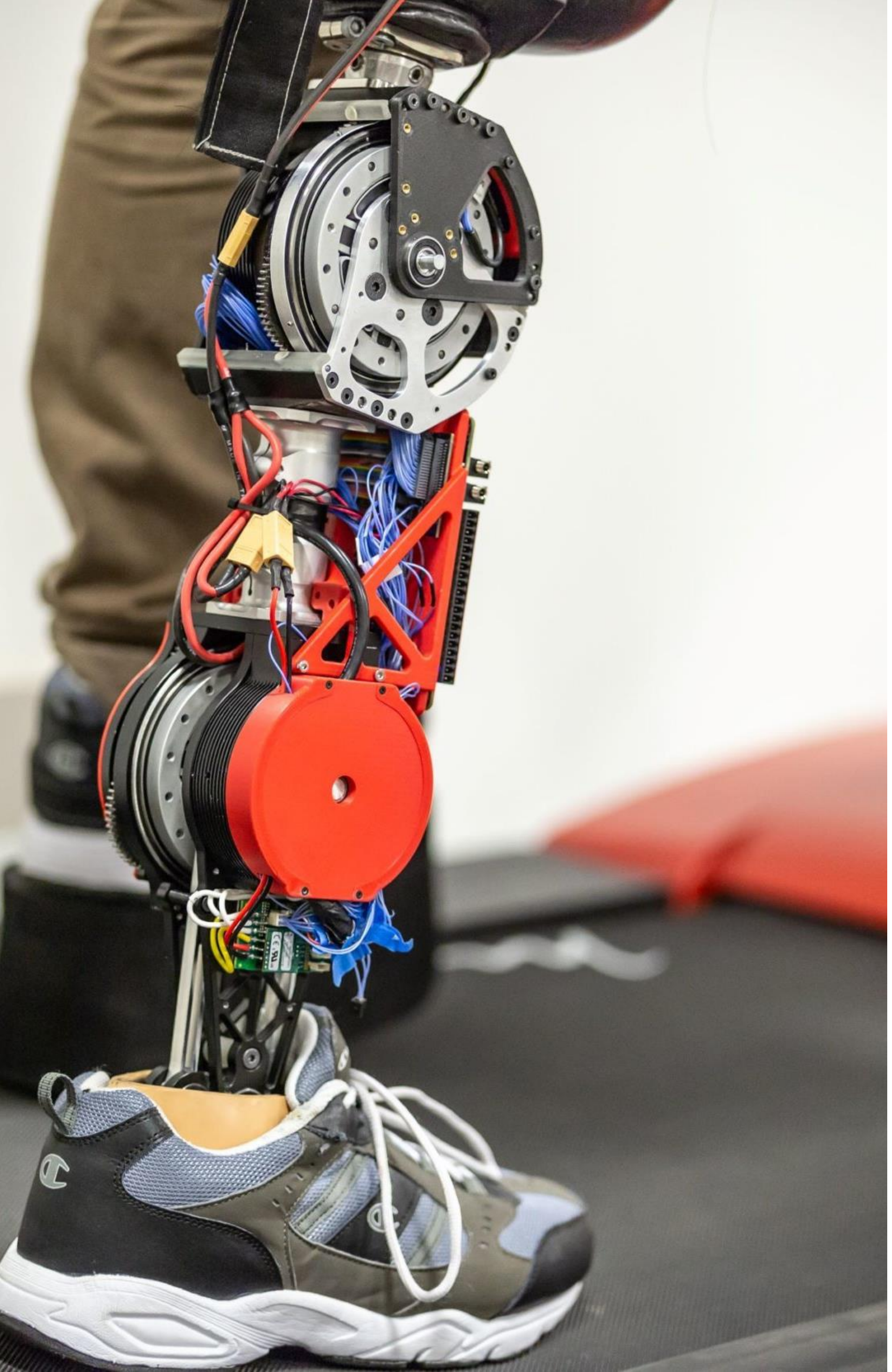
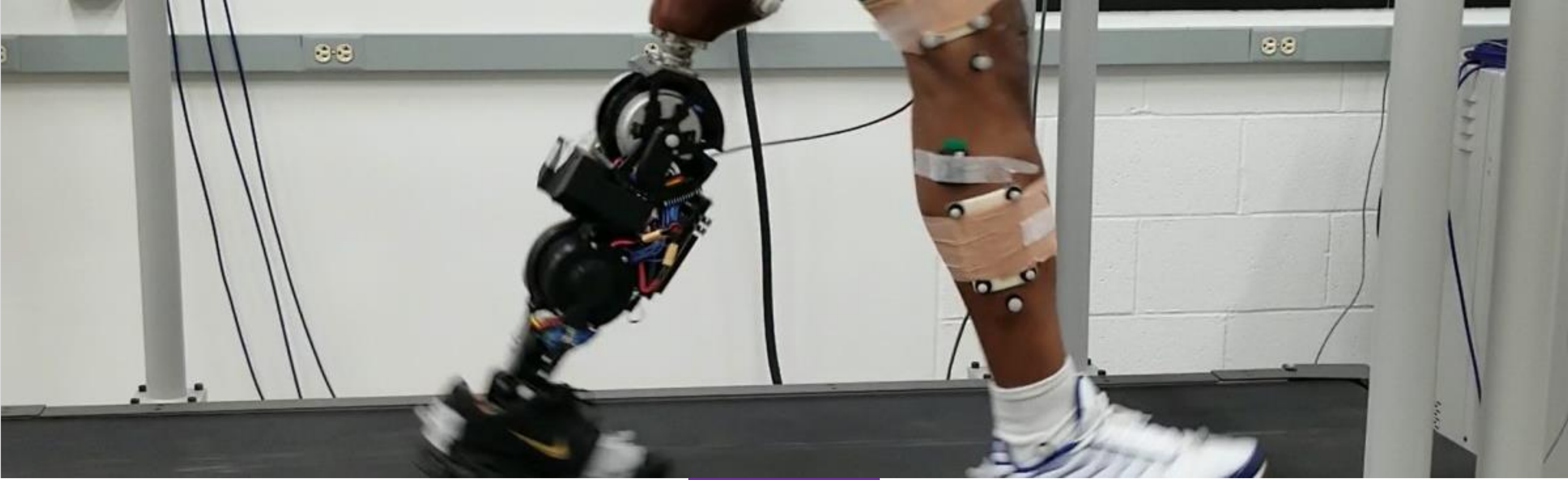


AN INTRODUCTION TO THE WORLD OF

ROBOTIC PROSTHETICS

BY **JYOTHISH K. J.**



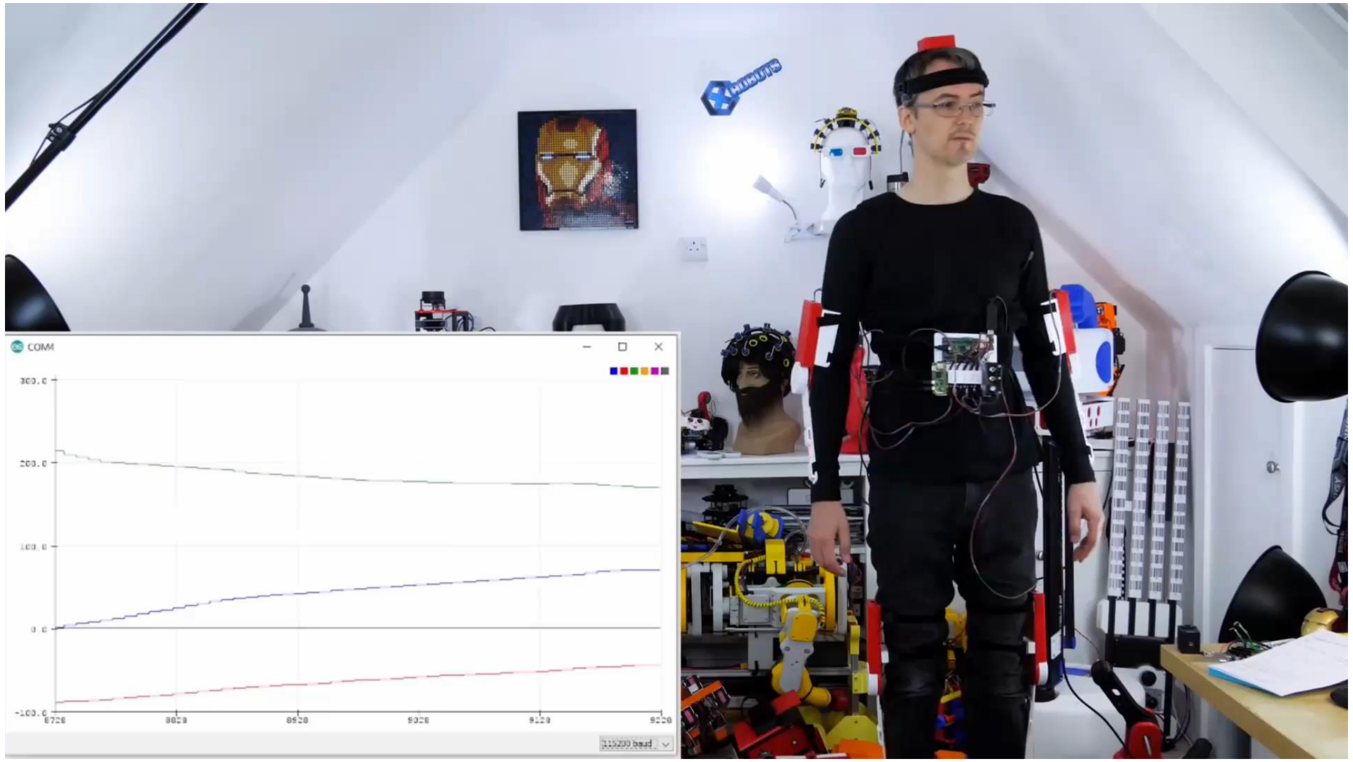
THE PROBLEM

- **Expensive**
- **People grow, things don’t**
- Not Practical – Poor Mobility, No Sensation, Inappropriate weight-look-and-feel
- Durability

CAN ROBOTS FAKE LIFE GOOD ENOUGH?

Your arm or leg sends sensory inputs (Such as touch, temp., pressure) to your brain and moves at brain's instructions.

Robotics is defined as reading the state of the universe using Sensors and manipulating it using Actuators.



Source: https://www.youtube.com/channel/UCUbDcUPed50Y_7KmfCXKohA YouTube - James Bruton | Machine Learning Prosthetic Arm Concept.

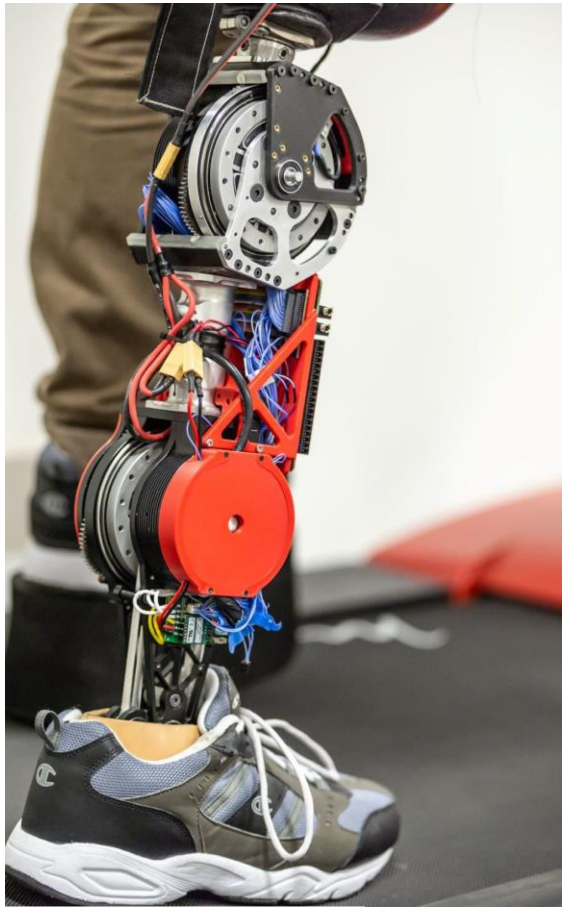
A POPULAR SOLUTION

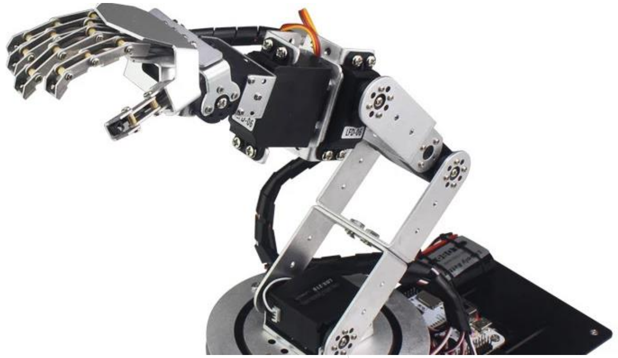
“Unlimited Tomorrow's TrueLimb” (Personalized Prosthetic Arm - Trans radial Bionic Arm (unlimitedtomorrow.com))

A YouTube coverage on the said company.

WHAT'S NOT SO STRAIGHT FORWARD?

- Why not strap on couple of motors, make a product and start selling?
  - Weight
  - Shape/Volume – Form factor
  - Typical Methods
    - Servo motors
    - Holding a position and backlash – Harmonic drives are an interesting read.
  - Powering the robot: Energy Consumption, storage, and Practicality associated with it.
- Typical methods of moving robots won't work





Interesting feeds upon

INITIAL LOOKUP

From the world of Material Science

Shape Memory Alloy (SMA)

Alloys that retain their shape upon transition temp.

e.g. NITINOL, Copper-Aluminum-Nickle alloy etc.

Electro Active Ceramics (EAC)

Piezoelectric and Electrostrictive materials.

e.g. lead zirconate titanate (PZT) etc.

Electro Active Polymers (EAP)

Piezoelectric and Electrostrictive materials.

e.g. lead zirconate titanate (PZT) etc.

Other Soft Robotics

Flexible structures changing shape or moving using non rigid energy transmission such as a balloon or something using compliant mechanism etc.

Molecular Machines

e.g. Catenanes, Rotaxanes, etc.

Interesting feeds upon

INITIAL LOOKUP

- Shape Memory Alloy (SMA)
- Electro Active Ceramics (EAC)
- Electro Active Polymers (EAP)
- Other Soft Robotics
- Molecular Machines

Source: https://www.youtube.com/channel/UC1VLQPn9cYSqx8plbk9RxxQ YouTube - The Action Lab | How strong are Nitinol muscles?

Interesting feeds upon

INITIAL LOOKUP

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Piezoelectric and Electrostrictive materials.

e.g. lead zirconate titanate (PZT) etc.

Recommended watch: Working of inchworm motors (Piezoelectric Motors)

Interesting feeds upon

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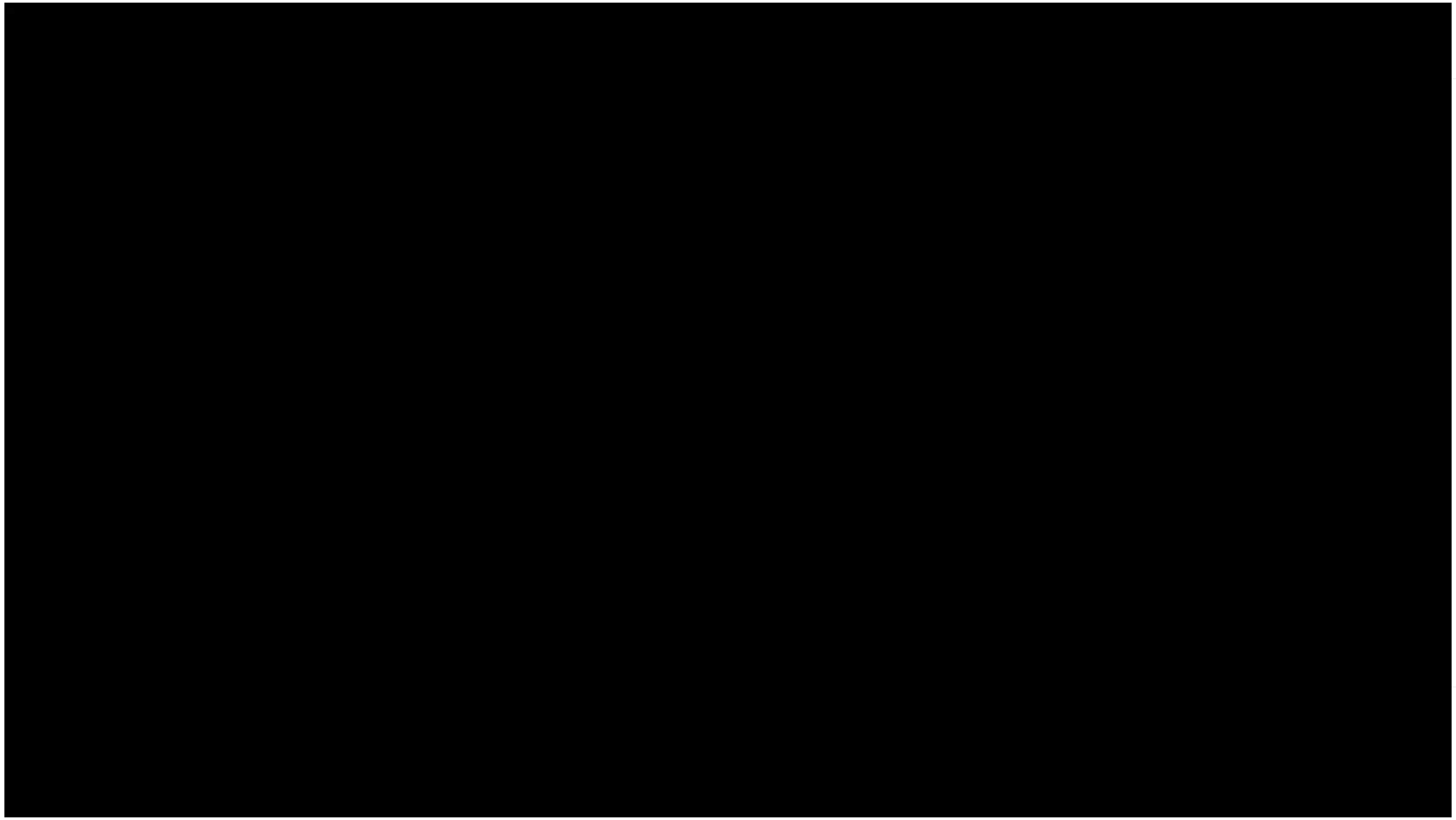

Source:
https://www.youtube.com/watch?v=PDqmGHHKkWw
YouTube – Malcolm Moreno | The Basics of Dielectric Elastomers

Interesting feeds upon

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TABLE 1: Comparison of the properties of EAP, SMA and EAC

Property	Electroactive polymers (EAP)	Shape memory alloys (SMA)	Electroactive Ceramics (EAC)
Actuation strain	>10%	<8% short fatigue life	0.1 - 0.3 %
Force (MPa)	0.1 - 3	about 700	30-40
Reaction speed	µsec to sec	sec to min	µsec to sec
Density	1- 2.5 g/cc	5 - 6 g/cc	6-8 g/cc
Drive voltage	2-7V/10-100V/µm	NA	50 - 800 V
Consumed Power	m-watts	Watts	watts
Fracture toughness	resilient, elastic	Elastic	fragile

https://ndeaa.jpl.nasa.gov/nasa-nde/lommas/robotics89-eap.pdf
Super Recommended Read.

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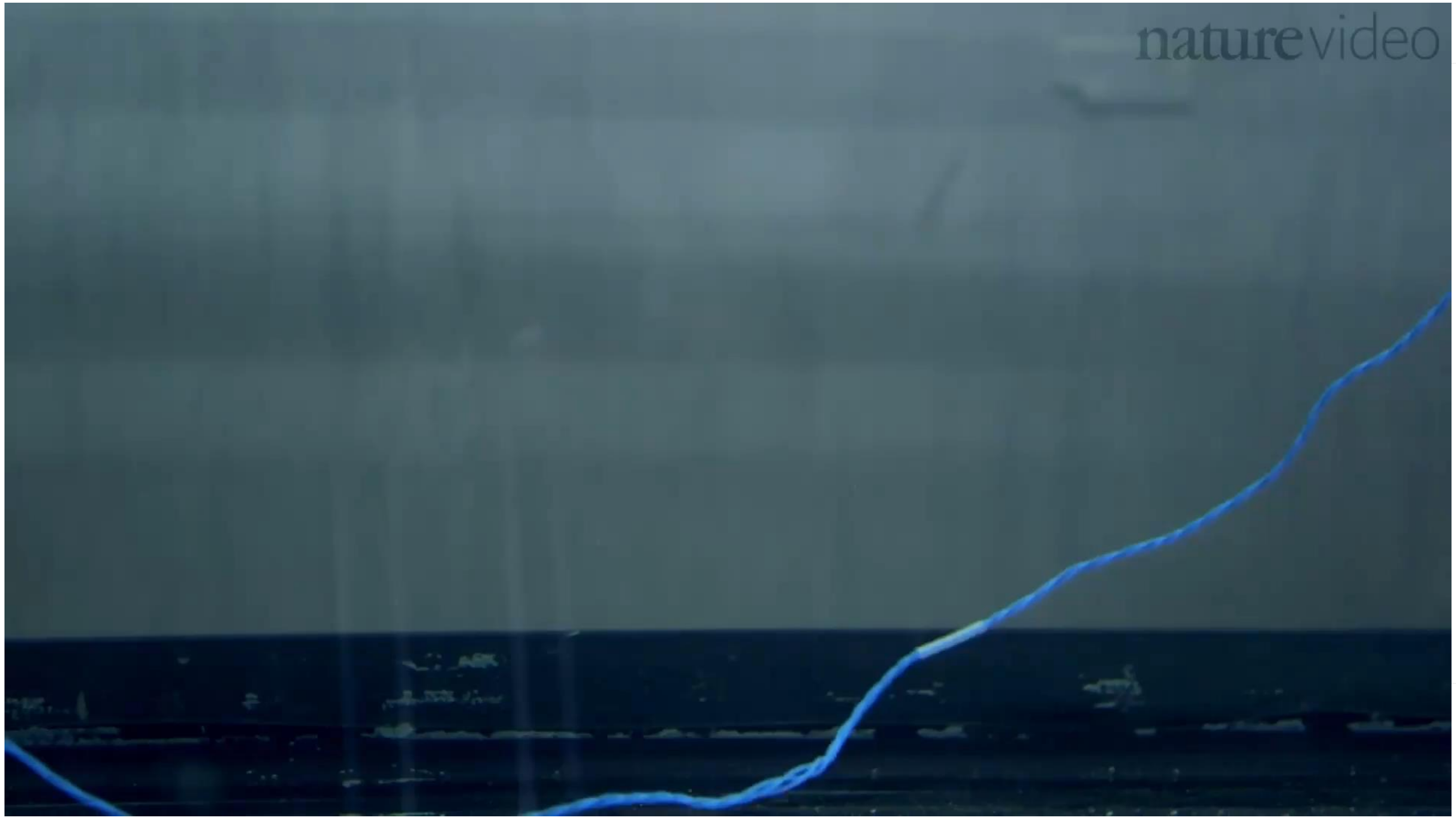


Source:
https://www.youtube.com/channel/UC7c8mE90qCtu11z47U0KErg
YouTube – nature video | Soft Robotics

TOTALLY SOFT ROBOTS

SHOUT OUT TO THIS RECORDED TALK FROM AUCKLAND BIOENGINEERING INSTITUTE

https://youtu.be/LqOQQsig7og?t=754

The link is provided with a timestamp to the logic making using soft materials, however entire video is an awesome watch.

QUICK FACT

Michael DeBakey

Domingo Liotta

When was the first fully Artificial Heart put into a human body?

(a) Before 1900
(b) Between 1900-1950
(c) From 1950-2000
(d) After 2000

Source:
https://www.youtube.com/channel/UCUMZ7gohGI9HcU9VNsr2FJQ
YouTube – Bloomberg Quicktake | Permanent Artificial Hearts Are Closer Than You Think

PROJECT PLAN

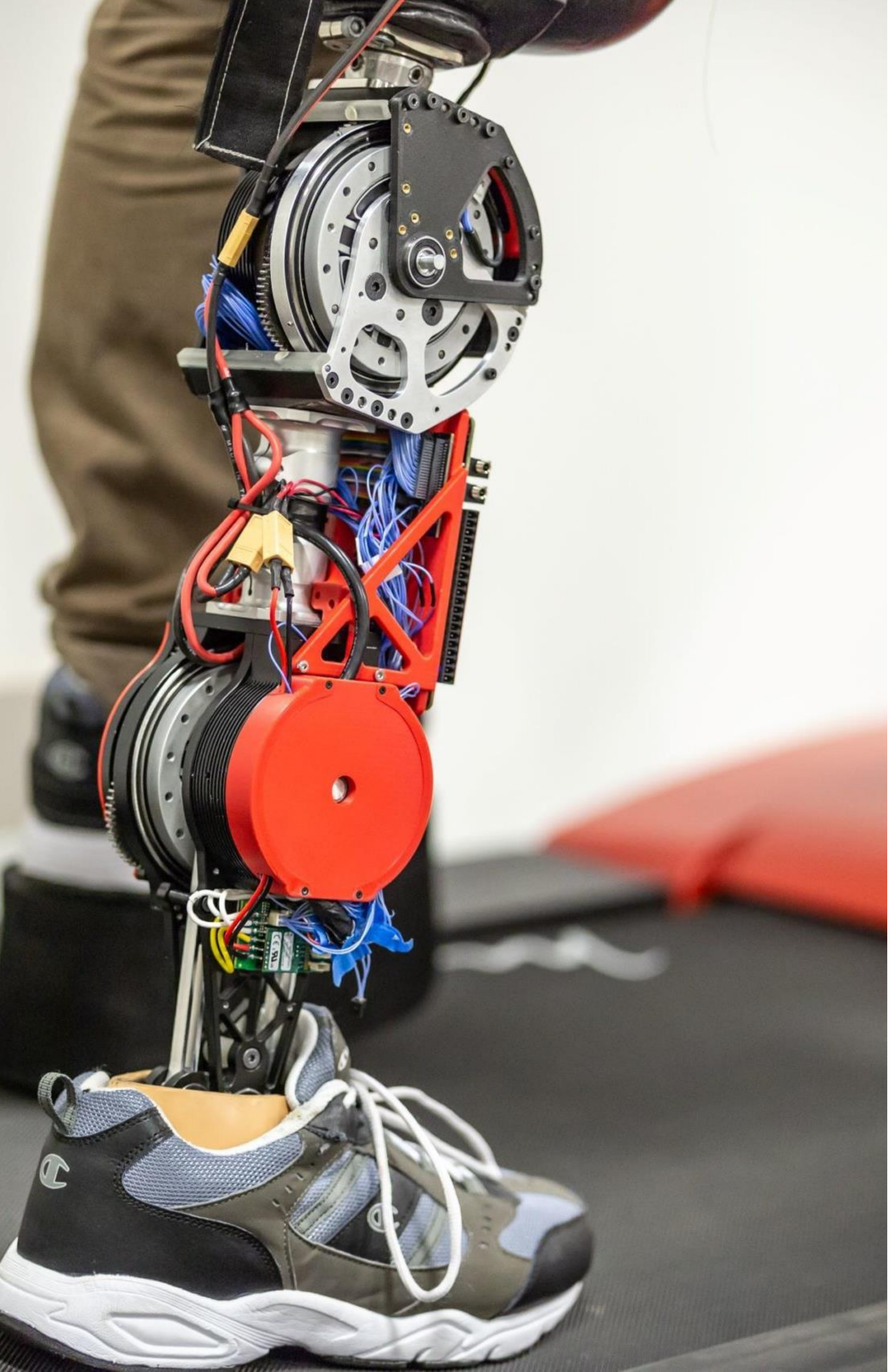
Read in-depth about various options which can create motion which is adaptable for an application such as prosthetic limb.

4th Year

- Design and fabricate a full robotic prosthetic arm using conventional options. This will be done with mimicking bio mechanics of a real hand in mind.
- Develop and test out an Electro Active Polymer (EAP) based muscle bundle.

5th Year

- Design and fabricate an advanced robotic prosthetic arm using EAP muscle bundle.
- Run experiments and test out the possibilities and limits of such a prosthetic limb.



THANK YOU