Figure 1. Announcing poster of the workshop "Pneuma" at the 2024 European Architecture Students Assembly. Image by Author

Hyphen No.2: Emergence (2025)
ISSN: 3066-151X
DOI: 10.59236/hyphen219

REVISITING PNEUMATIC STRUCTURES:

Report on the Creation of "Pneuma" at the 2024 European Architecture Students Assembly

By Adam Ackermann, Hanga Nádai

"Why inflatable architecture? Because it bears us off into another world, gets us thinking, and lets us forget what we learned at school, enabling us to become ourselves again."

Hans-Walter Müller

INTRODUCTION

There is no better place to throw off the shackles of architecture school than the European Architecture Students Assembly (EASA), as it offers a unique opportunity for architecture students across Europe to come together, collaborate, and reimagine architecture education and practice. Every year since 1981, about 500 European architecture students have gathered for a two-week-long summer residency. During their time together, the students engage in professional debates and learn from one another through lectures and workshops, working and thinking together on different-scale theoretical, performative, and design-build projects. EASA is an independent, decentralized organization run by a constantly evolving community of architecture students. It is a platform for an emerging, vivid, international network of dedicated, curious future Architects. This article presents the background, process, and results of the design-build workshop titled "Pneuma," tutored by the authors of this paper at the 2024 EASA event in Benidorm, Spain. During the workshop, participants rediscovered the world of inflatable structures through a hands-on project.

After the blossoming of inflatables in research and practice during the 1960s, crowned by the 1970 Osaka Expo, interest in the innovation of pneumatic structures has set back until recently. Today, in the world of shifting paradigms in architecture and urbanism, pneumatic structures exhibit qualities that could


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address the pressing questions of the 21st century, such as material shortage and the environmental impact of construction. In the presented workshop, after discussing the potential of inflatables in present times, participants designed and built "Pneuma," a lightweight, self-inflating, flying, inflatable canopy structure based on the 1974 "Desert Cloud" project by Graham Stevens. The 8x5 meter structure accumulates the heat of the Mediterranean sun, which inflates its volume and causes it rise with the help of the hot air's buoyancy, creating a much-needed shadow for the people under it. Through the hands-on example of "Pneuma," the workshop explored the question: How could a new attitude toward inflatables rediscover their potential against the challenges of the 21st century? The context section of this article introduces the context of the workshop, EASA, and the EASA 2024 theme, "Shanzhai". In the background section, the history of inflatable structures in connection with the workshop will be discussed. In the methods section, the concept and realization of the workshop will be presented. Finally, the workshop's findings and future research perspectives will be discussed in the conclusion.

CONTEXT - THE EUROPEAN ARCHITECTURE STUDENTS ASSEMBLY AND THE 2024 THEME "SHANZHAI"

The European Architecture Students Assembly (EASA) is a two-week-long event during the summer, organized by students as an alternative university and architecture residency. The first EASA was held in 1981 in Manchester when a group of architecture students reached out to students across Europe for help and invited them to Manchester to save their college from closure. Since then, EASA has evolved into a decentralized community where students participate in a unique, non-institutionalized, horizontal way of learning. They raise questions about architecture and investigate them through the eyes of all European cultures simultaneously.

Every year, during the International Contact Meeting, the national contacts from each European country gather to select the location and theme of the next EASA event from the bids submitted by the applicant national teams. In the bids, the teams propose a theme and a location, showing how the context of the location supports the understanding and discussion of the theme. Typically, the bids are driven by a strong personal motivation and stem from a desire to raise awareness about current issues in architecture, launch new initiatives, and often critique the current state of the architectural profession or education.

Figure 2. First flight of Pneuma, an inflatable, flying canopy structure created at the 2024 European Architecture Students Assembly in Benidorm, Spain. Image by Author

After the decision, the winning national team, a group of volunteering architecture students, organizes the annual Assembly. For the two weeks of EASA, the Assembly becomes a self-sufficient community where people eat, sleep, work, and live together. People have different roles during the event, such as participant, tutor, or helper. Helpers build, maintain, and ultimately dismantle the event's infrastructure. Participants take part in workshops organized and led by tutors. Tutors and workshops are selected through a call for workshops that takes place in the spring, prior to the event.

The primary components of EASA are the workshops and lectures. Each year, the tutors hold around 30 workshops based on the overarching theme of the Assembly. Through hands-on, theoretical, or performative methods, the workshops help participants acquire new skills and knowledge while engaging with the local context through the current event theme. Furthermore, in the evenings, invited professionals from different disciplines give lectures that explore and expand the discussion of the event's theme.

Figure 3. Workshop fair at EASA Shanzhai. EASA is a decentralized community and summer residency where architecture students from across Europe participate in a unique, non-institutionalized, and horizontal learning method, discussing issues related to architecture practice and education. Image by Mina Radovanovic

THE THEME AND VENUE OF THE 2024 EASA EVENT

In 2024, the Spanish team organized the EASA in Benidorm with the theme "Shanzhai" (a term whose original pronunciation was unknown to many attendees, which is a fitting example of the term itself). South Korean philosopher Byung-Chul Han defines it: "Shanzhai is a Chinese neologism that refers to the appropriation of a form or an idea, dismissing its original status (...) this concept today encompasses all areas of life in China: there is shanzhai architecture, shanzhai food, and even shanzhai entertainment stars. (...) Its innovativeness (...) is not defined by genius or creation ex nihilo, but by being part of an anonymous and ongoing process of combination and mutation." (Han, 2017) In simple terms, in Shanzhai, the more we copy something, the more we value it. In this sense, Shanzhai is not merely a reproduction, but a desire to improve upon something, a form of evolution. Therefore, Shanzhai should not be mistaken for forgery or falsification in any way.

Figure 4. The workshop 'Catching Wind' is setting up its installation at the Balcón del Mediterráneo in Benidorm. In the background, the skyline and beach of Benidorm. Image by Lara Ippolito

The site of the Assembly, Benidorm, is a vacation city on the southern coast of Spain. The town was a small village until the 1950s, when Spain opened up to international tourism. After that, it became a booming city with skyscrapers on its skyline (Fig. 4), hosting around 3 million tourists yearly, but with only seventy thousand inhabitants. The urbanization of Benidorm was a rapid process, leading to the transformation of the Spanish coast. The city aimed to attract tourists by replicating Western tourist attractions and entertainment, thereby creating a familiar and competitive environment for international visitors. From Las Vegas casinos to Irish pubs and fish-and-chip stands, we find multiple examples of "Shanzhai" in Benidorm. Benidorm has also earned the nickname "the New York of the Mediterranean" not only due to its dense cluster of skyscrapers but also because the development along Levante Beach (the eastern part of the city) was inspired by the American city. At the same time, the development along Poniente Beach (the western part of the city) was copied from the Garden City concept.

As the main question and theme of the Assembly, the Spanish team proposed the paradox that in architecture education, "original ideas" are valued more, and copying is considered dishonest and lazy, even though art and architecture are never created without consciously or unconsciously connecting them to something that has been made before. To resolve this conflict, the organizing team proposed Shanzhai, which challenges the Western notion of the value of "originality," as discussed, for example, through the thought experiment of the Ship of Theseus. Moreover, the organizing team introduced Shanzhai as a way of learning and understanding by deconstructing and reassembling a subject. In line with this ideology, the goal of the Assembly was to learn to copy shamelessly; consequently, the organizing team requested workshop proposals that incorporated some form of copying ("shanzhai-ing") into their methodology.

BACKGROUND - PNEUMATIC STRUCTURES AND THEIR CONNECTION TO SHANZHAI

Pneumatic structures, also called inflatables, are membrane structures in which the difference in air pressure between the two sides of the membrane determines their shape and stability (Otto, 1962). The history of inflatable structures dates back to the early days of aviation; from the first hot-air balloons, inflatables have symbolized lightness and ephemerality. The initial concept for the architectural use of inflatable structures emerged during World War I when a design for a temporary field hospital was proposed (Herzog, 1976). However, inflatables only gained widespread recognition in the 1960s, thanks to new materials like plastics that facilitated their large-scale applica-

tion. The lightweight nature of these materials, combined with the tensile behavior of the membranes, enabled them to span large distances economically and aesthetically.

At the 1970 World Expo in Osaka, numerous pavilions featuring inflatable structures were constructed. At Expo '70, inflatables evolved from a mere technological development to a herald of architectural innovation and a new way of living. Consequently, they both critiqued post-war, late-modern functionalism and inspired the utopian visionaries and radical architectural groups of the era (Migayrou, Moimas, 2021), such as Ant Farm. In 1971, Ant Farm published a do-it-yourself handbook called the Inflatocookbook, which detailed how to create simple, low-pressure inflatable volumes at home using everyday materials. The handbook provided instructions, for example, on gathering materials, making patterns for simple designs, and calculating the necessary airflow for the reader's design. Ant Farm promoted the playfulness, simplicity, and safety of inflatables, emphasizing that everyone, including children, should try to cre-

Figure 5. Playing with inflatables. As a warm-up, the workshop visited a pneumatic pavilion by Espacio La Nube to experience and get a better understanding of inflatable structures. Image by Artur Luure

Inflatocookbook

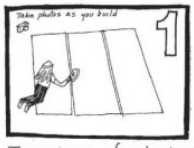
#3

SAME OL' PRICE

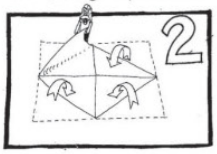
Ant Farm

KIDS

make your own bubble
EASY AS 1*2*3

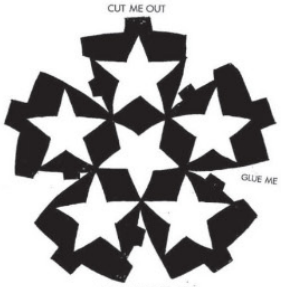


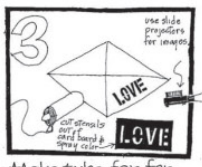
Tape strips of poly together into a large square....



Fold edges over and tape.....

CUT ME OUT

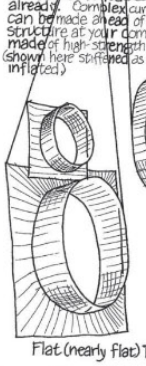




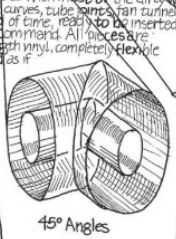
Make tube for fan, inflate & cut entry slit...

Invite friends spend the night together....

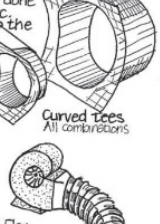
With these new Ant Farm Components you now can realize your fantasies with most of the dirtywork done already. Complex curves, tube joints, fan tunnels etc. can be made ahead of time, ready to be inserted into the structure at your command. All pieces are made of high-strength vinyl, completely flexible (shown here stiffened as if inflated.)



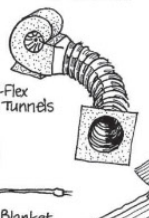
Flat (nearly flat) Tees.



45° Angles

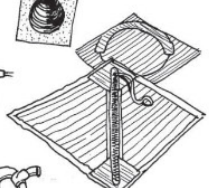


Curved Tees
All combinations



Rigi-Flex Fan Tunnels

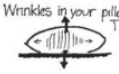
Power Blanket
4-Fan Patch

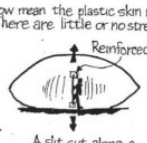


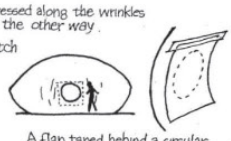
Zipper Hatchways
Access Panels

Idea Plumbing

Wrinkles in your pillow mean the plastic skin is stressed along the wrinkles. There are little or no stresses the other way.







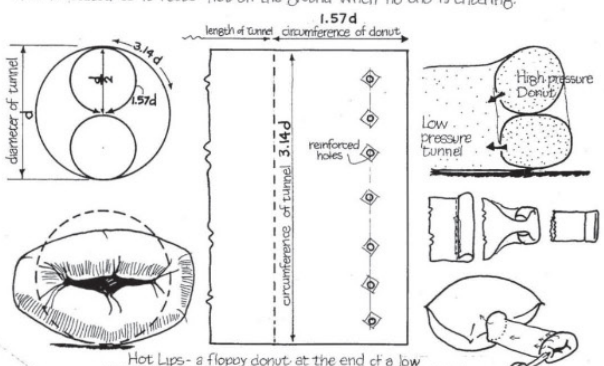
A slit cut across the wrinkles will tend to spread open and leak air. Not recommended

A slit cut along a wrinkles will be a self-closing entrance.

A flap taped behind a circular or ovoid hole. (No larger than crawl-through size) will automatically close due to the air pressure inside

ENTRY

A ring or hula hoop taped around a circular hole will become a self closing door if it is located so it rests flat on the ground when no one is entering.



Hot Lips - a floppy donut at the end of a low pressure tunnel. When connected to the blower, small holes admit air to the tunnel from the lips, thereby inflating it.

GEOMETRY

ate such structures and experience these spaces. They stated that "to unfold, inflate, and see each other in a black, white, red, purple cloud balloon can (conditions right) help to break down people's barriers about each other and their own abilities, and can be a hint at the idea that maybe maybe, anyone can, should, must take space-making, beautifying into her, his own hands."(Ant Farm, 1971) Furthermore, Ant Farm describes inflatables as instantly changing, immaterial environments and argues for the importance of their transitory behavior, clearly distinguishing them from conventional architectural spaces: "The freedom and instability of an environment where the walls are constantly becoming the ceilings and the ceiling the floor and the door is rolling around the ceiling somewhere releases a lot of energy that is usually confined by the xyz planes of the normal box-room. The new-dimensional space becomes more or less whatever people decide it is - a temple, a funhouse, a suffocation torture device, a pleasure dome." (Ant Farm, 1971)

In contemporary architecture practices, the most essential feature of inflatables is temporality. The "Spacebuster" project by the German Raumlabor Berlin was a small inflatable space attached to a van. The structure was independent of its surroundings and could be installed in minutes anywhere in the city. In a parking place, in a park, or under a bridge, the structure would inflate and fill the available space, creating an adaptive, temporary public space in minimum time and using the least materials possible. On the other hand, inflatables can be used as an affordable and straightforward hands-on tool in architecture education, through which students can easily experiment with scale and explore alternative methods for creating form and space (Moon, 2014).

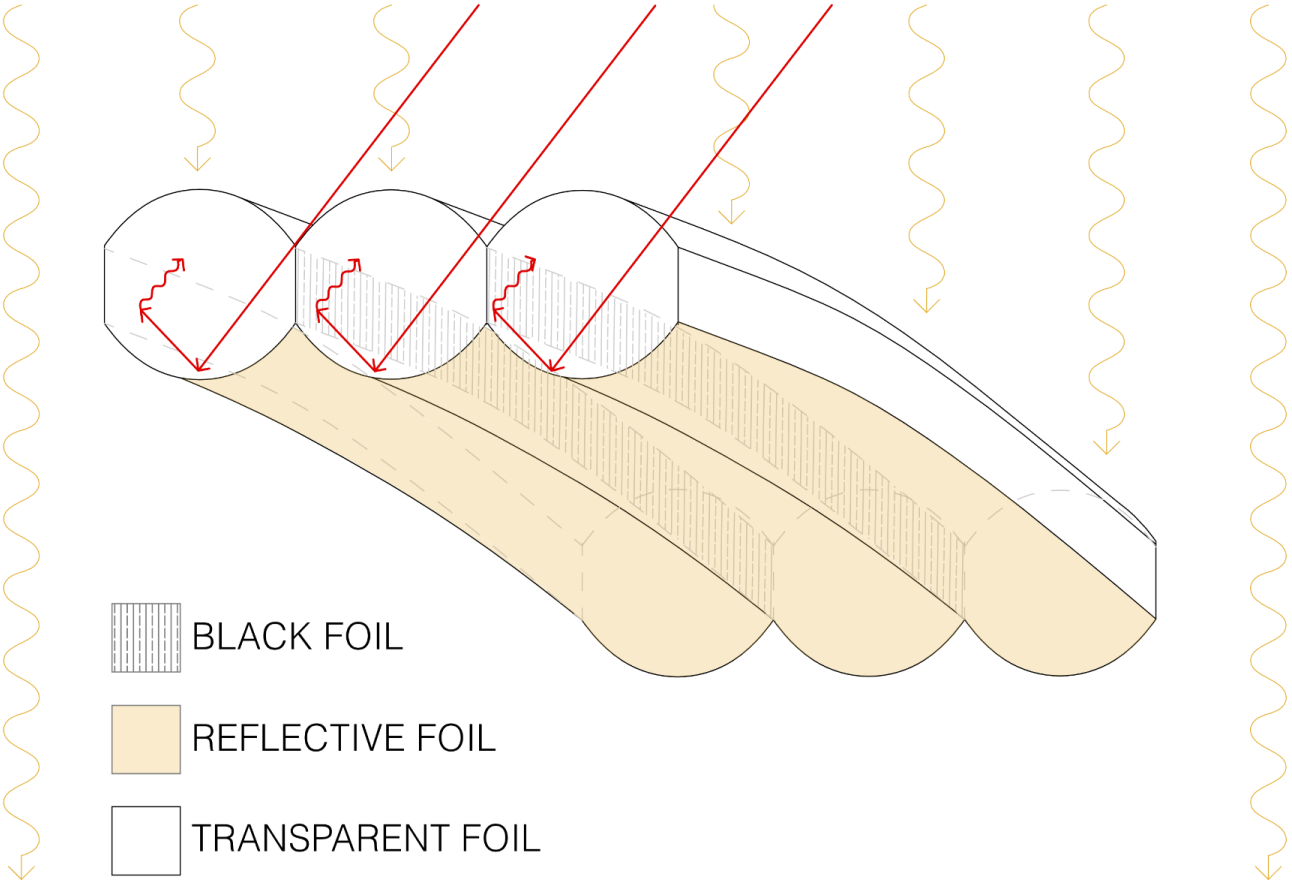
The ideology of Shanzhai, which emphasizes that everyone deserves to own, use, or experience a thing, a feeling, or a service, parallels the do-it-yourself nature of pneumatic structures presented through the Inflatocookbook. The analogy between the temporality of inflatables and the critique of originality in Shanzhai reinforces this correlation. Shanzhai emphasizes a process of constant renewal and evolution through copying, where the individual steps of the process have little significance; they are only temporary. Meanwhile, pneumatic structures (especially low-pressure inflatables) are subject to constant change. They are independent of location; their architectural form is indeterminate; and they are also easily copied and replaced. These aspects of inflatables challenge the idea of originality in architecture. Therefore, after discovering the parallel of pneumatic building and shanzhai, we decided to explore inflatables in our EASA workshop.

Figure 6. Pages of Inflatocookbook, the Do-it-yourself manual for inflatable structures published by Ant Farm in 1971.

METHODS - THE CONCEPT AND PROCESS OF THE WORKSHOP “PNEUMA”

For the workshop, we proposed copying and recreating the Desert Cloud project by Graham Stevens, a floating inflatable structure that could be used as a canopy structure to provide shelter from the sun in Benidorm. Based on the Inflatocookbook, the simplicity of inflatable structures provides an easy-to-use tool for creating and copying architecture, encouraging people to take space-making into their own hands. This makes inflatables a perfect candidate for studying and experimenting with the architectural aspects of the shanzhai phenomenon. Furthermore, in our workshop proposal, we argued for the attachment and significance of the workshop in the local context: “Benidorm is an extreme example of a vacation city. In the summer, the population rises significantly, and Benidorm must cater to the demands of its temporary citizens. In this context, we proposed that a seasonal city needs seasonal interventions. In an environment of ever-changing demands, we must seek interventions that are lightweight, low-impact, and capable of keeping up with the context. The transitory nature of pneumatic structures enables them to adapt to these rapid changes, which other types of architecture struggle to achieve.

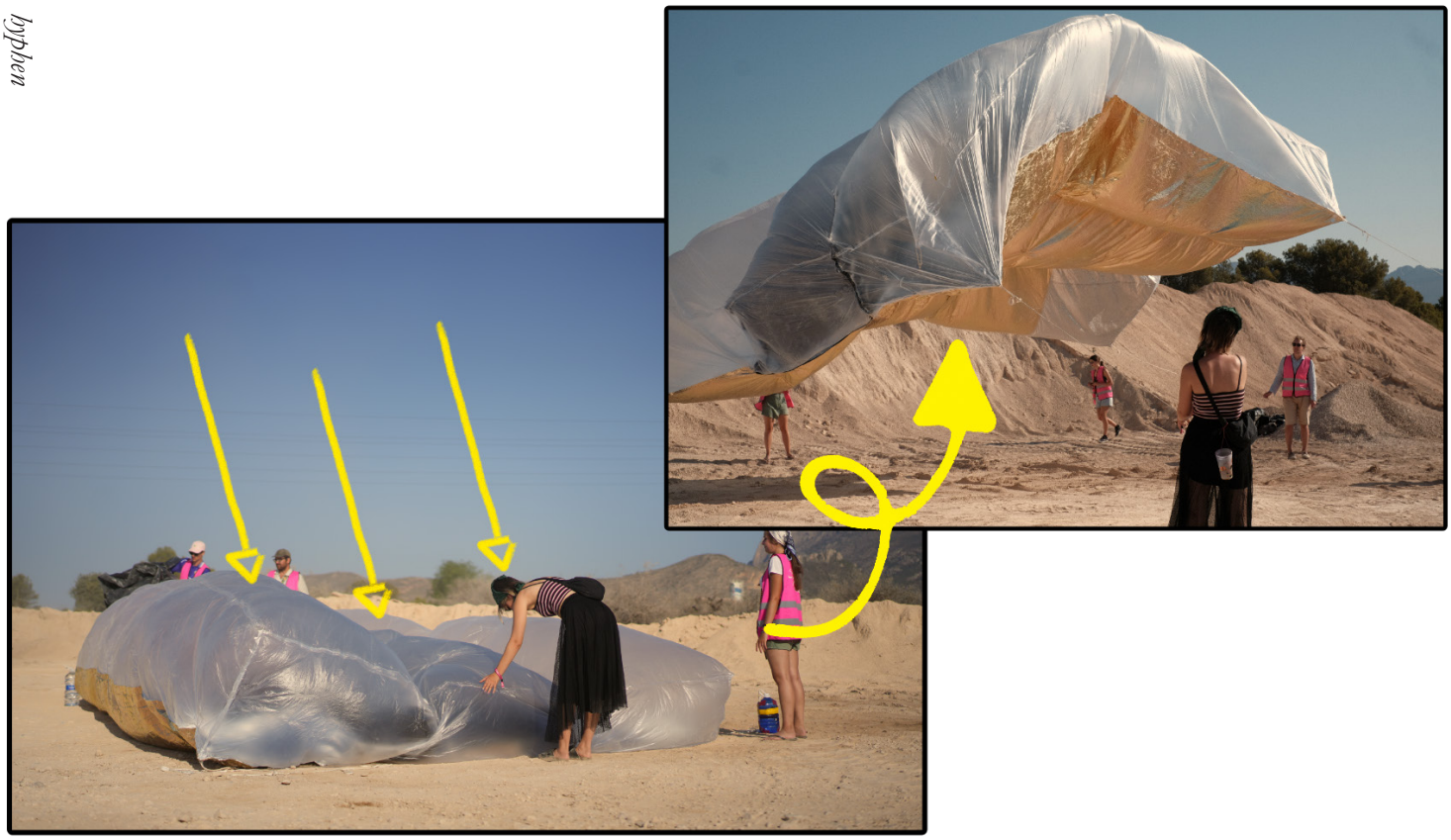
Figure 7. Assembly of the inflatable using techniques based on the Inflatocookbook. Image by Artur Luure



THE PRECEDENT: DESERT CLOUD BY GRAHAM STEVENS (1974)

The Desert Cloud was a floating, inflatable cushion structure. Its most exciting feature was that, unlike other inflatable structures, it did not need any machine or air supply; the structure was inflated exclusively by natural processes powered by the sun's radiation. On the brink of the oil crisis, this was a revolutionary idea addressing climate-active solutions. Stevens described his work using three key concepts: Absorption, Reflection, and Transparency (McLean, 2015). As the sun shines on the structure, it can enter it through the transparent membranes on the top. The black structural web on the inside of the volume absorbs the sun's radiation and turns radiation into heat. The reflective materials used for the bottom of the structure create a shade under the structure while reflecting the sun on the black internal parts. The air inside gets heated by the absorbed radiation; hot air expands its volume and inflates the structure. The heat creates buoyancy, lifting the structure and causing it to rise into the air (Fig. 8, 9). Stevens installed the Desert Cloud originally in the Arabian Desert, in Kuwait. One of the key questions in our workshop was whether the hot semi-arid climate of Benidorm would also be sufficient to make our structure fly.

Figure 8. Diagram of the structural concept of Pneuma. Image by Author



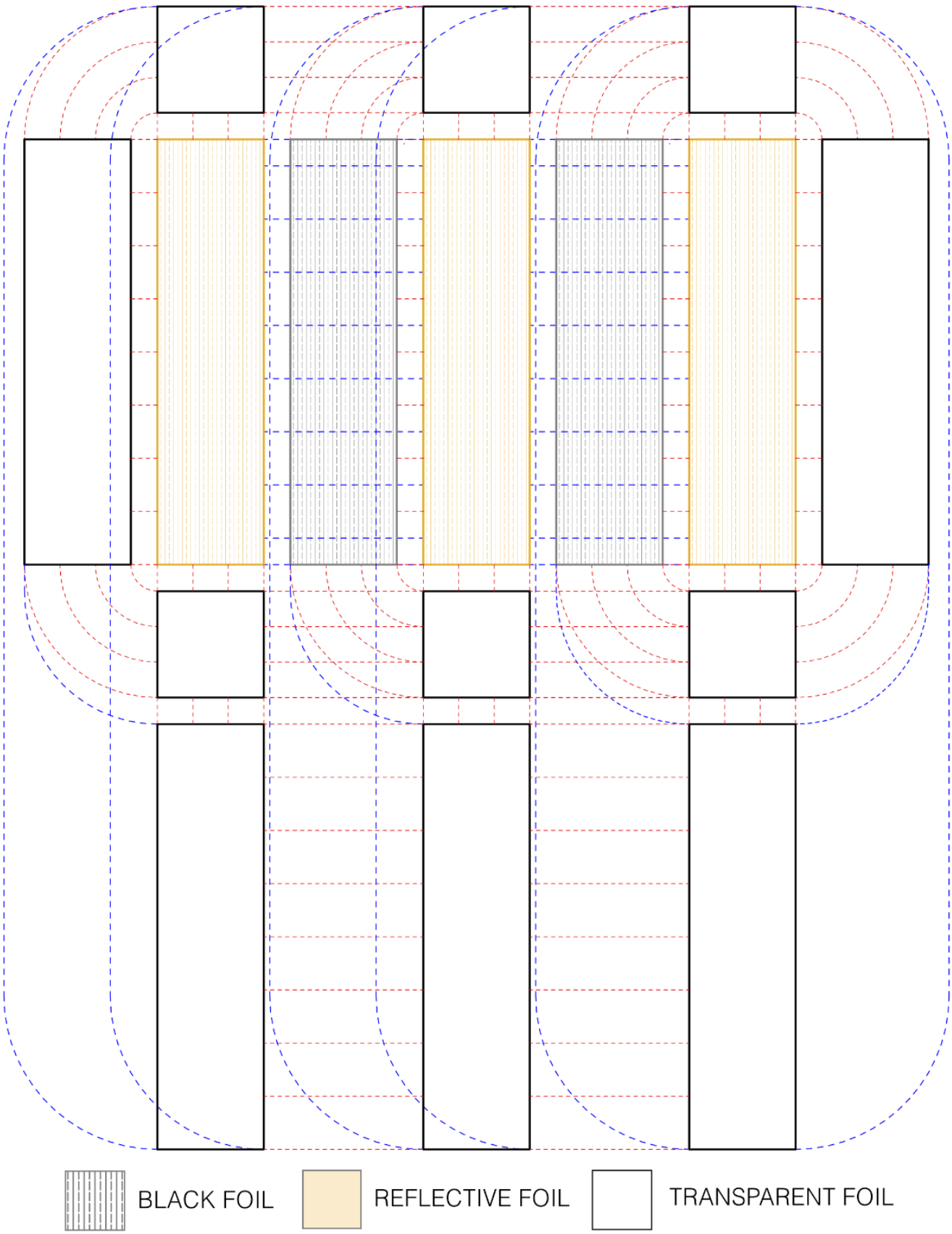
THE CREATION OF PNEUMA

On the first day of the EASA event, the tutors presented their workshop proposals at the workshop fair, after which participants were assigned to the workshops based on their preferences. After 10 days of workshops, the groups installed their outcomes on the EASA Open Day. Our workshop was structured around three levels. First, the participants explored the world of inflatables through selected readings. We also had the privilege of visiting an inflatable pavilion designed by Espacio la Nube that was installed at the EASA site. In the second section of the workshop, the participants created small-scale inflatable pavilions based on the techniques and precedents presented in the Inflato-cookbook. This part helped us become familiar with the materials used in our workshop and develop a fabrication workflow for our project (Fig. 7).

The third part of the workshop was the creation and testing of Pneuma. We looked at the photo and video documentation of the Desert Cloud, original sketches, and descriptions of the project, analyzed the concept, structure, and dimensions, and discussed how to implement these ideas in our version. Due to time constraints

Figure 9. Pneuma is only powered by the sun. The structure accumulates the sun's radiation and heats the air inside. Hot air expands its volume and inflates the structure, creating buoyancy that lifts the light structure in the air. Image by Author

Figure 10 (right). Assembly Pattern of Pneuma. Dashed lines indicate the seams between panels. Image by Author


BLACK FOIL
REFLECTIVE FOIL
TRANSPARENT FOIL

and the available materials, our design was smaller than the original, 5x8x1.5 meters compared to 12x10x2 meters. For Pneuma, we implemented the concepts of Absorption, Reflection, and Transparency as described in the original project. Simple, everyday materials were used for the structure to emphasize the DIY nature of the experiment. For the transparent structures, we used thin plastic construction foil; for the reflective layers, first-aid emergency blankets; and for the inner structure, black plastic garbage bags. A 5 cm wide polytape was used for the assembly, following the techniques described in the Inflatocookbook (Fig. 10).

After construction, we tested our structure at multiple locations and times of day. The objective was to find the perfect conditions in the city to make Pneuma fly. The membrane structure could be rolled into a backpack-sized package weighing about 5 kilograms, facilitating transportation and installation in the city. After rolling out the package on a sunny surface, the structure needed about 5-10 minutes to inflate its volume, and another 15 minutes were needed for the air to heat up enough to pull up the structure in the air (Fig.11). Depending on the environmental conditions, the structure's performance was noticeably different.

Figure 11. Waiting for Pneuma to inflate. After rolling it out, the structure needed about 5-10 minutes to inflate its volume and another 15 minutes to build up enough heat to take flight. Image by Vivien Graute

The most disturbing factor was the wind. The pressure of the strong gusts of wind could easily deflate the structure, pushing out the warm air and creating small holes in the thin membrane, allowing more hot air to escape. After each flight, we fixed the holes with polytape. The only windless time of day was in the morning. However, the morning sun was unable to generate enough heat for the structure to rise.

For the EASA Open Day closing event, we installed Pneuma in an open-air teatro sheltered from the wind (Fig. 12). It was fulfilling to see the structure slowly inflate, rise, and constantly move up and down in the air like a living creature. Its shiny surface played with the sun's reflections, and we moved into its shadow. With this event, our workshop reached its destination, and we ended the two weeks together with success and a handful of memories and new ideas.

Figure 12. Pneuma slowly rising at the EASA Open Day. The structure was anchored on the four corners by 10-liter water bottles to prevent it from flying away. Image by Artur Luure

CONCLUSION

This article presented the background and process of the hands-on design-build workshop "Pneuma" held at the 2024 European Architecture Student Assembly (EASA) in Benidorm, Spain. The EASA is an independent bottom-up organization run by architecture students that implements a horizontal, student-to-student learning process through a yearly summer residency event. In the presented workshop, participants discovered pneumatic structures by copying and recreating the Desert Cloud project by Graham Stevens (1974). The inflatable installation used the sun's radiation directly to inflate and the buoyancy of the accumulated heat to rise. Participants used the techniques and methods for creating low-pressure inflatables described in the Do-It-Yourself handbook, Inflatocookbook, published by Ant Farm in 1971. This handbook included instructions on using simple household materials and tools for construction. This approach and the methods were appropriate for the low-tech, low-cost settings of the Assembly. However, they negatively affected the durability of the installation. The most significant challenge was that the wind created tears and holes in the light structure, causing the hot air to escape its volume and consequently deflating the structure. Compared to the scale of the designed structure, a small amount of materials was used (approximately 50g/m^2). Regardless, the workshop generated a significant amount of plastic waste (approximately 0.7 m^3) because most materials used in the installation could not be reused. The materials used for pneumatic structures are one of the most significant environmental concerns associated with these structures. Nevertheless, a new generation of biodegradable membrane materials could show an alternative to the use of plastics and dispel the doubts about sustainable inflatables. Despite environmental concerns surrounding the materials used in pneumatic architecture, the temporary and instantaneous nature, as well as the extreme efficiency of inflatables, make them a suitable candidate to address pressing issues of 21st-century urbanism and architecture. Therefore, we find it necessary to engage in a renewed conversation about pneumatic building, revisiting and reassessing the visionary yet somewhat forgotten precedents of inflatables in architecture education to inspire the emerging generation of future architects.

Figure 13 - 16. PNEUMA - an EASA 2024 Shanzhai workshop. Images by Author, Artur Luure


Hotel ***
princepark

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