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Article

Form-Formation Principles in Paper-Based Architectural Design

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Abstract:

The modern world is unthinkable without an ancient Chinese invention dating back to the second century. Simple, lightweight, flexible, widespread and readily available, inexpensive, recyclable, biodegradable, and versatile are properties which make paper a preferred material for a variety of applications – from humble packaging to bearer of cultural heritage and a powerful means for communication. The aim of the article is to explore the potential of this ubiquitous material of everyday use in architectural design and furniture design in particular. First, I will analyze the experiments with paper from a historic perspective in order to frame the prerequisites for its emergence as a structural material and to explore its traditional formal qualities. The considered projects exemplify the constructive possibilities of paper for building three-dimensional structures and refute the perceived limitations of the material in regard to its strength and rigidity. Secondly, I will discuss how modern technologies and production processes transform the inherent properties of paper and expand its form-formation possibilities allowing entirely new creative approaches. The deliberately selected examples show how contemporary designers take a new look at the material and imply its unlimited potential for future development. In conclusion the values of paper-based products are discussed.

Key words: Paper; cardboard; paper-based design; paper architecture; paper furniture; furniture design; form-formation principles.

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1. Introduction

Since the dawn of the industrial revolution designers have been trying to optimize the use of materials. Technological advance constantly pushes the development of novel materials or transforms the characteristics of traditional materials to offer innovative design applications. The focus of this article is on one of the oldest and most widespread materials invented in the second century. Associated rather with its low price and poor quality, paper is considered too ephemeral and fragile to be suitable for architectural design. However, this highly flexible and versatile material draws the attention of many designers who rediscover its structural, aesthetic and utilitarian qualities. The design developments are supported by scientific research regarding the feasibility of paper as a building material [1–4] and as a material for furniture design [5]. Furthermore, paper's environmental aspect and its sustainability properties are also extensively explored [5–7]. In the context of increased environmental responsibility and in response to the global ecological crisis the innovative use of paper as fully recyclable, inexpensive and lightweight material is very encouraging.

2. Paper as a constructive material

Model making in paper has immensely influenced the development of the design vocabulary of generations of designers. Experiments with paper in the early stages of the form-finding process aid designers not only in the exploration of the form but also in the empirical knowledge acquisition about the inherent properties and behavior of the material in the particular structure.

Josef Albers (1888-1976) was the first who introduced the study of material as naturally preceding the creation of rational design. Paper, a well-known material but unfrequently used was considered exceptionally suitable for discovery purposes with its immense capacity for manipulation. As a teacher at Bauhaus and later at various universities throughout the United States, he encouraged his students to test the qualities of paper and pushed their creativity to invent new constructions in search of the limitations of the material while experimenting with the spatial laws which govern it (Fig. 1).

Experiential learning as a powerful tool for developing constructive thinking and feeling for shape, space and volume was considered of utmost importance for the training of students. By understanding the fundamental problems of the material they were prepared to respect it and to approach it with honesty and responsibility [8].

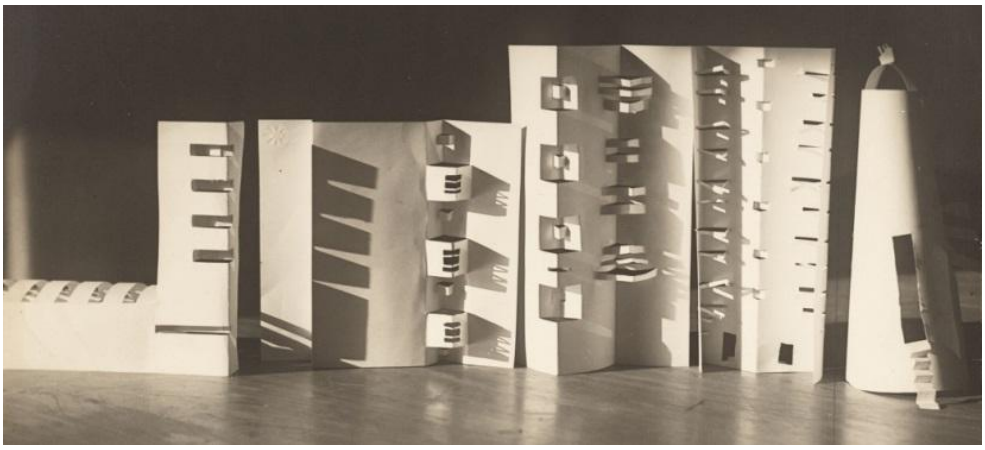


Figure 1. Material exercises in paper. Photo: Alfred Ehrhardt, ca. 1928–1929.
The Getty Research Institute © Alfred Ehrhardt Stiftung
www.getty.edu/research/exhibitions_events/exhibitions/bauhaus/new_artist/matter_materials/

Paper as a means for communication of concepts "provide a real glimpse into the mind of the artist" [9]. Though the new media in the digital age has immensely influenced the design process, even the most intricate and progressive architectural ideas may begin as physical experiments in paper. The simple material remains an indispensable means for tangible expression of the mental images in the creator's mind. Some of the most indicative examples are Zaha Hadid's (1950-2016) study models. Paper as a tool complements the 2d sketches and 3d computer models in the preliminary idea testing because it provides a specific articulation of the problems which are analyzed (Fig. 2).

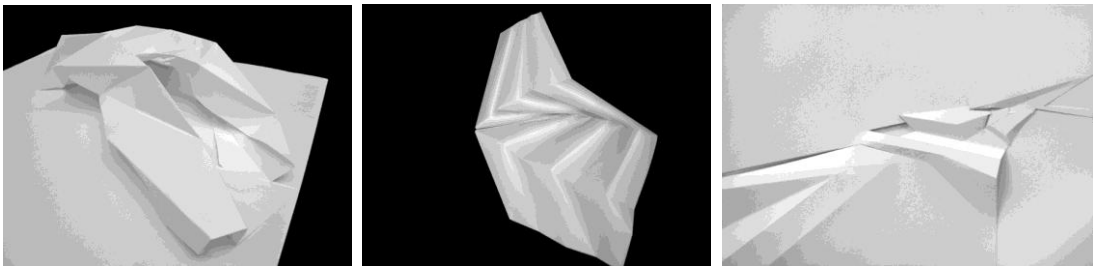


Figure 2. Paper study models for Eli & Edythe Broad Art Museum, Michigan.
Design by Zaha Hadid (2012)
www.detail-online.com/article/expressive-interface-eli-edythe-broad-art-museum-16483/

In product design, paper gives an opportunity to quickly visualize the design concept in 1:1 scale like a "sketch in space" [10]. Cardboard prototypes are a valuable insight in the understanding both of the structural geometry of the piece and its relationship with the space. Konstantin Grcic (b.1965) developed the groundbreaking die-cast aluminum construction of "Chair_One" exactly through the use of a series of cardboard models. The very first idea was built into a three-dimensional model which subsequently was transformed and adjusted until finally refined in a digital way (Fig. 3).



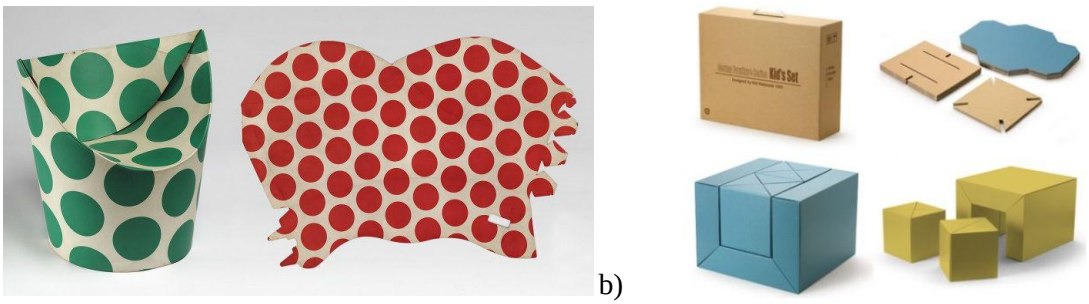
Figure 3. *Chair_One* paper models. Design by Konstantin Grcic (2004)
www.disegnodaily.com/article/konstantin-grcic-chair_one

3. Pioneer experiments with paper in furniture design

Despite the proven structural capabilities of paper, over a long period of time it was considered inappropriate to be implemented in any functional product. The preconceived notions about the longevity of paper products were challenged as late as the 1960s when pop culture emerged as a critique of the mass production and consumption model of the society. The cultural, political and technological changes of the 1950s incited the creation of entirely new forms. They symbolized the cultural break with the past and were aligned to the Pop aesthetic oriented towards the needs and preferences of the youth. The new generation of designers recreated the values of the modern world into fashionable pieces, consciously conceived to be cheap and expendable. Flat-pack DIY constructions made in commonplace materials gained popularity because they were simple and cheap to produce, easy to store and deliver, hence affordable and preferred by the users. The earliest experiment with cardboard as a material for furniture design was the *Spotty* chair (1964) by the English designer Peter Murdoch (b.1940). Whiteley describes it as "[t]he most complete example of fashionable and disposable Pop furniture" [11]. It featured a simple but impressive sculptural form accomplished by a fun polka-dot decoration. The user could assemble the chair as an origami from a single piece of flat paperboard composed of five laminates with polyurethane coating. The cost of production was just a few pennies and the retail price was 1,5 pounds but it required complex development and did not become a commercial success.

The enthusiasm of using paper for the making of objects that were never before imagined in this ephemeral material spread internationally in the late sixties. The exhibition "Made with paper" in the New York Museum of Contemporary Crafts and sponsored by the Container Corporation of America in 1967 captures the spirit of the time by presenting more than 200 items. Among them were garments, jewelry, toys, packaging, carpets, furniture, and paper sculptures [12].

Though the variety of paper products was huge, the formal principles used for the construction of the majority of them can be classified into two main groups. The first reiterates the traditional Japanese origami folding technique where the user can assemble the piece by folding a flat sheet with no adhesives. Fixing the product into a stable three-dimensional structure takes place through slots and tabs as in Murdoch's chair (Fig. 4a). The process is extremely easy and can be performed even by children. Another example is the award-winning Carton Furniture Series by the Japanese designer Riki Watanabe (1911-2013). It was conceived for children to construct their own chair and table in order to develop constructive thinking while playing (Fig. 4b).



a) b)

Figure 4. a) The flat sheet from which the *Spotty* chair by Peter Murdoch is assembled
© V&A Museum, London https://collections.vam.ac.uk/item/O21619/chair-thing-chair-murdoch-peter/
b) *Carton furniture series* by Riki Watanabe (1965) https://design-milk.com/carton-furniture-series/

The second structural typology uses cardboard tubes. Initially created for heavy duty application such as industrial packaging or formers for poured concrete, they are highly durable and rigid, and advocate a radically different design approach. Depending on the diameter, the product can feature either a single tube or a modular structure created through multiple repetitions of smaller-sized tubes. An example of the single tube design is the "Tomotom" range by Bernard Holdaway (1934-2009) for Hull Traders. It was presented at the "Ideal home" exhibition in 1966 and immediately became a Pop classic. The range comprised of chairs, tables and lamps made of cylinders of thick cardboard with high gloss enamel finishing in plain bright colours (Fig. 5a). Some of the details such as the tabletops and the shelves were made of chipboard seamlessly connected to the loadbearing cardboard tube structure with glue and metal pins. The collection was very well accepted by the fashion conscious families and was expanded with nursery furniture, toys, and a series of wall units. Another successful furniture collection featuring similar aesthetic language was developed by the French designer Jean-Louis Avril (b.1935). The chair is particularly interesting with the oblong cutouts in the Celloderme paper tube (a high density board manufactured from rolled-up humid pulp sheets) which visually lightens the structure and introduces a playful element (Fig. 5b).

a)  b)  c) 

Figure 5. a) *Tomotom* range, design by Bernard Holdaway (1966) © V&A Museum, London
https://collections.vam.ac.uk/item/O1191432/tomotom-side-table-holdaway-bernard/
b) *Container furniture* collection by Jean-Louis Avril (1967)
https://thegoodolddayz.wordpress.com/2013/12/08/chaises-de-jean-louis-avril-1967/
c) *Chaise longue* by Donald Lloyd McKinley (1967) © American Craft Council
https://digital.craftcouncil.org/digital/collection/p15785coll6/id/3307

The second approach in designing with paper tubes is exemplified by a chaise lounge by Donald Lloyd McKinley (1932–1998). He arranged the tubes vertically and connected them with glue and pins on their tangent points. The undulating surface was formed by slicing the tubes at an angle and concealing the openings with paper caps to ensure comfortable seating (Fig. 5c).

A striking departure from the two extensively experimented with typologies was made by Frank Gehry (b.1929). What started with an intuitive play with corrugated cardboard leftover pieces from the architectural models made by his studio, turned into the "Easy edges" avant-garde collection which brought international fame to its creator (Fig. 6). Gehry stacked the cardboard cut-outs into alternating layers with different orientation of the corrugation. This arrangement ensured the stability of the construction which was additionally increased by the addition of an edge-board of thin sheet of hardwood. The innovative structure with unusually soft texture resembling corduroy brought entirely new aesthetic dimension to the well-known material [13].



Figure 6. *Easy Edges* series (1969-1972). Design by Frank Gehry
www.moma.org/artists/2108?=undefined&page=&direction=

These earliest experiments with paper as a material for furniture design were an expression of the vantage point of a new generation of designers about the values of the modern world. Created as a reaction to the consumerist society, paper furniture emphasized the radical departure from the principles of Modernism by transforming the traditional notion of the everyday utilitarian products into cultural symbols with strong emotional impact. They set the beginning of a new era in product design which unfolded the form-formation capabilities of this unsophisticated material.

4. Paper in architectural design and engineering

The exploration of paper's potential for architectural applications also re-emerged in the middle of the twentieth century. Though paper is seemingly unsuitable for structural purposes it is proven that certain paper-based elements (e.g. paperboard tubes) possess sufficient strength and durability to carry structural loads and hence perform constructive role in architecture [14]. Paper's weakness in regard to its water impermeability and fire-resistance can easily be overcome with appropriate surface treatment and impregnation. In addition, the speed of construction, ease of assembly and disassembly, low maintenance requirements and minimal weight open a big perspective for the efficient and quick erection of temporary and emergency buildings.

Although there are several earlier attempts to design paper houses, the first substantial idea to use paper as a load-bearing structural material was explored by the famous inventor and visionary Buckminster Fuller (1895–1983). In 1954 at the Tenth Milan Triennale his famous geodesic dome was presented for the first time to the general public (Fig. 7). The 12,8 m diameter structure was assembled on site with pre-cut diamond-shaped modular components ready to be folded into triangular trussed pans. They were interlocked with specifically developed adhesives to form a spherical space-enclosing framework. The material was a sandwich consisting of five layers of corrugated cardboard. The outer layer folded inwards to become the inner surface of the dome [15]. To ensure the weather performance and durability of the material Fuller experimented with applying a layer of polyester resin, aluminum foil or other impervious materials but the corrugated cardboard he had at his disposal could not provide the desired water-resistance to create a permanent shelter. However, it was an important precursor of a building archetype which quite ahead of its time addressed problems like sustainability, optimal use of resources and accessibility.



Figure.7. Geodesic dome, design by Buckminster Fuller for the Milan Triennale in 1954.
http://aaa-laboratory.blogspot.com/2013/09/phase-2-p2-constructing-case-study.html
http://archivio.triennale.org/filtra

However, the real breakthrough pushing the limits of paper as a structural material took place more than thirty years later with the work of the Japanese architect Shigeru Ban (b. 1957). His interest in paper arose in 1986 while developing a concept for an exhibition dedicated to Alvar Aalto in Axis Gallery in Tokyo. Inspired by the ingenious way in which the great Finnish architect uses wood in his projects, but limited by the budget and the temporary character of the event he chose tubes made of recycled paper to create ceiling panels, partitions and display stands (Fig. 8) [16]. This "evolved wood" as Ban refers to it is to become the signature material of his work which he interprets in a huge variety of innovative projects – from temporary installations to unprecedented permanent paper architecture which proposes a radical break with the traditional approach to the structural system of the buildings. The unifying characteristics of them all are the efficient use of the material, minimal impact on the environment, and minimal efforts in the building practice.



Figure 8. Alvar Aalto exhibition, Axis Gallery, Tokyo (1986)
http://www.shigerubanarchitects.com/works/1986_alvar_aalto/index.html

The first project where paper tubes were used as structural wall elements is Paper Arbor (1989) designed for the Nagoya Design Exposition in Japan. Shigeru Ban utilized tubes mounted on a concrete base and joined at the top end with a wooden compression ring. Though it was a temporary small scale project, it proved that the tubes possess the required structural strength and he was encouraged to explore further the properties of the material and to implement it in a number of projects. In 1995 with the building of the Paper House in Yamanakako (Japan) paper tubes were authorized by the Ministry of Construction to be used as a structural material in permanent buildings.

The versatility of the material extends beyond its application for columns and framed trusses. This is exemplified in the construction of curvilinear structures. They implement two different approaches to the structural system. The first is a rod system composed of frames, arches or space frames of interconnected straight paper tubes as in the Paper Dome (Japan, 1998), the Paper Theater (Holland, 2003) and the Paper Bridge (France, 2007). The second approach is the more impressive shell system using pre-bent curvilinear tubes as in Paper Arch (USA, 2000) and Japan Pavilion (Germany, 2000). Particularly interesting achievement is the Japan Pavilion for Expo 2000 in Hannover where Shigeru Ban collaborated with Frei Otto to create a double-curved grid-shell structure (Fig. 9). It features a large frame of arches made of lengthy paper tubes connected with fabric tape which allowed three-dimensional movement of the tubes during the erection process. However, to comply with the requirements of the German building code a compromise was made with the addition of a timber frame of ladder arches and intersecting rafters which was incorporated to withhold the deformations of the paper tube structure. The pavilion is also noteworthy for its minimal impact on the environment as over 80% of the construction materials were recycled after its disassembly.

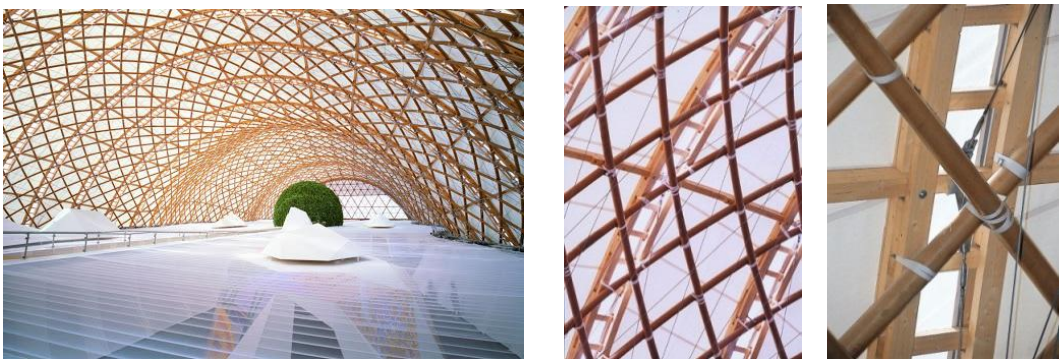


Figure 9. Japan Pavilion, EXPO 2000, Hannover, Germany
www.world-architects.com/nl/shigeru-ban-architects-tokyo/project/japan-pavilion-expo-2000
https://inspiration.detail.de/japanese-pavilion-at-the-expo-in-hanover-106867.html?lang=en

Though cardboard panels and paper tubes are the primary structural members defining paper architecture, important elements to be considered from design point of view are the connections between them (Fig. 10). Latka summarizes six different types – lamination, bracing, post-tensioned elements, interlocking, folding and clipping (tiding) [1]. In lamination, interlocking and folding the assembly of the structure is realized with the paper components themselves without the use of auxiliary elements. The other three types use additional elements made of more conventional materials like metal and timber (e.g. gusset plates, bearing plates, cables, bolts, nuts, etc.) [14] The design of the joints and the choice of

material depend on their structural purpose in the construction and aims to properly transfer the structural loads as they are subjected to a great stress concentration.



Figure 10. Different types of connections in paper architecture
https://inspiration.detail.de/japanese-pavilion-at-the-expo-in-hanover-106867.html?lang=en

5. New technologies and form innovations in paper-based design

The variety of the applications of paper in architectural design increased immensely in the twenty-first century with the introduction of new technologies in the field. In this subsection will be outlined some of the experiments which contribute to the structural value of paper and complement the milestones in paper-based design discussed so far. The trends stem from two lines of advance – innovations in the processing methods and innovations in the material itself.

5.1. Paper pulp

Pulp, the raw material from which paper is made provides many design opportunities. By experimenting with alternative fibers, filler materials and binding agents in its composition, the characteristics of paper are changed to allow innovative three-dimensional structural applications [17].

3d printing, one of the most widely applied technologies nowadays paired with environmental concern to reduce the negative impact of the plastic filament which is used in the process led to the creation of a sustainable version of a 3d printer using recycled paper pulp. The proposal by Beer Holthuis was his graduation project from the Design Academy Eindhoven in 2018. The products created with this technique share the distinctive layered structure typical for all 3d printed forms (Fig. 11).

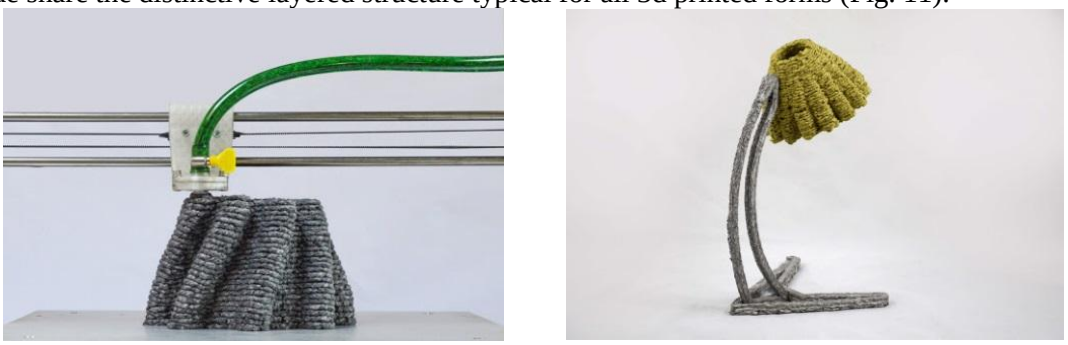


Figure 11. *Paper pulp printer*, design by Beer Holthuis (2018)
http://www.beerholthuis.com/portfolio/paper-pulp-printer/

The first project using pulp as a building material in an architectural scale was the Pulp Pavilion designed by Ball-Nogues studio for Coachella Festival in 2015. It was built by spraying wet pulp made of reclaimed paper onto a skeleton of organic jute ropes stretched on a plywood frame. During the curing process, the mixture made of pulp, water, pigment and adhesive hardened and resulted into a three-dimensional lattice which is both lightweight and robust to self-support (Fig. 12). Intended as an ephemeral structure it was entirely disposed of after the end of the festival.



Figure 12. *Pulp Pavilion*, design by Ball-Nogues Studio for Coachella Valley Music and Arts Festival, Indio, California (2015) https://www.nousengineering.com/pulp-pavilion-project

Paper Bricks, designed by WooJai Lee provide another option to transform recycled paper into robust construction material. The bricks obtained through pressing a mixture of newspaper pulp and glue into a mould allow processing similar to solid wood. At the same time, they combine the visual aesthetics of natural stone with the soft and warm surface typical for textiles. A possible application is illustrated by the designer with the "PaperBricks Pallet" furniture series (Fig. 13).



Figure 13. *PaperBricks*, design by WooJai Lee (2016) http://woojai.com/paperbricks.html

5.2. Paper layering

One more proposal utilizing waste newspapers inverts the traditional process of paper manufacturing by turning paper into wood. The "NewspaperWood" developed by Mieke Meijer (b.1982) in collaboration with Vij5 turns paper into wood through gluing multiple layers of newspaper. The material resembles solid wood with its specific grain and growth-rings which are unveiled from the specific combination of printed texts, photographs and graphics of the original paper when the "NewspaperWood" log is cut (Fig. 14). The design possibilities offered by the material were explored by a team of young Dutch designers, who developed prototypes to be exhibited during the Milan Design Week in 2011.



Figure 14. *NewspaperWood*, design by Mieke Meijer in collaboration with Vij5 (2008) https://www.vij5.nl/en/newspaperwood/

Inheritors of a rich historical tradition of work with paper, the Japanese designers are creating some of the most impressive projects. The "Cabbage" chair was designed by Oki Sato (b.1977) for an exhibition curated by the fashion designer Issey Miyake. It uses pleated paper which is a waste material

from the process of making of pleated fabric. The final form is obtained by simply peeling off layers from a compact roll of paper (Fig. 15). The chair does not need any additional support structure because the paper itself is sufficiently resilient from the pre-impregnation with resins added during the original production process. At the same time, it is very flexible and forms a soft and comfortable seat. The design is very trendy. It addresses the environmental concerns by using recycled material but also provides user customization by giving the possibility for the user to shape one's own chair.



Figure 15. *Cabbage* chair, design by Oki Sato (2008)
http://www.nendo.jp/en/works/cabbage-chair-2/

Paper layering is demonstrated in its most inconceivable form in Ryuji Nakamura's (b. 1972) experiments with vulcanized paper. This material with long tradition in Japan is manufactured from soaked in zinc chloride plies of paper which are pressed together to form a very strong and durable sheet. The "Hechima" chair was developed in several versions from 2006 to 2012. Its organic form is obtained from pre-cut paper sheets with a honeycomb pattern which are stacked into a three-dimensional truss-like structure (Fig. 16).



Figure 16. *Hechima 4* chair, design by Ryuji Nakamura (2008)
http://www.jiajumi.com/news/design/7208.html

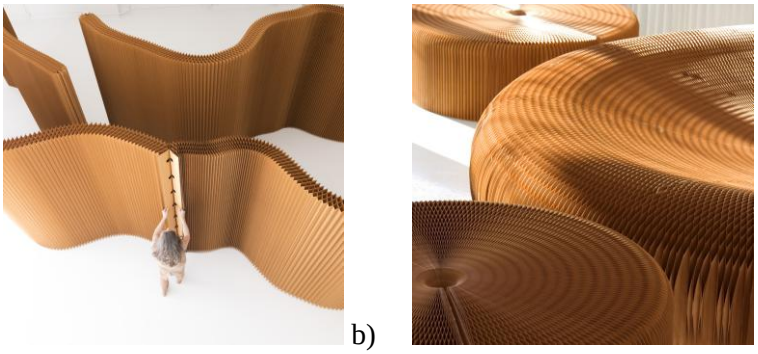
The fascinating constructive properties of layered paper inspired the creation of the first of its kind complete interior space (Fig. 17). In 2005 the Dutch designers Adrianus Kil (b. 1963) and Ro Koster (b.1965) designed a small office for an advertising agency in Eindhoven (the Netherlands). The space was rented for a limited time so cardboard turned out to be the most suitable material with a reasonable price which provided opportunity to be discarded at the end of the lease. Walls, tables and shelves were made by piling layers of honeycomb cardboard finished with acrylic paint to protect the surfaces and a fire-retardant coating. The resulting texture is not only variegated and visually pleasing but also ensures the noise insulation of the space.



Figure 17. Scherpontwerp office interior,
design by Adrianus Kil and Ro Koster. Eindhoven, the Netherlands (2005)
https://www.ro-ad.org/projecten/cardboard-office

5.3. Honeycomb structures

The hexagonal geometry of honeycomb paper makes it very stable as a construction material but also creates visually attractive three-dimensional forms which are revealed when the paper is fanned open. The most representative exploration of these properties in furniture design is proposed by the Canadian company Molo Design. The designers Stephanie Forsythe (b.1970) and Todd MacAllen (b.1966) developed a collection of stools, benches, partition walls and lighting. They are shipped in a compressed form and then are expanded more than one hundred times to form a variety of straight or curvilinear elements (Fig. 18). Developed as a modular system each item has magnetic end panels which allow to connect to itself or to be attached to another module to create longer structures. This flexibility gives the opportunity to easily reconfigure the interior space which is just one of the advantages of the design. Its sound absorbing qualities, zero-waste production, recyclability and portability make it a sustainable alternative for the creation of adaptable spaces for open plan offices, hotels, exhibitions, etc.



a) b)

Figure 18. a) Soft Wall; b) Soft Seating, design by Molo (2003). https://molodesign.com/

In 2001, Tokujin Yoshioka (b.1967) designed an experimental chair using 120 layers of glassine, a traditional paper for lanterns (Fig. 19). The form, cut into a specific outline transforms from a flat piece into a chair with an accordion-like opening of the material. However, the ultimate shape is not yet achieved. What makes the concept of the piece exceptional is that the user is involved in the form-generation process. Under the weight of the body the surface layer is deformed and fixed into shape. This unique collaboration between the designer and the user challenges the preconceived notions of industrial production by introducing variation and personality to the final product. “The designer’s work is not just designing form,” says the author in an interview for MoMA, “my principle is to design the process before the form emerges. That I believe is the way to create a simple and powerful form” [18]. The name “Honey-Pop,” in addition to the direct reference to the honeycomb which the chair resembles, also refers to the legacy of the Pop Culture which debuted the use of paper in furniture design.



Figure 19. *Honey-Pop* Armchair, design by Tokujin Yoshioka (2001)
https://www.themethodcase.com/honey-pop-tokujin-yoshioka/

5.4. Laser cutting

Removing material as one of the basic form-generation principles also achieves new dimensions with the implementation of current technologies. The exhibition "Slash: Paper Under the Knife" at the Museum of Arts and Design in New York from 2009 explored the variety of paper processing techniques within this category rendered through the creative prism of fifty visionary artists [19]. One of the projects which deserves attention for its innovative interpretation of the laser-cutting technique is "Your House" by Olafur Eliasson (b. 1967). The Danish-Icelandic artist studied the relationship between the flat sheet of paper with three-dimensional environment. He conceived a book representing a novel approach to architectural modelling with cut in the paper negative spaces which take the viewer to a virtual walk through the rooms of his own house when the pages are flipped (Fig. 20). Each one of the 908 pages is individually laser-cut to reproduce an exact cross section, corresponding to 2,2 cm of the actual house.



Figure 20. *Your House*, design by Olafur Eliasson (2006)
https://www.thisiscolossal.com/2013/09/your-house-olafur-eliasson/

6. Conclusion

Emerging as a response to the mass-market requirements for affordable and stylish products oriented towards the youth, paper, though ostensibly unsuitable, established itself as a structural material with immense potential for experimentation. Frank Gehry, one of the first who proposed a revolutionary use of cardboard for furniture design defines: *"Paper is structure. If I can make it out of paper I know I can build it"* [20, p. 13]. Paper's recyclability, relatively low cost compared to other materials such as solid wood and plywood, the exceptional lightness, appealing soft texture, and the diverse form-formation possibilities are quite inspiring for designers to explore this rather traditional material in a variety of innovative applications. From temporary pavilions, to furniture design, complete interior spaces and even permanent architectural structures, the life of the fragile paper is re-invented and transformed into long-lasting functional products and spaces.

Nowadays, the more conventional origami-folding and layering of flat paper, along with paper tubes whose limits are constantly pushed in the work of the Japanese architect Shigeru Ban, are complemented with innovative interpretations enabled by current technologies. The inherent properties of paper are also expanded by adding structural strength and resilience, weather and water resistance, thus

elongating the life of the products and widening its application areas as a structural material. Paper products are characterized with honest form and a logical structure dictated by the properties of the material. It reflects the manufacturing method and minimizes the use of materials while achieving maximum results. The construction method is clearly manifested. The inessential details are omitted and the importance of the whole structure is emphasized which predetermine the efficiency, expressiveness and the dynamics of the form. Produced from renewable resources or waste paper products and itself being recyclable, are advantages which make paper a sustainable material with low environmental impact. Its lightness and possibility to be transported in a flat-pack format economize redundant expenses for transportation but also provide the opportunity to actively involve the users in the design process by allowing them to participate in the assembly and the final form-giving of the paper product. This unique combination of qualities, demonstrated to a certain extent in the avant-garde projects discussed in the article, rehabilitate paper as a structural material, expand its meaning, and bring added value for the users.

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Form-Formation Principles in Paper-Based Architectural Design

Аннотация:

Современный мир немыслим без древнекитайского изобретения. Простая, легкая, гибкая, широко распространенная и легкодоступная, недорогая, пригодная для вторичной переработки, биоразлагаемая и универсальная – это свойства, которые делают бумагу предпочтительным материалом для множества применений – от простой упаковки до носителя культурного наследия и мощного средства коммуникации. Цель статьи – изучить возможности этого повсеместного повседневного использования материала в архитектурном дизайне и дизайне мебели, в частности. Во-первых, проанализируем эксперименты с бумагой с исторической точки зрения, чтобы определить предпосылки для ее появления в качестве структурного материала и исследовать ее традиционные формальные качества. Рассмотренные проекты демонстрируют конструктивные возможности бумаги для построения трехмерных структур и опровергают предполагаемые ограничения материала в отношении его прочности и жесткости. Во-вторых, проанализируем, как современные технологии и производственные процессы преобразуют неотъемлемые свойства бумаги и расширяют возможности ее формования, открывая совершенно новые творческие подходы. Сознательно выбранные примеры показывают, как современные дизайнеры по-новому смотрят на материал, и подразумевают его неограниченный потенциал для дальнейшего развития. В заключение обсуждаются ценности бумажной продукции.

Ключевые слова: бумага; картон; бумажный дизайн; бумажная архитектура; бумажная мебель; мебельный дизайн; принципы формообразования.

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