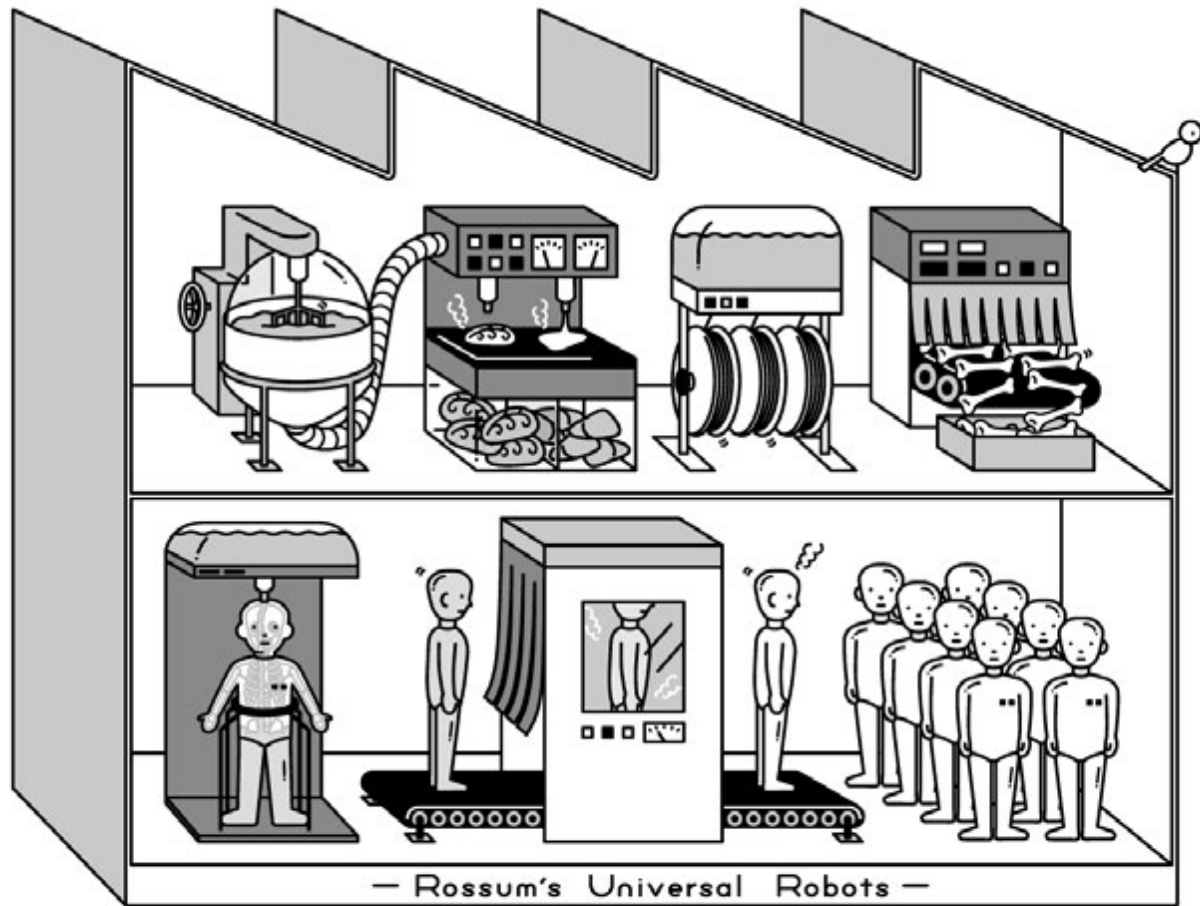


Open Soft Machines

Ryuma Niiyama

Assistant Professor,

Graduate School of Information & Science, The University of Tokyo



“

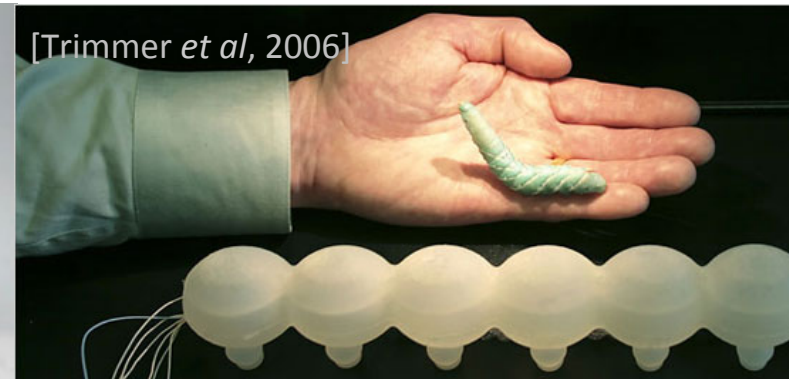
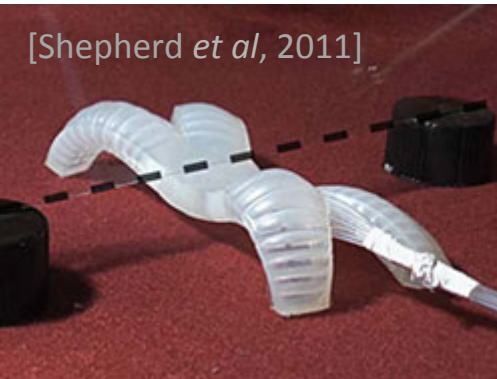
Mixers can mix the dough for a thousand robots at a time. Then there are the vats of liver and brain and so on. The bone factory. The spinning mill where we make the nerve fibers, veins, and intestine. Then there's the assembly room where all these things are put together, it's just like making a car.

”

“R.U.R” Karel Čapek, 1920

Fabrication Challenges

- Continuum body, Integrated/embedded (not an assembly of modular components)
- Handling deformable materials/fluids, nonlinear properties



Recipe = materials and methods



Video-based Journal



Advanced



START A TRIAL

LOG IN

ABOUT JOVE

FOR LIBRARIANS

PUBLISH

VIDEO JOURNAL

SCIENCE EDUCATION

What is JoVE?

JoVE is the world's first and only **peer-reviewed** scientific video journal that increases productivity.

JoVE has produced over 7,000 videos demonstrating experiments from laboratories at top research institutions and delivered online to millions of scientists, educators, and students worldwide. Today, JoVE subscribers include more than 1000 universities, colleges, biotech and pharmaceutical companies.

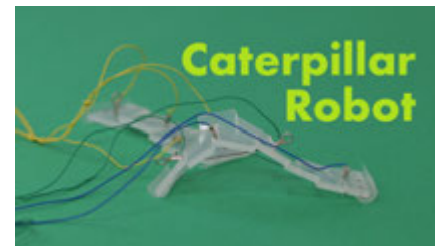


Open Soft Machines

<http://opensoftmachines.com>

The screenshot shows the homepage of the Open Soft Machines website. At the top left is the logo "OPEN SOFT MACHINES recipes for". The navigation bar includes "HOME", "RECIPES", "KIDS", "TIPS", "BLOG", "GUIDE", "ABOUT", and "ENGLISH". Below the navigation bar is a "RECIPES" section with a grid of five items: "McKibben Artificial Muscle", "Dielectric Elastomer Actuator", "Caterpillar Robot", "Shape Memory Alloy", and "Introduction to Soft Robotics". Each item has a small thumbnail image and a title. Below this is a "YouTube Channel" section featuring a video player for "McKibben tripod - opensoftmachines" and a list of other videos.

The screenshot shows a recipe page for the "Dielectric Elastomer Actuator". The navigation bar is the same as the homepage. The page has a search bar and a list of categories: "Brush", "Spatula", "Fabrication", "Kids Menu", "NONE", "Sensors", and "Blog". The "RECIPE OF THE DAY" section features the "Dielectric Elastomer Actuator" recipe. The "Directions" section includes two steps: "1 Draw the guide line" and "2 Stretch". The "1 Draw the guide line" step includes a photograph of a hand drawing a circle on a piece of yellow elastomer sheet. The "2 Stretch" step includes a photograph of the stretched elastomer sheet. The "RECIPE OF THE DAY" section also includes a list of other recipes: "Small-Sized McKibben Pneumatic Artificial Muscle", "DEA (Dielectric Elastomer Actuator)", "Caterpillar Robot with SMA", "SMA (Shape Memory Alloy)", and "Introduction to Soft Robotics: first year of soft robots".



Platform Design

- Target Users
 - 12+ year old
 - Scientists in any discipline, educator, makers (hobbyist)
- Focus
 - Encourage a cross-disciplinary collaboration projects
 - Soft actuators/sensors, polymer and gel, biohack, compliant mechanism, system integration
- Methods
 - Video format within 2 minutes
 - Off-the-shelf material and tools

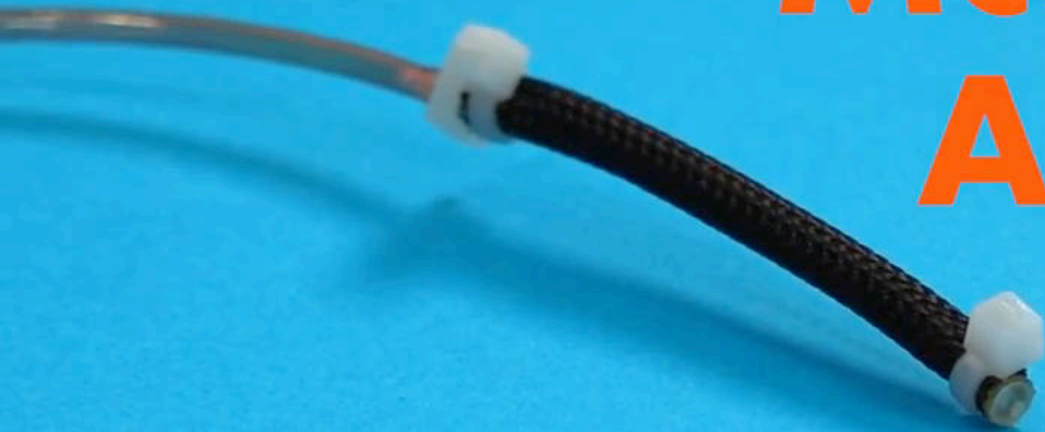
Challenges

- Reproducibility
 - Robotics papers usually have no detailed “Materials and Methods” section.
 - How-to tips
- Availability of Materials and Tools
- Citations to your papers, followers

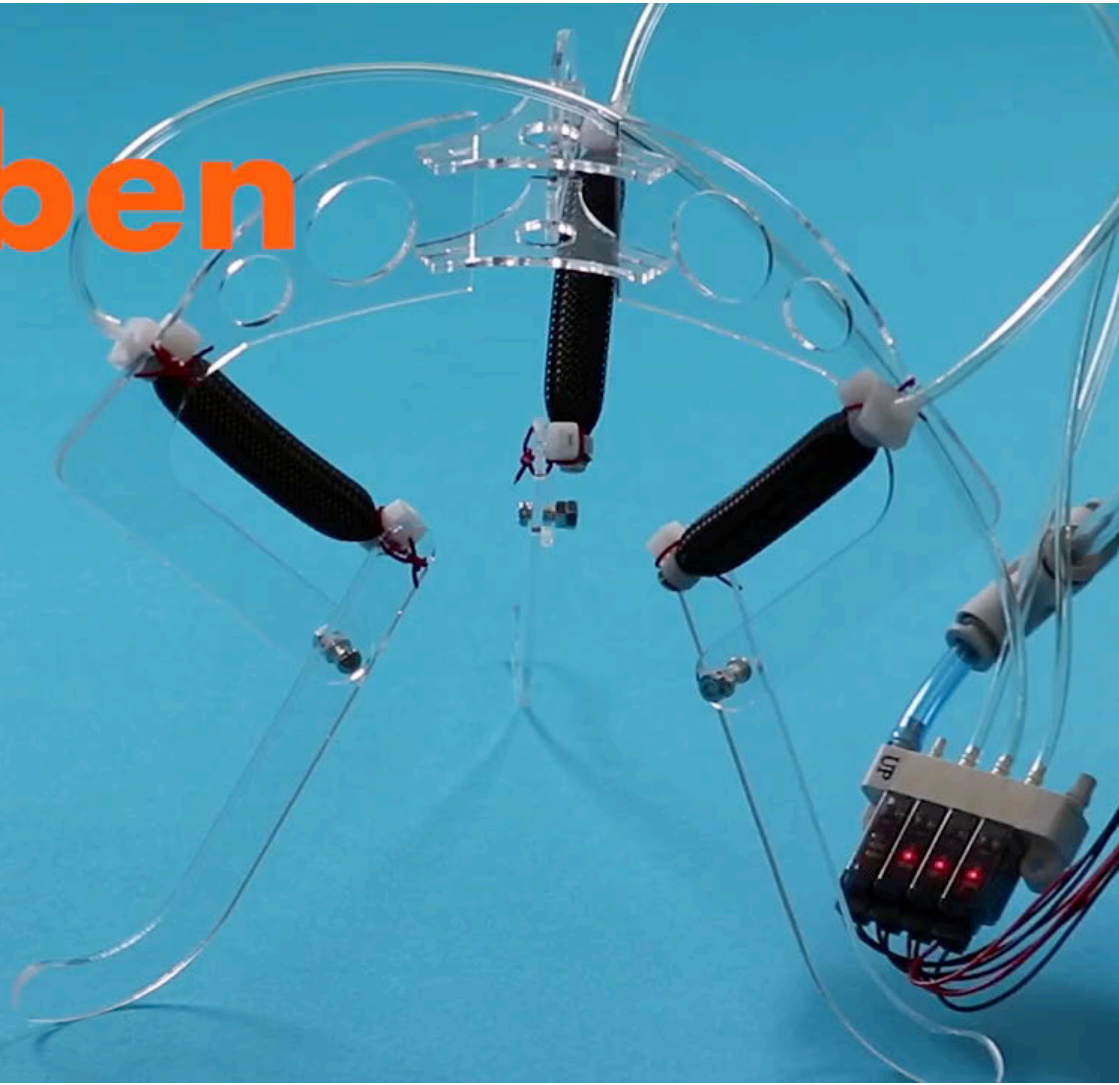
Artificial Muscles for Soft Machines



McKibben Artificial Muscle



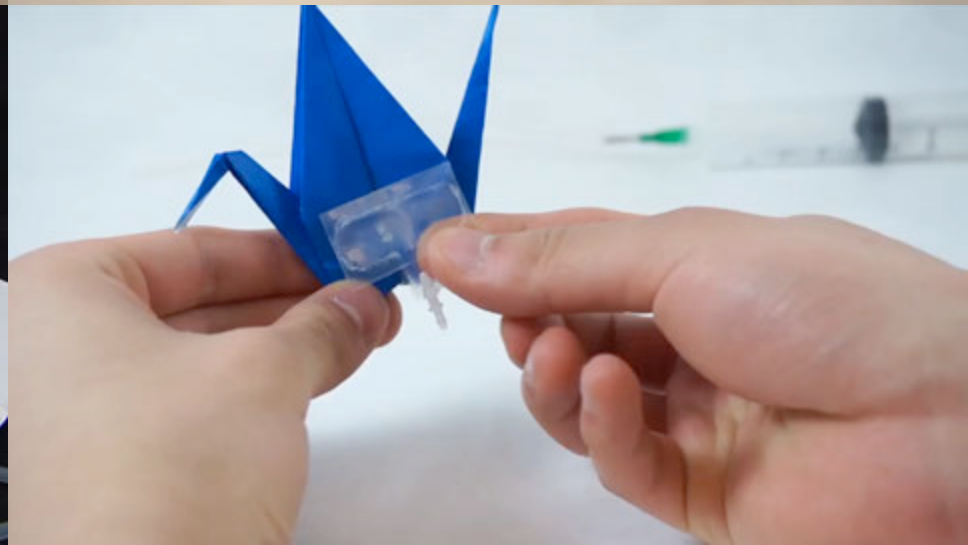
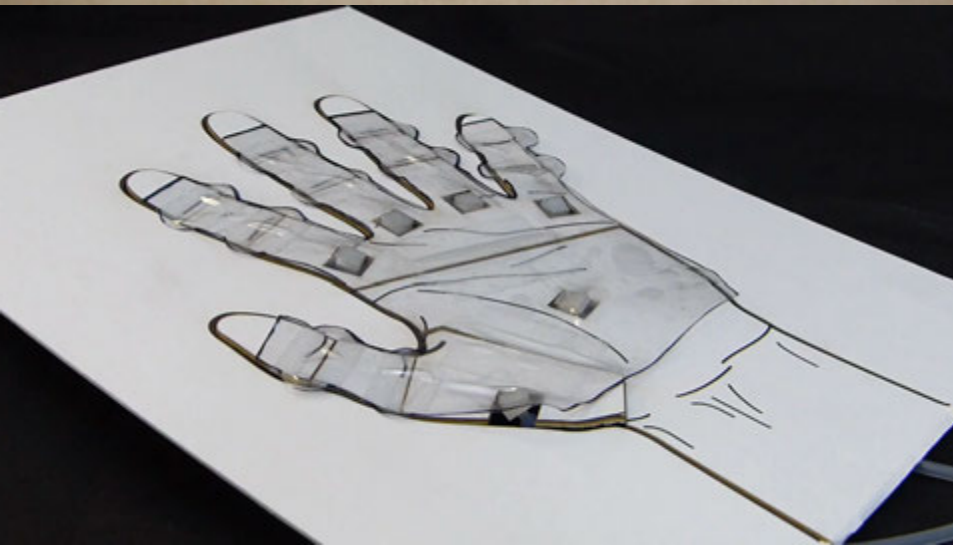
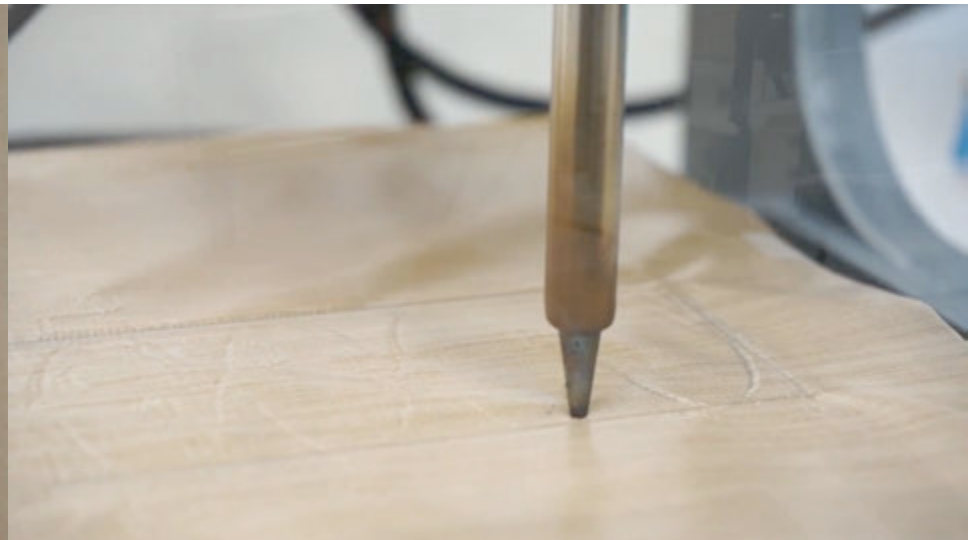
McKibben Tripod Robot



Pouch Motor

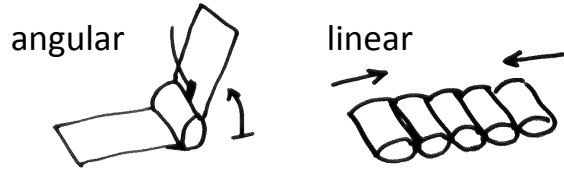


Linear Pouch Motor

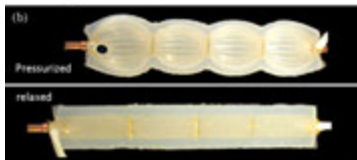


Map of Film-based Fluidic Actuators

Pouch Motor



[Niiyama+, ICRA2014] [Niiyama+, 2015]

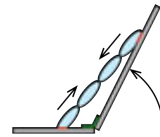


Flat PAM [Park+, 2014]

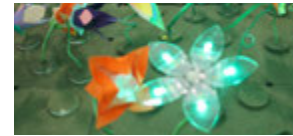


Peano Actuator [Sanan+, 2014], Otherlab

Second Generation



Self Folding
[Sun+, ICRA2015]



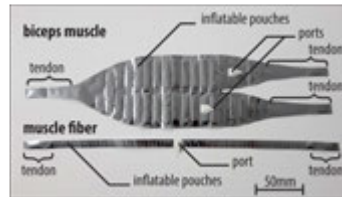
Robotic Garden
[Sanneman+, ICRA2015]



Angle Sensor
[Sun+, IROS2015]



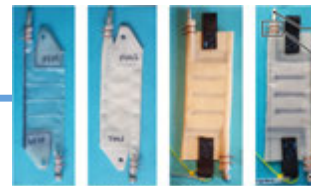
Rat rehabilitation
[Chang+, EMBC2015]



Printable PAM
[Niiyama+, Humanoids2015]



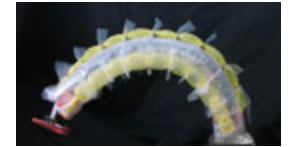
Sticky Actuator
[Niiyama+, TEI2015]



Peano Fluidic Muscle [Veale+, 2016]



aeroMorph
[Ou+, UIST2016]



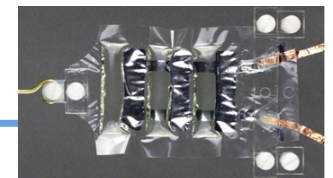
Series PAM
[Greer+, ICRA2017]



Electric Phase-change
[Nakahara+, ICRA2017]



Origami-inspired muscle
[Li+, 2017]



Peano-HASEL
[Kellaris+, 2018]

Liquid Pouch Motor



Share your recipes, get more followers



RECIPES

All

Actuators

Blog

Fabrication

Kids Menu

Materials

Recipes

Robot

Sensors



McKibben
Artificial
Muscle

Actuators

Small-Sized McKibben
Pneumatic Artificial
Muscle



Dielectric
Elastomer
Actuator

Actuators

DEA (Dielectric Elastomer
Actuator)



Caterpillar
Robot

Recipes

Caterpillar Robot with
SMA



Shape
Memory
Alloy

Actuators

SMA (Shape Memory
Alloy)



Introduction to Soft Robotics

Blog

Introduction to Soft
Robotics: first year of soft
robots

YouTube Channel

McKibben tripod - opensoftmachines

McKibben
Tripod
Robot



McKibben tripod -
opensoftmachines

01:57



McKibben tripod - opensoftmachines
01:57



McKibben Artificial Muscle -
opensoftmachines
01:41



Dielectric Elastomer Actuator -
opensoftmachines