# Active Textile Tailoring

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**Figure 1: A textile garment shown before activation (Left) and after activation, demonstrating a tailored fit (Right).**

## ABSTRACT

Active Textile Tailoring is a new process for creating smart textiles in which its fibers change shape and structure in response to heat. This adaptive textile can create a new type of sizing customization or aesthetic patterning for the preference of individual customers. This system was developed in collaboration with MIT, Ministry of Supply, Hills Inc. and Iowa State University with support from the federal non-profit Advanced Functional Fabrics of America (AFFOA).


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## CCS CONCEPTS

• **Hardware → Emerging tools and methodologies**.

## KEYWORDS

Active Textiles, Material Transformation, Knitting

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## 1 INTRODUCTION

Today, garments are mass-produced using static fabrics in generic sizes. Active Textile Tailoring demonstrates a new type of knit garment in which individual fibers and yarns with unique material properties are combined to enable control of localized garment dimension. From an apparel design perspective, this enables garments to be customized to an individual's unique body shape without cutting and sewing fabrics–beyond what is possible in traditional tailoring. Additionally, this smart textile opens up a new aesthetic design process in which patterns and colors can be programmed into the fabric, and change appearance in response to heat and moisture.

At a macro level, this technology is part of a greater trend around advanced manufacturing technology in the apparel industry. For the most part, clothing design and manufacturing today is much the same as it was since the 19th century, employing cut-and-sew construction and traditional dyeing processes. At the other end of the spectrum, many current advances rely on electronic devices, flooding our wardrobes with wearables like smart watches and fitness trackers. Furthermore, new technology for custom-fit garments often involves inefficient workflows that attempt to transfer individualized measurements into customized patterns.

Today's smart and high-performance clothing aims to introduce new functionality to garments, but traditionally relies on device-heavy solutions that require electronic components and complex mechanisms for sensing and actuation. This approach adds extraneous devices to traditional garments, increasing cost, complexity, failure, and bulkiness. Active Textile Tailoring proposes a radically different approach that instead relies on the inherent physical properties of fiber-based textiles. Taking advantage of stitch-level control of industrial textile machines, garments can be pre-programmed with the ability to shift in size according to individualized customer data.

## 2 METHOD

Existing work in the field outlines both consumer demand for custom-fit garments and manufacturing processes for garments that integrate three-dimensional data from individual consumers [Buecher et al. 2018]. These strategies focus on in-store experiences, such as 3D body scanning, that can transfer dimensions related to individual fit into customized 2D patterns [Bellemare 2018]. These examples demonstrate the significant challenges in applying current knit manufacturing technology to the production of individualized items [Apeagyei and Otieno 2007].

Our approach is based on a combination of 1) materials properties enabling fiber-level physical transformation in response to temperature or moisture change, 2) fabric-level structural responsiveness based on knit structure, and 3) industrial knitting of whole garments enabling precise control over local/global structure.

The proposed garments integrate standard materials with selectively placed active material that exhibits permanent local shrinking in response to heat. The configuration of the active material in the garment's knit structure produces fabric contraction in the horizontal and vertical directions, allowing flexibility in adapting to different scenarios of fit adjustment. The active knit structure can be applied to any area of the garment to allow for targeted fit adjustment.

By applying heat to adjust the shape of the garment, a robotic arm provides a method of transference between dimensional data related to the consumer and a resulting individualized pattern. This can be applied precisely and evenly by the robot without the need to convert customer data into a textile pattern, circumventing the complexity of manufacturing problems typically involved in achieving custom fit.

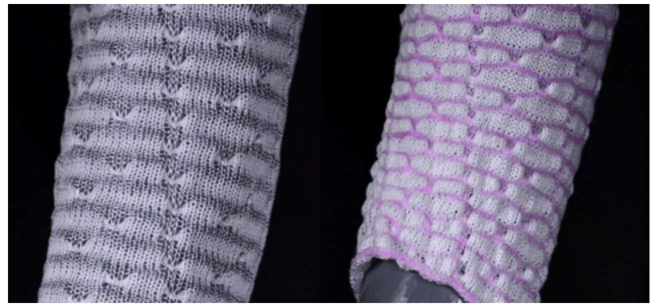

**Figure 2: A textile sleeve shown before activation (Left) and after activation with porosity, shape and color change (Right).**

## 3 CONCLUSION

Active Textile Tailoring is a first step in a series of investigations into programmable material in textiles. In addition to fit customization, current projects seek to create built-in material configurations that can passively respond to changes in body heat or environmental conditions. Among our investigations, we have shown that by designing complex knit structures including both temperature active and non-active fibers, we can change both compression and porosity in response to heat, demonstrating the potential of active of material-based activation for garments.

## ACKNOWLEDGMENTS

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