

Designing on the Edge of Fashion and Architecture



Elena Kriklenko*

Architecture, Built Environment & Construction Engineering Department, University in Milan, Italy

Submission: July 27, 2020; **Published:** August 10, 2020

***Corresponding author:** Elena Kriklenko, Architecture, Built Environment & Construction Engineering Department, University in Milan, Milan, Italy

Abstract

The following paper introduces the interdisciplinary approach to the work and connection between adjacent design areas. It highlights the migratory nature of design methods and technologies introducing as a case study the design method for double curved soft shells. Current work discusses problematics of designing such shells, considers the use of spacer fabrics unveiling its peculiar properties, and describes the work of the developed system. In addition, it states the specific rules and guidelines for form-finding of double curved shells made by spacer fabric or analogue material and represents available instruments of its design implementation.

Keywords: Structural textiles; Spacer fabrics; Bending-active; Self-formation; Lightweight; Soft structure; Material design; Complex bending; 3D spacer; Interdisciplinary study; Protective clothing

Abbreviations: CBA-CFS - Complex Bending Active-Continuous Flexible Sheet

Introduction

The current state of the modern industry is characterized by a growing trend towards interdisciplinarity in a way of learning, thinking and designing. Most branches of design industries draw inspiration from neighboring fields and adopt technological developments from other sectors. Such a tight interoperability of many disciplines is requested for highly individualized adaptive designs in the world of "Industry 4.0". Moreover, interdisciplinarity is inevitable when dealing with multiparametric complex design tasks, and acts in favor of more effective design solutions. This context motivates formation of design teams made by specialists

and researchers derived from different fields. In the same time, it requests a wide background and set of skill of each professional for smart design implementation.

New design inventions go often hand in hand with new material developments and vice versa. Furthermore, a material designed for a certain aim can be sometimes rediscovered finding a new alternative application. In this paper, in particular, I would like to introduce the design method for double curved soft shells as an example of multidisciplinary study applicable in both architecture and fashion industry (Figure 1).



Figure 1: Interoperability of Different Design Industries Illustrated by Development of CBA-CFS System.

CBA-CFS System

The curvilinear surface made by so called CBA-CFS (what means complex bending-active continuous flexible sheet) system

was developed in architectural context for the purpose of creating temporary or semi-permanent structure, easy for assembling and disassembling. Initially, this research was focused on homogeneous self-bearing shells based on bending-active lightweight elements.

Architecture

One of the main problematics in designing bending-active planar structures is cross limitation between the material property requirements used for such structures, which are low density and high strength of material combined with low bending stiffness [1]. To a certain extent, this required combination can be satisfied by planar materials such as plywood, aluminum, bamboo and many types of GFRP. Yet, this issue directed the research to adoption of an alternative material for the structure. Another issue in bending-active planar structures is inability of materials such as plywood to bend bidirectionally. This is always resolved by tessellation or introduction of additional holes in the global shape of a curvilinear surface.

Materials

In order to introduce a uniform non-tessellated shell, multiply

bent in different directions at once, CBA-CFS system used spacer fabric-like material. In smaller models, spacer fabric showed to be suitable due to its voluminosity, and bending ability involving extension and compression. These properties allow it to shape synclastic and anticlastic curvatures by fixing it with a set of membranes. Furthermore, this material can be produced with different densities. Spacer fabrics are more commonly used in other industries rather than in architecture. The main application currently being cushioning or reinforcement in composites, but it is not considered as an autonomous structural material for bending-active planar structures, mostly due to its actual fabrication size. Thus, the proposal of CBA-CFS system was to elaborate a new “architectural spacer”, scaling the regular material up to architectural size.

Functioning parts

Apart from material aspect, CBA-CFS as a bending structure is particularly interesting in terms of its geometrical concept and organization of its functioning parts (Figure 2). The system is conducted by interaction between the bending-active initially planar component (Bent layer) and the system of separate tensioned membranes (Tensioned layer). Geometrically, the Tensioned layer almost repeats the initial shape conceived by the designer (General shape), while the Bent layer always follows it in a nearby proximity and forms the Final shape.

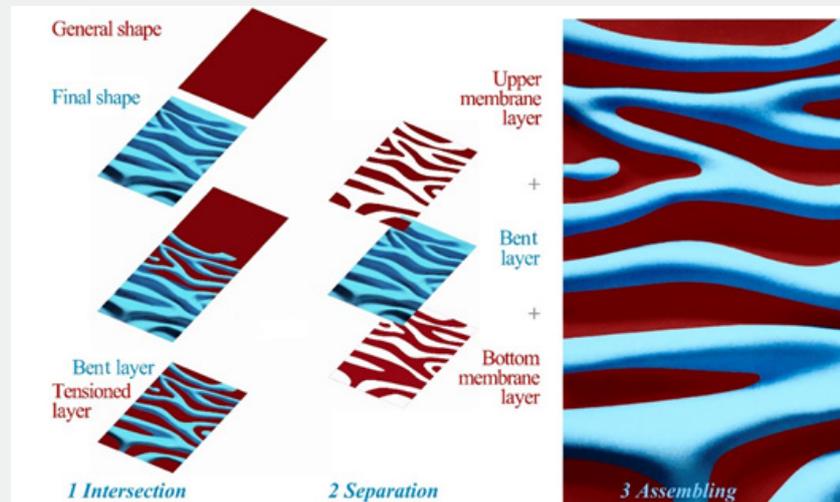


Figure 2: Geometrical Concept of the CBA-CFS System.

The whole system is built up as follows:

- The desired General shape is intersected with an analytically defined Final shape;
- Some parts of the General shape are seen above and another under the Final shape;
- The outline of these parts becomes the guideline for

tailoring the top and bottom parts of Tensioned layer.

All these parts joined together, stabilizing each other and the structure as a whole (Figure 2).

Rules and Instruments

Structural performance, stress distribution in CBA-CFS as well as the basic rules of its form-finding was discovered and explicitly

described in the work of E Kriklenko [2]. The major factors which lead to the buckle form-finding process in CBA-CFS are overall height of the buckled section in amplitude; intensity of buckling-frequency; and the direction of buckling (Figure 3). The curvature

of the General shape is tightly connected to the proper tailoring, prestressing and placement of the Tensioned layer in relation to the center of the overall height of the section.

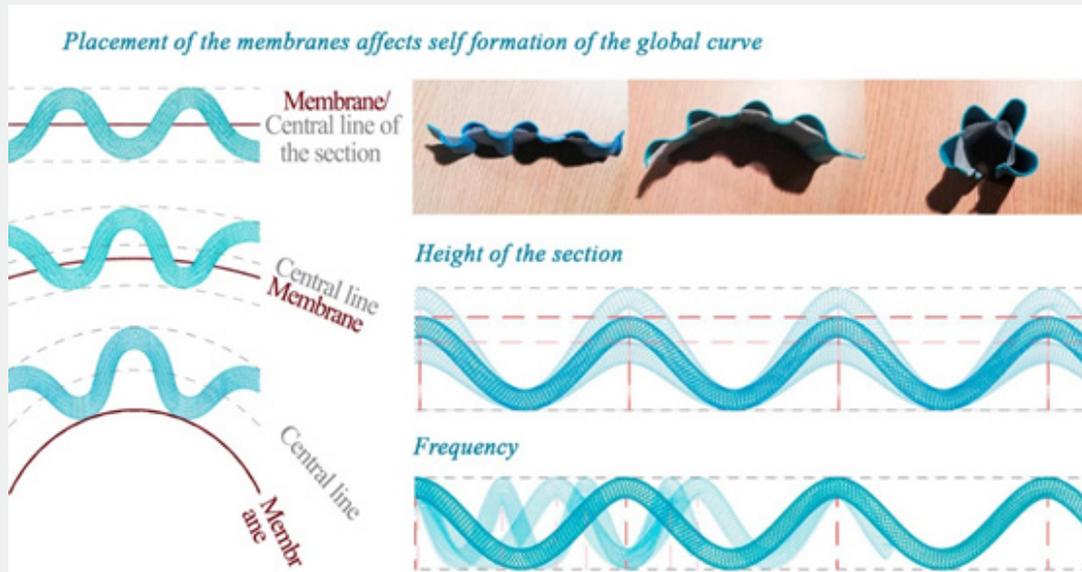


Figure 3: Form-finding and Form-Defining Rules of CBA-CFS System.

For the aim of precise geometrical mapping of CBA-CFS and its physical simulation, a custom digital definition made with 'Grasshopper' software was prepared considering abovementioned basic tendencies and range of desirable General

shapes. The developed script helps to produce the flat pattern of Bent layer starting from General shape of the shell, define geometry and stretchability of the membranes.

CBA-CFS for Garment



Figure 4: Physical Models Representing Samples of CBA-CFS System Produced by Stitching Layers on a Sewing Machine.

In architectural scale CBA-CFS system requires particular attention to the joining areas between its layers. On a smaller scale, three layers (bottom tensioned, bent, and top tensioned) can be joined together on a sewing-machine prestressing each layer differently (Figure 4). This observation and numerous experimentations raised an idea of using CBA-CFS for garment and create textile curvilinear prestressed “shells for human body”.

Since the digital definition written for CBA-CFS system employs general geometrical and physical parameters it can be used as a universal instrument whether for large architectural or smaller scale designs.

Resulting shell can be modified according to, and owns the following qualities:

- Rigidity map (Mindfully designed stiffness, elasticity in CBA-CFS can vary from area to area)
- Anisotropy of the shell (stiffness, elasticity, and bending ability can vary according to given direction)
- Self-formation
- Shape control

Moreover, through the use of spacer fabric, it possesses the qualities of microclimatic comfort buffering in terms of humidity and facilitate natural ventilation which affects the wearing comfort [3]. Worth mentioning as well the impact of particular bent and buckled geometry of CBA-CFS on the wearing comfort. Such shells in garment can be used as protective clothing with chosen amortized and reinforced areas, as well as clothing requiring particular attention to the shape control and aesthetics together with structural tectonic. In architecture it has potential for temporary lightweight shelters. Thus, different industries can use the same technology and benefit from CBA-CFS development.

Conclusion

Design methods and technologies naturally derive from one field and roam to another. In this way, spacer fabric, as a material initially used in automotive and fashion industries, moved to architecture. This material inspired the development of a new structural typology, and moved back in fashion capturing from architecture a new structural organization and geometrical arrangement. The CBA-CFS technology was described in this paper in support of, and illustration of multidisciplinary workstyle. The digital scripts for the CBA-CFS are constantly improving and adapting to new design challenges.

Acknowledgement

The research on CBA-CFS system was realized in the Polytechnic University of Milan TEXTILESHUB Department of Architecture, Built Environment and Construction Engineering. Spacer fabric material for experimental work was kindly provided by Muller Textile Group.

Conflict of Interest

No potential conflict of interest was reported by the author.

References

1. Lienhard J, Alpermann H, Gengnagel C, Knippers J (2013) Active bending, A review on structures where bending is used as a self-formation process. *Intrnational Journal of Space Structures* 28(3-4): 187.
2. Elena Kriklenko (2020) Complex bending-active structures from continuous flexible planar sheets or a hybrid structure introducing the use of spacer fabrics. *Architectural Engineering and Design Management*.
3. Qin Y (2016) Applications of advanced technologies in the development of functional medical textile materials. In: 1st (edn.,) *Medical Textile Materials*, pp. 55-70.



This work is licensed under Creative Commons Attribution 4.0 License
DOI: [10.19080/CTFTTE.2020.07.555702](https://doi.org/10.19080/CTFTTE.2020.07.555702)

Your next submission with Juniper Publishers will reach you the below assets

- Quality Editorial service
- Swift Peer Review
- Reprints availability
- E-prints Service
- Manuscript Podcast for convenient understanding
- Global attainment for your research
- Manuscript accessibility in different formats
(Pdf, E-pub, Full Text, Audio)
- Unceasing customer service

Track the below URL for one-step submission
<https://juniperpublishers.com/online-submission.php>