



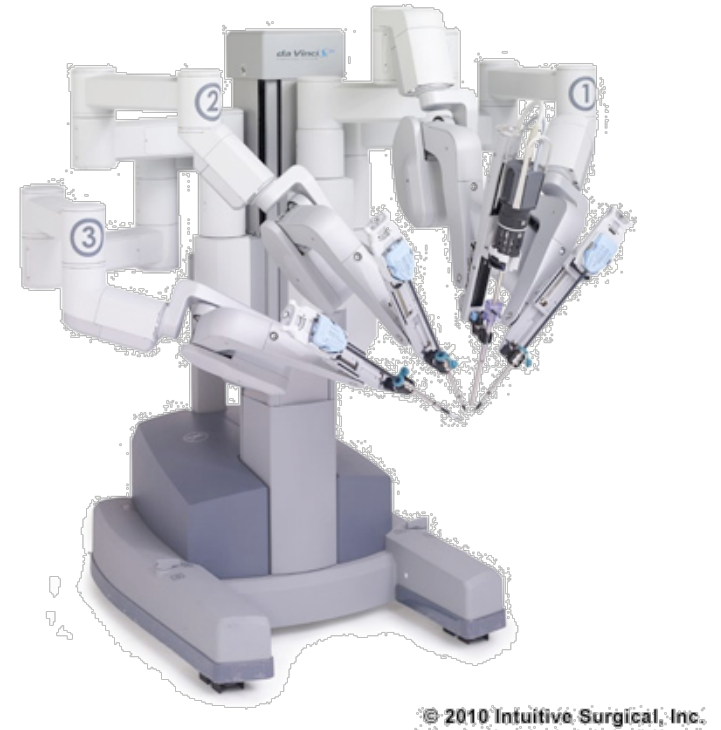
# Robotics, Automation, Sensor Feedback, Biomechatronics and 3D Printing

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CSUDH Department of Orthotics and Prosthetics

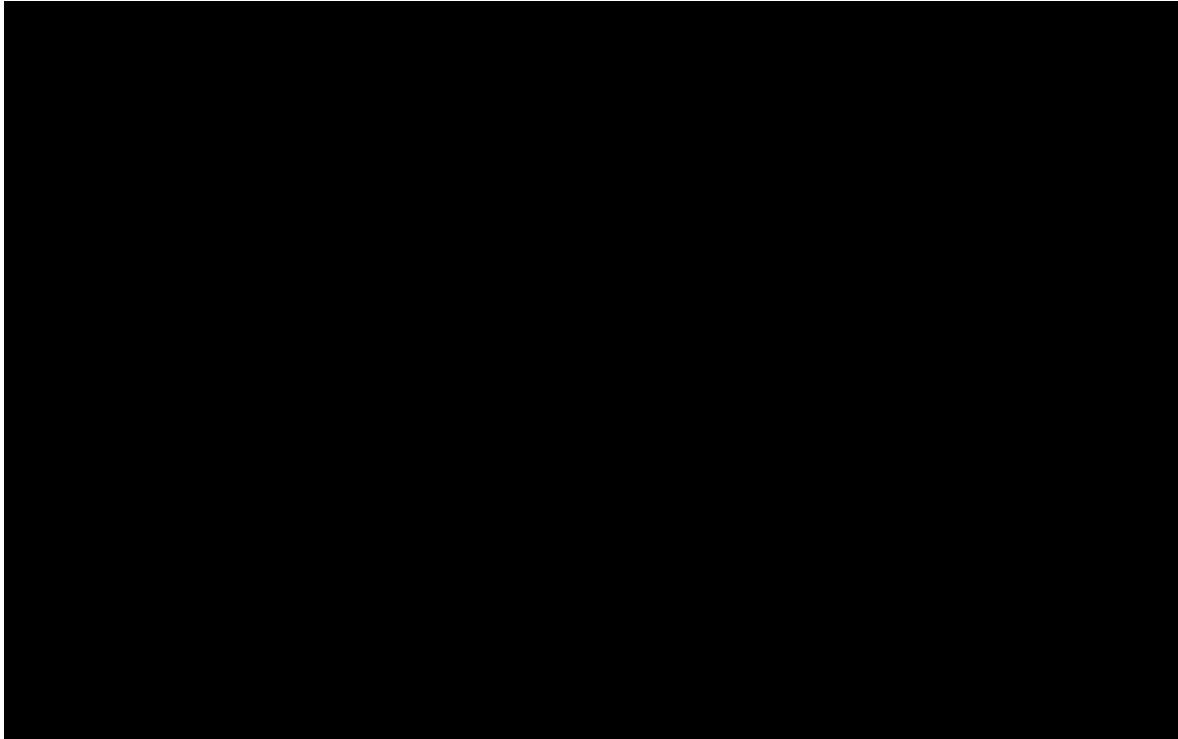
# Agenda

- Robotics – Healthcare
  - Surgical Robots
  - Feedback systems
  - Osseointegration
- Bio-Mechatronics
  - Exoskeleton
- Automation
  - Additive Manufacturing – 3D printing



# Assistive Robots

Deliver medicine, supplies, remove waste, work 24/7



TUG

<https://www.youtube.com/watch?v=bVKcjLCmX5I>

# Disinfecting Robots

about 15 manufacturers marketing disinfection robots.

## Xenex Ultraviolet Robot

is a machine used to disinfect hospital rooms.



**Clorox Co. and  
UltraViolet Devices  
joint venture**

# Surgical Robot

## Minimally Invasive

- Robotic devices enabling the surgeon to learn and perform minimally invasive and open surgery safely and effectively.
- Every Major and most Minor surgery centers in LA

### Specialties

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**Robotic-Assisted  
Surgery**



**Robotic-Assisted  
Cancer Surgery**



**Robotic-Assisted  
Gynecologic Surgery**

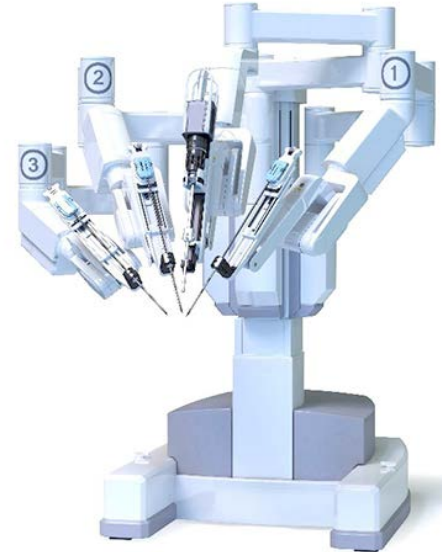


**Spine Surgery**

# USC Keck Medical

## Da Vinci Robot from Intuitive Surgical since 2000

- 4 arms
- Holds, Moves, Cuts, Stitch
- Smaller incisions
- Surgeon Finger control over scalpel
- Less Physician fatigue
- Greater Range of Motion
- Less post-operative pain
- Reduced trauma to the body
- Less scarring
- Shorter hospital stays
- Reduced blood loss and need for transfusions
- Quicker recovery and return to normal activities



# Dental Robots

Dental Implant Surgery  
With Advanced  
Robotics

Neocis  
Yomi-



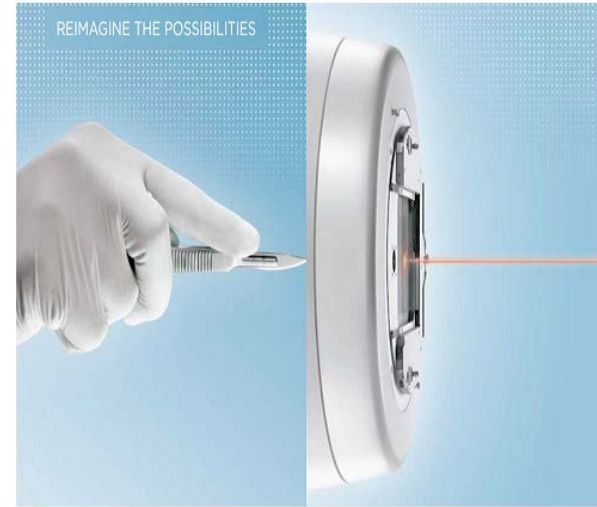


# Surgical Robots

Non-Invasive

## Stereotactic Radiosurgery

- **without an incision or general anesthesia**
- patients are usually home the same day.
- focuses high-power energy - small area of the body.
- Gamma Knife<sup>®</sup>, CyberKnife<sup>®</sup>, and TrueBeam<sup>™</sup>



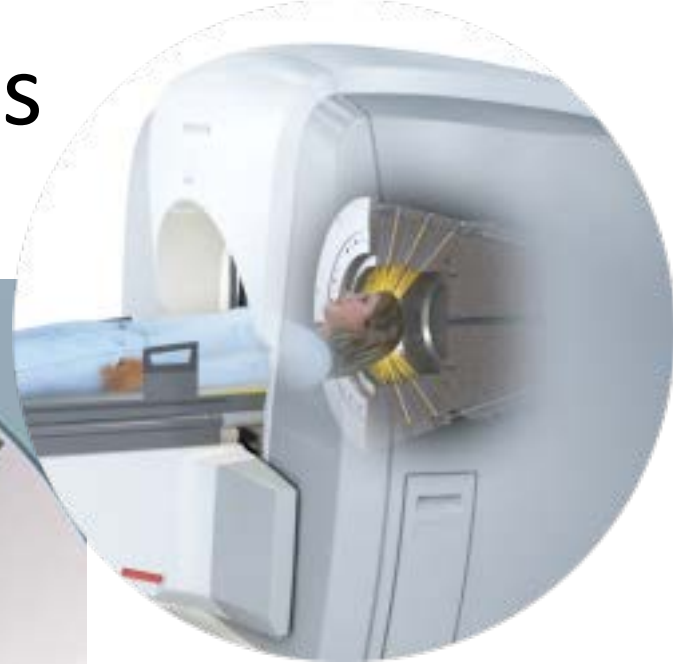
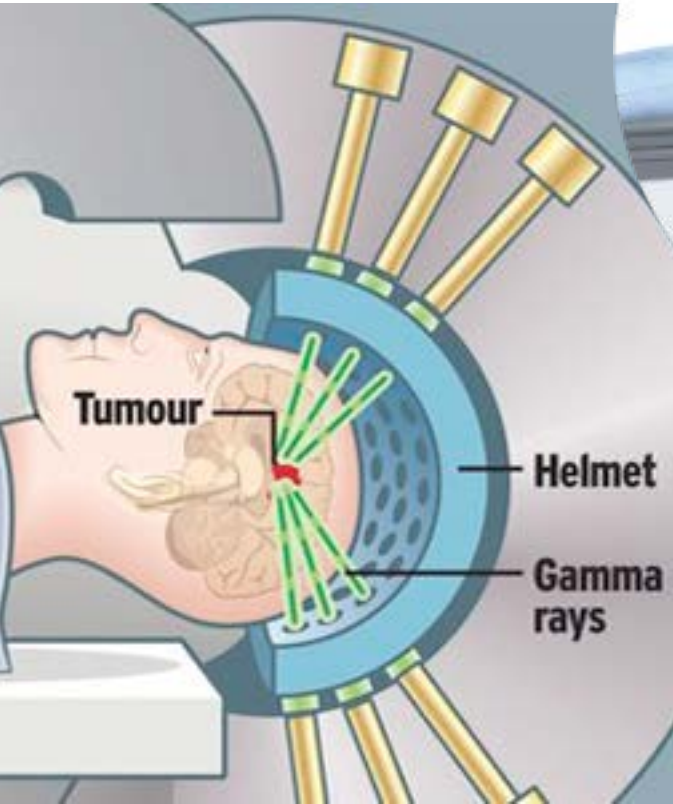


# Surgical Robots

## Non-Invasive

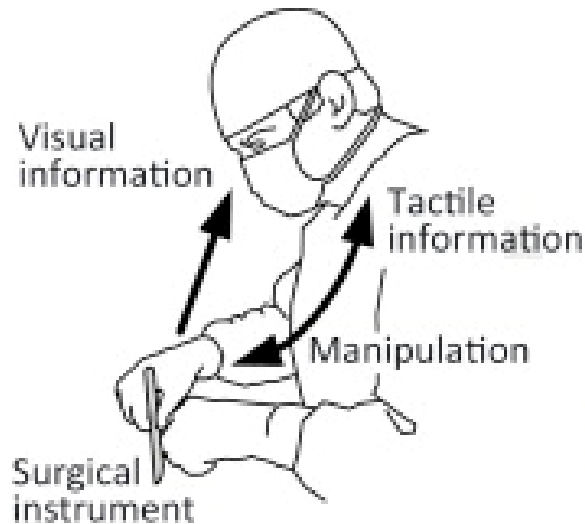
### **GAMMA KNIFE MACHINE** How it works

The patient's head is enclosed in a helmet device which focuses narrow beams of gamma radiation to target a tumour in the brain

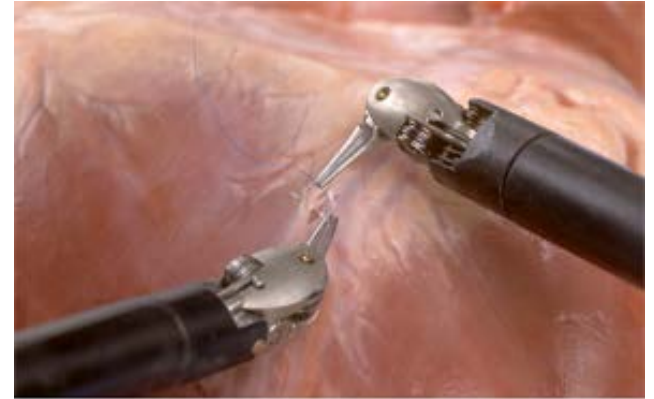
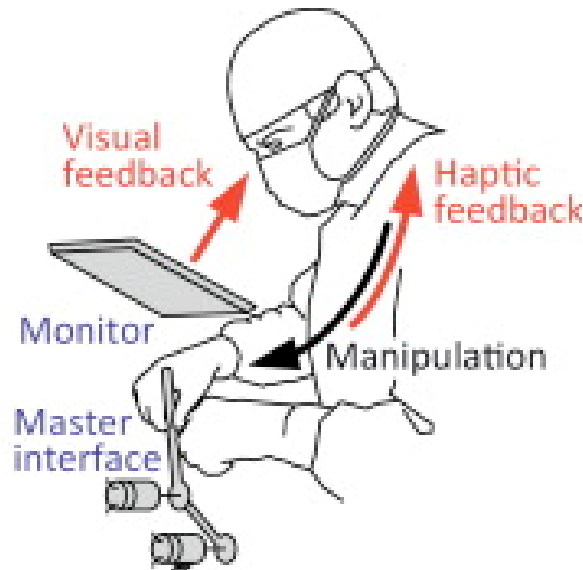


# Controlling the robots

## Haptic Feedback



[www.sciencedirect.com](http://www.sciencedirect.com)



<https://www.nibib.nih.gov/news-events/newsroom/adding-feeling-robot-assisted-surgery>

UCLA

Robotics Labs

Biomechatronics

– Haptic Sensor

USC

Computer science

Haptics

Mimic human touch

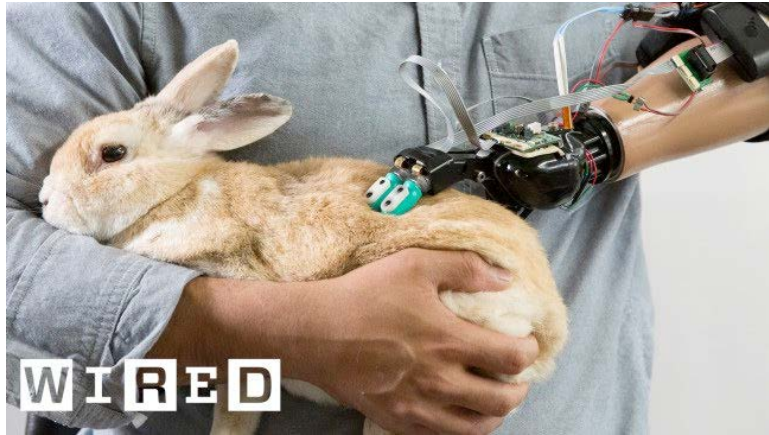


<https://samueli.ucla.edu/robotics/>

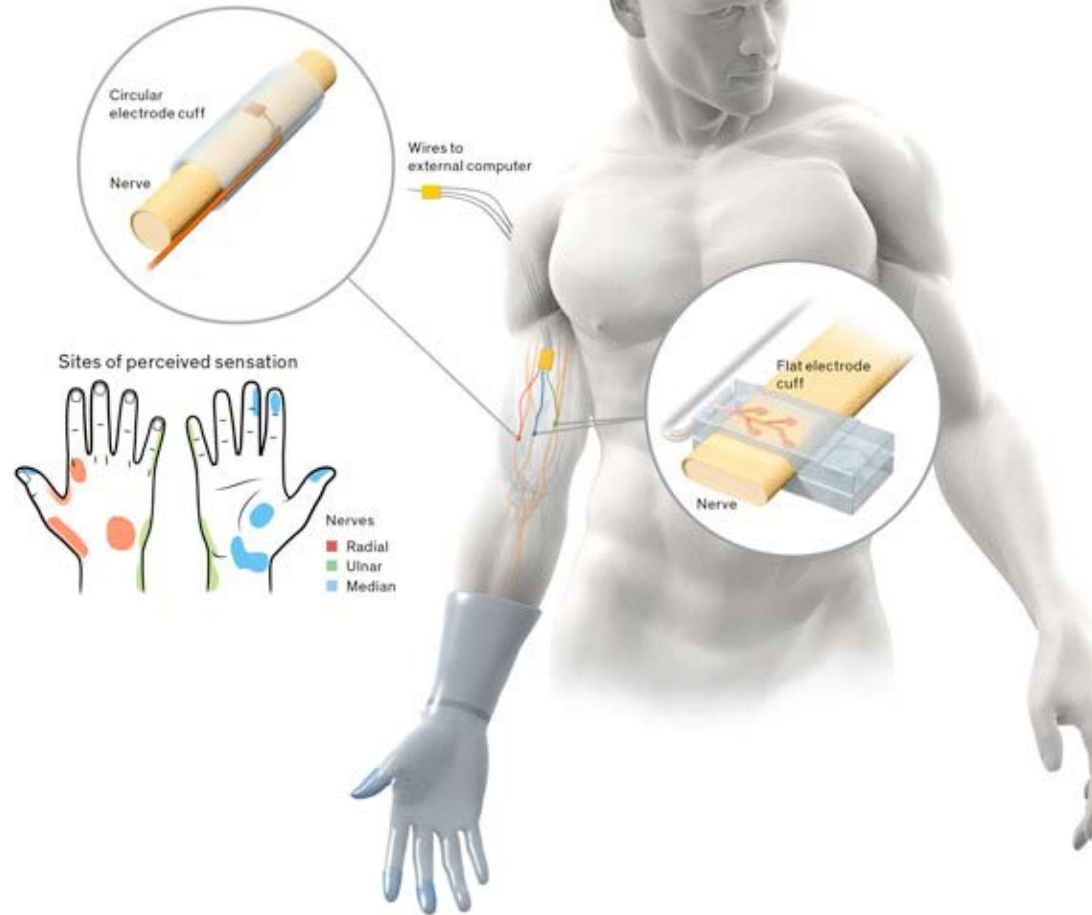
# Where it is needed

## Creating a Prosthetic Hand That Can Feel

- DARPA's HAPTIX program aims to develop a prosthetic hand that's just as capable as the original



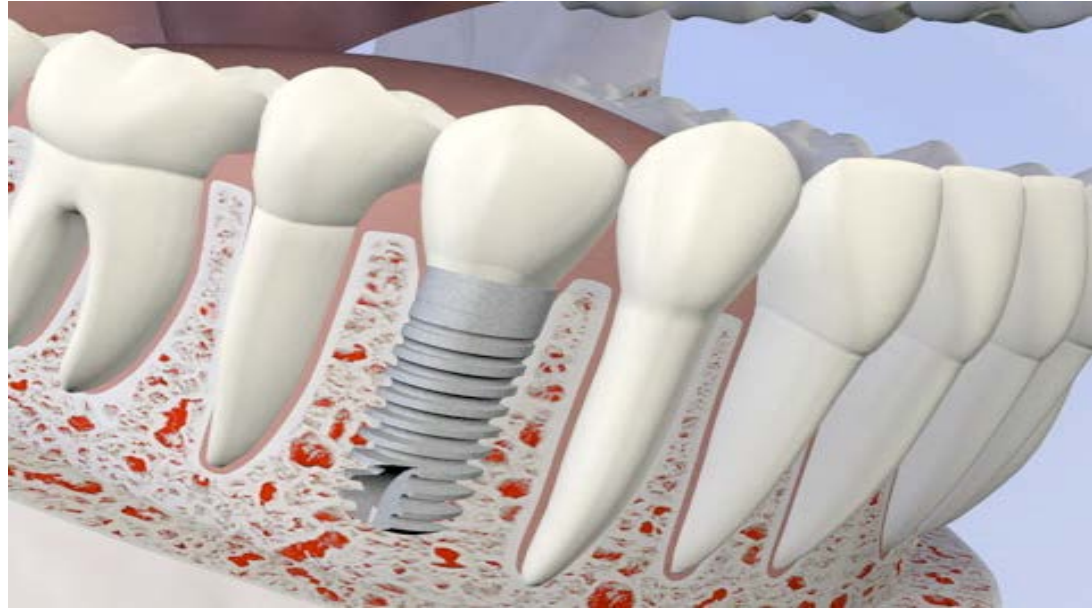
# Direct Nerve connection





# Osseointegration

- Dental
- Limb Prosthetics

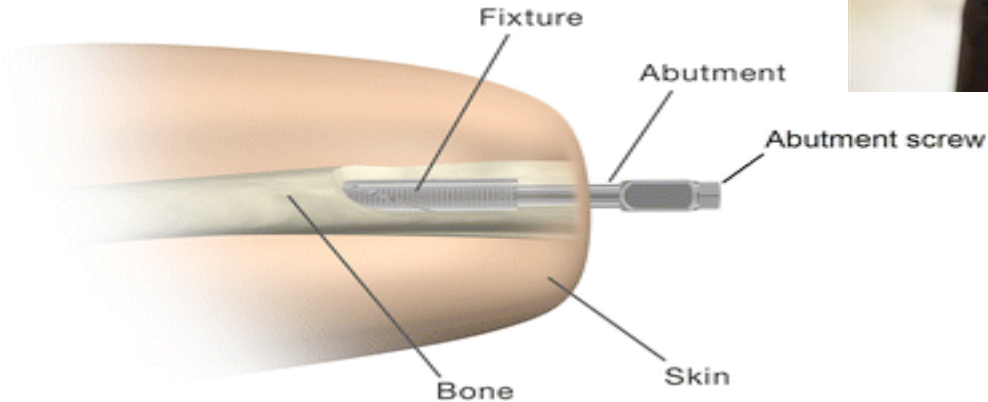


# External Prosthetics

- OPRA



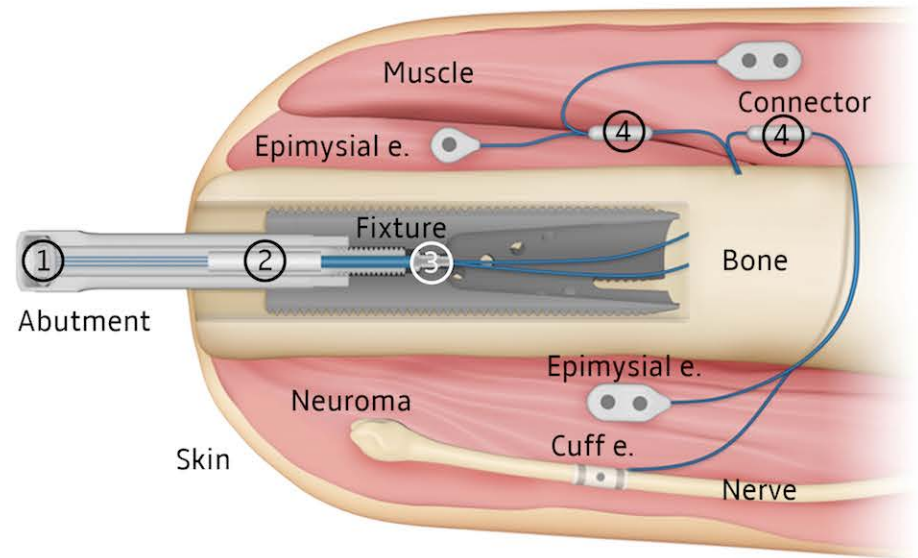
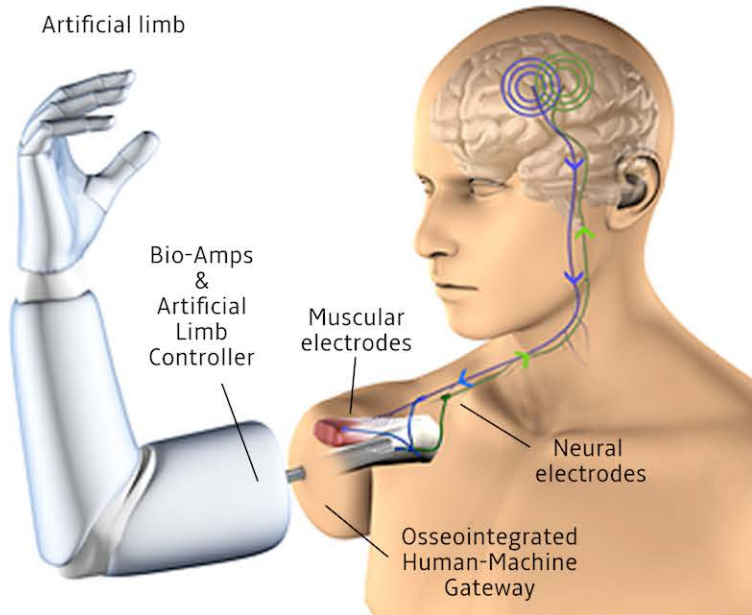
Saketortho.com



Integrum.com



# Combine Direct nerve control and Osseointegration





It really works



# Fingers and Toes



High numbers that are not  
being well served with  
current prosthetics

# Wearable Robotics

Bionics – Interface biological systems  
and medicine

UCLA Bionics

## [Wearable Robotics - Exoskeletons](#)

- Robotic systems that are worn by the human operator as an orthotic devices and used as a human-amplifier, assistive device, haptic device, or for automatic physiotherapy and rehabilitation.



Upper Limb Exoskeleton

Lower Limb Exoskeleton

Muscle Modeling

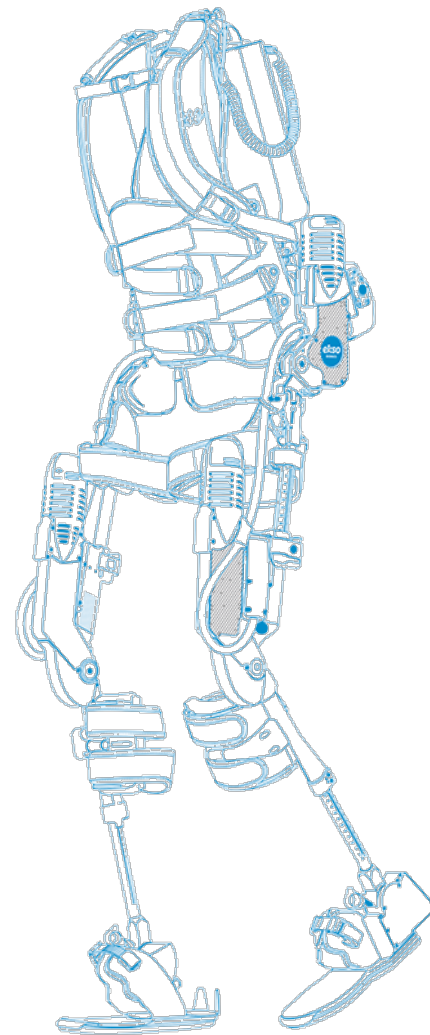
Kinematics & Dynamics of the Upper Limb



# Ekso Bionics –

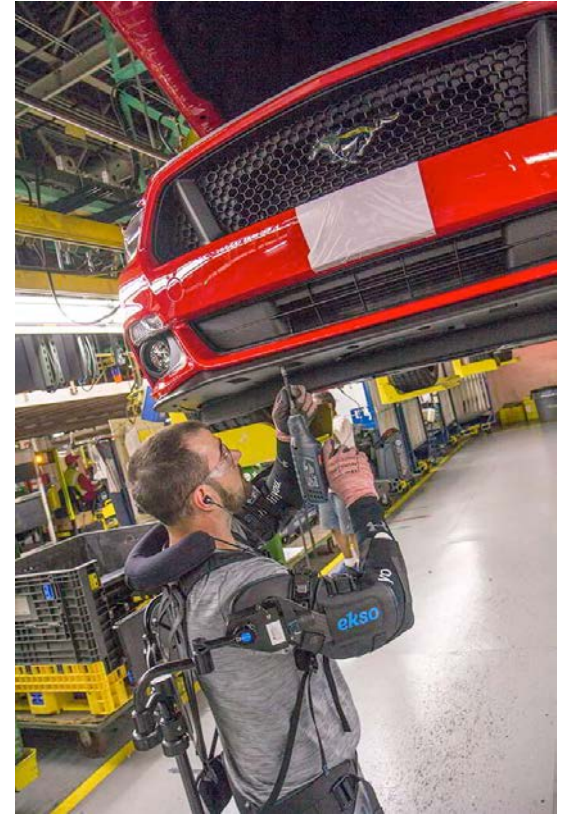
## Commercial

- Headquarters in Northern California
  - Berkley-Lockheed Martin
- UCI, VA, LA Children's, Casa Colina, Loma Linda...



# Ekso Bionics -

- Military and Labor use



Ford

# Exoskeletal Devices

- Wearable robotics



[www.cyberdyne.jp](http://www.cyberdyne.jp)





# Automation

## Additive Manufacturing - 3D Printing

- DIY and Commercial Prosthetics



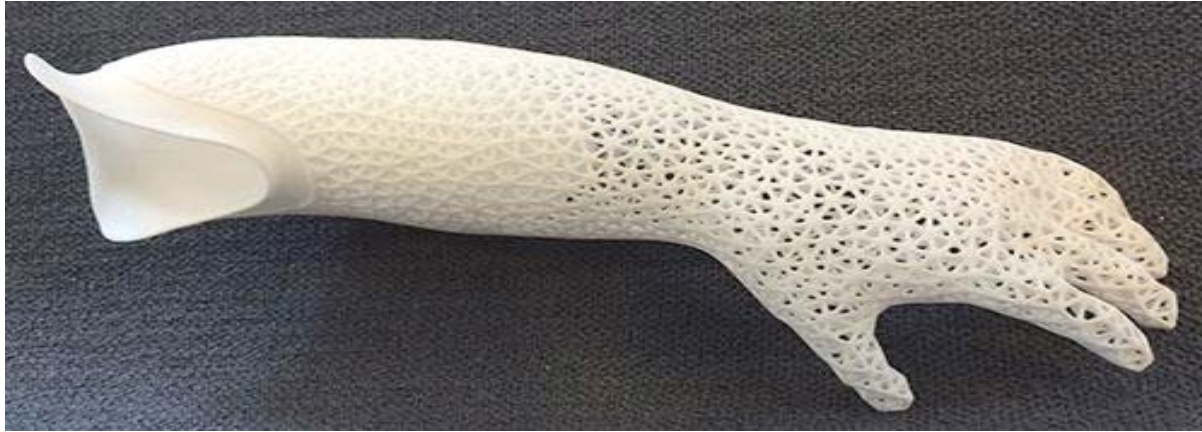
E-nable



Besopke – 3D systems

<https://3dprint.com/132530/lund-prosthetic-socket/>

# Prosthetic design

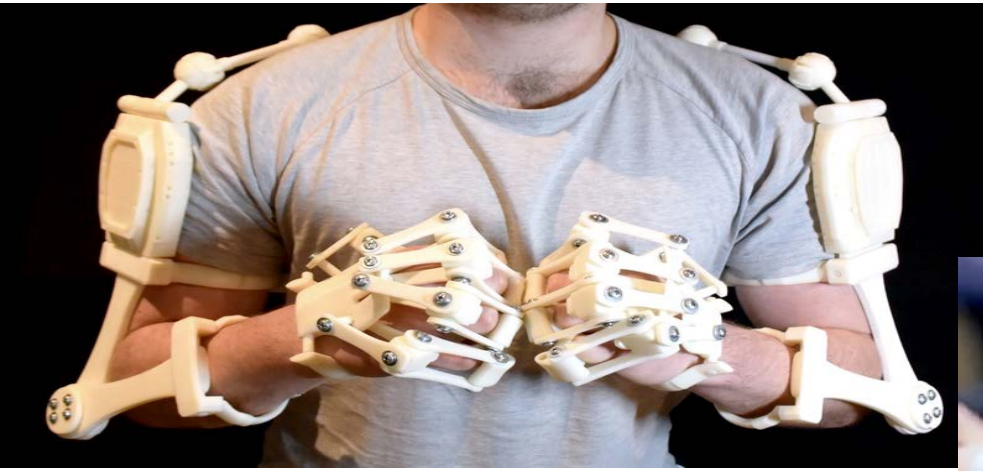


<https://weburbanist.com/2015/01/08/exo-prosthetics-light-cheap-custom-3d-printed-body-parts/>

# Cast- Braces



# Exoskeletal



<https://tractus3d.com/3d-printed-prosthetics-reduce-labor-time-immensely/>





[https://metrouk2.files.wordpress.com/2016/06/ad\\_210817664.jpg?quality=80&strip=all&strip=all](https://metrouk2.files.wordpress.com/2016/06/ad_210817664.jpg?quality=80&strip=all&strip=all)



<http://www.abc.net.au/news/2016-01-28/romina-tests-her-3d-printed-legs/7121152>

# Reconstruction

## Ti Printed Implants

- Hip, Knee, Ankle, Shoulder

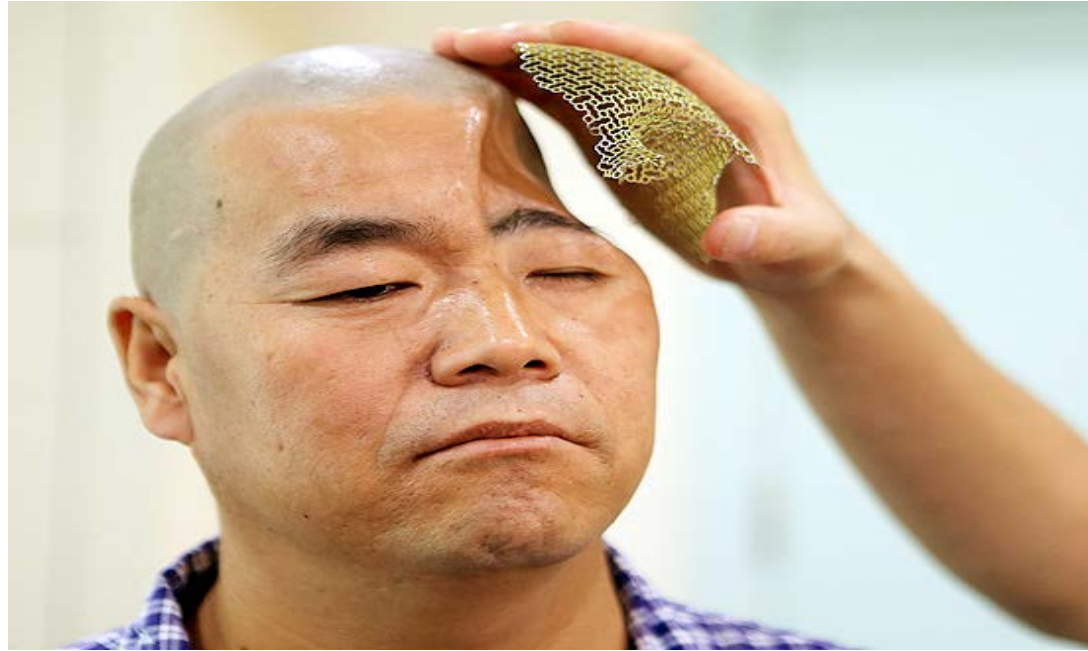


3D Systems

# Reconstruction

Ti Implant

- Cranial



*Image from China Foto Press/Getty Images*



# Reconstruction

- MaxioFacial



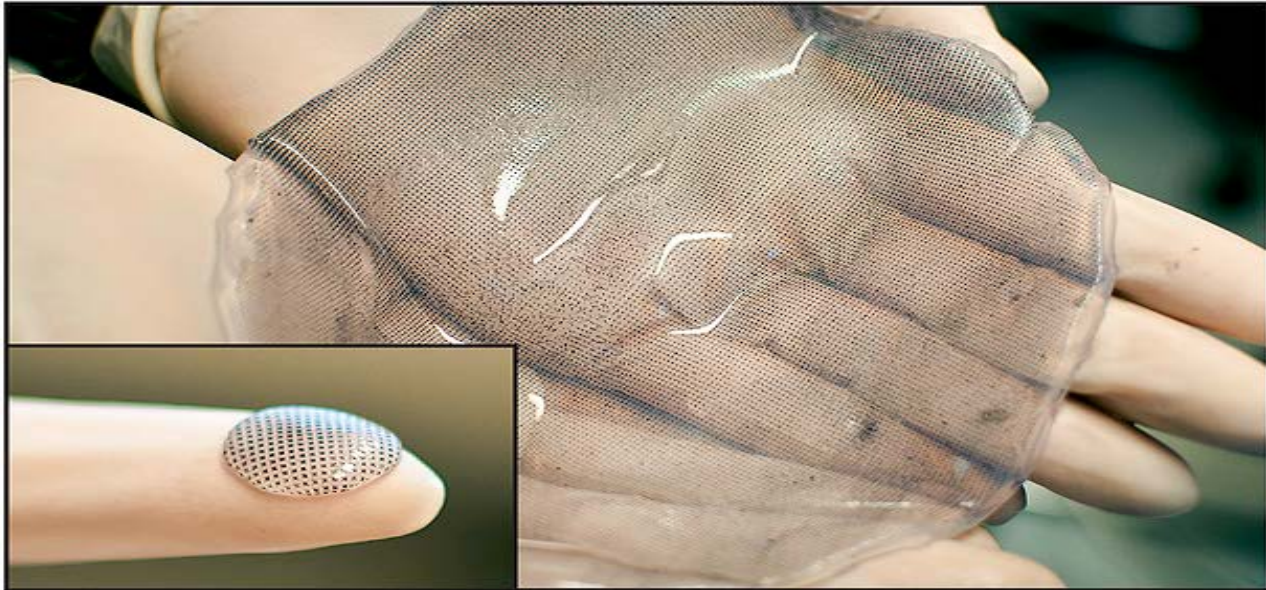
Photograph: Fripp Design



Printing mixture of silicone and pigments

# 3D Print Organs – Bio-printing

- MIT cell stacking



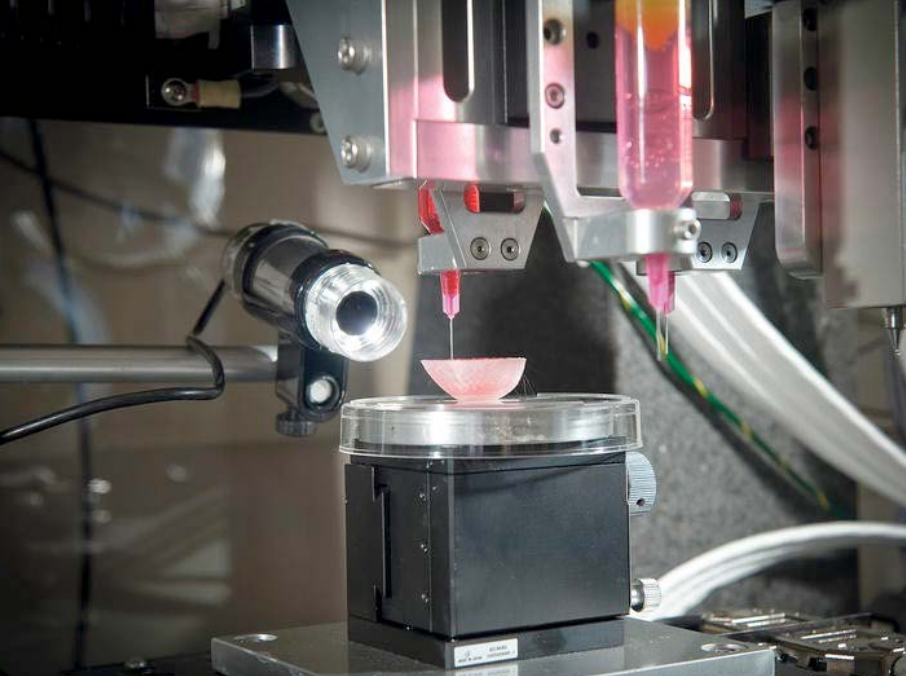
# Bioprinting – Scaffolding

- 2014 - Wake forest 3D print ear scaffolding



# Bioprinting – Scaffolding

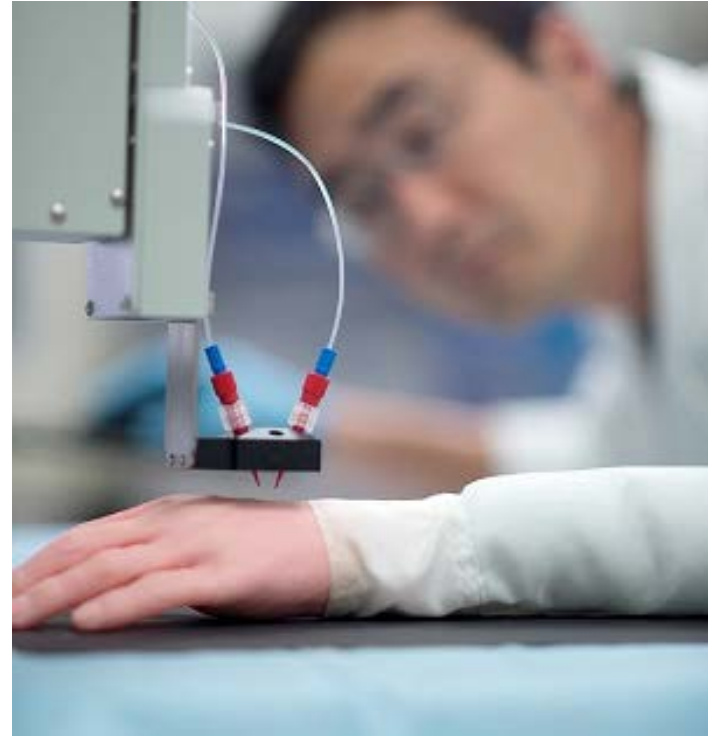
- Kidney and other organs



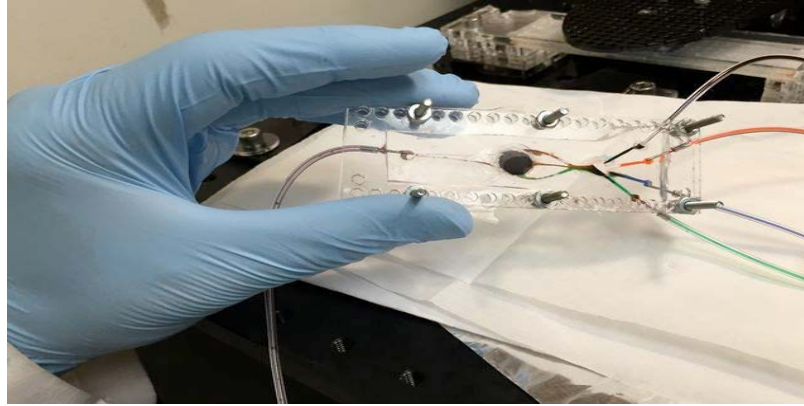


# Bio-printing – Skin

- Print Skin directly on person



# UCLA printing tissue



SCIENCE + TECHNOLOGY

HEALTH + BEHAVIOR

ENVIRONMENT + CLIMATE

NATION, WORLD +  
SOCIETY

SCIENCE + TECHNOLOGY

## UCLA engineer develops 3D printer that can create complex biological tissues

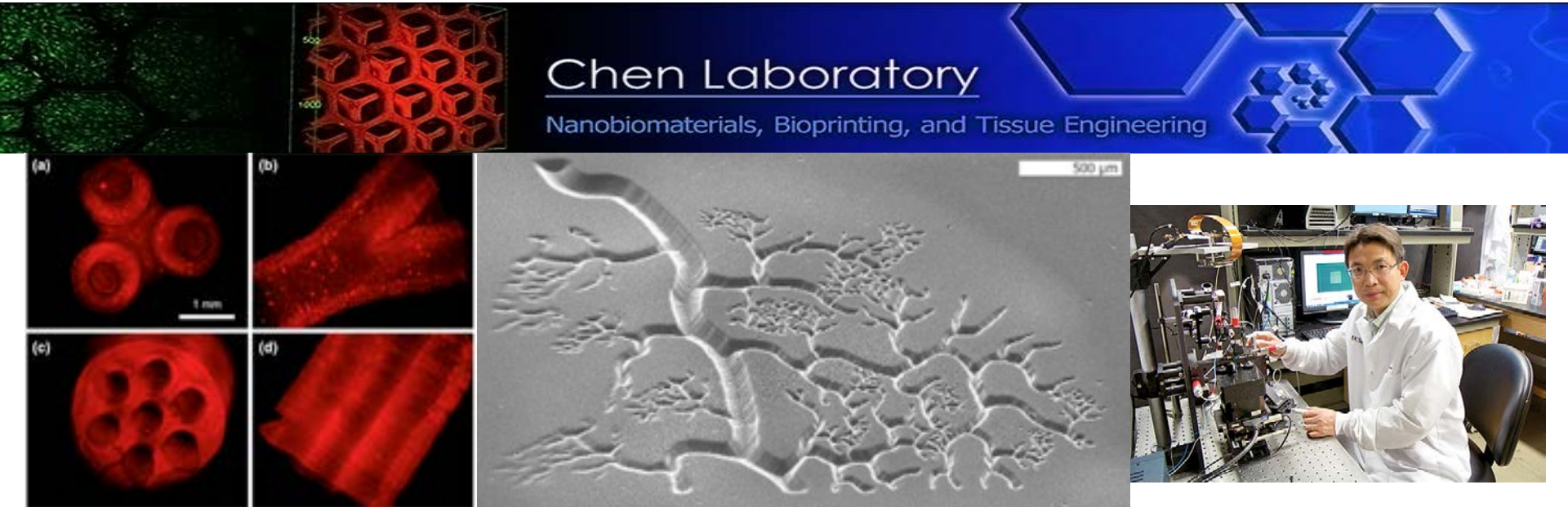
Device could help advance regenerative medicine



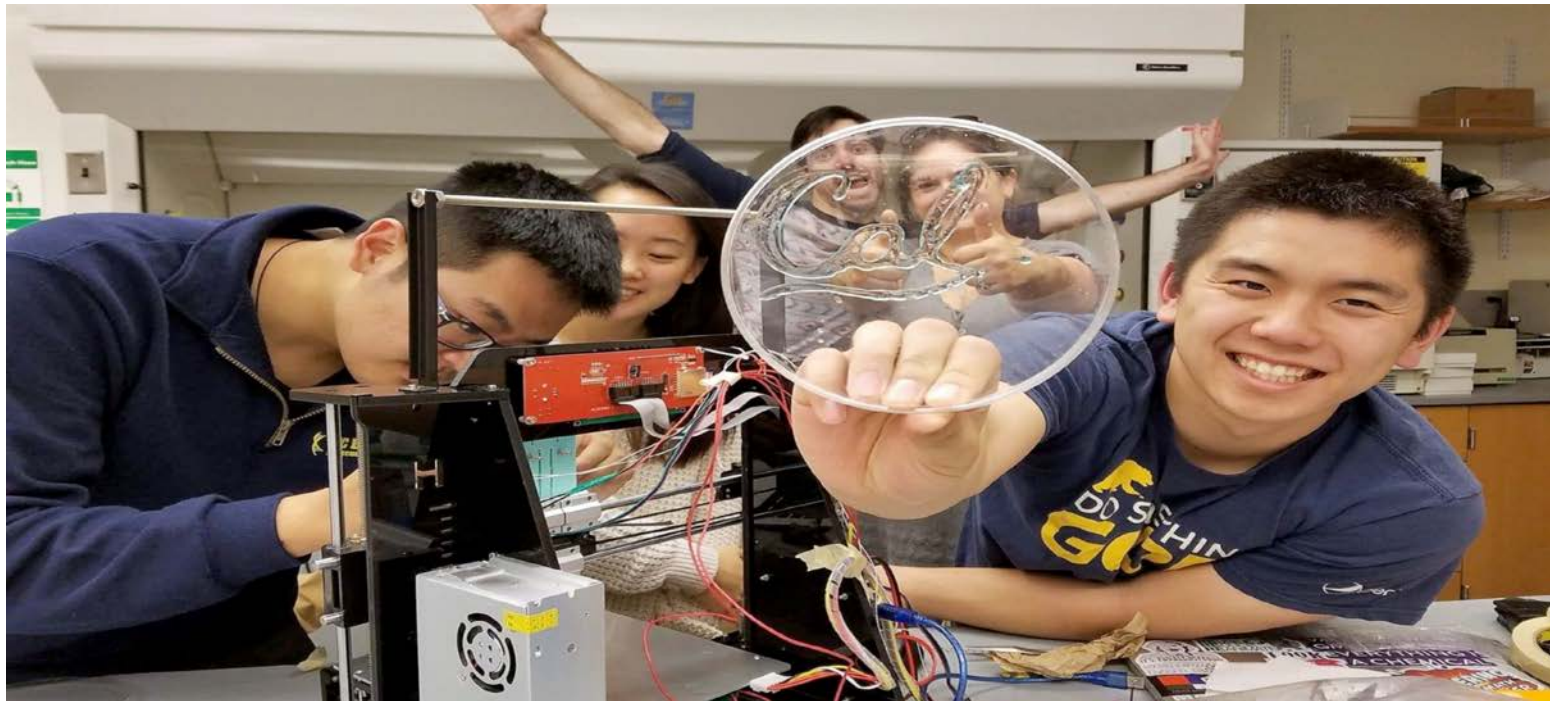
# Chen Lab UCSD

## Bio-printing

Making scaffolding for arteries and vascular with printer using biomaterials as ink



# Bio-printing at Berkley



# Aether Bioprinter

San Francisco

Syringe filled with

- Bone
- Muscle cells
- Stem Cells
- Fibrocartilage



# Organovo

## San Diego



CHANGING THE SHAPE OF  
MEDICAL RESEARCH AND PRACTICE



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# bioprinted human tissue

BIOPRINTED HUMAN TISSUE





# Thank You

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CALIFORNIA STATE UNIVERSITY, DOMINGUEZ HILLS