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# Bodily Sketching With Sensable Stretchables



**Figure 1** Just some of the different bodily positions stretchable sensors can be worn. Top. elbow angle measurement; middle, gait monitor, and; bottom, skin sensor.

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## Abstract

Come and get creatively hands on with the next generation of stretch sensors! This studio will see participants familiarize themselves with, and devise exciting new uses for dielectric elastomer (DE) stretch sensors. Unlike normal stretch sensors, these skin-like sensors are highly durable and reliable. DE sensors can also be customised into nearly any shape or size, whilst being only 0.5mm thin makes them near undetectable to the wearer. After introducing the technology by walking through some easy to adapt examples, participants will be supported to express and test their ideas around stretchable interfaces through a collaborative maker session. Through attaching the sensors to our bodies or by modifying second hand garments, participants will explore the design opportunities of DE sensors. The session will culminate in a design crit of participants' application mock-ups and a discussion of opportunities for future interactive materials, garments, artefacts and environments.

## Keywords

Stretchables; interactive materials; wearables.

## ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

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## Introduction

Huge predicted growth in the wearable technology market [1] and increasing demand for inconspicuous wearable sensors [2] has led to the commercialisation of a number of new technologies capable of being integrated into textiles and worn close to the body. This studio focuses on mechanical sensors for motion capture using one of the most promising sensor types available – dielectric elastomers (DE).

### *Dielectric elastomers – very stretchable sensors*

“Dielectric” means electrically insulating. “Elastomer” means an elastic material. The highly supple material of DE sensors behaves as an electrical component whose characteristics change when stretched. It is primarily a mechanical sensor, as it is a parallel plate capacitor whose geometry (and thus capacitance) is changed when stretched.

### *Benefits of DE sensors*

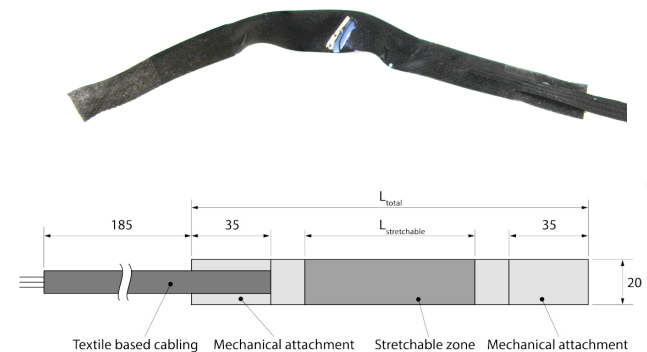
These characteristics result in sensors with a number of exciting qualities for interactions that are informed by human bodies and informative of our embodied selves.

- Versatile form factor (can be made in almost any shape).
- Potentially low cost
- Lightweight and thin
- More accurate than other stretch sensors
- High strain bearing of up to 100% (i.e. double their length).

- Washable (yes, in domestic laundry machines!).

The very thin, silicone rubber film conforms to the skin or clothing during human movement. Thus when DE sensors are embedded in textiles, they are often unnoticeable both to the wearer or other people. Amongst many proposed uses, this unique and adaptable elastic sensor technology has been used as artificial skin for an on body controller [4], as a sensor for motion capture in sports applications [5], and as a gait monitor for medical applications [6] (see figure 1).

Commercialisation efforts are now coming to the point where off-the-shelf standard sensors are available ready for textile integration and encapsulation into other elastic materials [3, 7, 8].



**Figure 2** Example stretch sensor photo and drawing (the numbers are dimensions in millimeters)

## Proposal

*Bodily Sketching with Sensable Stretchables* will provide participants with a working knowledge of DE sensors, through a hands-on introduction and subsequent completion of a mini design cycle. Working in small groups with a development kit that includes a variety of DE Sensors, participants will draw upon their own interests and expertise to envisage, develop and evaluate new ways of using this technology. Participants will experience and use the stretchable sensors with their own bodies to develop use cases and applications. At least one novel idea from each group will be developed into an interactive mockup.

This creative session may result in real product ideas, but could also generate directions for provocative designs and artistic experimentation, or provide vehicles with which to manifest theoretical concerns. The studio will be a blend of basic technical theory, design, sketching, hands-on creation, reflection and documentation. Through collaboration, participants will also be encouraged to critique and feedback on concepts developed throughout the day, in both small group and plenum sessions.

*Stretchables is open to all disciplines and skill levels*  
Since the mechanical characteristics of this technology make it suitable for use close to, or on the human, we wish to engage the celebrated diversity of TEI community and attract a wide range of disciplinary expertise to come together in this studio.

The studio will provide a very accessible technical introduction to this technology despite the engineering considerations for designing such sensor being complex. Organisers will act as “prototyping

technicians” to assist the development of design concepts from groups who are lack any particular skills (e.g. using sewing machines). Thus participants from all backgrounds will be able to take part. All that is required is a willingness to collaboratively generate and explore ideas for new interactions with minds and bodies.

## Duration

1 day.

## Topics to be covered

The day will follow a design and concept development process resulting in new sensor applications and reflection and debate being described and published digitally. A session, working with the body and the sensors to gain first hand appreciation of their function will be a strong practical basis for topics included in the day:

1. Dielectric elastomer sensors
  - Design, construction and function
  - Scope and limitations
  - Current applications
  - Sensor kit demonstration
2. Idea generation (in groups):
  - Brainstorming ideas
  - Concept selection
3. Concept fabrication (in different groups)
  - Build chosen idea
  - Test and document
4. Reflection
  - Presentation of concepts
  - Feedback from other participants with discussion

We aim to work with interested attendees to disseminate ideas, observations and analysis of the day to relevant academic and industry outlets across a spectrum from the highly technical (e.g. SPIE Smart Materials and Structures) to the more design oriented (e.g. DPPI).

### Learning Goals

The main learning goal of the studio is to provide a critical, experiential and practical introduction to working with DE sensors. Participants will leave with an appreciation of if, when and how to possibly exploit the properties of these stretchable sensors in their own research and practice. Furthermore, through fostering a positive collaborative atmosphere, the studio will also support participants in learning a great deal from each other by exchanging diverse approaches to generating, developing and evaluating ideas for embodied interactions.

### Positioning

The studio will be based around the skills and creativity of the attendees to apply and give context to DE stretch sensors. As such, the positioning between theory and practice will be defined largely by the inclinations and expertise of the eventual participants. The organisers' own diverse backgrounds enable flexibility in this regard. They will provide theoretical support concerning basic sensor construction and manufacture to provide realistic constraints to industrially oriented concepts. At the same time, the organisers are also well placed to nurture more speculative, critical, and research focused approaches to sketching with stretchables.

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