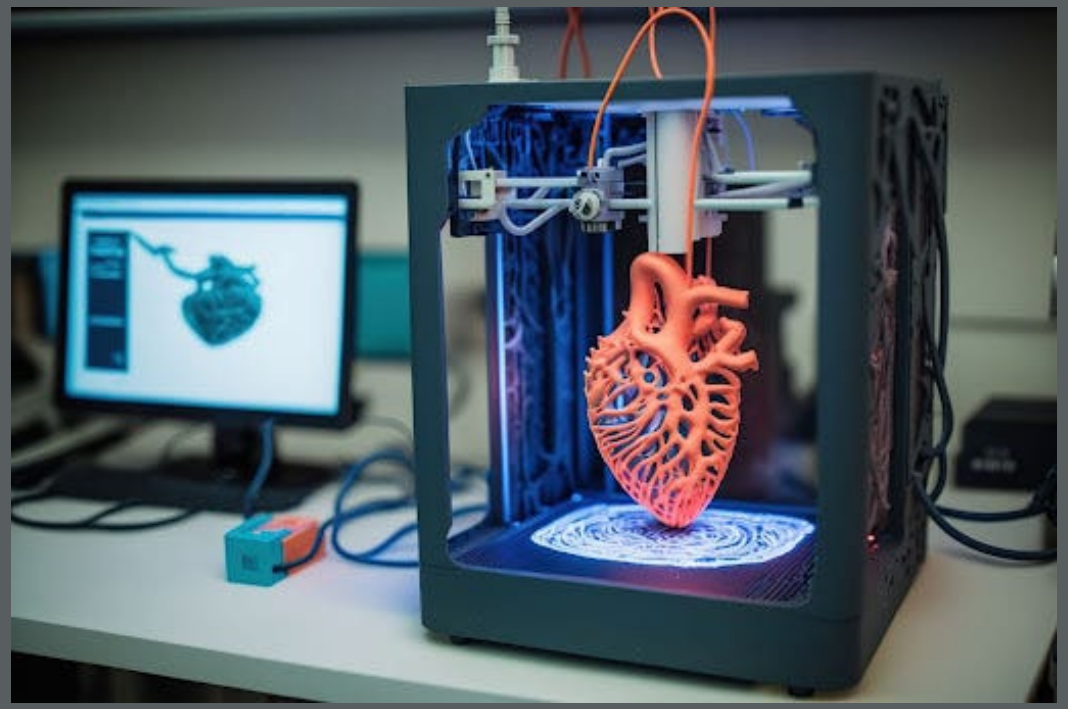

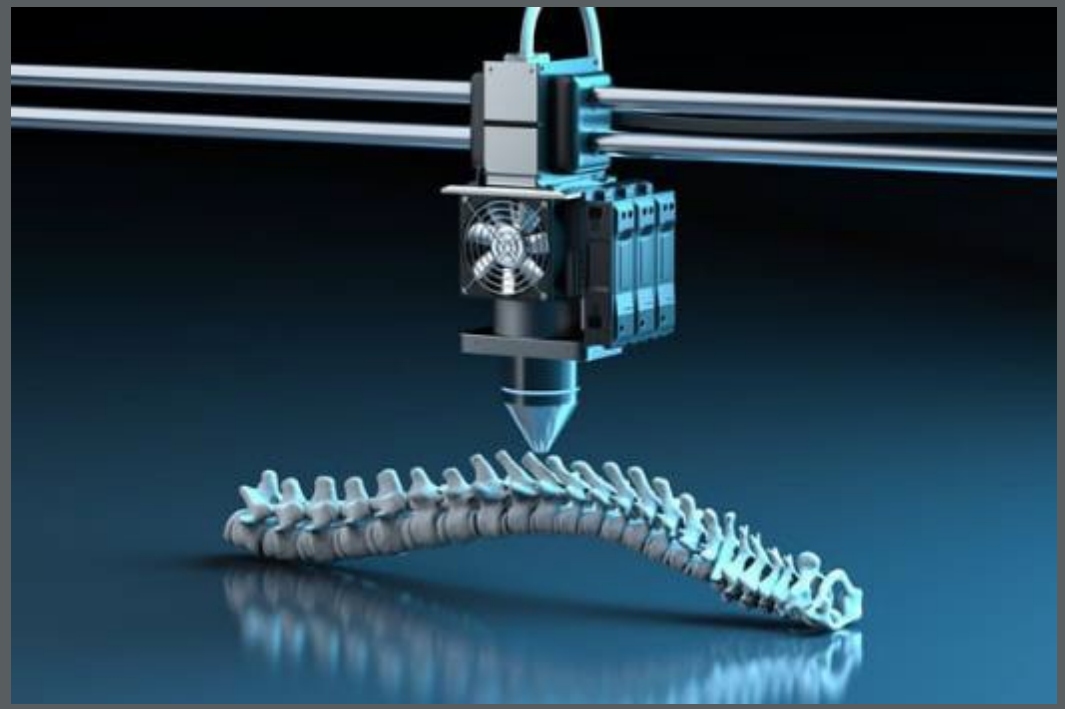

3D Printing in Medicine

Albert Chi, MD, MS, FACS
Associate Professor, Division of Trauma and Critical Care
Research and Exploratory Development, Johns Hopkins Applied Physics Lab
Commander, Medical Corps, IRR USN

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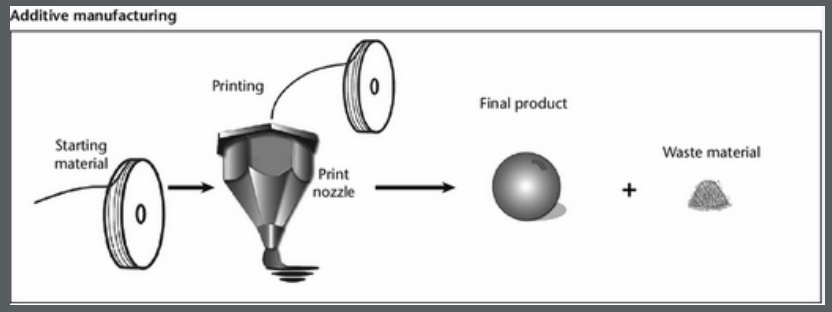
What is 3D printing?

- A manufacturing technique first developed in the late 70's. The technology has matured since and has become a disruptive tool finding application in nearly every aspect of manufacturing.

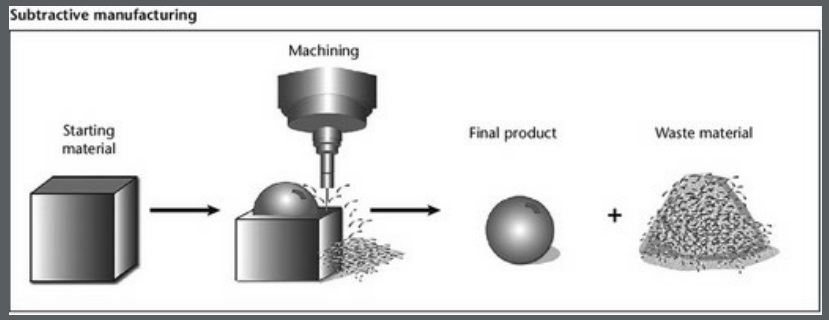
3D printing is additive manufacturing.

Items are created by adding material where material needs to be vs traditional subtractive machining..



Machining is Subtractive manufacturing.

Items are created by subtracting material from a larger block. There are many different styles of subtractive machining, CNC, Lathe, mill etc.



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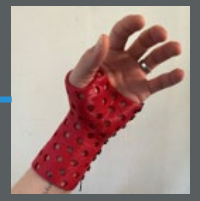
Why should we use 3D printing?

- Efficiency
- Affordability
- Patient safety
- Rapid iteration
- Increased design capability
  - Design can use techniques that are impossible to machine with traditional techniques

Point-of-care

Surgical planning

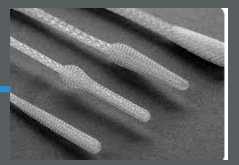
Ortho plates



Splints and braces

Osteo-implants

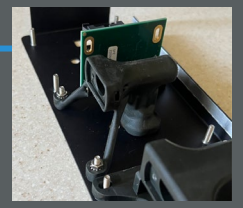
Manufacturing



Nasal Swabs

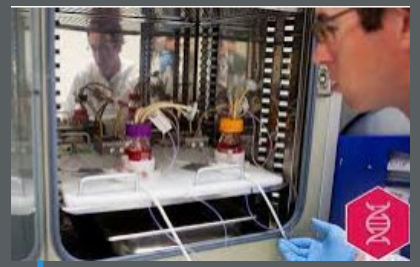
Ventilators

Dentistry

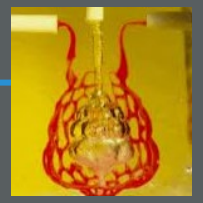


Diagnostics

Research

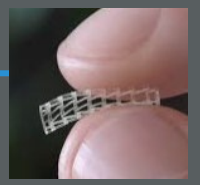


Drug discovery



Organ transplant

Osteo integration



Resorbable stents

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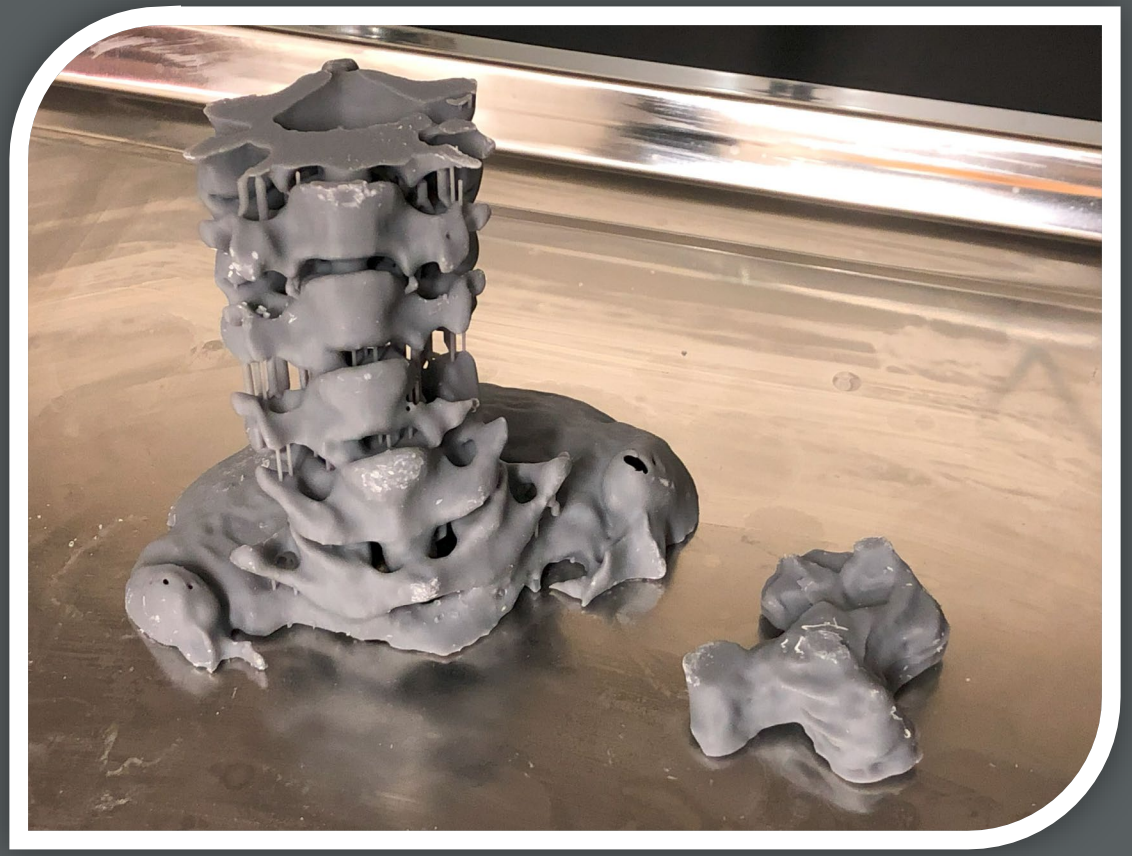
Surgical Planning

- Our prints have assisted on over a dozen fracture cases
- Mirrored models help prebend implants
- Support Systems allow for accurate positioning of floating bone fragments

Spinal Tumors



Education

- ATLS Trainer
  - Includes cricothyroidotomy and chest tube trainers
  - Pressurized fake blood for realistic action
  - Inexpensive multilayer silicone inserts for repeated use through 3d Printed molds
- Interosseous Trainer

- Kidney Transplant Simulation

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E-nabling the Future

A network of passionate volunteers using 3D printing to give the World a "Helping Hand"

- Prevalence 1-4 per 1000 births Congenital Limb Deficiency
- Limited prosthetic coverage
- Enables gross grasp capabilities and stabilization
- Psychosocial benefits
- Strengthening and prosthetic acceptance

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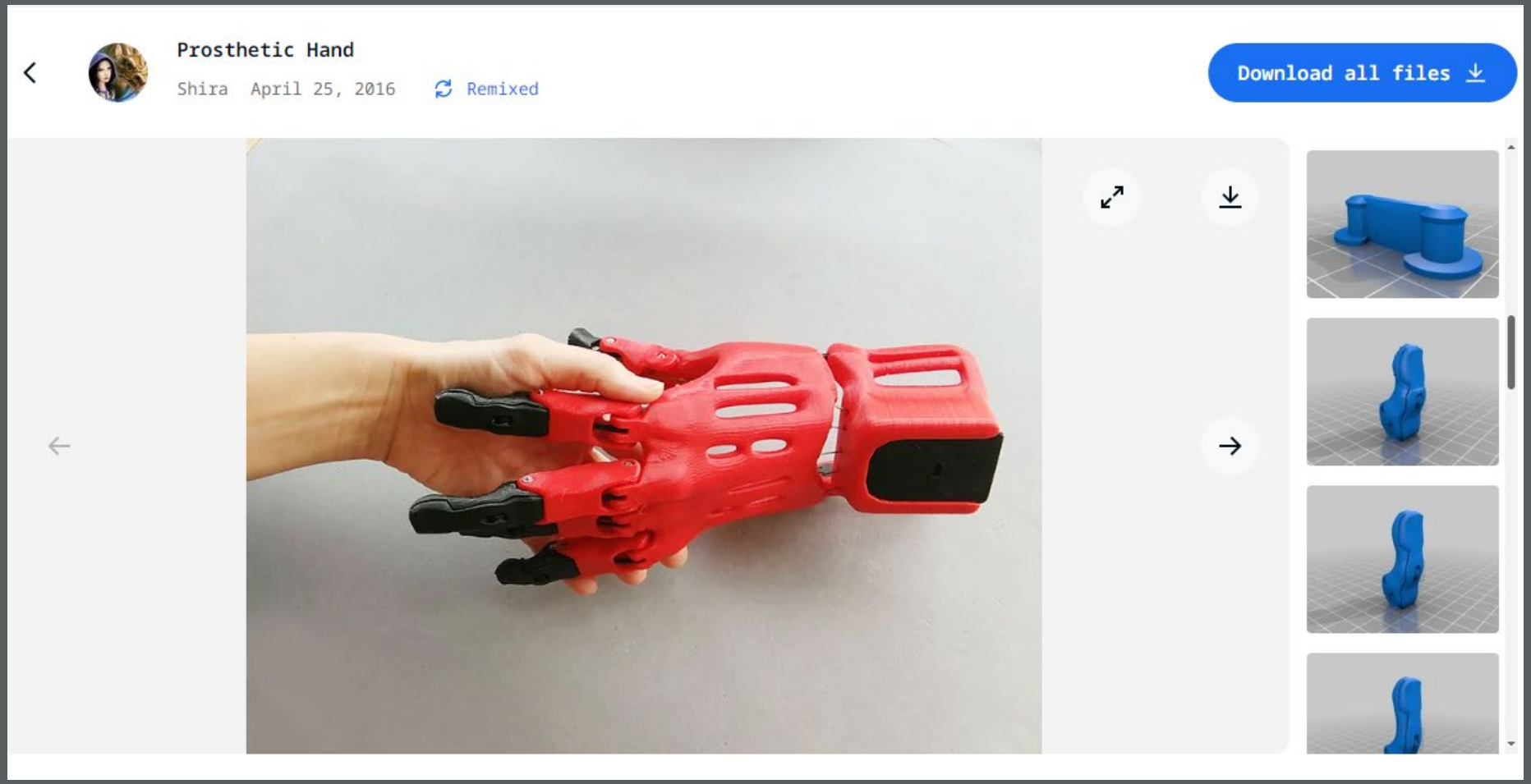
Welcome to Thingiverse

Digital Designs for Physical Objects



Crossroads

MPL

3D Printed myoelectric

- MPL
  - 250M Research and Development
  - Open Source: Bluetooth / App interface / Pattern Rec
- HERO ARM
  - UK based company commercially available
  - 20K cost with two site control
  - 6K out pocket cost with insurance
- Limbitless ARM
  - OHSU/UCF clinical Trial – projected 5K cost

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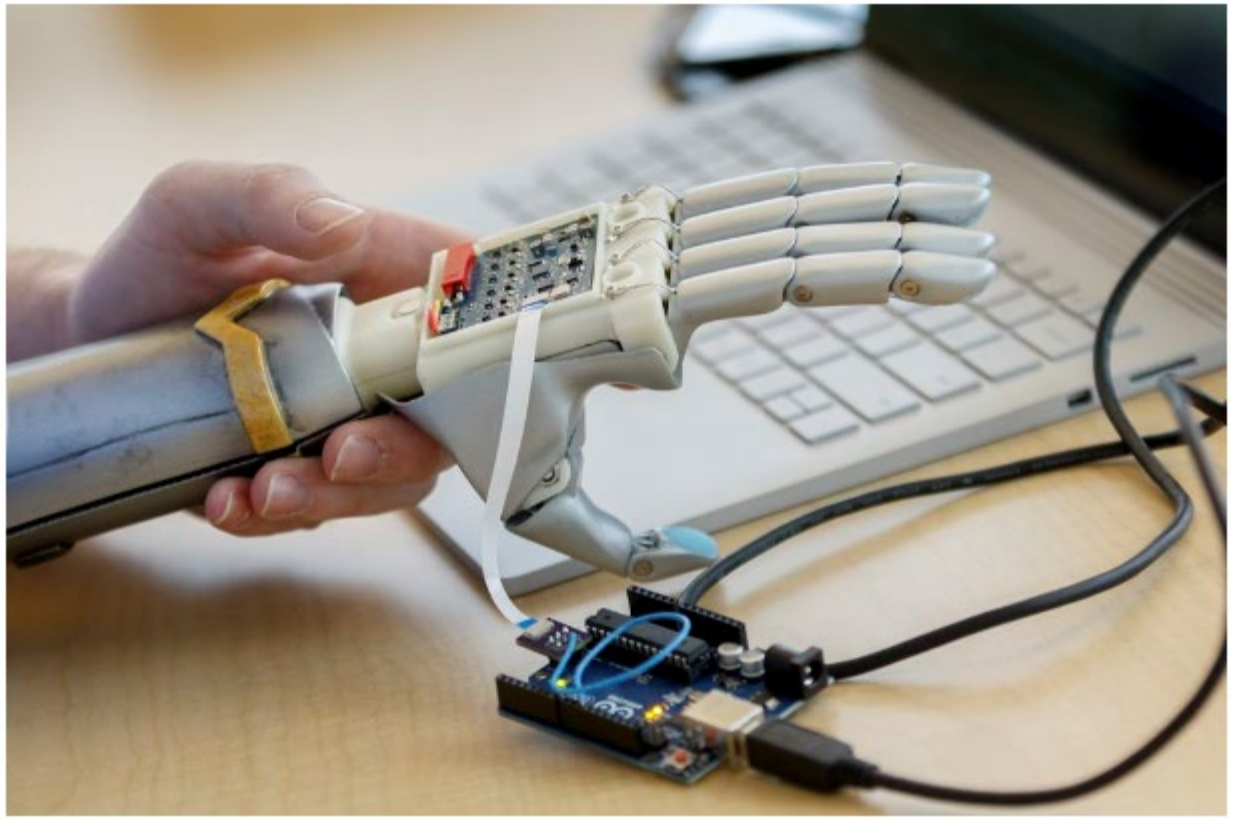
OHSU, UCF launch first U.S. clinical trial of 3D-printed prosthetics for children

By Erik Robinson May 16, 2018 Portland, Oregon



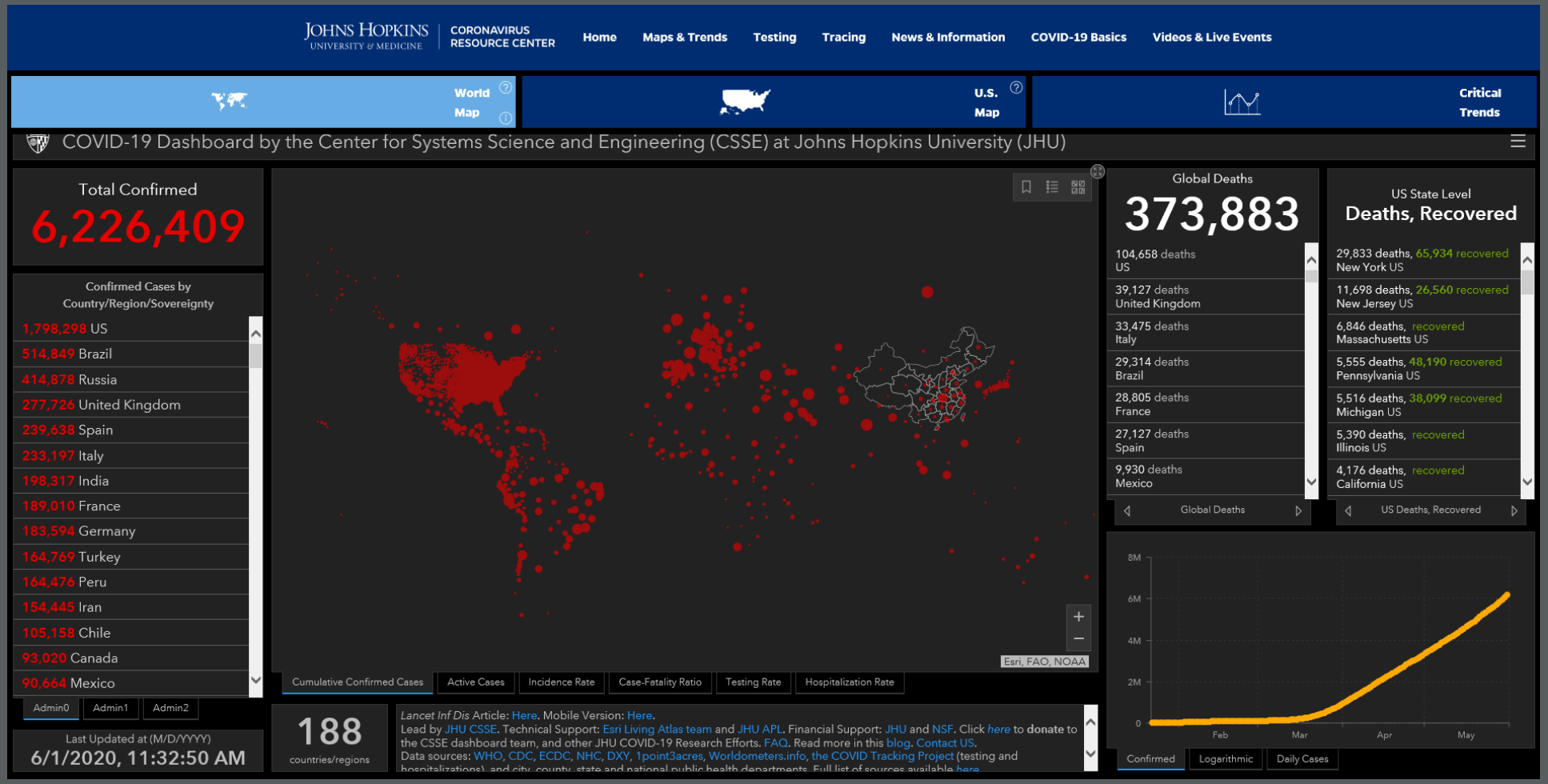
Functionality / ADLs

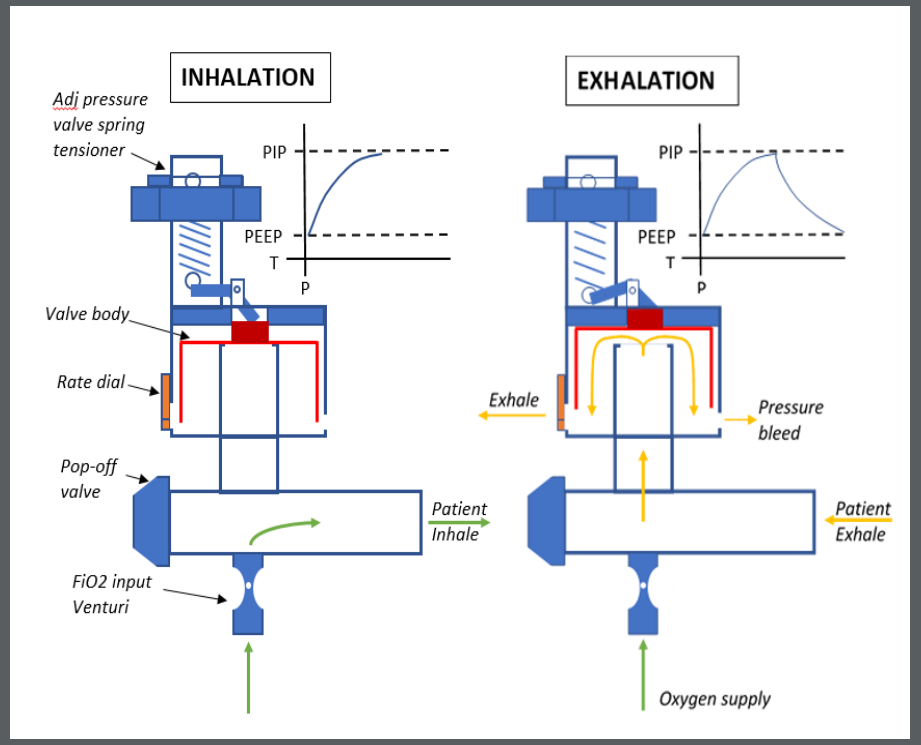
Functionality / ADLs

Bike Riding prosthetic

- Robust and inexpensive
- Custom fit from 3D scan or arm measurements
- Compliant safety mechanism releases prosthetic during crashes
- Fits most bicycles without modification

Johns Hopkins Coronavirus Resource Center




INHALATION
EXHALATION
Adj pressure valve spring tensioner
PIP
PEEP
T
P
Valve body
Rate dial
Pop-off valve
FiO2 input Venturi
Patient Inhale
Exhale
Pressure bleed
Patient Exhale
Oxygen supply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OHSU

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Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.elsevier.com/locate/amjsurg

Original Research Article

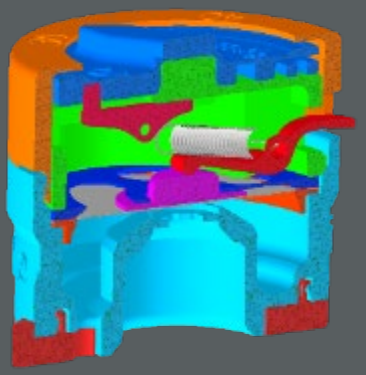
CRISIS ventilator: A 3D printed option for ventilator surge in mass respiratory pandemics

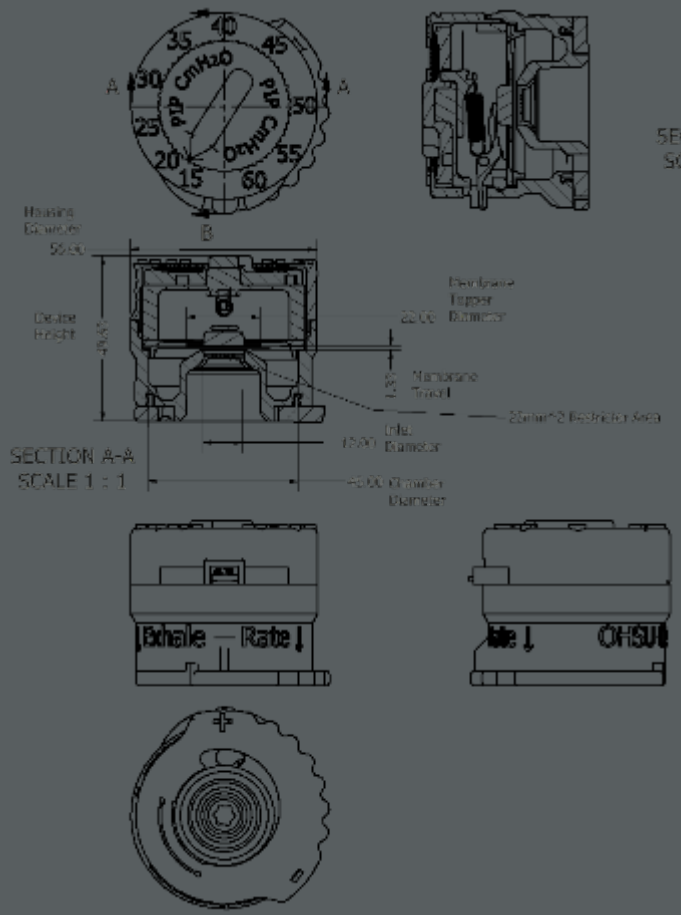
S. James El Haddi [a,*], Alex Brito [b], Xiao-Yue Han [a], Evan Fontaine [b], Whitney Menzel [b], Dennis Child [c], Michelle Kenny [d], Stephanie Nonas [e], Albert Chi [b]

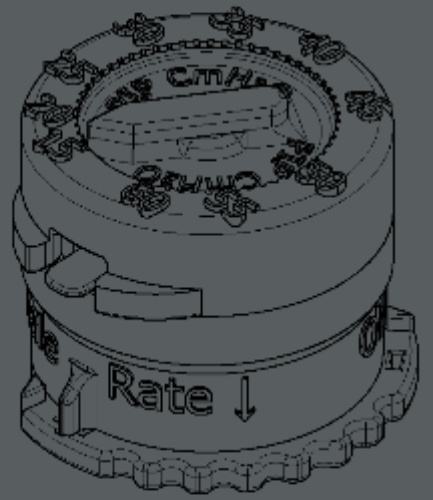
- FDA EUA experience
- Passed all performance and environmental testing
- Animal Studies performed
- Licensing agreement in place in process of FDA application

Patent Application

- PCT Filed (WO2021257472A1)
- Utility Patent Filed
- Licensing / Commercialization
  - Partnership with Astoria Pacific







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- FDA's draft framework does not yet provide enough details on how regulations will be applied to 3DPOC facilities and their activities.
- FDA may not have sufficient resources to effectively oversee devices that may be manufactured at hundreds of sites by entities, such as hospitals and other health care settings, that the agency does not typically regulate.
- Innovation is moving faster than government. This could pose risks to patients as increasing numbers of health care providers adopt 3D printing without clear federal guidance or oversight.

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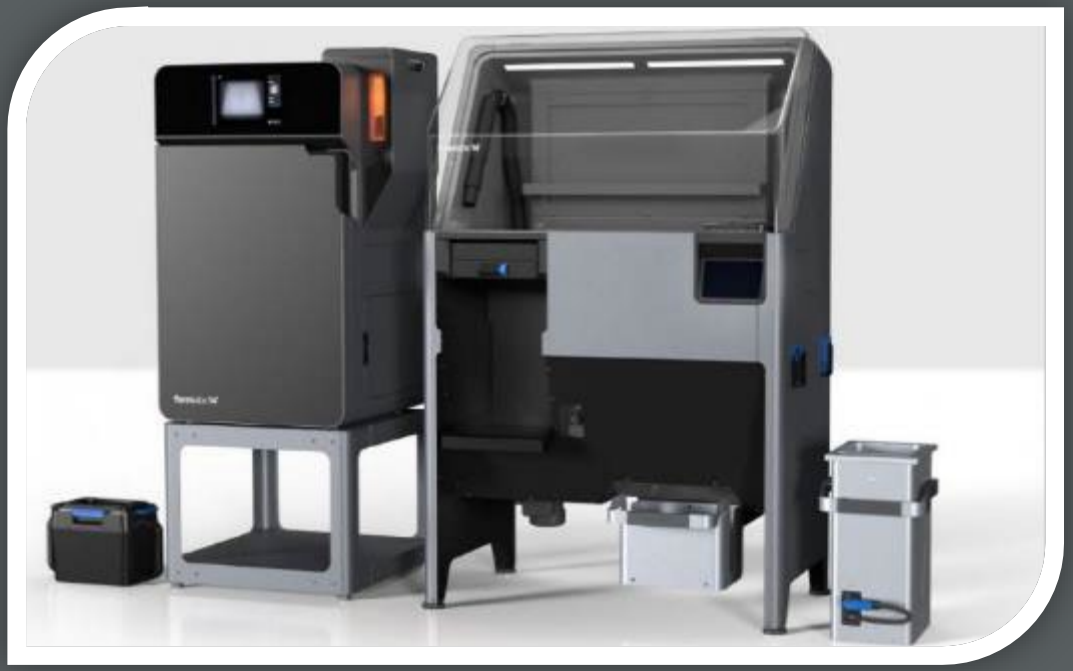
OHSU Vision Bioinnvoations Lab
3D Printing

- Point-of-care
  - EPIC order
- Research
  - Rapid Prototyping
  - Medical design
- Education
  - Training Models
- FDA Regulatory Compliance



Questions?