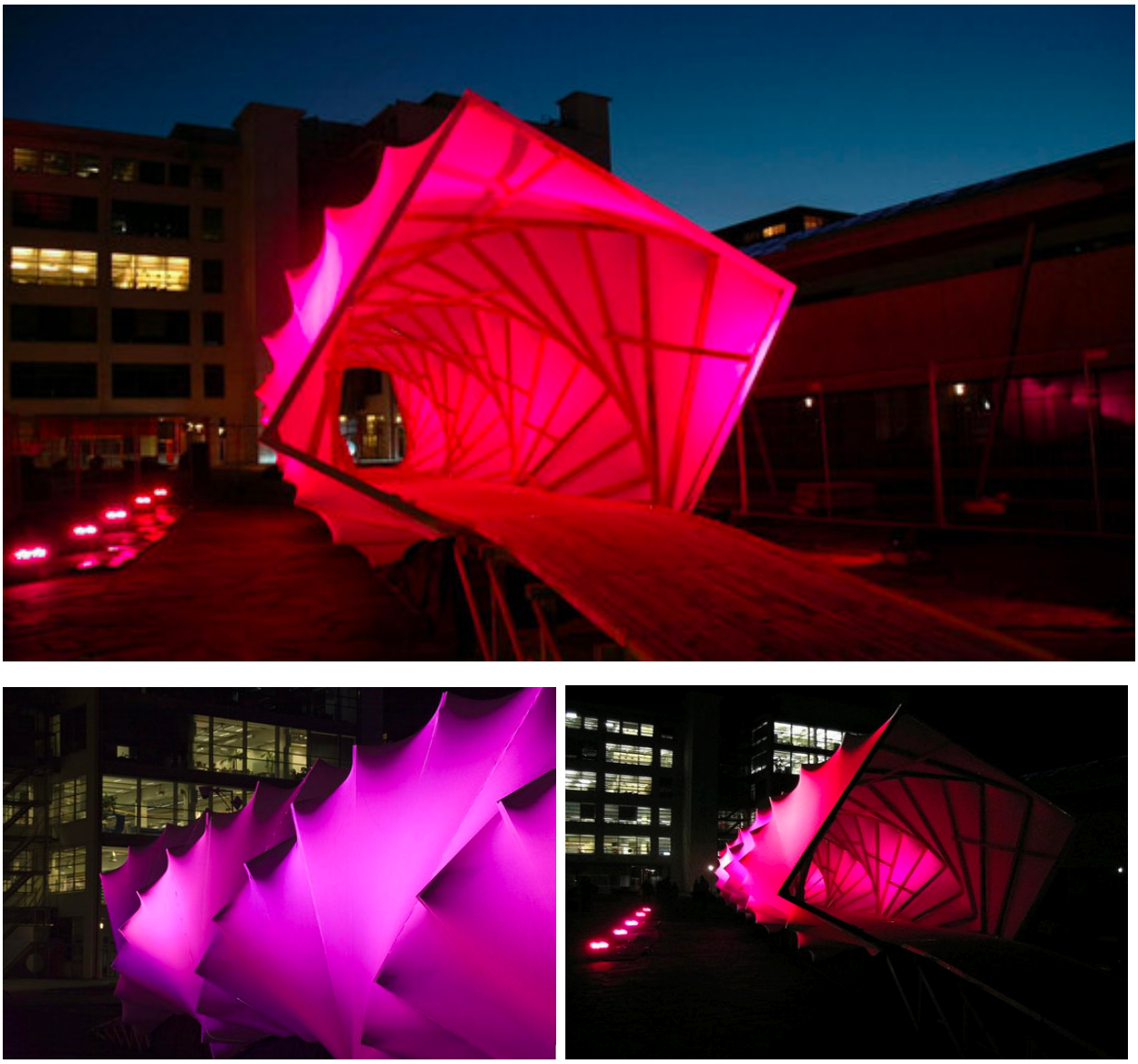


Fig 3.94. Textile installation providing an illuminated, immersive experience

Fabrics make it possible for the light show to be projected both on the interior as well as the exterior surface at the same time, owing to its transparent properties. While the framed geometry takes the edgy route, the textile envelope adds a layer of softness and comfort to the installation. This renders an approachable quality, which is picked by the visitors who are intrigued by the rhythmic composition. Similar to a dynamic bubble, the installation becomes a portal of light as one traverses through it.



Fig 3.96. Artist interacting with the lighting iterations of the textile installation

The most interesting part of the installation is that it has multiple sensors that react to the movement impulse of the visitors. Along the path, LED floodlights are placed that can be individually modified to paint a vibrant picture of light beams that keep changing their color and sync with the sound. The intensity of light too can be modified. Similar to how the fabric has been sheathed in a controlled manner, using only its comfort, stretchable and cocoon-like characteristics, the installation too portrays a controlled and monitored light and sound show. A peculiar quality of textiles is that when they impersonate as backdrops, they act like a blank slate—carrying the properties of a foreign element (in this case, technology of light) and presenting them at the forefront. Whereas, materials like concrete, stone, metal or brick retain their aesthetic composition while allowing the light combinations to be projected on their facade. This is what makes textiles a unique material that whole-heartedly works towards creating an interactive medium for the end users as well as a symbol of dialogue for the site surroundings.

3.4.3. Technology of Sound

Case Study 02: *Eurogress Aachen* by Bert Haller Innerenarchitekten, Germany

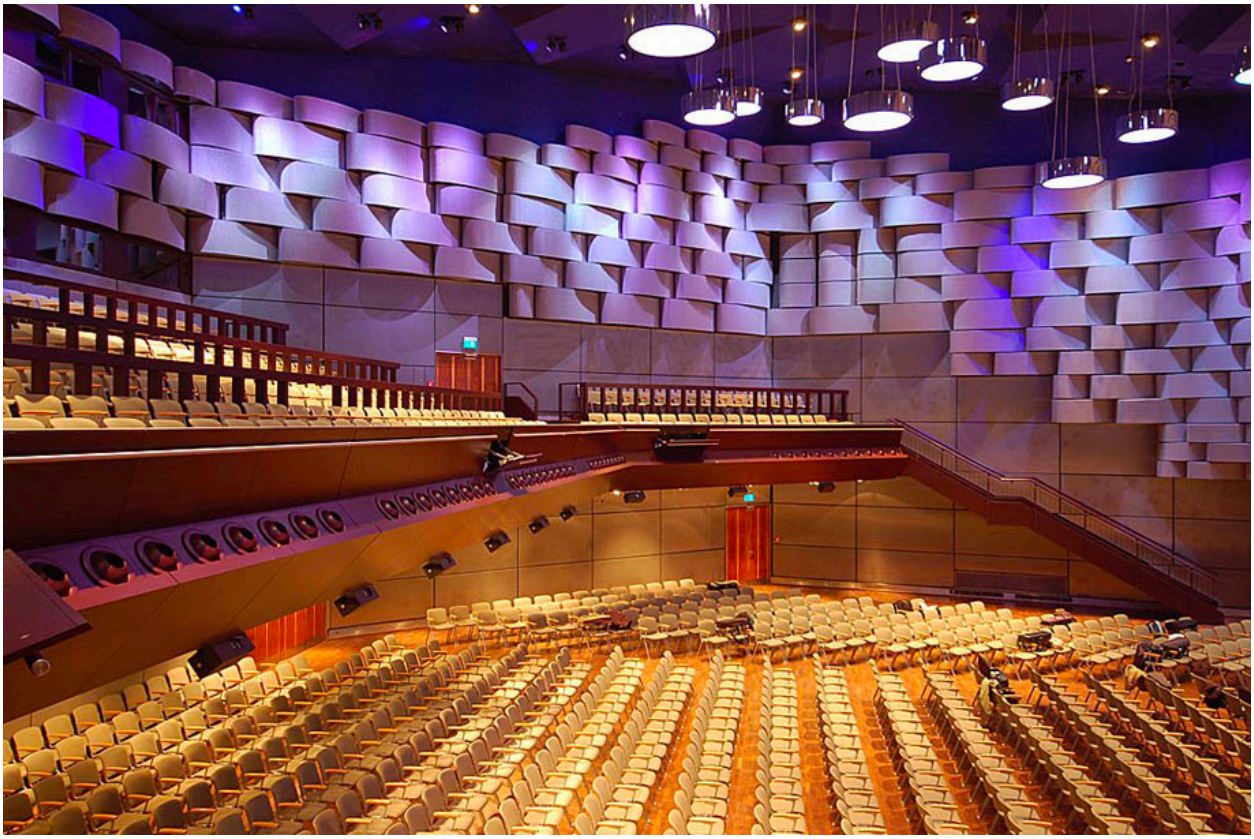


Fig 3.97. View of the sound acoustics donning the walls of an arts and cultural center

Envisaged as a concert and event venue by Bert Haller architects, this Public Arts Center uses an integration of technology and textiles predominantly to make way for an immersive and mesmerizing architecture. The aesthetics of the space is governed by lighting interplay as well as acoustic treatments that align with the geometry of the interior arrangement. The architects collaborated with GKD Metal Fabrics to take advantage of the textiles' sound insulation and light reflection properties. The center comprises concert halls, conference rooms and gathering spaces; all of which revolve around sound, light and aesthetic coalescence. Structural or acoustic fabrics in architecture are either coated or woven (meshed). This very project uses three kinds of woven metal fabrics namely, Baltic, Lamelle and Escale.



Fig 3.98. Perspective view of the auditorium, lights reflecting off the textile acoustic surface

Catering to a seating capacity of 1,700 people, the auditorium achieves the desired aesthetic and acoustic treatment by combining the different fabrics together. For the stage backdrop, 200 Lamelle fabric panels are used in a vertical format. While their composition involves the technique of weaving, they do not appear to be woven in appearance. The stage is however flanked by walls on either side, both of which are adorned with Baltic fabric panels that are woven in composition as well as in their aesthetic appeal. Resembling a basket weave pattern, 600 curved fabric panels are laid out in a horizontal manner for delivering a functional acoustic environment. Accentuating the auditorium in interlocking waves, the metal fabric panels add a three-dimensional character to the space and represent textile weaves in function and expression. The ambience is rendered further with LED lights that operate through suspended downlighters, track lights, wall lights and stage uplighters. The downlighters reflect beams of light off of fabric panels, displaying a soft glow that highlights the acoustic panel design.



Fig 3.99. Sound acoustics at entrance of the auditorium to filter outside noise

At the entrance, Escale metal fabric panels are witnessed in a concave form, owing to the ability of textiles to be molded into varied geometry. The fabric panels play a major role in generating efficient sound acoustics and in delivering a sculptural, theatrical quality to Eurogress.

3.4.4. Structural Technology

Case Study 03: The CUBE by HENN, Dresden, Germany, 2021



Fig 4.0. Carbon concrete composite structure with a textile exoskeleton

Inscribing the future of the design and construction industry is the world's first carbon concrete building that combines the attributes of textiles with the power dynamic of technology to innovate a new form of structural system. Conceived as an experimental model, the building consists of laboratories, event rooms and research-oriented spaces. Built by the architectural firm, HENN in collaboration with the Technical University of Dresden, *The CUBE* is a resource and environment conscious prototype. While its form certainly borrows from the fluid, organic nature of textiles, the structure itself is embedded with carbon fibers. Similar to the concept of forming an exoskeleton in the automotive industry, carbon fibers are put within a mold and a liquid is poured over them to solidify these fibers in place. A Carbon-Concrete-Composite (C3) material is invented as an alternative to reinforced concrete. The structure sits on a building footprint of 243 square meters and has been a byproduct of multiple technical tests as well as research.



Fig 4.1. Top view shows a skylight that diagonally cuts through the structure

A major aspect of skepticism towards considering textile as a permanent material stemmed from its strength and durability, which more often than not has been under scrutiny. However, with this structural-material innovation, the whole narrative is set to dynamically shift in textile's favor. With this project, the industry has tapped the structural potential of textiles, which turns out to be more efficient and sustainable as compared to its similar counterpart. The architects have found out that carbon concrete is four times lighter in weight and six times stronger than steel. It also minimizes CO_2 emissions by nearly 50%. Although it has a higher carbon footprint, the strength of the material suffices for its lesser quantity thereby contributing little to the footprint. The project has urged the design and construction industry to look at textiles in a new light, to recognize that there is more to this all-encompassing material than what meets the eye, to deeply observe and understand the varied forms (strings, nets, meshes, coatings, fibers, fabrics, drapes, glass cloths, skins) in which a textile can benefit architecture and to rethink its narrative.



Fig 4.2. The unified roof echoes the curves of a textile piece and is infused with carbon fibers

Apart from merging structural technology and materiality, the built form also focuses on a unified curved geometry; one where the ceiling and walls are merged into a single, continuous entity. There is a character associated with textiles that tends to promote fusion and gathering, enclosing all facets under one roof. Reiterating the same, the architects state, “The design of The CUBE reinterprets the fluid, textile nature of carbon fibers by seamlessly merging the ceiling and walls in a single form, suggesting a future architecture in which environmentally-conscious design is paired with formal freedom and a radical rethinking of essential architectural elements.” A sleek, thin, undulating facade projects a striking appearance. Punctuating the roof in a diagonal manner throughout the span of the structure is a series of glazed skylights that illuminate the interiors.



Fig 4.3. Skylight over the discussion room that is compounded in organic curves

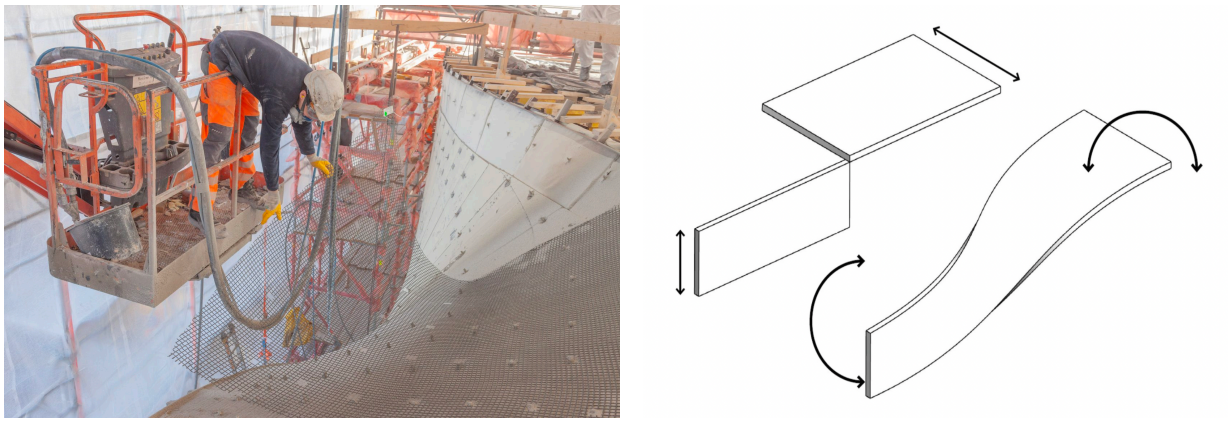


Fig 4.4. Installation and development process of the roof form



Fig 4.5. Exterior view of a materially innovative structure

Another advantage of carbon fiber over steel is that it is rust-proof in nature, which allows it to be durable thereby increasing the building lifecycle. Carbon fiber also possesses conductivity, which is why insulation pads and interactive touch surfaces are attached to the walls of the building. Working towards a greener future, the designers and material experts are researching bio-based carbon fibers that could act as a replaceable and sustainable solution.

3.4.5. Sustainable Technology

Case Study 04: ***MINI LIVING - Breathe*** **by SO-IL, Milan, Italy, 2017**



Fig 4.6. Sustainable textile dwelling shrouded in between massy city core

Acting as a visual and functional breather in the dense core of Milan, the dwelling installation, *MINI LIVING - Breathe* by SO-IL architects is an 'ahead of its time' initiative towards sustainable living. Shrouded in between massy, rigid structures, *Breathe* steps away from a conventional residence to break the barrier between a home and its surrounding environment. Minimal footprint, recyclability and conscious use of resources is what sustainability advocates about. Addressing all these important factors, the housing module stands tall at 10.35M height on a mere 50 square meters plot with a strong yet elegant vertical presence amidst linear walled structures. Conceived as a creative yet sustainable solution to the idea of reinventing living strategies, *Breathe* crafts an ecosystem of its own. Designed as a mobile prototype, its outlining modular metal frame is dressed in a material, versatile and flexible in all its forms—Textile.



Fig 4.7. Textile dwelling standing light and tall with its rooftop garden to catch rainwater

Wrapping the metal skeleton of the structure, a white PVC mesh fabric behaves as a light-weight, flexible fabric skin leading to a dwelling that's predominantly textile. Taking the form of a moldable, permeable outer covering, the textile structure dons a sleek, approachable character. While all other construction materials are focused in creating walls/enclosures and divide the spaces in the process, textile creates a connection between two spaces, physically demarcating them through thin skins/membranes. The structural installation here uses a translucent fabric that nurtures visual connectedness and lets the silhouette interact. Conceived as a prototype with the ethos of sustainable living at its forefront, *Breathe* comprises two levels, six rooms and a roof garden to collect rainwater and distribute it within the house for domestic use.



Fig 4.8. Interior nooks with meshed floors (left); Structural frame model (right)

In a conversation with the ArchDaily portal, Esther Bahne, Head of Brand Strategy and Business Innovation MINI explains that, “MINI LIVING – Breathe calls into question conventional living concepts and introduces a creative problem-solving approach for future challenges in urban areas.” He further adds, “The installation shows what happens when we view houses not only as a space in which we live, but as an active part of our environment – one which plays a positive role for the environment and the people living there.”[32]



Fig 4.9. The translucent quality of textiles creates interactive silhouettes and shadows

For a majority of projects around the world, textiles have been majorly used either for installations or as an additional textile skin to a solid building facade. However, this very model surpasses all these stereotypical molds and presents textile as a facade, in the form of a dwelling installation, which has been regarded as a prototype for future, green conscious living. The PVC mesh fabric

[32] https://www.archdaily.com/868550/mini-living-breathe-so-il

renders a diffused play of light beams into the house thereby minimizing the energy consumption. A Titanium oxide (TiO_2) coating has been applied to the mesh fabric in order to filter and neutralize the air, improving the quality of indoor air. What appears to be a grace personified structure from the outside has actually been strengthened within the interiors to carry loads. The geometry of the dwelling reflects upon the perception of how soft and delicate textiles have been perceived broadly across the globe. However, breaking the norm, textiles not only replace walls but also act as ceilings and floors in this very project. Heavy duty netting has been incorporated in suspended floors to resist the live and dead loads. On the other hand, a combination of elastic meshes and intricate netting are employed for sleeping chambers to provide maximum privacy. This clearly shows that textile as a material has all the relevant qualities under its umbrella, which are usually distributed amongst varied construction materials.

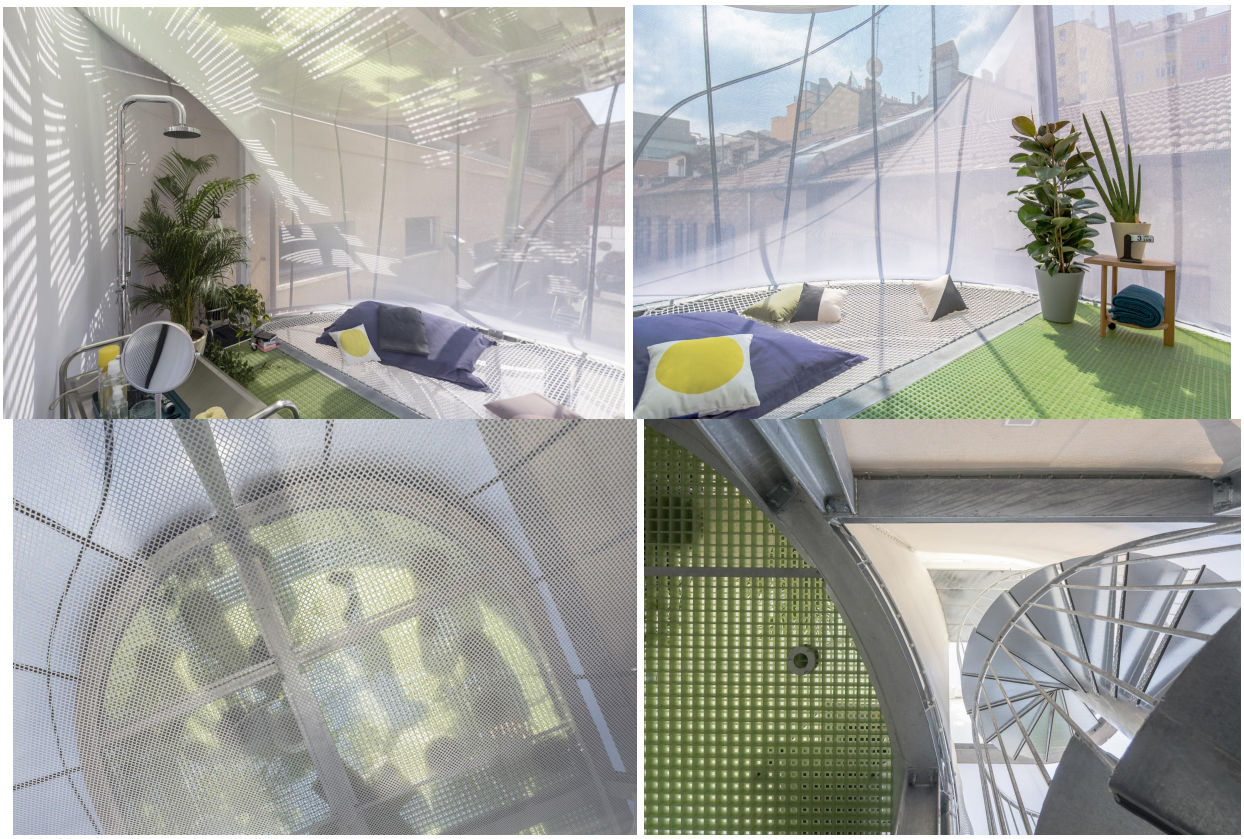


Fig 4.10. (CW from top left) Living room; Reading nook; spiral staircase view; Heavy duty mesh floor

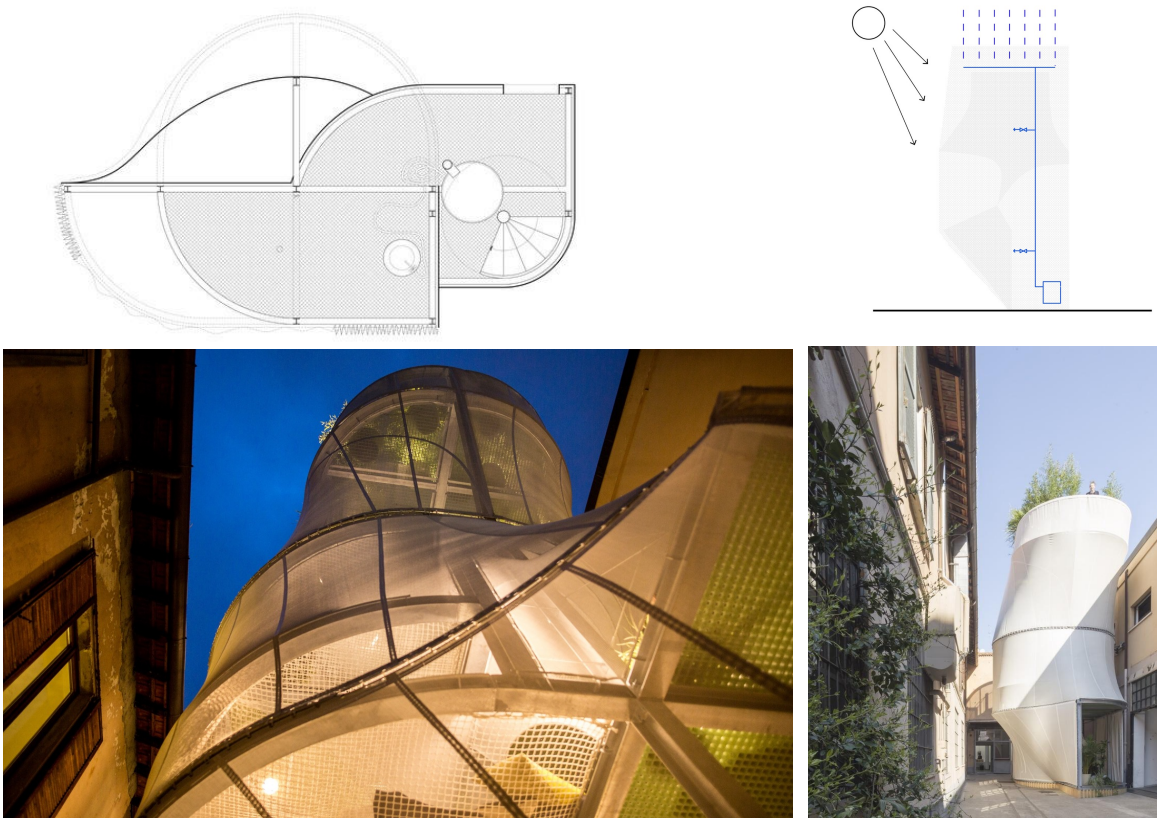


Fig 4.11. Floor plan and climatic design consideration for illuminated textile dwelling

A press release by SO-IL architects describes the house organization as "composed as a loose stack of porous realms. A variety of atmospheres and spatial experiences [that] are generated through the manipulation of light, air and water." A textile bubble allows users to interact with the outdoors in an efficient way by providing a whole-hearted view, filtered light and ventilation, scope to carve out niches that offer a tent-like indulgence, a textural quality, and a sense of belonging through visual connection. The prototype future house is entirely portable and can be set up in a new location with a replaceable fabric that aligns with the climatic conditions of the new region. Textiles don't just integrate multiple functions in its singular domain but are also adaptable in nature, being open to future iterations with respect to design and materiality. Reiterating all the core principles of sustainable living, textiles have not just been the basis of primitive design but are also the face of a green future.

3.4.6. Illustrative Examples

Example 01: *Sacmi New Auditorium 1919* by EOSS Architecttura, Imola, Italy, 2017

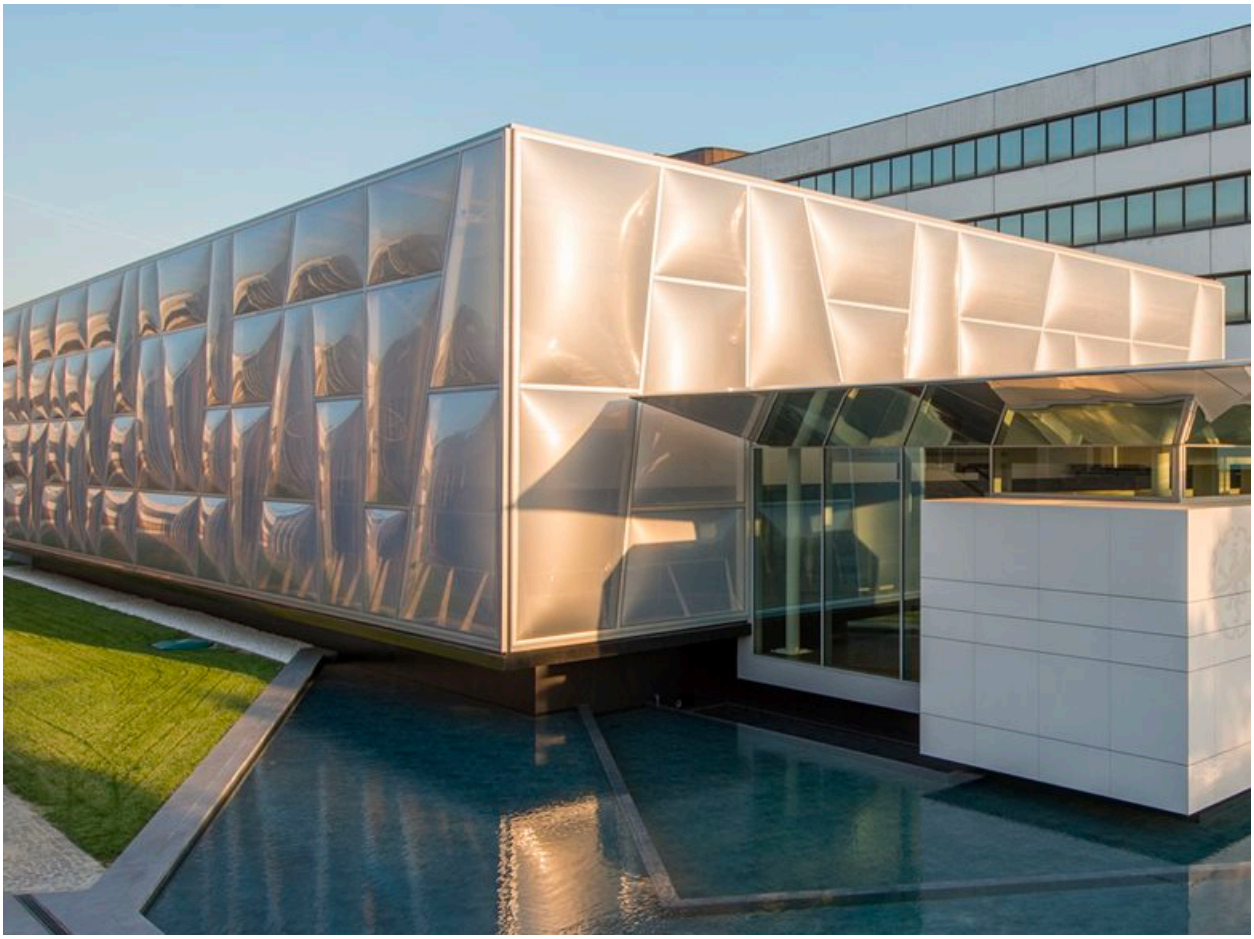


Fig 4.12. ETFE textile facade cushions the auditorium

Standing out in striking materiality is this auditorium that's designed and executed by EOSS Architecttura, Canobbio Textile Engineering and MB MONTAGGI. While auditorium spaces are generally associated with large solid masses and volumetric compositions, this structure for the same amount of spatial configuration sits snugly and lightly on a grass lawn. This very impression directly accounts to the aesthetic expression of the auditorium's textile materiality. Enveloped by the ETFE textile facade, the material imparts dynamism and a sense of cushioning to the structure. Around 110 screen-printed ETFE cushions in triple layered silk are digitally crafted in varying sizes and applied to an area of 1000 square meters.



4.13. ETFE cushion provides sound insulation as well as becomes a backdrop for projections

The space comprises community engagement areas and an auditorium capacity of 500 people. Integration of lighting technology by Linea Light Group converts the cushioned facade into an uber-cool backdrop that absorbs and reflects color-changing light beams, radiating a modern tech vibe to the auditorium plaza. The structure certainly steals the show at night with its tech bubble allure. The silk layer in the ETFE membrane adds a glaze to the facade, fashioning an urge to touch and interact with it. The textile skin also regulates sound acoustics and keeps the external noise out thereby embracing both light and sound technology through its singular materiality.

Example 02: *Soundforms* by Flanagan Lawrence, London, United Kingdom, 2012



Fig 4.14. Mobile prototype for outdoor concert venues made in textile

Realized as a game changer for the outdoor performance dynamic, Soundforms has been created as a mobile prototype to extend the fine acoustics of indoor event venues to the outdoor. An inflated PVC fabric membrane is molded around an aluminium frame structure that echoes the form of a seashell, believed to have sound propelling properties. This shell-like model has since been an efficient solution for outdoor music and dance festivals. A research-intensive study in acoustics paved the basis of developing Soundforms. Musical notes often hit the subtle and dynamic chords. Similar to them, this fabric shell is dynamic in geometry and yet has a subtle footprint. While primarily incorporating the aspect of sound technology, the module also focuses on being light-weight, adaptable to different weather conditions and having a minimal footprint—all of which are principles of sustainable technology. It further extends to light technology when it transforms

into a color changing fabric shell, engaging the audience with its attractive demeanor. The architects of this project believe that, “The shell is designed to project the enhanced sound produced from the performers to the audience—generating a clearer, louder and reverberant acoustic.”

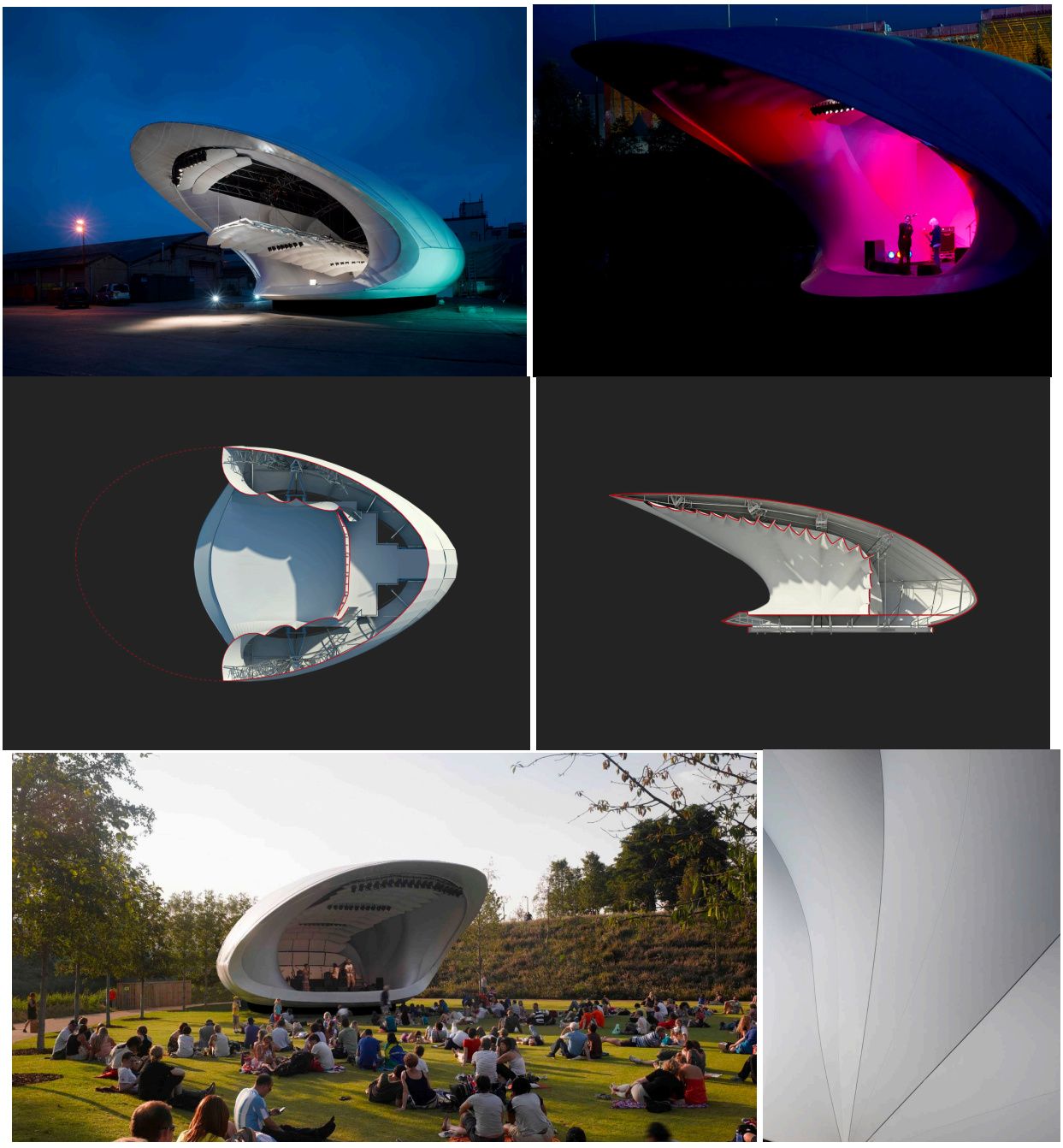


Fig 4.15. The structural mobile prototype in varied illumination setting

During its conceptualizing stage, the structure was tested for varied kinds of acoustic compatibility with symphonies, orchestras, choirs and the likes of it. *Soundforms* went a step further to enable a new function that lets musicians listen to themselves thereby producing music that's more enriched in clear, amplified sound. The quality of the performance is also subsequently enhanced. Outdoor performance venues have previously been covered in textile compositions of string installations or stretchable fabrics that project light and sound and are interactive in nature. Music revolves around strings, chords, connections, comfort and rhythm—each of these qualities being synonymous with the attributes of textiles. This relativity seems to have been a reason for choosing textiles majorly for music venues. In this project, apart from the metaphorical relation, the tangible purpose of wanting a light-weight, adaptable, flexible and acoustical material influenced the need to engage in a textile skin. Textile here also acts like a protective enclosure, offering a sense of privacy and demarcation but at the same time, imparting a visual as well as physical connection with the environment. Tents, the oldest and most familiar typology of textile architecture, have always been used as comforting enclosures for ceremonial as well as celebratory functions. Textiles clearly have an edge over other materials, be it in a symbolic sense, in a metaphorical light, in a functional way, in a sustainable dimension, or in a sensory interaction—they always hit the right chords.

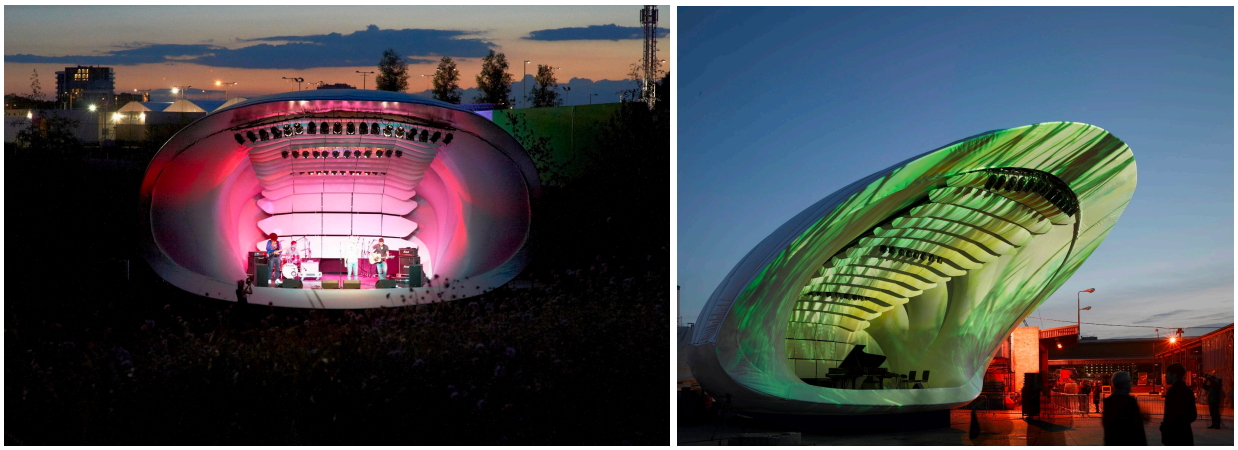


Fig 4.16. Shell-like form of the module enhances sound propelling quality when paired with textiles

4.0. Chapter 04: Analysis and Conclusion

After identifying the relationships between textiles and architecture, studying its evolution through earliest form of shelters to modern reinterpretations, investigating the parameters on which textiles integrate with art and architecture and analyzing different dimensions through demonstrative case-studies and illustrative examples—the thesis concludes the following:

(i) Textiles persist in duality

A peculiar trademark of textiles is that they persist in duality, at the intersection of two opposing forces. They either act as a prominent foreground or transform into a backdrop to highlight other elements of architectural integration. Textiles add a touch of softness to a rigid space or solidify themselves and achieve an impression of fluid drapery. Textiles either inspire woven facades or are woven as a facade, existing as both illusion and reality. Reiterated from the case-studies, it is evident that textiles exist at the intersection of both clarity and curiosity, entity and identity, tradition and modernity, division and connection, opaque and translucent, and in between the act of concealing and revealing.

(ii) Textiles act as portals between architectural past and future

As stated, and witnessed throughout the thesis, textiles are associated with cognitive functions of memory, senses, and thoughts that intangibly travel through realms. They also carry a legacy, reinvent, and reinterpret themselves, merging tradition with innovation towards a promising future. Looking into the past, textiles have been the earliest form of architectural shelters in the form of tents. In the present itself, the thesis provides multiple case-studies and examples of structures that stem from age-old textile materials, prints, motifs, patterns, and techniques. Moving into the future of architecture that involves sustainability and material innovation at its forefront, textiles act as the perfect choice to be independently experimented or be merged with latest technologies. Unlike

any other material, when a hole is pierced through textiles, it creates an opening on the other side of the textile piece, symbolic of a portal that connects the architectural past, present and future.

(iii) Textiles constantly renew themselves

As seen in tensile cable or suspension bridge projects, while the structure of a bridge may undergo design changes to suit the constantly evolving site context or technical adaptations, textiles on the other hand, only have to be replaced. They hold a renewal property to them that extends their temporality and continues their purpose like a linear stitch in time. Textiles also have the potential to be recycled, which assigns them a new purpose to live on. I believe that while other building materials build up structures, textiles carry on an architectural story for years to come—either by renewal, reinterpretation, adaptivity or cultural legacy.

(iv) Textiles behave as an all-encompassing material

Textiles extend from our body garments to physically encompass us in its warmth and comfort. They are flexible, durable, relatable, dynamic, solid, sustainable, temporal, cultural, portable, adaptable, and moldable in their functions thereby possessing every essential quality required to create architectural spaces that enrich the built environment and have a familiar cognition with the users. Textiles have also started to blur the boundaries between the walls and ceilings, as seen in a couple case-studies in this thesis. They act as a unified element, in a continuous organic curve that encompasses individual building components into one entity.

This thesis taps the varying potential of textiles and highlights its advancing relevance in the field of art and architecture. Textiles as a material have many layers attached to it, which are decoded through each case-study presented under the theoretical framework of four devised dimensions—Temporality, Craft, Drapery, and Technology.

5.0. Chapter 05: Recommendations

After closely researching into the domain of textiles and architecture, their intersections and integrations, the thesis recommends the following to highlight the importance of textiles as a paramount building material, capable of enriching spaces in aesthetic, cultural, sculptural and structural appeal:

(i) Since working with textiles requires innovation and experimentation, it has been observed that designers instead decide to pursue a tried and tested material that is ubiquitously used. The thesis recommends that architects take a step back and analyze textiles as a material that attaches varying character to a design and is an art in itself that uplifts spaces. Architects need to tap the cognitive functions of textiles and convert them into effective design solutions, also contributing to the study of architecture and psychology.

(ii) From the research, it is observed that presently, textile architecture is prevalent in European countries, especially in Germany. However, the countries rich in textile weaving communities and handmade textile production are India, Indonesia, Africa, Mexico and New Zealand. The thesis suggests architects to identify this gap, tap it, and leverage collaborations with these local weaving communities to create textile architecture in these regions, wherein it will be largely accepted, valued and recognized.

(iii) For the past couple of years, Sustainability, Green Buildings, Reduced Carbon Footprints and the likes of it have been the focus of research for the architectural and construction industry. However, there's barely any institution or organization that researches this important intersection between textiles and architecture. The thesis recommends that to spread awareness about these overlapping disciplines, research institutes should fund for study in this very domain.

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