

2019 **NATIONAL CONFERENCE** adaptive sports usa
NOVEMBER 10-12 PHOENIX

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Applied Technology

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Rapid Prototyping
&
Additive Manufacturing for Adaptive Sports



We need to create or augment a device for our athletes.

How do we do it?

- Readily available solutions:
 - Duct Tape, Straps, Carboard, Glue, etc..
- Take measurements and build
 - Buy Parts, Weld, Fabricate
- Take and impression and build
 - Plastic vacuum form, Lamination, silicone molds
- Trial and error, learning from our mistakes



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In O&P we do subtractive manufacturing



In O&P we do subtractive manufacturing



Subtractive or Additive Manufacturing

What if we could add materials to make a final device and quickly change the design to fit our needs?

Additive Manufacturing



- What do you need
 - Good CAD model or good a Scan to start with
 - Appropriate CAM machine to create it

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Additive Manufacturing for Adaptive Sports

- Rapid Prototypes
- Quick changes – Variations easily made
- Vary materials
- Fast turn around

Articles from 2015-19

3D printing: A disability revolution?

How 3D Printed Sports Equipment is Changing the Game

RESEARCH STUDY EXPLORES 3D PRINTING FOR ATHLETES WITH DISABILITIES

Report Highlights the Disruptive Potential of 3D Printing Sports Equipment for Athletes With Disabilities

3D printing to help Paralympic athletes!

Disabilities

Printed by Luke Tappin on June 11, 2019

CAD CAM

Computer-Aided Design (CAD)



- Designs the product (Drafting)

Or

- Scan the shape – Mesh

Computer-Aided Manufacturing (CAM)

- Uses CAD geometries to program the cutting tools
- Uses CNC machines
(Computer Numerically Control)
- Slicer Programs for 3D Printing machines

Scanners

\$400-\$500


- Makerbot and Cyclops platform
- Structure Sensor
- 3D Systems Sense

\$3000-\$9000

- EinScan Pro 2
- Peel 1 - 2

\$11,000-\$60,000

- Artec Eva – Spider
- Drake
- GoScan Spark
- TScan



CAD Software

- Autodesk
 - Tinker CAD
 - MessMixer
 - Fusion 360
- 3D systems
Geomagic
- 3D Builder
- SketchUp
- Blender
- Rhino

**Free*

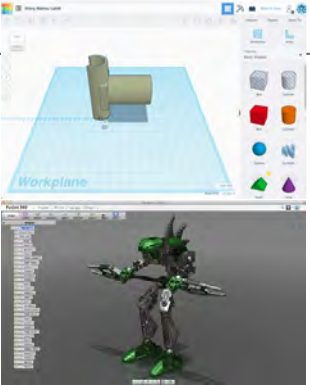




Table Tennis example

- Scan impression or limb & paddle






Table Tennis example

- Clean up and merge augmentation

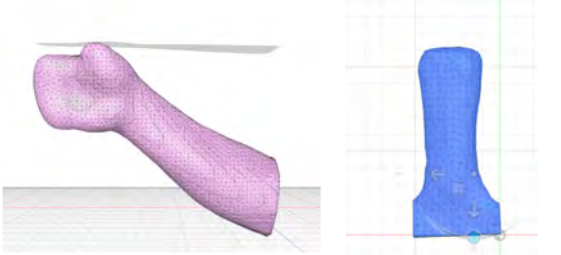




Table Tennis example

- Clean up and merge augmentation

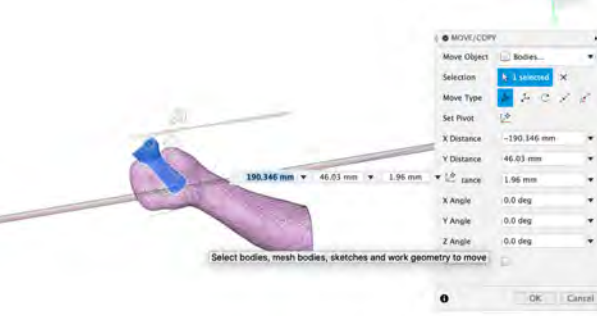




Table Tennis example

- Clean up and merge augmentation

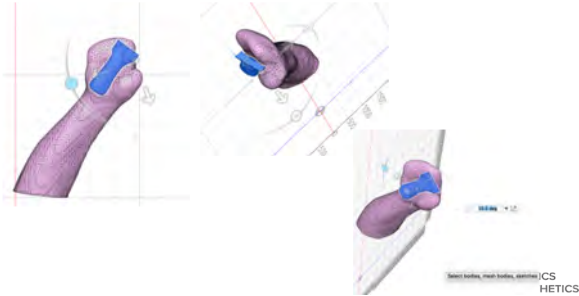
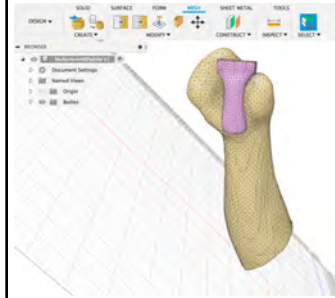


Table Tennis example

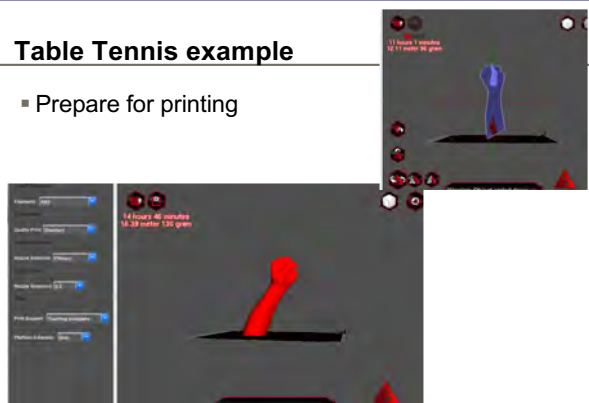
- Prepare for printing



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Table Tennis example

- Prepare for printing



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Types of files that you can use

- Most Common
 - .stl & .obj. others .ply, .amf, .aop, asc, ptx
- Graphic
 - .vrmf, btx
- Slicer files to tell the printer or CNC machine what to do
 - .gcode

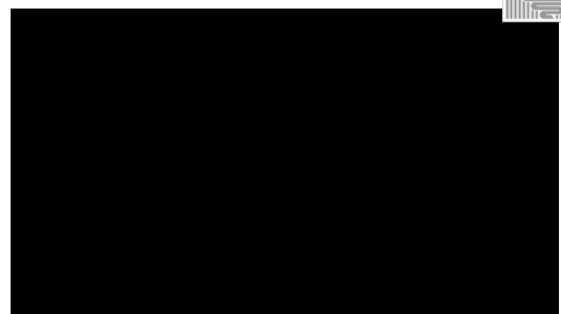
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Types of Additive Manufacturing

Type	Technologies	Materials
Extrusion	Fused deposition modeling (FDM)	Thermoplastics (e.g. PLA, ABS), HDPE, eutectic metals, edible materials
Wire	Electron Beam Freeform Fabrication (EBF ³)	Almost any metal alloy
Granular	Direct metal laser sintering (DMLS)	Almost any metal alloy
	Electron beam melting (EBM)	Titanium alloys
	Selective laser melting (SLM)	Titanium alloys, Cobalt Chrome alloys, Stainless Steels, Aluminium
Powder bed and inkjet head 3D printing	Selective heat sintering (SHS) ^(rotation needed)	Thermoplastic powder
	Selective laser sintering (SLS)	Thermoplastics, metal powders, ceramic powders
Laminated	Plaster-based 3D printing (PP)	Plaster
Light polymerised	Laminated object manufacturing (LOM)	Paper, metal foil, plastic film
	Stereolithography (SLA)	photopolymer
	Digital Light Processing (DLP)	photopolymer

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Fused Deposition Modeling FDM



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Filaments

- Ultimate 3D Printing Materials Guide
- <https://www.simplify3d.com/support/materials-guide/>



ABS
ABS is a thermoplastic acrylic plastic that is strong, tough, and durable. It is commonly used for prototyping and end-use parts that require high mechanical strength.



Flexible
Flexible filaments, commonly referred to as TPU or TPE, are known for their elasticity and ability to withstand repeated bending and stretching.



PLA
PLA is a biodegradable thermoplastic derived from renewable resources like cornstarch. It is commonly used for prototyping and end-use parts that require high mechanical strength.




HIPS
HIPS is a thermoplastic resin that is commonly used as a dissolvable support structure for FDM printing.


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PETG
PETG (and PET) filament is known for its high strength and durability. It is commonly used for prototyping and end-use parts that require high mechanical strength and are resistant to heat and chemicals.



Nylon
Nylon is a strong and durable thermoplastic that is commonly used for prototyping and end-use parts that require high mechanical strength and are resistant to heat and chemicals.



Carbon Fiber Filled
Carbon fiber filament is a high-strength, lightweight material that is commonly used for prototyping and end-use parts that require high mechanical strength and are resistant to heat and chemicals.




ASA
ASA is a common alternative to ABS that is known for its high strength and durability. It is commonly used for prototyping and end-use parts that require high mechanical strength and are resistant to heat and chemicals.


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Filaments


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Polycarbonate
Polycarbonate is known for its strength and durability. It has a high heat and impact resistance, making it a popular choice for high-stress applications.




Polypropylene
Polypropylene is a great for high cycle, low-stress applications. It is commonly used for prototyping and end-use parts that require high mechanical strength and are resistant to heat and chemicals.



Metal Filled
Metal filled filaments are made by mixing a fine metal powder into a base material, creating a composite material that is stronger and more durable.




Wood Filled
Wood filled filaments contain a PLA base material with wood particles. They are commonly used for prototyping and end-use parts that require high mechanical strength and are resistant to heat and chemicals.



PLA
PLA is a common alternative to ABS that is known for its high strength and durability. It is commonly used for prototyping and end-use parts that require high mechanical strength and are resistant to heat and chemicals.

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Directed energy deposition Wire – Electron beam Freeform Fabrication



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Powder Bed Fusion – Selective Laser Melting

Ti Granular Layering – Electron Beam Melting

O&P & Sports Applications?



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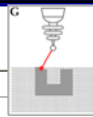
Powder Bed Fusion - SLS

How Selective Laser Sintering works - Nylon

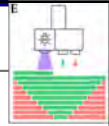


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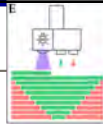
Powder Bed Fusion - SLS
HP MultiJet – Fusion Nylon 11 & TPU



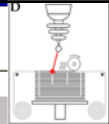
Material Jetting
StrataSys PolyJet printers – Multi-plastics
– like InkJet printers (FDM + SLS)



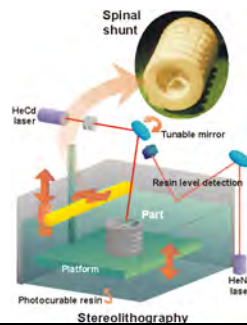
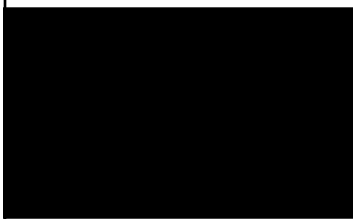
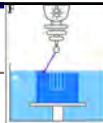
Material Jetting
StrataSys PolyJet printers - 2



Sheet Lamination
Color prints-Paper, Gypsum – Color Jet
Powder + Binder + Ink (SLS + PolyJet)



Liquid to Solid - Light Polymerization
SLA - Stereolithography



Stereolithography

Introduction to Stereolithography



**Automation
Additive Manufacturing - 3D Printing**

▪ DIY and Commercial Prosthetics



E-nable

Besopke – 3D systems

<https://3dprint.com/132530/lund-prosthetic> **CSUDH** ORTHOTICS & PROSTHETICS

Prosthetic design



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

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Lower Limb / Cranial Ox – different ideas



Inventmedical.com

3Ders.org

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Cast- Braces



<https://weburbanist.com/2013/07/18/handicapable-3d-printed-flexible-casts-artificial-limbs/>

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Exoskeletal



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

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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> **CSUDH** ORTHOTICS & PROSTHETICS

Reconstruction

Ti Printed Implants

- Hip, Knee, Ankle, Shoulder
- Skull, Bone



3D Systems

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Reconstruction – ColorJet (Powder) or PolyJet (Plastic)

- MaxioFacial



Photograph: Fripp Design

Printing mixture of silicone and pigments

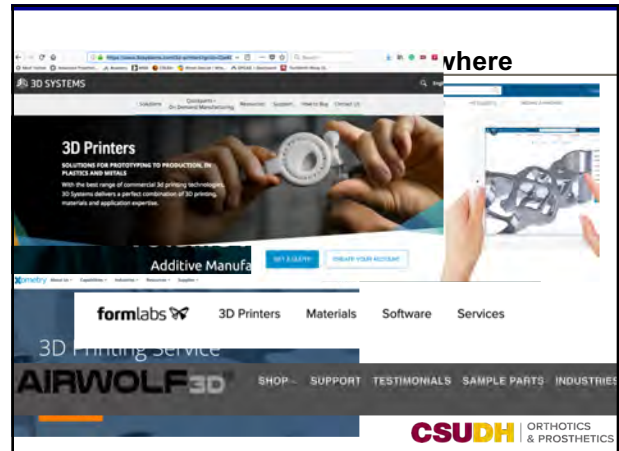
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Getting Started Local Maker Clubs

- Create MakerSpace
- Makers of Phoenix
- Heat Sink Labs



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CSUDH – O&P Program wants to help

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