

**INSTITUTE OF ART STUDIES,  
BULGARIAN ACADEMY OF SCIENCES**



**VESELINA LYUBOMIROVA MIREVA**

**PAPER IN ARCHITECTURE.  
TENDENCIES AND INNOVATIONS**

**ABSTRACT**

FROM A DISSERTATION PAPER FOR CONFERRING A  
*PHD* DEGREE IN  
*THEORY AND HISTORY OF ARCHITECTURE, 5.7.*

Sofia, 2019

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Adviser: Assoc. Prof. Arch. Stela Tasheva, PhD

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Prof. Milena Georgieva, PhD

Sofia, 2020

This Dissertation Paper was discussed and designated for public defense during a meeting of the *Fine Arts* sector of the *New Art* research group on August 22, 2019.

The Dissertation paper is 138 pages long and consists of an introduction, 3 chapters and a conclusion. The sources and acknowledgments list includes 19 titles in Cyrillic; 16 titles in the Latin alphabet; 5 laws, ordinances and regulations; and 33 standalone web-based sources. Additional literature: 46 titles. Included in the acknowledgments is an attachment showing various images.

The public defense will take place on 25th February 2020 at 11:00 AM at a meeting of the scientific panel: Corr. Mem., Prof. Arch. Atanas Kovachev, DSc; Prof. Arch. Asen Pisarski, PhD; Assos. Prof. Andronika Martonova, PhD; Prof. Milena Georgieva, PhD; Assos. Prof. Arch. Milena Nanova, PhD.

The materials which will be used in the defense will be made available to all interested parties in the Administrative Department of the Art Studies Institute at 21 Krakra Str.

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## **BASIS OF THE RESEARCH**

### **Relevance of the research**

My current research started as I took a look at the vast scope of opportunity to operate as a “green” architectural designer and the development prospects available from idea to implementation. This made me realize how important things like materials and the structure of architectural units are. Why did I choose to research paper? Why not straw, ash, shipping containers, or reusing and recycling materials from old buildings? It was because I was inspired by the work of the famous architect Shigeru Ban. At the time, I was familiar with only a few of his works but was touched by his efforts to help disaster victims. His favorite, signature material is cardboard tubes. As I was researching small residential units, I found out that he had made some significantly larger structures out of paper and I became curious. While I was looking for more information on this designer and his ideas, I gradually became familiar with the work of many other authors and their projects. So I decided it was going to be worth it to research the topic even more. (Let me mention here that I had just finished my Master’s paper entitled "Residential Modules For Disastrous Situations" and I was preoccupied with logistics, urban planning and the diverse concepts used. Later, I warmed up to the idea of using unconventional materials and *became more comfortable* with the temporariness of these residential units.) And so, while my research started as a look towards paper as an option for building residential units to be used after disasters, it grew to include other important temporary buildings and ended up with even bigger paper projects suitable for festivals and fairs. Later, the research of the data, the methods and the structure became more involved and precise. I review various architectural concepts and projects down to the level of individual details and looks into the use of paper and the architectural shapes that can be achieved with it.

“Architecture is an art which aims to design and build various types of structures. It is also a science because it is based on known technical methods, which must be understood”<sup>1</sup>, Atanas Donkov (Атанас Донков) wrote in 1945. He was one of the first architecture professors in Bulgaria. “The core of the architectural art is to realize and materialize shapes that someone has thought of based on a concept, which, to be durable, have to be constructed in line with the laws of physics and factors such as strength of materials and gravity.”<sup>2</sup>

The question of whether architecture is art is often asked in an architect’s practice, for

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<sup>1</sup> Донков, Ат., Ръководство по архитектура, Част I - Историческо развитие, форма и естетика, София - печатница "Ст. Хр. Баръмов", 1945, с. 3. [Donkov, At., Rakovodstvo po arhitektura, Chast I - Istoricheskoto razvitiye, forma i estetika, Sofiya - pechatnitsa "St. Hr. Baramov", 1945, p. 3.]

<sup>2</sup> Ibid., p. 5.

one reason or another. The main one being that it is somewhat limited by math, gravity, structure and technology. While these factors may confine the imagination of architects, they are unavoidable factors in any journey from concept to implementation. Maybe the repetition of rules and principles, shapes and rasters make certain people look at it as something else rather than art. Perhaps their doubts occur when they see buildings that represent a certain type dictated by the specifics of their functions. In addition, a building is always a collective achievement, and its existence is the result of the efforts of architects, investors, constructors, different engineers as geodesists, plumbing and sewage designers, electrical installation designers, HVAC system designers, etc.; and finally are builders and building material distributors. Some of the factors that leave their mark on the final form of the implementation, which shape it as its co-authors so to speak, include society in general, the architectural environment of the buildings, the age and even the political environment in which the building was constructed.

These correlations work both ways. “Like other works of art, architecture has the peculiar property of translating into artistic expression human spiritual drives, emotions and ideas, to evoke certain aesthetic and artistic experiences and to speak to people on an emotional level.”<sup>3</sup> It may sound paradoxical, but these views taken from the socialist-era “Aesthetics” (“Естетика”) by Elena Hristova (Елена Христова), in my opinion, are still relevant, if one can ignore the ideological paradigm. According to Ms Hristova, it is the „spiritual equivalent of architecture that reveals itself to bring it closer to art. It also possesses the common property of art - to serve as a form of social consciousness and be not only cognitive but also an aesthetic and an emotional reflection of the human condition, which, in turn, exerts an aesthetic and formative influence over people.”<sup>4</sup> On the other hand, regardless of the possible characteristics of architecture in a similar cultural and social plane, the concepts of what is art also change. This brings about questions regarding the temporal synchronization between the terms of architecture and art.

In addition, today architecture does not always have to be "permanent". On the contrary, there are cases where it is useful, necessary and completely sufficient with its temporary presence<sup>5</sup>. Some of the key elements of temporary architecture are materials and the structures through which it is built. Paper is one of the materials, which pre-determines the design

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<sup>3</sup> Христова, Е. Естетика на архитектурата. Техника, София, 1979, с. 9. [Hristova, E. Estetika na arhitekturata. Tehnika, Sofia, 1979, p.9.]

<sup>4</sup> Ibid., p. 9-10.

<sup>5</sup> Architecture is known for its durable buildings which make up the environment we live in, but there are also many temporary architectural solutions which have a fixed lifespan.

solutions. At the same time, it is expected that the architecture in which paper is applied will remain educational, innovative, environmentally friendly, safe, protective and yet art and a reflection of society with its understandings and development.

The use of paper in contemporary architecture is increasingly becoming more widespread and important, with its specific characteristics. The advantages of paper as a building material lies in its ability to inspire, prototype, to be reused and recycled. It meets the growing need for *alternative* solutions in architecture, but also in the area of *temporary structures* as the best solution in the wake of natural disasters and hostilities, or for festival pavilions and venues. Looking to diversify the materials they use, designers choose paper even in engineering applications such as bridges, towers, water containment facilities, etc. Research has been made for long-term structures, with some of them being able to be assembled, disassembled and relocated as necessary depending on people and their needs. Paper as a building material is also used in interiors to fit various purposes and concepts such as going back to nature and allowing the reuse of the materials. Paper has a special place in Asian culture, and contemporary Eastern architects seek to expand its application before it has become a global tendency as an alternative material.

The relevance of this issue is indisputable for sustainable architecture and the search for alternative materials, specifically within the re-use and recycling concept. Studies and research into paper are also being conducted in the scientific field tasked with experimenting to find and justify new models. This is very important for buildings that are temporary structures, such as pavilions or shelters for victims of disasters, which are always relevant, given the refugee issues that occur during and after hostilities and for the social needs of communities.

The topic of paper as a building material in architecture has been the subject of several research efforts, concept developments and implementations. One of the oldest studies of paper was conducted by Buckminster Fuller, who made models of his famous geodesic domes using various materials. One of them was paper. He presented his geodesic paper dome at the 1954 Milan Triennial. In recent years, the research of paper as a building material has seen a considerable resurgence. This is evidenced by the number of publications, papers and dissertations examining the technological history of paper and its various applications and use<sup>6</sup>, as well as its relationship with architectural solutions<sup>7</sup>.

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<sup>6</sup>Needham, Joseph. Science and Civilization in China. Volume 5. Chemistry and Chemical Technology. Part 1: Paper and Printing by Tsuen-Hsuei, Ph.D., Cambridge University Press, 1985.

Carter, Thomas Francis. The invention of printing in China and its spread westward. Columbia N.Y. 1925.

Hunter, Dard. Paper-making: the history and technique of an ancient craft. Courier Dover, 1978.

There is a direct continuity in the development of the research initiatives on the topic: one of the more relevant contemporary works is that of Mick Eekhout from TU-Delft, which traces the application of cardboard in architectural solutions. Jerzy Latka's dissertation applies the findings of that research and builds upon them, analyzing aspects of paper use as well.

Another motivated author looking for ways to use paper as a building material in the creation of architectural objects is the Japanese architect Shigeru Ban, who, together with his colleagues working in his studio, examines paper as a building material in several realizations - interior (since 1986) and exterior (since 1989 and to this day). He is also a major designer in the current research paper in the field of "Paper Architecture". His body of work has become an inspiration and a "case study" for many architects, designers, engineers, researchers. His projects in the field of paper architecture have a strong social focus and are related to several current environmental protection concepts. In this paper, the parallels to his solutions define and illustrate a broad range of possibilities, directions and details for the application of paper in architecture. The aforementioned Jerzy Latka was also a researcher at Shigeru Ban's studio in 2013.

Meanwhile, various competitions and workshops whose topic is paper or where some of the participants have chosen to express themselves by using paper as material are being organized by universities and other organizations. Often paper projects are the answer or an alternative when looking for temporary shelter solutions. Some of the most notable events are the International Building Festival of Tongji University held in 2015 in China and the student event at the University of Chongqing, China of 2014. The Hualin Temporary Elementary School was built in the city of Chengdu (province Sichuan) in 2008, following a design of Shigeru Ban.

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*Bloom, Jonathan M. Paper before print : The history and impact of paper in the Islamic world. New Haven, Conn etc. : Yale Univ. Press, 2001.*

*Стефанов, Стефан. Книга за хартията. Техника, София, 1965. [Stefanov, Stefan. Kniga za hartiyata. Tehnika, Sofia, 1965.]*

<sup>7</sup>*Eekhout, Mick. Verheijen, Fons. Visser, Ronald. Cardboard in Architecture. Netherlands, TU Delft : IOS Press, 2008.*

*Ayan, Özlem. Cardboard In Architectural Technology And Structural Engineering: A Conceptual Approach To Cardboard Buildings In Architecture. Dissertation Paper, ETH Zurich. 2009.*

*Acocella, Alfonso. Paper Design. Altralea edizione. Florence. 2014.*

*Latka, Jerzy. Paper in architecture. Research by design, engineering and prototyping. Dissertation Paper, TU-Delft, public defence on 7.12.2017.*

## **Object, Subject, Goal, Confines and Methodology**

This dissertation paper looks at various examples of the use of paper as building material; classifies some of the concepts influenced by it, which have come out of the field of experiment and have entered practice; and analyzes the different degrees of application of paper as a building material in the various construction solutions. Particular attention is paid to Shigeru Ban and his work. The different applications of paper in the direct and figurative sense is considered.

The **Object** of the study is the different architectural forms that use paper. (It is not the first time where the practice has moved ahead of the research, but research and analysis in the field have their significance: they can help develop the idea of using paper in modern architecture and construction, and illustrate its effectiveness and specific features).

The **Subject** of the dissertation is the influence of paper on contemporary architectural tendencies - the moments in which it is an innovation, although it is a well-known material. New directions for the development of the material are discovered and its perception is changing in general.

The **Goal** of the dissertation is to define the tendencies in the development of paper as a building material and its modifications in the present and future of architecture. For this purpose, a selection of implementations and design models is examined to propose a way of systematizing and classifying their characteristics.

For the purposes of this work, in the term architecture (without going into the etymology of the word and studies on the nature of this matter) will refer to buildings (and their image), which are the object of architecture. Like many researches before me, I will also view the visual expression of architecture as a text, and its elements as language at different levels. At the same time, architecture is constantly interacting with construction, which takes the concept and proceeds to the realization of the architectural object. An indispensable part of architecture is its structures and details.

**This paper will not look into** the already established partial applications of paper in construction and architecture (such as the many basic components like drywall, paus, wallpaper, black insulation paper, flexible paper tape (reinforced with galvanized steel strips to protect the outer and inner corners of drywall), plywood (lined with phenolic-resin impregnated smooth paper, suitable for making concrete forms)). The specifics of the various types of paper such as printing paper (typographic, offset, lithographic for intaglio), writing paper; drawing

and drafting paper; electrical insulating paper; cigarette paper; absorbent paper (filter), etc., will also be placed outside the scope of the study.

**The chronological boundaries of the study** encompass the period from the middle of the twentieth century with the first manifestations of the use of paper in architecture in an *unconventional* way to the present day and the current tendencies and endeavors in this direction. At the same time, references are made to traditions and established properties of paper that cannot be placed on a timeline.

This paper builds on the concept of *quality* architecture because of its substantive aspects listed below. Generally speaking, the following characteristics of an architectural work can be used as a kind of an “ideal for architecture”:

- It is designed intentionally and purposefully with its objectives, functions and predetermined lifespan;
- It checks all the boxes of the Vitruvian triad, “stability, utility, and beauty,” and it is safe for its users;
- It is a reflection of the regional and global cultural understandings and complies with their tendencies;
- It has a traditional value - the application of the construction experience;
- It is created *for* the people and impacts their senses;
- It relates to the environment and nature;
- It is a possible vehicle of innovation.

Avoiding the etymologically and philosophically controversial definitions of what is *high quality, beautiful, good, perfect, etc.* architecture, I use the characteristics listed above as criteria for selecting the architectural examples considered in this work. In this way, I exclude the spontaneously occurring, undesigned structures and ghettos, movable random objects, as well as the typical solutions for state, military, etc., buildings.

In my **study**, I examine the characteristics of paper as a building material, with its history, figurative meanings and pragmatic features and look into and classify contemporary architectural concepts concerning the use of paper. I proposed a classification system for the different ways in which paper is used with respect to the relative scale and options for its inclusion in construction. There is an offer of opportunities for future development in this field. The study applies the method of comparative analysis in terms of requirements and concepts, as well as the functional purpose, structures and details.

As I conducted my research (which was assigned to me at the beginning of 2016), I discovered that at the end of 2017, Jerzy Latka submitted his dissertation work on paper. Before the two of us, the topic had been researched by Mick Eekhout and his team in 2008 and by Özlem Ayan in 2009. The current spike in interest in this field emphasizes the relevance of the subject matter and the convergence of different scientific schools. This is also confirmed by the increasing use of materials such as paper.

What distinguishes my work from previous and parallel studies is a logical consequence of my different scientific perspective - namely, the art environment of the Institute of Art Studies, which made me analyze the objects not only from an architectural, structural or construction point of view. The main lines my work follows are the links with culture, with architectural forms of application in the urban and social fabric, the interplay of *paper and social* traditions seen through the prism of art and contemporary humanities as opposed to technical sciences.

**Objectives** of the study:

- To offer a systematic classification of the properties of paper which make it a suitable building material in architecture;
- To differentiate between the various applications and uses of paper outside of its well-known roles;
- To outline the typology of the architectural forms for which paper can be used as a building material;
- To clarify the tendencies and the innovations in the use of paper as a building material as well as their relation with traditional practices;
- To determine the possibilities for using paper in architecture in Bulgaria.

My research paper consists of:

- Introduction defining the relevance, the degree of research, the object, the subject matter, the goal, the scope, the methodology, the tasks and the expected results from my dissertation work.
- Three chapters structured as follows:
  - The first chapter of the study is entitled “Selected information about paper”. It consists of three parts. The first part of this chapter focuses on the history of paper as a material and the roles it takes. The second part deals with paper in an architectural context and the points of interaction between paper and

architecture. In the third part, one of the leading contemporary authorities on paper, Shigeru Ban, is introduced. The chapter concludes with a summary.

- The second chapter is entitled “Temporary Architecture and Paper. Disasters and Festivals. Tendencies.” The chapter consists of seven parts, the first four addressing disaster situations and how architecture can manage them. The remaining three sections are dedicated to festival architecture. The first part outlines the concepts and characteristics of disaster architecture. In the second part, the various types of temporary housing units are classified as they form the predominant part of this type of architecture. The third part focuses on the use of temporary architecture and paper to help disaster-stricken communities. Part four focuses on Shigeru Ban’s paper projects in the field of disaster-relief architecture. Part five looks into temporary festival architecture and its concepts, specifics and characteristics. The sixth part deals with the typology of festival architecture that uses paper projects. Part seven outlines the decisions and projects of Shigeru Ban in the field of temporary festival architecture. The chapter concludes with a summary of temporary architecture for disasters and festivals. It draws conclusions about the specifics of architectural sites in which the paper is used as a building material.
- Chapter Three is entitled “Paper: Contemporary Context and the Interpretation of Traditions. Innovation” and consists of three parts. The first part examines the influence of traditions on the creativity of the designer Shigeru Ban and their interpretation in a contemporary architectural context. The second part looks at paper in architecture and its independent or relatively independent constructive and formative role in architectural objects. The third part focuses on paper and its interaction with other materials used to create structures and architectural forms. The chapter concludes with a summary.
- The dissertation conclusion offers a systematic outline of the results as well as remarks on the scientific novelty and relevance of the work.

The research **results** are in the field of contemporary architecture and its theory. The application of paper as a major structural element in architecture is evaluated in terms of architectural and aesthetic vision, as well as in the context of sustainable development and environmental awareness, and as a conscious shift towards a smaller material footprint and a more conscientious attitude towards the others and the environment.

A **certain prognostic contribution** is made in answering the question of whether paper has a future in a new, so far uncharacteristic form in current architecture, or whether it will remain a utopia with a limited number of modern realizations. Whether it is definitive, positive or negative, I hope the answer will inspire creative minds.

## **CHAPTER 1. Selected information about paper**

Paper, as a product, takes many forms and has excited the minds of inventors since its inception. In the beginning, the way it was made and the material used for it were key moments. Today, its production technology is highly sophisticated and many raw material options have been tried. “Paper is a felted sheet of fibres formed from a water suspension process using a sieve-like screen. When the water escapes and dries, the layer of intertwined fibres becomes a thin matted sheet which is called paper. Over the span of the two millennia which have elapsed since the inception of the idea of papermaking, the craft has changed and the tools have become more complex, yet the basic principles and processes remain the same.” Joseph Needham writes, in *Science and Civilization in China*.<sup>8</sup> Needham’s definition of paper addresses the formal structure of this material and is relevant to a great extent to many of its forms.

The first part of Chapter One deals with the history of the paper and its traditional manifestations and applications, development and significance in China, its homeland.

The story of the creation of paper is not as clear as a blank white sheet, but is based on assumptions. However, it is not disputed that paper’s country of origin is China, though it is uncertain when it was invented. Its subsequent history also follows an undocumented but assumed path. In my work, I have chosen the version suggested by Joseph Needham. “Traditionally, the invention of paper was attributed to Tshai Lun early in the + 2nd century, but recent discoveries of very ancient paper fragments in North and Northwest China have pushed back the date of this invention at least some two to three centuries before him”, he writes. According to him, the invention of paper in China came as a result of the process of breaking and stirring rags into water several centuries before the beginning of our era. “It is very likely that an accidental placing of fibres from the rags on a mat with water draining away, may have suggested the idea of making a thin sheet of paper”, Needham explains.<sup>9</sup>

Joseph Needham also offers a brief timeline of the spread of paper around the world,

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<sup>8</sup> *Needham*, Joseph. *Science and Civilization in China*. Volume 5. Chemistry and Chemical Technology. Part 1: Paper and Printing by Tsien Tsuen-Hsuei, Ph.D., Cambridge University Press, 1985, p. 1-2

<sup>9</sup> *Ibid.*, p. 2.

which I will also cite for the purposes of this study. First paper spreads in the East “first eastwards in the + 2nd century, then westward during the + 3rd century. However, it did not reach India until the + 7th century, and only became popular there in the 12th. Paper arrived in Western Asia in the middle of the 8th century, and to Africa in the 10th. The Arabs monopolised paper-making in the West for some five centuries. Only in the 12th century was it manufactured in Europe, and it did not reach America until the 16th century and Australia in the 19th”.<sup>10</sup>

Paper, in its essence, is a material used for various purposes and in numerous forms, ranging from household and sanitary products, packaging, sorting and transportation, to making scientific recordings and art, to using it in construction applications and more.

From a semiotic point of view, there is a kind of trinity in the concepts of sign, object, and idea in architecture. For example, a single-family dwelling can be all of the following: in the drawing, it is a *sign*; once executed, it becomes a tangible material object - a *house*; and in essence, it is an idea which, once it has been lived in and infused with certain meanings for its inhabitants, is transformed into a *home*. Paper can also be seen as a sign, object and idea. As a sign, it can be an index, for example, indicating the existence of (sheets) of paper, (packs of) cardboard, etc. As a tangible object, it can be itself in its chosen form. As an idea, paper can have an additional significance, such as the meaning of the white sheet (cleanliness, a new beginning, a chance for new creation, etc.) and many more. In order to exhaust all of the possible cases where paper may be involved, I examine its pragmatic and semantic appearances in architecture and their syntactic combination in practice. (In this text, I use the term semantics to refer to the meaning of a phenomenon; the pragmatic side will refer to its practical (functional) value, that is, whether it fulfills its intentions; and the links between the elements will be considered syntactically).

Since China was the environment in which paper was created and developed and the place where much of the functions of paper were determined, I will discuss its applications there. I start with the practical side of paper and its gradual introduction into people’s lives. Initially, paper was used in China in an extremely wide range of situations, according to Needham: “in the fine and decorative arts, at ceremonies and festivals, for business transactions and records, monetary credit and exchange, personal attire, household furnishings, sanitary and medical purposes, recreations and entertainments, and so on. What is more, all these non-literary applications were common in Chinese society before paper was introduced into

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<sup>10</sup> Ibid., p. 2-3.

Europe...,” he writes.<sup>11</sup>

Religion helped the spread of paper and increased the need of it. Paper was part of rituals and was used to teachings; it was also used to express reverence for important personalities. The use of paper in interior decoration was also varied - under a form of wallpaper, part of movable or stationary light partition walls or as a substitute for glass in window and door panels.

Over time, various types of paper with different densities and strengths were developed, some more transparent than others. As they evolved towards their purpose, they assumed different semantic weight. Sometimes, paper objects that seemed insignificant could take on special ceremonial roles of great importance. Arts and crafts in China did not remain indifferent to paper, adding their own emotional charge and meaning, whether expressed in stylized or literal forms and images.

Paper had many other uses, but it can be concluded that from a material object, it had *transformed* into an idea. As it becomes clear later in this study, current architectural ideas and concepts go in this direction, and some of them manage to find a unique expression by incorporating paper not only as a building material but also a symbol.

The second part of Chapter One examines the relationship between paper and architecture. The importance of paper in the pragmatic and semantic sense and its relation to nature make it suitable for the development of certain architectural concepts.

The possibility of reusing paper intrigues designers’ minds in architecture as well. Various concepts have emerged for the use of paper pulp by spraying it on other materials, by mixing it, for example, in concrete, by directly producing shapes such as parallelepipeds and tubes; of paper products in other forms for load-bearing walls, for structural columns and beams. In the application stage where paper does not imply durability, but emphasizes the temporary nature of structures, it can be a suitable material for *temporary architectural objects* - an opportunity to experiment without endangering nature. On the contrary - by making paper an accomplice in the realization of new, interesting, bold, different ideas, goals, and concepts. Despite the challenges, there are modern, sustainable buildings, designed to be permanent, with which paper has a chance to prove itself over time.

Another intrinsic aspect is that paper recycling is featured in regions, where paper is popular and widespread product, i.e. where it is a *local* material and does not need to be transported over long distances.

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<sup>11</sup> Ibid., p. 2.

Architecture works to protect its inhabitants even during a disaster. However, as architect Shigeru Ban points out, if a building collapses, it threatens or takes the lives of the people in it: *“I think a lot of what we call natural disasters are in a sense man-made disasters. People don't die in earthquakes. People die in buildings that collapse in an earthquake.”*<sup>12</sup>.

Timber frame structures in combination with paper screens are a good example of the well-intentioned response by the people of the East to the sometimes aggressive acts of nature. These structures manage to reduce the weight of the materials used. Although paper structures may become heavy from one point on, they are still more maneuverable like wooden structures and safer than collapsing buildings with reinforced concrete skeletons.

Architecture is part of our cultural heritage. By law, it is classified as tangible<sup>13</sup> and intangible<sup>14</sup>. In architecture, we can see examples of both. The first category includes physical sites, which bind architecture to the existence of archeological, historical, artistic, cultural landscapes, etc. in the form of single buildings, structures, group ensembles, complexes and more. At the same time, architecture reflects the locally available materials, climate, understanding and lifestyle. Traditions, together with the public's attitude and views at the time, tastes and cultural development, are frozen in the material form of a building. Again, their expression is material, but the reasons for them lie in the sphere of the intangible. Another legally recognized form of cultural heritage is the cultural footprint left from the processes of construction. In this context, it can be said that building traditions belong to the intangible cultural heritage.

Through tradition, paper also finds its expression in architecture. As part of my work, I have examined the connection between material-related traditions and construction traditions, echoed in the application of paper in architecture. At the same time, paper is an answer or at least an attempt to find an answer to contemporary needs and a reflection of current cultural contexts and understandings.

Materials and their characteristics call for particular construction methods and structures, and if a certain type of material fails in a certain type of structure, this does not mean that it cannot be key to the implementation of another. Experience, success and failure contribute to the development of architecture. If a material such as paper is to be rediscovered

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<sup>12</sup> *NHK WORLD TV*. Direct Talk. Paper Architecture in Disaster Areas - Shigeru Ban. Available at: <http://www3.nhk.or.jp/nhkworld/en/tv/directtalk/articles/20160509/index.html> [accessed 11 July 2019]

<sup>13</sup> Закон за културното наследство, Глава четвърта, Материално културно наследство. В сила от 10.04.2009. Обн. ДВ. бр.19 от 13 Март 2009. Последно изм. ДВ. бр.45 от 15 Юни 2012. [Zakon za kulturnoto nasledstvo, Glava chetvarta, Materialno kulturno nasledstvo. V sila ot 10.04.2009. Obn. DV. br.19 ot 13 Mart 2009. Posledno izm. DV. br.45 ot 15 Yuni 2012.]

<sup>14</sup> Convention for the Safeguarding of the Intangible Cultural Heritage, Paris, October 17, 2003.

for architectural purposes, what has been learned about it in the past must be taken into account. The application which has proven itself to be successful could be chosen and only then we will be able to build upon it.

In the course of analysis, it is determined that the fields of application and uses of paper as a building material in contemporary architectural practice could be classified under the following categories: architecture in relation to nature; reducing the weight of materials; architecture in relation to traditions. The further development of these concepts will require the determination of the durability of the architectural objects.

Part Three outlines some of the first impressions from the work of designer Shigeru Ban. Shigeru Ban whose buildings and structures have been built in various places throughout the world, not just in his home country of Japan. Some of his projects are socially oriented with regard to the materials used and an approach to people and nature. Some of them include paper as a constructive and formative component. These projects are not episodic events in Shigeru Ban's creative career, but are rather the result of years of experience and rely on tried and tested practices. His preferences about materials, shapes and structures make his paper projects recognizable, but I am sure he would not mind if other authors use his inspirations and knowledge.

A large portion of Shigeru Ban's paper projects is considered in the next two chapters as actual architectural realizations of paper, predominantly in the field of Temporary Architecture - specifically, in the case of disaster-relief and festival architecture.

## **Summary of Chapter 1**

Architecture was officially recognized as tangible cultural heritage, but as noted, every valuable architectural object carries the markers of the age and the culture in which it was created, as well as the memory of what was learned and of the traditions. Sealed in the building, they make architecture both a historical source and a vessel of intangible cultural heritage.

A peculiar contemporary tendency is the dematerialization of parts of architecture. It is achieved by reducing the resources and the means used, by connecting the buildings with the cycle of nature and by the digitization of processes and phenomena. In other words, beyond the already mentioned interaction with culture, in our modern times, we are seeing an additional intangible aspect of architecture developing before our very eyes. In order to reduce inputs, equipment and technology have enabled us to rethink the time and durability of architectural

objects, consider more environmentally friendly and less resource-intensive processes, and use building management to reduce the possibility of human error. All of this is done in pursuit of an answer to the current tendencies for environmentally conscious and sustainable development.

We can be certain that digitalization will not eliminate the material aspects of architecture, but it does allow for new architectural concepts that are not related to actual materiality. Given this, it is not surprising that designers are looking into the use of materials such as paper in architecture. New generations develop traditions, interpret them, and in the process leave their cultural heritage for future generations, which could be intertwined tangibly and intangibly in architecture, but in a new and different way. Part of the intangible heritage is the semantic value of architectural objects.

In the spirit of reflection on the tangible and the intangible and their interaction, contemporary architecture embraces the temporary as an opportunity. The following inferences regarding the durability of architecture can be made:

- The characteristics of permanent and temporary architecture allow for their interaction and simultaneous existence. (For example, a permanent structure can have additional volumes and functions supported by temporary structures. Another option is to have temporary objects inside permanent buildings sectioning off and creating separate spaces.);
- Temporary is also a characteristic of permanent architecture;
- The two categories satisfy separate needs of society and allow for a more diverse range of buildings with different purposes and lifespans;
- Permanent architecture can create the need for certain new temporary buildings;
- Permanent architecture preserves what has been learned and creates a solid foundation for temporary architecture, which can then explore and test new horizons, such as the use of novel building materials;
- After successful testing, paper can become a proven option to be used as a building material and a means of expression even in permanent architecture as part of the interplay between the temporary and the permanent.

The chapter examines the history of paper and outlines the directions of its development as a finished product, working material and a means of expression most notably in temporary architecture.

A brief overview of paper traditions and its application in China shows the value of paper, which can easily be extrapolated to other cultures. Each of the applications of paper is loaded with meaning; sometimes it is a symbol itself, sometimes it is a vessel for other symbols drawn or written on it. Its “full-blooded” essence is the architectural motivation for its use as a building material. Thanks to the totality and interaction of all of its characteristics, paper is suitable for the implementation of the three architectural concepts outlined here - creating a connection with nature; reducing the *weight* of the used materials; keeping in touch with traditions. Of course, these concepts interact and complement each other to a point where sometimes it is not possible to distinguish them from one another. Nature, materials, traditions and time are in constant relation to each other in history, in practice and in theory.

As a building material paper can answer other, more specific problems in contemporary architecture such as accessibility, recyclability and reuse, and economy.

Perhaps one day paper will no longer be used by humans, but until then, enough paper waste will have been accumulated for reuse and recycling.

Thanks to designers and their ideals and dreams, architecture undergoes transformations, retaining its essence of art, but keeping in pace with new techniques and technologies. Sometimes the goals are achievable; other times they approach a level of perfection people are not yet ready for.

## **CHAPTER 2. Temporary Architecture and Paper. Disasters and Festivals. Tendencies.**

In the previous chapter I mentioned the topic of the so-called temporary architecture. My study of contemporary paper implementations shows that this is an architecture that allows paper to be widely used as a building material. In other words, paper is becoming one of the means of expression of temporary architecture.

There are two main types of temporary architecture:

- Architecture for disaster relief;
- Festival architecture.

The following sections of this chapter explore these two areas and their purposes. The already distinguished architectural forms are monitored and their paper *replicas* are examined.

The first four parts of the chapter put an emphasis on disaster relief architecture.

In the first part, I take a look at the nature of disasters and the response needed under such conditions. In this sense, temporary architecture has its own direction. Here, it was created in response to an aggressive external environment, such as a cataclysm or war, but it does not

try to resist them, but rather to fit in and provide relief as they proceed. Non-permanent in its nature, yet utilizing modern technology, it can be seen as a particular cultural phenomenon.

The definition of “disaster” provided in the Bulgarian Disaster Relief Act exhausts all of the possible meanings of this word and successfully implements the phrase “disruption of the normal functioning of society”:

“Article 2 (as amended by State Gazette issue 80 of 2011, in effect as of 14. 10. 2011) Disaster shall refer to any considerable disruption of the normal functioning of society created by natural phenomena and/or human activity, which has negative impact on the lives and health of the citizens, property, the economy and the environment, the avoidance, containment and prevention of which is beyond the capability of the system put in place to provide the usual measures required to protect the public.”<sup>15</sup>

Part of the logistics in emergency situations is providing accommodation (often tents), water supply, food, medicines, transport, medical services, and household services, among others. From time to time, concepts for easily assembled homes emerge in different places around the world as a way to ensure quick response to accommodation needs. In addition to the residential units, governments and relief organizations must provide other types of buildings as well, such as medical centers, warehouses, administrative buildings, facilities for children, etc. (schools, churches, chapels - depending on the scale of the disaster) should also be provided. With temporary buildings, it is important to have options for urban planning solutions for different areas and landscapes developed in advance, which will also allow for faster and easier construction of temporary transport and installation infrastructure.

The second part of the chapter examines the types of temporary architecture needed in distress situations. The lifecycle for this type of temporary shelter architecture could vary depending on the duration of the effects of the damages. The units themselves could be of different complexity and size. If they are intended to be used for a very short time, they might not have a kitchen / kitchenette. But, for longer like a year, it is a good idea to look for ways to provide cooking options as well. Of course, where residential units are expected to have an intermediate-term use, the solution to the cooking issue may be common areas with shared kitchen appliances.

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<sup>15</sup> Закон за защита при бедствия. Чл.2. (Изм. - ДВ, бр. 80 от 2011 г., в сила от 14.10.2011 г.) [Zakon za zashtita pri bedstviya. Chl.2. (Izm. - DV, br. 80 ot 2011 g., v sila ot 14.10.2011 g.)] Available at: <https://www.lex.bg/laws/ldoc/2135540282> [accessed 13 July 2019]

I take a look at the use of tents and yurts, repurposing shipping containers for use as shelters or residential units as well as the perspectives they offer and the rapid response concepts for the aftermath of disasters.

In the third part, based on the previous section, reference is made to paper concepts and projects to be used as a response to disasters and for the provision of shelters and dwellings for short or longer periods of time.

Disaster situations and the inability to respond adequately are an architectural problem that is of great concern to the architect Shigeru Ban. As he puts it, architects have to intervene here, because architecture should be in the service of people. This attitude and Shigeru Ban's projects in this area are the subject of Part Four of Chapter Two. A comparison is made with some of the popular solutions to disasters previously considered.

Shigeru Ban uses his knowledge to help those in need. He uses his tubes (special cardboard pipes) with objective (environmentally-friendly) reasons and at the same time shows the architectural community a way to exert a positive impact on the world. What makes Log house project by Shigeru Ban special is its characteristics:

- It uses available, lightweight materials;
- It provides an alternative use for recycled paper - reuse of waste materials;
- The assembling of units can be possible by non-professional builders;
- Construction is quick and provides the necessary shelter.

In his projects, Shigeru Ban seeks to turn architecture to the people. He is trying to be in the field when disaster strikes in order to help. When he deems it necessary, he foregoes the cardboard tubes and adopts other materials that are more accessible or more appropriate in the particular case. Shigeru Ban develops his designs and has provided various alternatives for construction. In my opinion, his proposals are an appropriate temporary alternative and a quick way to help the victims of disasters.

The fifth, sixth and seventh part of Chapter Two take a look at the other major category of temporary architecture - festivals. They require a variety of structures with different functions. Occasions vary and architecture faces different challenges but at the same time, the main objective is to provide a solution for a temporary event. This is where the specifics of festival architecture come from.

Part five focuses on the nature of the festivals and their characteristics. Temporary festival architecture is perhaps a broad concept that I frame based on my research. I use the term *festival* to refer to organized events that occur on a particular occasion, a holiday (music festival, exhibition, fair) and any accompanying trade events where pavilions are established

(for example crafts); exhibition pavilions (outdoor or indoor); training activities and “workshops” (activities organized by universities, etc.). There are usually food stalls, places to eat and places where people dance, listen to music, watch cinema or theater (a stage may be needed); it is possible to have specially designed spaces for this purpose or to use existing ones. *In this work, I use the term festival architecture in reference to both festivals and the exhibitions.*

Some festival events are opportunities to experiment and innovate. For example, for the World's Fair, the pavilions and their architecture are part of the program. Something expressive, memorable, innovative, technological or other distinguishing characteristic is presented in their concepts and implementations.

Here the logistics are quite similar to that in disaster management in terms of the preliminary organization and the thinking that goes into it to allow everything to take place quickly. The difference is that here this is not dictated by an emergency. Disaster relief is fraught with tension that comes from the suddenness of the events. With festival architecture, if the organization is inadequate, it risks ruining an event with a predetermined duration. Both types of architecture are temporary and, if properly organized, designers can make a difference.

Part six focuses on festival buildings, in which paper was applied as a form-determining material. For the sake of clarity, I look at a certain type of festival or exhibit and provide an example of how paper was used during it. Here, I draw attention to paper as a building material and the variety of structures that have been built with it. I use as an example two paper pavilions built in Bulgaria.

In his creative career, Ban has used paper in many applications with varying scale. Part seven focuses on his paper-made objects with exhibition- and pavilion-oriented architecture. I look at some of Ban's units and analyses their basic characteristics that shape them or illustrate Ban's creativity. Each of the structures has own significance in the development of Paper Architecture in terms of components (building blocks such as tubes; details similar to traditional knits or triangles as in Buckminster Fuller's geodesic dome, etc.), degrees of complexity, size and scale. These architectural implementations are valuable because of the underlying concepts, achieved thanks to the use of paper. However, they would not have had that value if the paper had been used to replace traditional building materials just for the sake of it, and without appropriate forms of expression.

## Summary of Chapter 2

Chapter Two looks at architecture and its relation to disasters and to the totally opposite theme of festivals. Although designed for occasions that are opposites to one another emotionally, it turns out that the architecture has similar characteristics, for example:

- Need for excellent logistics;
- Intention for temporariness;
- Variety of scales and solutions;
- A significant opportunity to experiment, innovate and be brave about the choice of alternative materials such as paper.

From the examined, in the second chapter, makes it clear that paper has gained popularity as a building material for shelters and pavilions and although the task is difficult, designers are making an effort to use it. Of course, as some of them point out, it is used entirely in the field of temporary architecture. Here the ephemeral nature of the structures is built-in. However, this tendency does not exclude the possibility of using paper in permanent architecture.

Regarding disaster relief architecture, one may debate as to whether tents belong in the architectural field, but as a source of inspiration and shelter, they should not be overlooked, although they are more at home in the design sphere. By arriving at the idea of using paper in disaster relief architecture, designers have come a long way, which I can only mention here as its ignoring would not have been right.

In the case of disasters, most of the design decisions are focused on the initial reaction, which can actually be taken care of by the well-known tents, which may not be much different from the cardboard tents in financial terms. Although there is considerable demand for suitable and efficient solutions, which cardboard tents may very much meet, given that they allow the recycling and reuse of paper, their lifecycle is very short. The more durable options look much more complicated and raise doubts as to whether they are more economical or easier to assemble or whether they offer better quality than tents. More importantly, do they actually offer more than tents and provide a regular rhythm to life? The use of paper in disaster relief remains an early stage of development with most designers, repeating the image of the paper house (The 1944 House), though with different spatial solutions. From time to time, some of them cross this boundary but do not consolidate and develop their efforts.

Still, most projects are episodic events around the world. For the moment, architect Shigeru Ban is the leader in paper-based disaster relief and festival architecture.

Certainly, Ban wants architecture to be of assistance to the victims and is trying to achieve that. But then, why are there only 50 homes in Rwanda if the victims are 2 million?<sup>16</sup> And in Haiti, with 1 million and 200,000 victims, we have another 50 homes for the homeless<sup>17</sup>. Where should we look for the cause? It may be difficult for governments to adopt different disaster response policy, perhaps people are not mature enough for this option. I may be interested in this largely because of my educational background and enthusiasm for developing paper as an alternative building material. Maybe to people who are not so familiar with the subject matter this does not sound as a good option. In my opinion, state policy and the wrong attitude play a big role here.

Do the residents really like these homes and do they love them? Given the low number of actually deployed units compared to the staggering number of victims, I am skeptical as to whether consumer feedback has been gathered and analysed. Still, I believe it is better for a person to have a roof over their head, a dry floor under their feet and protection from the whims of the weather. Perhaps one disadvantage of Ban's system is these characteristic pipes that are specially manufactured, even if recycled. Is it possible to make these tubes in place with 3D printing? Given the technology of these printers, a lot of material will need to be further recycled and re-processed before it can be used again for printing. On the other hand, Ban's structures can evolve in many places around the world and are easily adaptable to different climatic conditions (with the exception of the particularly inhospitable environments at the Earth's poles), as proved by Ban with the housing units for disaster relief he has built so far as part of his project. They can be stored in a state of disassembly and are designed to be assembled by the victims themselves. If they are no longer needed, they can be recycled successfully. If adopted by more governments and institutions, countries will be able to help one another as well. They will also be able to carry out comprehensive tests, studies and experiments to improve the system, and so it will become even more sophisticated, with many more variations for families of different sizes, for different climates, for easy transportation and assembly, and for recycling.

Architect Shigeru Ban's efforts to promote paper as a building material are evident. However, for this to happen, the enthusiasm of just one architect, his studio, the students, or even just the victims and refugees will not be enough. A possible direction for a comprehensive disaster management policy has been identified, but more actors need to join forces to support

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<sup>16</sup> Jodidio, Philip. Shigeru Ban. Taschen, printed in Germany, 2012, p. 45.

<sup>17</sup> *Shigeru Ban Architects*. Paper Emergency Shelter for Haiti - Port-au-Prince, Haiti, 2010. Available at: [http://www.shigerubanarchitects.com/works/2010\\_paper-shelter-haiti/index.html](http://www.shigerubanarchitects.com/works/2010_paper-shelter-haiti/index.html) [accessed 13 July 2019]

this solution and develop it. Today, architecture seeks expression in helping people, in harmony with nature, with efforts towards sustainability and ecology. Architects, designers and masters of the various arts are finding ways to be more responsible to the world around us, to nature, and to the future.

In terms of festival architecture, the mood is more positive; investors and designers are open to innovation and experimentation. Responsibility to mankind, to nature and toward materials and the environmentally friendly attitude are central again. Shigeru Ban has once again proposed directions for development and inspiration, and I hope that his concepts will be further developed by other authors. The social focus is less pronounced here than with disaster relief, but that is understandable as the occasions are happy and scale is about the size of the experiments and not about the number of the units. The budget is different, too, as it is possible to invest more money in one site for the sake of accumulating experience, although, as it turned out, in many festival applications building with paper results in lower costs.

Paper architecture at festivals allows for different manifestations and a variety of forms. The intrinsic limitations of the material provide for the originality to the works. Depending on the goals and the vision sought, in my opinion, paper can compete with familiar building materials in temporary festival structures. Several of the implementations highlight the economic and environmental factors that give paper an advantage as a form-determining structural material. I cannot allow myself to skip the interior implementations in festival architecture or the much smaller-scale solutions, because they are part of the stages of development of Paper Architecture: each of the projects carries a coded message and specific details and, accordingly, its scientific and practical weight. As evidenced by the experience gained by designers around the world, even a temporary home only “sounds” like an easy task to solve.

It is as if paper has consistently overtaken Ban’s consciousness since 1995 and has occupied the minds of designers around the world since 2000. However, a real spike in the interest in the material took place around 2010 (when it started developing into a modern tendency).

### **CHAPTER 3. Paper: contemporary context and interpretation of traditions. Innovations.**

In this chapter, I emphasize the application principles of paper, the structures it is used in, and its role in the various instances. First, I look at paper in the context of the Japanese tradition and how it is interpreted in the works of the featured author, Shigeru Ban. In the second and third part, I classify the types of joints and components of paper architecture based on the work of various authors around the world, who, although with occasional implementations, drive the development of paper as a form-determining structural unit of buildings. All the time, references are made to Ban's projects, which have been used to test a significant portion of the possible paper-built structures. A significant distinction between the types of architectural use of paper can be made with based on whether paper is the predominant or auxiliary (additional) component.

New concepts are built on a sound foundation. In construction, foundations are assessed not only based on the soil, but also by what has been learned in the practice and the development of various construction systems and structures in history. There are several important concepts in this section of the text - the first two of which are *tradition* and *innovation*.

In architecture, *innovation* can be the scaling of components and spaces; the selection of atypical material; changes in the building principles, etc. However, innovation is often also an interpretation of the familiar - rediscovering the old and learning from it. Thus, tradition takes a different form, viewed through the prism of different generations. A seemingly small change may also have a significant impact.

In this chapter, I look at traditions in two different aspects:

- Traditions in building and architecture;
- Traditions in the use of paper.

In the first aspect, tradition applies to the construction of buildings: either directly or further developed - refined in terms of the technology of execution and (often) seeking a better attitude to the environment. Tradition in the second aspect is predominantly found in a small scale and is revealed in interior products, books, decorations and accessories.

In the context of my research, the terms *detail* and *joint* have key significance. I have used them in their broadest meanings as follows:

- component (detail) - m. 1: a relatively small structural unit; element, peculiarity. 2. *specific* a part of a mechanism or a machine that cannot be disassembled any further.

<fr.><sup>18</sup>

- Joint – 1. convergence into one; joining. 2. only sing. the union, of two or more people for a common cause.<sup>19</sup>

The qualities and factors of a composition can also be joining or uniting: symbolism (lightness, ephemeral nature); the function (load-bearing); the environmental friendliness and sustainability (reuse and recycling). In the context of the study, however, I have examined the material forms of unity. This sets out several options for the types of joints and components used in paper architecture - a classification that has been applied in sections two and three:

- Part of the whole (structural unit, structure, furniture and fittings);
- Joint (connection between components);
- Connection type (principle, repeatability, module).

The object of my examination in the first part of chapter three is the influence of traditions and their application in modern conditions and the search for their possible development. The focus is on the social and experimental architecture of Shigeru Ban, which is often the result of rethinking traditional Japanese techniques from a contemporary point of view. I take a look at examples of life and culture in Japan, the philosophies and perceptions that are leading in the construction of the living environment, and compare them to the projects and implementations of Shigeru Ban. I make a comparative analysis of Shigeru Ban's designs and Japanese craft techniques involving bamboo, wood and paper as materials (as a true alternative to heavy materials). Examples of seemingly weak materials are considered, which, by entanglement or folding or a suitable structural design, can create a strong structure. A comparison is made of the same form-defining principles found in everyday life, interior design and furniture, and their transfer to a larger scale in architecture.

Design principles such as modular repetition are discussed, as in basket weaving, for example, or in embedded modules in shoji screens. In some of Ban's projects, the references are literal while in others, they are interpreted or reminiscent. Attention is also paid to origami as a structure. A parallel is drawn between partition walls in the interior and partitions such as fences in the exterior and their form-determining elements and principles, which are transferred

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<sup>18</sup> Буров, Стоян. *Пехливанова*, Пенка. Малък тълковен речник на българския език. Слово, Велико Търново, 1998, с. 93-94. [Burov, Stoyan. *Pehlivanova*, Penka. Malak talkoven rechnik na balgarskiya ezik. Slovo, Veliko Tarnovo, 1998, p. 93-94]

<sup>19</sup> БАН. Речник на българския език. Съединение. [BAS. Rechnik na balgarskiya ezik. Saedinenie] Available at: <http://ibl.bas.bg/rbe/lang/bg/съединение/> [accessed July 14, 2019]

to Shigeru Ban's paper projects. In part one of chapter three, I focus on Ban's design philosophy, which includes minimalism, the use of local materials and builders, the intrinsic temporariness of our environment, and the constant nature of change.

At the start of the chapter, I offer a classification of components and joints, which determines the structure of the second part of chapter three. This section focuses on projects and implementations where paper has been given the main role, i.e. cases of architectural objects or parts thereof where paper performs relatively independently. For the purposes of this section, I have assumed that paper performs independently the role which has been given to it, although it is not always structural and includes cases involving: binders such as adhesive, etc; joints that position individual paper elements (bolts, clamps, ropes, etc.); compositions that improve paper qualities such as strength, moisture resistance, etc. All of them are considered to be natural (necessary) for components made solely out of paper.

I look at paper in the form of boxes, tubes and panels. It is used for partition walls, structures and parts of the interior. Emphasis is placed on its ability to fold and intersect, cut into panels or tubes. It is also possible to be put in layers (one over other) corrugated cardboards for building walls, for example.

The common denominator between the types of joints classified in the second part is that they are all part of structures limited in size and with short lifespan. With significantly larger and imposing structures in terms of height and spanning distance, paper is combined with the equivalent materials, as part of paper components (such as wood, metal and other materials). In such applications, paper is usually protected with membranes, polycarbonates and other materials. In instances like these, paper operates in conjunction with other materials, which is discussed in the third part of Chapter Three. The already defined classification of paper applications in components and joints is used. Here, paper is part of systems such as partition walls, of mixtures such as paper concrete or as pulp in combination with other materials. Paper is part of structures in an attempt to replace concrete, or to be used in structural elements such as columns and beams. Paper is used to constructing complex surfaces or three-dimensional grids fixed with paper pulp. A parallel is drawn to timber and metal structures. The repetition of elements, forms, modules, principles of construction is again considered.

## Summary of Chapter 3

The key moments in the work of Shigeru Ban, which are related to the traditions of his homeland, can be classified in the following classic semiotic directions:

1. *Decision semantics:*

- *Revealing the characteristics of visible material;*
- *Optimal utilization of materials;*
- *Subordination to the concept that “everything is temporary”.*

2. *Pragmatism (benefit to people) of decisions:*

- *Earthquake stability created by the modular nature and the bearing connections;*
- *Use of natural and environmentally friendly materials contributing to sustainability;*
- *Use of local materials and traditions, economy and availability.*

3. *Syntax - structural definition of the formation of decisions:*

- *Characteristics of form determination - modular design, repeatable components;*
- *Shape transfer “from the simple to the complex“;*
- *Shape transfer “from the small scale to the large scale“;*
- *Application of similar principles to the use of timber, bamboo and paper.*

Despite the impressive endeavors and solutions discussed in this work, I believe that Shigeru Ban has elevated above the limitations of his Japanese roots, despite his success in transferring the traditions of his native land to many of his projects, and especially those aimed towards solving social issues or purely architectural experimentation.

Based on Ban’s projects and his interpretations of tradition in modern architecture, several fundamental principles can isolate and which can be followed by other architects:

- To learn from the past instead of merely copying it;
- To interpret traditions properly in order to discover current solutions - traditions are the foundation of the present;
- Using contemporary, even innovative materials, could reveal new fields for expression and experimentation;
- Innovations can find their roots in something small such as the substitution of a basic material;
- Available materials are a sustainable and cost-effective solution;
- (Contemporary) repetitions of (the traditional) module can be interesting and even

sufficient to form the final concept of a project.

Often details solve the basic architectural tasks, and therefore more attention is paid to the smaller scale in Japanese arts and crafts. The beauty of crafts has been studied so deeply and has been tested so many times over the centuries that it becomes possible to transfer it on a much larger scale.

In the second and third part of Chapter Three, along with the possible paper structures, I have talked about structural systems including wood and metal and the possibilities they offer. The relatively independent use of paper as a sole construction material proves to be a very difficult task, as suggested by the fact that the only major physical implementation is the unfinished Paper Arch for the Museum of Modern Art in New York (where metal connections have also been used).

The paper has expanded to many points and has refused to be confined to the term "joint". It offers a variety of alternatives, including attaching it to a variety of materials. Although it has good sound and thermal insulation properties, it is still looking for its place as a structural material. For the time being, results have also been achieved in structures protected from the atmosphere conditions. The essential design and geometric properties of paper include its ability to be folded, intersected, cut, as well as its ability to take different shapes such as panels, blocks, tubes, and pulp. In addition, it can be used in projects with environmental significance which require sustainable development and the ability to be reused; as well as the ability to use recycled paper or to recycle paper items when scrapped or are dismantled permanently.

At the same time, paper is integrated into contemporary constructions not only on its own merits as a building material, but also because of traditions (for example to imitate wooden assemblies or where small-scale elements are needed). Furthermore, paper is a vessel for a number of cultural and artistic features in architectural creativity. In this way, its application brings together tradition and innovation, which are always looking to find their final proportion.

## CONCLUSIONS FROM THE DISSERTATION

### Conclusions and results

It sounds almost utopian for projects to start as sketches on paper and end up as implementations made of paper. It is as if the paper models are growing to a 1:1 scale. Yet, as has already become clear, this may also be a reality - there are a number of projects that started from paper sketches, went through the paper models, and ended up being implemented with the use of paper in the process of defining their shape.

The author hopes that this research will arouse the interest of Bulgarian designers in paper and its application in architectural forms, that it will provoke them to create concepts, projects, implementations and conduct research of their own.

The study of *paper* architecture today shows the absence of geographical boundaries (except perhaps the earth's poles), as well as the independence of its use from standard climatic features. At the same time, the paper composition may include additives improving its qualities (such as strength, moisture resistance, water resistance, etc.); paper can be shaped into tubes to provide additional thermal insulation. Regarding paper's vulnerability to water, solutions that have become popular are canvass, membranes, polycarbonate - light enough yet effective in protecting its surface. Using paper in conjunction with other materials such as wood and metal increases its structural capabilities and the forms in which paper can appear.

From the implementations discussed here, it should be noted that paper has been used to build walls and roof structures, but not for floor slabs. In single cases, there have been attempts to use paper in multilevel structures, mainly as paper concrete mixes, but mostly for structures up to two levels. Otherwise, the volumes and sizes achieved by paper are considerable (the Japanese Pavilion for EXPO 2000, the Nomadic Museum, etc.). Usually, in larger structures, interior space is sectioned off into levels by additional volumes.

In my study, I explored and classified a portion of the work of the contemporary Japanese architect Shigeru Ban, who is known for his unconventional look on architecture and his knowledge of traditions (cultural and construction). Some of his practice is based on the rediscovery of paper and its application in architecture as a building material.

In the Japanese tradition paper seems to be part of the imagination - as suggested by the arts of origami, kiri-e, painted light partition walls, etc. Through these ephemeral and fragile structures, the Japanese emphasize the value of time. In his works, Ban insists that architecture can only be permanent if people love it - otherwise, all architecture is temporary. A particularly strong example in this direction is the *life cycle* of the Paper Church in Kobe (1995-2005).

Through paper, Shigeru Ban also expresses the “Japanese” attitude toward the temporary - i.e. the value of the phenomenon of temporary architecture and its potential to serve as spiritual food and provide home comfort.

At the same time, despite the strong borrowing of constructive and philosophical conditions and the sophisticated approach of the East, Shigeru Ban's architecture is supranational. Similar principles can be shown (and some are already known) in other geographical regions. Their modern interpretation is another way to reflect the change in time.

Here, I have summarized several common conclusions following the tasks initially targeted by the study:

1. The properties that make paper a potentially suitable material to be used in architecture include:
  - Its presence as a globally available material - production, waste and recycling;
  - The potential for using recycled paper in the manufacture of new components (thereby making use of paper waste);
  - The paper components themselves can be recycled after they are scrapped or found to be surplus to requirements.

It is important to note that as part of composite solutions, some of the existing paper forms (corrugated core, honeycomb core, pulp) can be used for their thermal and sound insulation properties. Paper has proven compression strength. Thus, in combination with other materials, it can be part of a complete construction system. (The analogy is reinforced concrete, where concrete takes on compressive forces while the tensile strength is provided by the steel reinforcement.)

2. In my work I have classified the **various forms of paper which are used in building and architecture**, namely:
  - Masonry blocks for non-bearing walls - solid blocks of paper concrete or hollow boxes (modeled after the properties of bricks as structural units);
  - Tubes for vertical or horizontal installation;
  - Solid form (pulp or paper concrete mix);
  - Multiple layers one over other (by panels with honeycomb cores, corrugated cores; by 3D printing);
  - Volumes created by the intersection or folding of panels (folding may be only seemingly creating a system of folds and shapes that brings stability to structures);

- As part of a composite solutions for walls in combination with other materials (in the form of panels and cellular core).
3. Architectural shapes and structures where paper is a suitable building material option given the scale and character of the structures. The following cases are possible:
    - **At the component level** - purely paper assemblies (through the intersection of panels or tubes; panels allow to be literally or seemingly folded and can be used in combination with intersection methods); components created by connecting elements with ropes (cardboard tubes and their binding to one another; "stitching" cardboards together); intricate components with paper as building material in combination with metal, wood or both; unusual components such as wire mesh sprayed and stabilized with paper pulp; construction of walls from paper pulp blocks, paper concrete, boxes or tubes; repeatability of the same shapes (triangles, folds), of the same components (tubes, boxes, blocks, boards) or of the same structural details.
    - **At the structural level** - for laminated structures; for mesh-reinforced spatial structures on a plane and on a surface with a single or double curvature; for domes; for arches and frames; for mixed structures such as paper columns (and girders) and timber or metal roof structures; faux timber or metal structures; bridge structures.
    - **At the architectural shape level** - parallelepiped volumes; volumes under double-pitched roofs; cylindrical volumes and yurt-like structures; volumes with single or double curvature; domes; grid-like shapes; origami-inspired shapes; conical towers; bridges.
  4. The use of paper as a building material is determined by several conceptual directions:
    - Illustrating the principle of respect for the materials, minimum waste and optimal use;
    - Meeting the rapidly changing needs of people and the need for temporary architecture;
    - Rethinking well-known traditions;
    - Introducing paper as a form-defining factor for the shapes of architectural objects;
    - Seeking new materials as a form of expression in construction and architecture.
  5. The properties of paper as a building material determine its innovative applications:

- Possibility for implementation of transparent, lightweight structures enabling the passage of additional light into the interior;
- Overall reduction of the weight of the building;
- Achieving a contemporary interpretation of traditions (of architecture and construction; transferring details from the scale of decorative art to the scale of buildings);
- A more economical alternative to durable structures for shorter-life applications;
- A variety of solutions for components made from a seemingly weak material such as paper.

#### 6. Research and assessment of the manifestations of Paper architecture in Bulgaria.

In recent years, two exterior designs of *paper* pavilions have already been implemented: in Veliko Tarnovo and in Plovdiv.

Also important is the fact that Bulgaria has a rich and varied history in terms of timber structures, which can be a starting point in the development of paper structures. I believe that by rediscovering Bulgarian timber construction, *paper* architecture can appropriate certain new components and even new evolution lines.

Buildings have a life cycle that starts from the conceptual phase and ends with their destruction.<sup>20</sup> **Parts of this cycle are the design and construction processes, and they consist of several phases that can be characterized as follows:**

- **conceptual phase** - paper is a typical part of the conceptual phase participating in it in the form of sketches, drawings, and models. It is used to present and clarify the design concept;
- **design phase** - here paper is a vessel for the symbols of the working and technical projects.
- **realization, construction** - paper is part of the tangible execution of interior designs in the form of wallpapers, curtains, partition walls and many pieces of contemporary furniture made of paper. At the same time, paper is also part of the construction process in elements such as formwork, drywall, plywood and more. Adapting design solutions to the use of paper and cardboard components is an important contemporary tendency. *It is evident that today paper is part of the last stage as well.*

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<sup>20</sup> The life cycle of an architectural object is examined in detail in an article by Architect Stela Tasheva (Ташева, Стела. Виртуалната мрежа – свободният пазар на архитектурната идея?, Изкуствата, пазарът, публиките. ИИИЗк, БАН, София, 2013, с. 223-224. [Tasheva, Stela. Virtualnata mrezha – svobodniyat pazar na arhitekturnata ideya?, Izkustvata, pazarat, publikite. Institute of Art Studies, BAS, Sofia, 2013, p. 223-224])

Of course, for paper **to be a building material for architectural objects, it must be included as early as at the design in all levels (including engineer designs)**. As it became clear, it takes the shape defining process in architecture in different directions; gives specific traits to structures; water supply and sewerage systems must be taken into account in terms of their location and vision; it has different thermal performance characteristics, which is important for the design of HVAC installations. Respectively, the energy efficiency indicators of buildings will be different; there will certainly be specific fire safety requirements, etc.

In the design process, due to the novelty of paper structures, it is necessary to take into account the climatic features; to take the required precautions to protect the material; to perform preliminary tests and studies especially when developing new components; to define the durability of the architectural object.

The study clearly emphasizes the growing temporary architecture tendency and its advantages over permanent architecture. As is clear from the examples discussed, paper is one of the materials that is used as a means of expressions in temporary architectural objects.

The main features of architecture include durability, defined since the times of Vitruvius in the famous Vitruvian Triad, which distinguishes three qualities that architecture possesses: “firmitas, utilitas, venustas” (stability, utility, and beauty). This is the basis on which the concepts of temporary and permanent architecture are usually divided. At a quick glance and on a more literal plane the time period during which architecture exists can be taken as the principal criterion in this division. However, these concepts must take into account intentions, purpose and functions, even the political situation. A watershed example could be the case of a building which, after approximately 10 years since its completion, is demolished for unforeseen reasons by the investor or another person because it does not meet its expectations. It was built as a piece of permanent architecture, but due to certain circumstances, it has to be demolished. Even though it has had a short lifespan, it is not part of the temporary architecture.

The constant tangible presence of certain buildings gives people a sense of security and is a part of the environment. However, sometimes there is a need for a short-lived building that does not need to be retained and changed beyond what has been deemed necessary. Thus, the ability of a building to exist only temporarily is a rather a useful and flexible feature of architectural decisions. Nowadays, the durability of a building is generally determined in the phase of its design and creation. In fact, temporary architecture is identified as such as early as during its design stage. Its temporary lifespan is part of the end result and a means of achieving it.

Of course, the delineation between temporary and permanent architecture is conditional. In a more abstract and broader sense, all architecture is temporary compared to the concept of time; everything is temporary. *It can be argued that a building with a non-fixed lifespan should be considered permanent architecture, while buildings with pre-determined lifespans can be qualified as temporary architecture.*

However, temporary architecture could have a recurrent lifecycle - such as pavilions that are built every year for a festival, then disassembled and stored. In such cases festivals may even be move to other locations with no geographic limitation, always centered on the building as its point of reference. *In this case, the concepts of temporary and permanent architecture are again intertwined: the building exists indefinitely, but for short periods of time.*

**I would like to summarize the typical characteristics of most permanent architectural objects as follows:**

- There is a social/economic need for their existence for an indefinite period of time;
- Their construction (necessitated by the need for a particular function to be performed) is a planned process over time: even if they require quick realization, they are not a *surprise for the government and residents* and are not built as a matter of urgency;
- They rely on proven and established building principles and traditions - a confident result is expected, even when innovation is applied;
- They are made of durable materials, proven historically or under special certificates; stability checks are carried out in abnormal atmospheric and natural conditions;
- their construction is carried out by professional builders and is managed by technically competent persons;
- contemporary solutions have a long-term relevance for the environment and sustainable development of the region.

**To compare them to those of permanent architecture, I will mention the following characteristics typical for temporary architecture:**

- There is a social/economic need for their existence for a certain period of time (low cost of paper, especially reused);
- It is possible to interpret construction principles and traditions in an uncharacteristic way with new nuances, materials and technologies; they are also an open field for possible experimentation (with materials, structures, shapes) - this is where the paper shines;

- Durability of materials (such as paper) is not sought;
- The construction may be suitable for a particular set of weather conditions and inappropriate for others for which additional facilities are required (again paper options);
- In some cases, construction could also be by non-professionals - after proper training and with the guidance of trained workers (such as in post-disaster situations);
- They are relevant to ecology and sustainable development, but on a more modest temporal and geographical scale (such as material reuse).

Temporary architecture is the result of a conscious choice of *temporariness*. If performed professionally, the construction process can be marked by the same high quality inherent to objects of architectural art, creating a kind of ideal for temporary architecture:

- It is conceived to have a limited lifespan but to be safe to use over time;
- It is consistent with the Vitruvian Triad - “stability, utility, beauty”;
- Even when a sudden need for it arises, its creation is to some extent organized, pieces of temporary architecture can be built as a matter of urgency following a military operation or a natural disaster;
- It is designed with people in mind and influences their perceptions;
- It is relevant to the environment and nature;
- It bears the responsibility for developing current cultural understandings at the moment and adjusts to the tendencies;
- It has scientific value - even if it is a failed experiment, provided it contributes and expands the knowledge to develop architecture even through failure and provide a new direction and an opportunity for innovation.

Of course, *real* temporary architecture does not always have the attributes of ideal temporary architecture. Therefore, the concept excludes the chaotically constructed semblances of buildings in affected areas, put together with no idea of the overall end result, or sprawling ghettos in poor neighborhoods that do not follow any architectural and urban planning principles. Self-contained experiments without an idea of the overall concept and attitude to the end result are not included.

Due to the still not enough established application of paper in construction and the qualities of *ideal temporary architecture*, paper is more suitable for temporary architecture (the discussed disaster relief sites and festivals facilities are included here) or for specific investors

who are aware of the necessary maintenance and attention to the material, who will conduct further tests and observations of the structures. The latter is not as troublesome as it sounds, given the experience with metal and wooden structures, which also require attention so as not to lose their load carrying capacity and integrity. Paper will have a future if designers and investors become enthused about it. If it is successful, it will be accepted by the public as well.

*Temporary architecture* could perhaps become a *new* kind of intangible heritage. The expression of this heritage can take many forms. Some of the architectural sites that are temporarily necessary but are used periodically - for example, assembled once a year for a festival - could become part of the traditions for this event (pavilions, scenes). For some exhibitions, the pavilions change. For example, at the World Expo (World's Fair) there are *traditionally* new and innovative pavilions each time. I.e. this is part of the tradition for all editions of the World Expo that could be viewed through the prism of intangible cultural heritage at the global level. For other festivals, pavilions can be built with traditional techniques and thus become guardians of the building memory of a culture, which is a option for passing on knowledge from generation to generation.

The functional necessity of an architectural object is in synthesis with its artistic characteristics and references to different forms of traditions. The tangible and intangible aspects of architecture are intertwined in the fabric of traditions and social needs. And *tradition* can even follow in the direction of *innovation*, as is the case with the pavilions at the World Expo. It can be a tradition to look for new expression, new materials and new technologies, to look for development, to step on the foundation of what has been learned and the familiar in order to try something new.

Thus, paper, as a material characteristic of the countries of the East, carries their traditions and memory and its *innovative* presentation in architecture and modern interpretation and application is sought after.

As a result of the research of paper as part of people's lives since ancient times and its modern application, including in architecture, it can be concluded that paper has a future in architectural forms, although it is still at a fragile age compared to the long history of the evolution of architecture. Its future development will intensify in the field of temporary architecture, which is tectonically responsive to the otherwise fragile material that is paper. Albeit with less confidence, designers will continue to apply paper in permanent paper architecture as well, but, to a degree, this contradicts the essence of the material itself, which creates its own set of difficulties. Paper can become a typical material used in permanent architecture, if opportunities to use it in conjunction with materials such as wood, metal, ropes,

etc., continue to be sought, and if paper structures borrow from the experience of metal and timber structures, which also require regular maintenance.

In architecture, paper is an endeavor to attain the perfect balance between people and nature. Nature has its character, humans too - if humanity does not make sure it assumes a better attitude towards nature, I honestly believe that nature will take care of itself and continue to exist without us. Regardless, we are constantly looking to find that balance, part of which is perfection in architecture. Paper is used because it is, in its essence, a natural product made from renewable sources. What is more, it is recyclable and can, in turn, become a raw material for something else. Of course, there is the problem with its vulnerability to fire and water (despite the developments in this direction), but this is exactly the beauty of this material - it has its characteristics and requirements and forces people to come up with new solutions. Do wooden structures not burn? Metals are also susceptible to fire. Both materials are also affected by water. This is perhaps why paper, metal and wood have worked so well together in the various projects examined in the study. I would like to emphasize here that architecture in its essence has no aspiration to be eternal, in my opinion. Its main purpose is to serve people, to be safe and to protect them from the elements. If a building is erected with the clear understanding that it will exist for 10 years only, it will be useful during that time and then it will be dismantled. But I would also like to reiterate that permanent paper buildings have been constructed and the necessary measures have been taken to protect them (as is done with wooden and metal structures).

Does paper have a future at all? Based on the research done here, it is safe to say that paper could be one of architecture's materials of the future. Will it become a structural and form-defining architectural material or will it remain in the sphere of the visual and decorative? In my opinion, it has already proven to be an alternative in the construction of various types of temporary architecture, and even in cases of permanent architecture. Many of the projects discussed here use cardboard which, to a significant degree, is a recycled material - reused paper. Often, paper's temporariness can be a guarantee that there will be no permanent implementations.

Can paper itself be just a temporary fashion trend, a short inspiration until designers find a better material or a better solution? Isn't it possible that some authors are only looking for ways to be different and to attract attention? Perhaps some of the designers who have only one-off implementations in this field are looking for just that. Are people like Shigeru Ban, who have persevered and found a way of expressing themselves on the path to using accessible materials with a mission to help people, only seeking popularity? Are these ideas beautiful

enough and are they appreciated for their essence? Perhaps projects like the Japanese Pavilion in Hannover are also advertising the use of materials such as paper, but at the same time, as Shigeru Ban himself says, this project is an international implementation and collaboration - a common goal bringing together experts from different professional and geographical fields. Other projects, perhaps, are rather executed in the name of the experiment. But maybe are these still directions with a possible future and development? Does a peculiar and extravagant reinforced-concrete building that has become renowned internationally and has an indefinite lifespan contribute more to the world, to people and to the future? Are these buildings always striving for sustainability? Are these architectural achievements better than a paper building built for the sake of doing it? Could they be recycled and reused? Have we become accustomed to them and are we no longer as critical, labeling them as “exercise in self-serving”? As I have pointed out in this paper - users and architects had a hard time of accepting metal structures, whose visibility in public areas had long been considered absurd... Paper is still too “green” even for green architecture, so I will not claim that there is a guaranteed future for it, as compared to metal. However, I do believe that the topic is completely up-to-date, modern, a strong tendency and a response or an attempt at a response to other tendencies. I am of the opinion that, even if it does not find perspectives in the current architecture, given its variety of buildings, it is at least a good option for a temporary dwelling and shelter or for a temporary pavilion. (That is, when fashion goes away, there will actually be appropriate alternatives due to the advantages of the solution. And it is also possible for fashion to become part of the traditional architectural practice). Paper as a building material in architecture borrows from the knowledge amassed from the construction of metal and timber structures. As a non-standard form-defining architectural material, paper gives architecture an alternative, a more cost-effective means of expression for temporary buildings. It is used in known structural systems instead of other materials. It provides directions for reusing some of the paper waste. It gives a new direction for reflection in architecture and the search for new architectural solutions.

I believe that the use of paper in architecture is a topic that will continue to be explored by other designers and scientists around the world. Some of the constructive critique toward my dissertation work during the discussions, for example, sought more connections between the Western world and paper. Others evaluated paper's recycling capabilities after the treatments it underwent. For example, I, too, have some additional questions about future norms and standards. If for the so-called „movable facilities“ and “temporary buildings” in practice we define temporary materials such as paper, will that be enough to ensure their temporariness?

When I started my research, I imagined and other discoveries. Or at least I thought I imagined. This ended when I began to shape my ideas based on quantity and detail, and not just on my sporadic knowledge of a random paper-made object. This helped me internalize the idea of temporariness in architecture, which impressed me with how the timeframes for the existence of objects were determined at the design stage, where the question of the temporariness of investments is rarely posed. This is an unusual direction, but often it is more appropriate than the application of well-known practices. Thinking about temporariness in the future is part of sustainable development, and defining the durability of architectural sites is taking responsibility for the future.

### **Contributions from the research**

The following results can be summarized for the dissertation:

1. Introducing paper and *paper* architecture in the research space on the national level.
2. Identifying and classifying the connections between paper and traditional architecture – the significance and practical characteristics of paper. Outlining the connections between paper, traditions and architecture leading to the innovative „Paper architecture“.
1. Systematization of paper application possibilities in architectural form
3. Classifying the architectural joints and components using paper.
4. Defining the tendency of creation a temporary architecture using paper. Outlining the applications of paper in temporary architecture

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