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# Introduction

## What is this booklet about?

This booklet is a practical and exploratory guide to **inflatable textiles**: materials that hold air, change form, and expand (no pun intended) the possibilities of what textiles can do.

Rather than presenting a single product or solution, this is a **reference tool**. It can be read linearly from beginning to end or consulted selectively. Designers, engineers, artists, and researchers can use it to understand existing approaches, test new ideas, and adapt inflatable textile systems to their own contexts.

The booklet is structured around three main sections:

- **Research**, which maps materials, fabrication methods, and existing applications
- **Experimentation**, which documents hands-on testing, successes, failures, and iterations
- **Results**, which synthesize findings into transferable insights and design considerations

This is not a manual that prescribes a single “correct” way of working with inflatable textiles. Instead, it is an invitation to **experiment, adapt, and reinterpret**.

## What are inflatable textiles?

Inflatable textiles are textile-based structures designed to **contain air as an active material**. Through inflation and deflation, these textiles can change volume, stiffness, insulation capacity, or shape.

Unlike traditional textiles, which are largely passive, inflatable textiles behave as **dynamic systems**. Air becomes a design parameter: invisible, lightweight, and responsive. By controlling how air is contained and distributed, it is possible to create textiles that adapt to environmental conditions, body movement, or functional requirements.

At a basic level, inflatable textiles rely on:

- Flexible materials capable of sealing air
- Methods of bonding or joining textiles into chambers
- Internal or external mechanisms for introducing and releasing air

From these simple principles, a wide range of behaviors and applications emerge.

Inflatable textiles have been explored across multiple disciplines:

- **Apparel and wearables**, where air provides adjustable insulation, cushioning, or fit
- **Medical and therapeutic uses**, such as compression, pressure distribution, or support
- **Architecture and spatial design**, through lightweight, deployable textile structures
- **Soft robotics and interaction design**, where inflation enables movement and actuation
- **Outdoor and technical equipment**, prioritizing weight reduction and adaptability

What unites these applications is the use of air not as a byproduct, but as a **functional material**, one that can be shaped, controlled, and designed.

## Brief history

The idea of using air to shape flexible materials predates modern textiles. Early inflatable structures appeared in maritime and military contexts, where buoyancy and rapid deployment were critical. Rubberized fabrics and coated textiles enabled the first air-filled shelters, life rafts, and protective systems.

In the second half of the 20th century, inflatable architecture and experimental design movements began to explore air as an expressive and structural medium. Artists and architects used inflatables to challenge ideas of permanence, rigidity, and scale.

More recently, advances in material science, digital fabrication, and soft robotics have reintroduced inflatable systems into contemporary design practice. Lightweight coatings, precise heat-sealing techniques, and embedded electronics now allow inflatable textiles to move beyond novelty and toward **functional, repeatable systems**. Today, inflatable textiles sit at the intersection of fashion, engineering, and interaction design.

*This research project is a work in progress and will continue to be so.*

## Research (Theory)

This section lays the foundations for all the experimentation and results that follow. Before inflating, sealing, or testing anything, it is necessary to understand **what has been done, what materials are available, and how air behaves when trapped inside textiles.**

The performance of these textiles depends not only on the textile itself, but on the material, how it is sealed, and how it responds over time.

With this section we build a framework that will be tested, challenged, and expanded.

### State of the art

This is a *snapshot* of how inflatable textiles are currently used, researched, and commercialized. The goal is not to replicate the existing solutions, but to analyze and identify patterns, materials, and design strategies, as well as their limitations.

By mapping what already exists, this research establishes a point of reference from which new experiments can diverge.

## Architecture

Inflatable structures in architecture are not something new; this technique has been experimented with since the popularization of commercial polymers. Some interesting examples of this use are documented below.



### **Binishells**

The architecture firm uses inflatable “balloons” for creating the negative space inside of a house, then it is covered with a hardened mixture, thus creating organic shapes for habitable space. One of the most famous examples of this firm is Robert Downey Jr.’s home in Malibu.



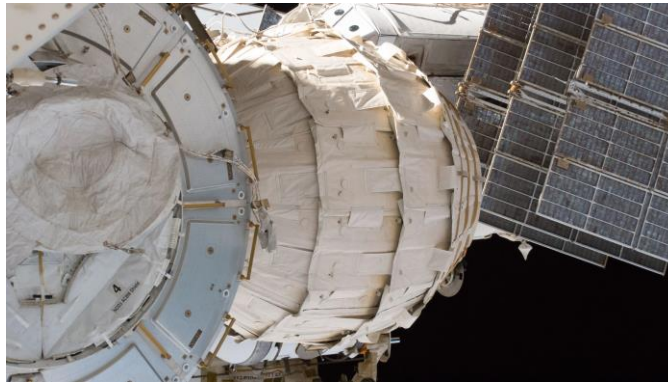
### **ETFE Cushions**

Ethylene Tetrafluoroethylene membranes are sealed and pressurized for its use on modern architecture. They provide high light transmission, great thermal insulation, low structural weight, and long durability. Currently used on the **Allianz Arena** for example.



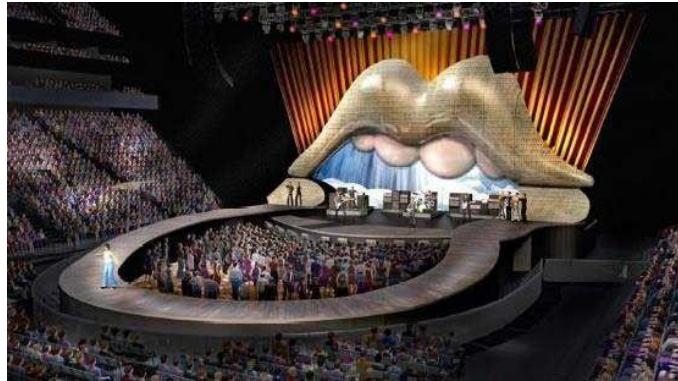
### **Ant Farm collective**

This group of architects and artists are considered pioneers in the use of inflatable structures as tools for cultural critique, and architectonic experimentation. Mostly active between the 60s and 70s. Their Publication **Inflatocookbook (1971)** included accessible methods for designing and constructing temporary architectural structures, emphasizing lightness, movility and the ephemeral nature of these spaces.



### **NASA's Bigelow Expandable Activity Module (BEAM)**

This project is an inflatable module that was coupled to the International Space Station on 2016. It was designed to be expanded once it reached orbit, and it's a clear example of how inflatable structures can offer resistance, insulation and protection in extreme environments.

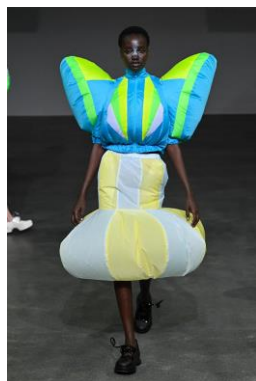


### **Mark Fisher**

Designer and architect specialized in inflatable structures and sculptures for scenography and great-scale concerts. He worked with the stage design and fabrication for U2, Pink Floyd, Roger Waters, The Rolling Stones, Cirque du Soleil, Elton John, Lady Gaga, Madonna, Metallica, among others.

### **Fashion**

Inflatable textiles have expanded (no pun intended) the boundaries of fashion by introducing air as a structural and expressive material. Beyond spectacle, inflatable wearables explore themes of protection, portability, adaptability, and the relationship between the body and temporary architecture. Advances in lightweight coated fabrics, compact air pumps, and heat-sealing technologies have enabled garments that can expand, contract, and reshape dynamically, turning clothing into responsive systems rather than static forms.



### **Anrealage “WIND” Inflatable Jackets**

Japanese designer Anrealage created garments with built-in fans that inflate parts of the textile to transform silhouette and function



### **Fredrik Tjærandsen Balloon Dresses**

Graduate fashion shows have featured inflatable “balloon dresses” that expand with air for dramatic, sculptural runway pieces.



### **Diesel & Dingyun Zhang Inflatable Style Pieces**

Fashion brands have produced inflatable while-wearable items as statement pieces or runway art, exploring air as shaping and expressive material.



### “Sleeping Bag Dress” by Ana Ręwakowicz

An early conceptual piece that can inflate to transition from wearable garment to sleeping module — merging clothing and temporary shelter.



### Inflatable Custom Apparel for Luxury Fashion Houses

Specialized studios design bespoke inflatable fashion garments that act as couture show pieces and explore structure through pressurization.

### Sports

Pneumatic structures provide temporary or semi-permanent facilities such as covered courts and training domes, while high-pressure textile technologies allow rigid inflatable equipment that rivals traditional solid materials. Inflatable systems also enhance athlete safety through cushioning and airbag-based protection. The field combines material engineering with ergonomic design to create adaptable environments and equipment that optimize performance, reduce injury risk, and simplify transport and installation.



**Nike Therma-FIT ADV Repel Down Jacket Milano**

A performance winter jacket that uses air-trapping baffle structures to enhance insulation while reducing weight. Though not visibly “inflatable,” its sealed chamber construction mirrors pneumatic textile engineering used in technical sportswear.



**Dainese D-air Racing Suit**

A professional racing suit with integrated inflatable airbag textiles that deploy instantly during crashes, protecting critical body areas without restricting movement during normal use.



### **Alpinestars Tech-Air System**

A wearable airbag vest worn under racing suits that inflates in milliseconds upon detecting impact, using sealed textile chambers designed for flexibility and high tear resistance.



### **Helite Airbag Vest**

An inflatable protective vest used in equestrian and extreme sports that deploys upon sudden separation from the saddle, cushioning the torso and spine using pneumatic textile structures.

### **Medicine**

Medical applications of inflatable textiles focus on adaptability, softness, and safe interaction with the human body. Pneumatic textile systems can conform to anatomical shapes, distribute pressure evenly, and provide adjustable support, making them ideal for rehabilitation devices, assistive wearables, and patient positioning systems. Their compliance allows movement assistance without rigid mechanical components, improving comfort, and reducing injury risk.



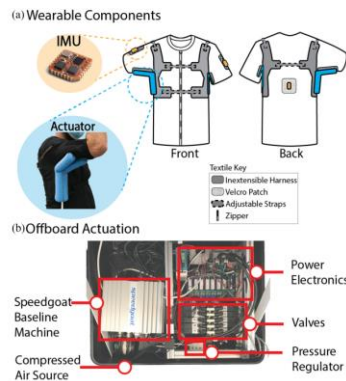
### **Wearable Soft Pneumatic Actuators for Rehabilitation**

Fabric inflatable actuators can assist limb movement in soft robotic exo-sleeves used for rehabilitation or mobility aid.



### **Wearable Airbag Protection Systems**

Medical-inspired wearable airbags (e.g., protective jackets/helmets) can inflate upon sensing impact to protect the wearer's head and torso in injury scenarios.



### Textile Inflatable Actuators for Shoulder Assistance

Textile pneumatic actuators integrated into wearable garments can reduce muscle activation in assisted movement therapy.

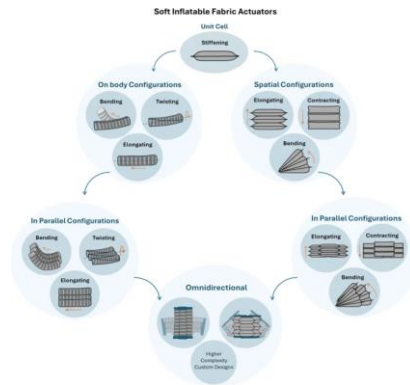


### Soft Inflatable Glove Devices for Hand Rehabilitation

Soft fabric actuators within gloves can pneumatically assist hand extension/flexion during therapy and recovery.

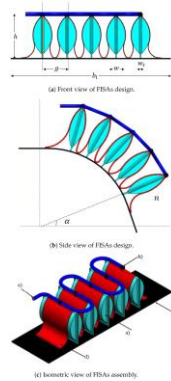
### Soft Robotics

Soft robotics use inflatable textiles to create lightweight, flexible mechanisms that mimic biological movement. Instead of rigid joints, pneumatic chambers embedded in fabrics generate motion through controlled air pressure, enabling bending, twisting, expanding, and contracting behaviors. Textile-based inflatable actuators are safer for human interaction, adaptable to irregular surfaces, and easier to fabricate than traditional robotic systems.



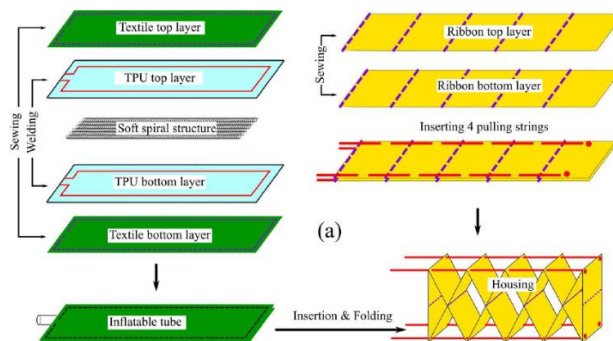
### Unified Framework of Soft Inflation Fabric Actuators

Research demonstrates modular inflatable fabric actuators that bend, contract, and move — a key soft robotics approach.



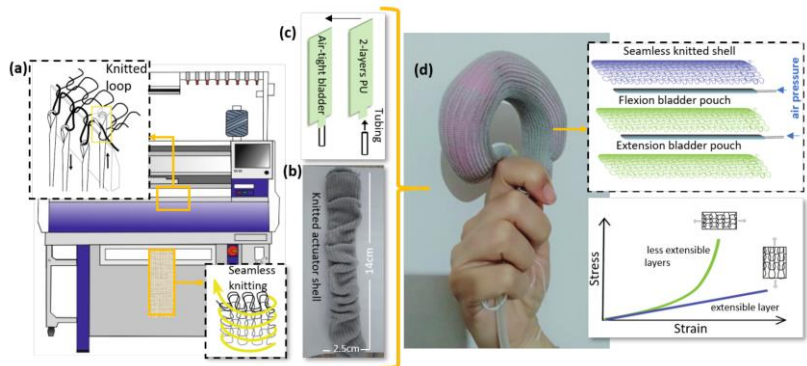
### MOSAR Fabric Inflatable Soft Actuators for Wearables

Fabric pneumatic actuators form modular bending/extension mechanisms used to assist motion in soft wearable robotics.



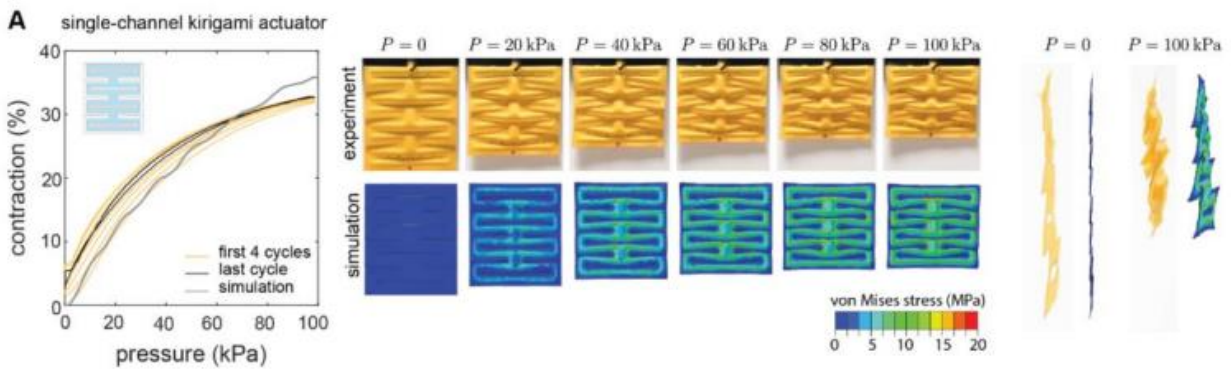
## Marionette-Based Programmable Textile Inflatable Actuators

Programmable inflatable textile actuators that change bending and twisting behavior using tensioned textiles.



## Knitted Pneumatic Textile Actuators for Wearable Robots

Machine-knitted inflatable actuators deliver bending motion while conforming to the body for assistive robotics.



## Inflatable Kirigami Crawlers

Innovative research combining kirigami cuts with inflatable textiles to create textile actuators capable of locomotion.

## Art

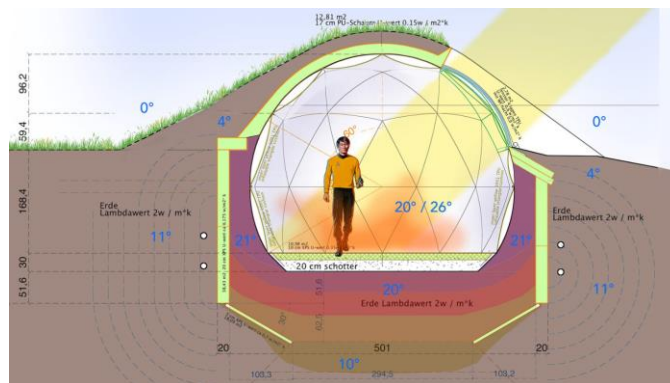
Artists and designers employ inflatable textiles to explore scale, temporality, and audience interaction. Air-filled forms transform spaces rapidly, creating immersive installations, kinetic sculptures, and participatory environments that challenge perceptions of

mass, permanence, and materiality. Because inflatable structures are lightweight and transportable, they enable large-scale interventions in public spaces and temporary exhibitions.



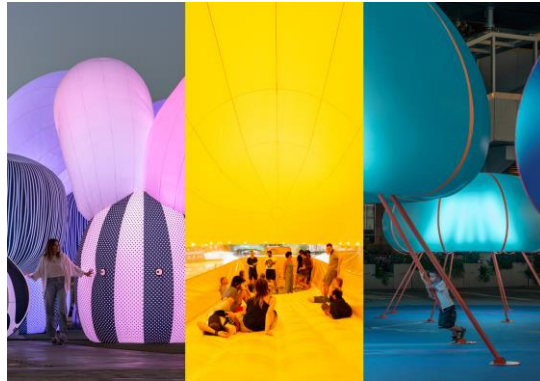
### Bubbleecture Work & RedBall Project

Artists such as Kurt Perschke create inflatable interventions (“Bubbleecture”) that use air-filled balloons and textiles as large public art.



### Pneumocell

Large inflatable textile installations provide interactive art experiences in urban environments and festival contexts.



### Temporary Inflatable Art Pavilions

Inflatable textile spaces used as pop-up galleries or interactive art pavilions explore form and spatial experience.



### Inflatable Latex Sculptures by Sasha Frolova

Contemporary artists use inflatable latex/textile sculptures as expressive forms often exhibited in galleries and public spaces.

### Materials

The materials that were chosen for this experimentation must be:

- Easy to find
- Non-expensive
- Standardized

So, this is the selection of materials:

- LDPE – As in dog litter bags

- HDPE – As in heavy duty trash bags
- Textile vinyl – That adheres with heat
- Crystal PVC
- Satin Fluorescent PVC
- Soft transparent PU – As in transparent curtains
- RipStop (cotton – polyester blend + PU) - As in camping tents
- Mylar – As in emergency blankets
- PolyPropilene + aluminum – As in Chip bags

## Sealing methods

The purpose of these techniques is, on one hand, capture air between the layers, and on the other hand, preventing it from escaping. This can be done through heating, adhesives, and mixed techniques.

### Heat

The purpose of this book is to experiment on heat-sealing methods for the different materials, all done through means of digital fabrication.

#### *Laser*

Using a laser cutter, it is possible to *weld* different layers of thin materials. Special thanks to [Saskia Helinska](#) and [Javier Alboguijarro](#), whose previous research helped and inspired me a lot on this topic.

#### *Fusing with ironing.*

Using the heat press we can fuse different layers of materials, and with a “isolating” material in between, it is possible to do it in specific parts, so the result behaves like we want to.

#### *3D printer hot-end fusing*

With “Cheating” the 3D printer, it is possible to use the hot-end to fuse layers of materials in specific areas.

### Air retention

How long can the material and technique hold the air inside without any leaks.

#### *Leaks*

Leaks can be repaired with the same material, a bit of all-purpose glue, and/or heat.

#### *Valves*

By using off-the-shelf check valves, it is possible to increase the air retention time and capacity of the materials.