3D PROTOTYPING

AARHUS
UNIVERSITY
DEPARTMENT OF COMPUTER SCIENCE

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OVERVIEW

Additive Methods

Subtractive Methods

- CNC
- Laser

Additive Versus Subtractive

3D Prototyping Research

ADDITIVE METHODS

Fused deposition modeling (FDM)

Stereolithography (SLA)

Selective laser sintering (SLS) – Direct metal laser sintering (DMLS)

Plaster-based 3D printing (PP)

Thermal Phase Change Inkjets

Laminated object manufacturing (LOM)

HOW TO CHOOSE THE MOST APPROPRIATE ADDITIVE METHOD

Technology	Additive Manufacturing Process	Advantages	Disadvantages	Plastic based material	Metal or Brass	Resin	Multicolour
Fused Deposition Modelling	Material Extrusion	Strong Parts Easy to print yourself	Poorer surface finish and slower Requires support structures	Yes			
Selective Laser Sintering	Powder Bed Fusion	No support required High Heat and Chemical Resistant High speed	Precision limited to powder particle size Rough surface finish	Yes			
Direct Metal Laser Sintering	Powder Bed Fusion	High-density components Intricateness	Finishing step is a mandatory		Yes		
Electron Beam Melting	Powder Bed Fusion	Good printing speed Less distortion	Needs finishing Caution required when dealing with X-Ray		Yes		
Stereolithography	Photopoly-merisation	Complex Geometries Detailed parts Smooth Finish	Post-finishing required Requires Support structures			Yes	
Digital Light Processing	Photopoly-merisation	Concurrent production Complex shapes and sizes High precision	Thickness limitation Limited range of materials			Yes	
Continuous Liquid Interface Production	Photopoly-merisation	Concurrent production Complex shapes and sizes High precision	Thickness limitation Large choice of resins simulating different properties			Yes	
Multijet et Polyjet	Material Jetting	Good precision Good surface finish Use of multiple materials and colours No removal of support material	Slow Build Process			Yes	Yes
Binder Jetting	Jetting	Lower Price Enables colour printing High speed	Limited choice of materials Fragile parts				Yes
Selective Deposition Lamination	Sheet Lamination	Lower Price No toxic materials Quick to make large parts	Less accurate Non-Homogenous parts				Yes

From Sculpteo

SUBTRACTIVE METHODS

Subtractive manufacturing: 3D objects are constructed by successively cutting material away from a solid block of material.

- CNC
- Laser cutter

CNC

CNC machines are electro-mechanical devices that manipulate machine shop tools using computer programming inputs.

CNC: Computer Numerical Control

Materials: aluminum, brass, copper, steel, and titanium, as well as wood, foam, fiberglass, and plastics such as polypropylene.

https://www.youtube.com/watch?v=4Fikcxmnn8Q

CNC TECHNOLOGIES

Drills: Drills work by spinning a drill bit and moving the bit into contact with a stationary block of material.

Lathes: Lathes spin the block of material against the drill bit.

Milling Machines: the most common CNC machine in use today. They involve the use of rotary cutting tools to remove material from the block.

https://youtu.be/Qj0A7FFyP8U?t=181

CNC VS. FDM

CNC: huge variety of materials

- metal alloys (e.g. aluminum, steel alloys, brass, copper)
- softwoods and hardwoods
- thermoplastics, acrylic, modeling foams
- machining wax

FDM: thermoplastics (PLA, ABS, sometimes nylon)

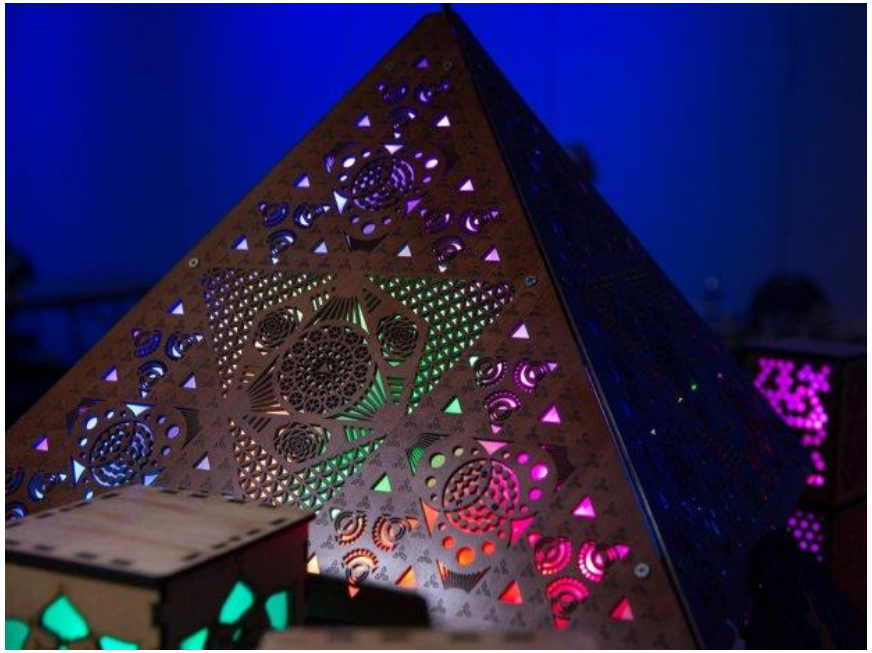
- Thermoplastics can be mixed with other materials such as ceramics, wood, metal, but the workpieces produced on a 3D printer will not be as robust as workpieces cut from a block of metal or wood.

LASER CUTTER

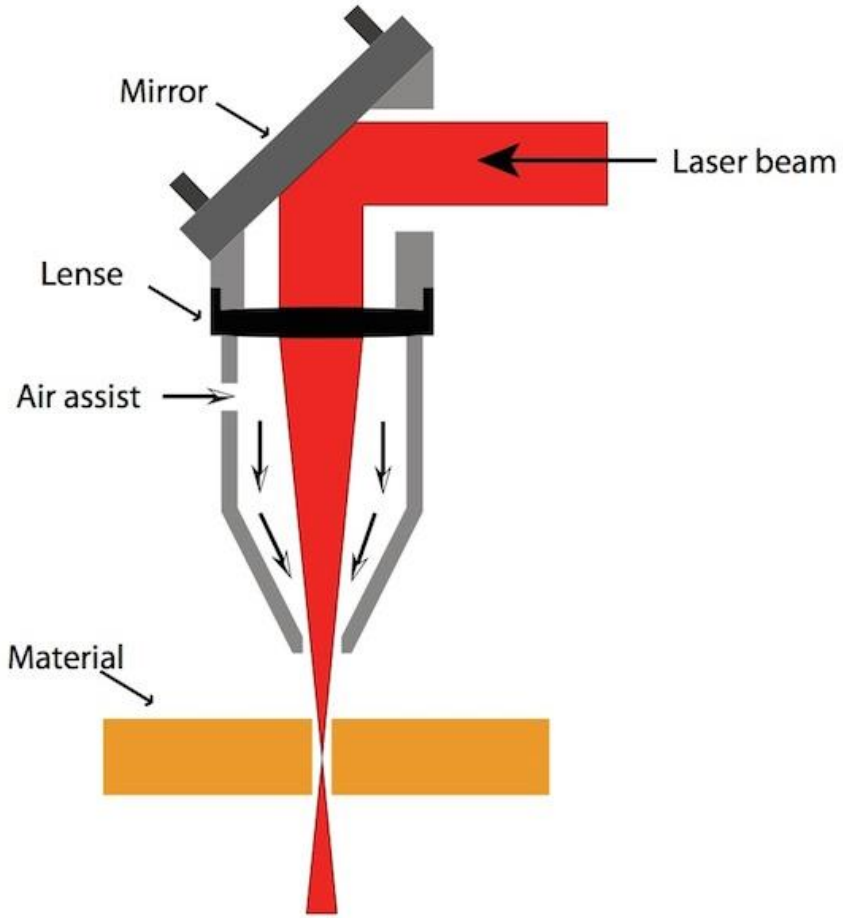
Uses a laser to cut through materials

Cut through a wide range of materials with high precision.

- CNC has a hard time creating ultra-sharp details
- A laser's beam is so narrow that it can give you that precise detail.



From Makezine

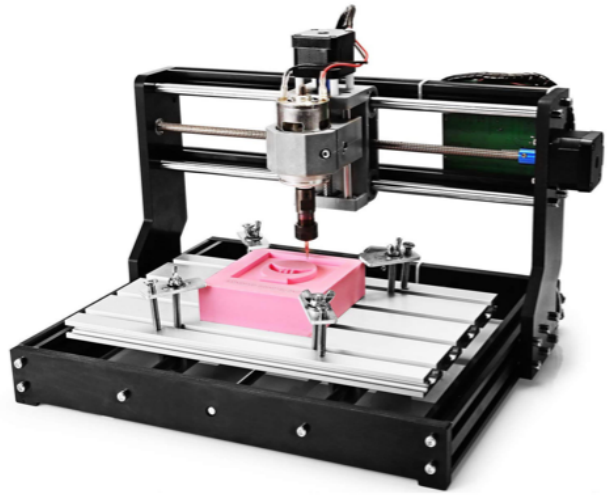

Mirror
Laser beam
Lense
Air assist
Material

https://www.youtube.com/watch?v=uGduSO7wDZE

ADDITIVE OR SUBTRACTIVE?

Additive Manufacturing	Subtractive Manufacturing
3D printing as example	CNC (Computer Numerical Control) milling as example
Adding layer by layer	Taking away layer by layer
Material base = often plastic	Material base = often metals/wood
Often used for fast initial prototyping	Often used for sturdy construction

Combo =
Hybrid Process



1. What type of features does your product have?
   - small organic and intricate features → **additive methods**
   - large or sharp features, drilled and tapped holes or other fastening features →**subtractive methods**

2. What type of material do you want to work with?
   - thermoplastics and resins → **additive methods**
   - materials like metals, wood, or foam → **subtractive methods**

3. How many units do you want to produce?
   - low-volume production or iterative prototyping → **additive methods**
   - large-volume production runs → **subtractive methods**

3D PROTOTYPING RESEARCH

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RESEARCH AREAS

Helping users build 3D models

Helping users optimize 3D models

Enabling rapid prototyping with 3D printers

Adding interactivity to digital fabrications

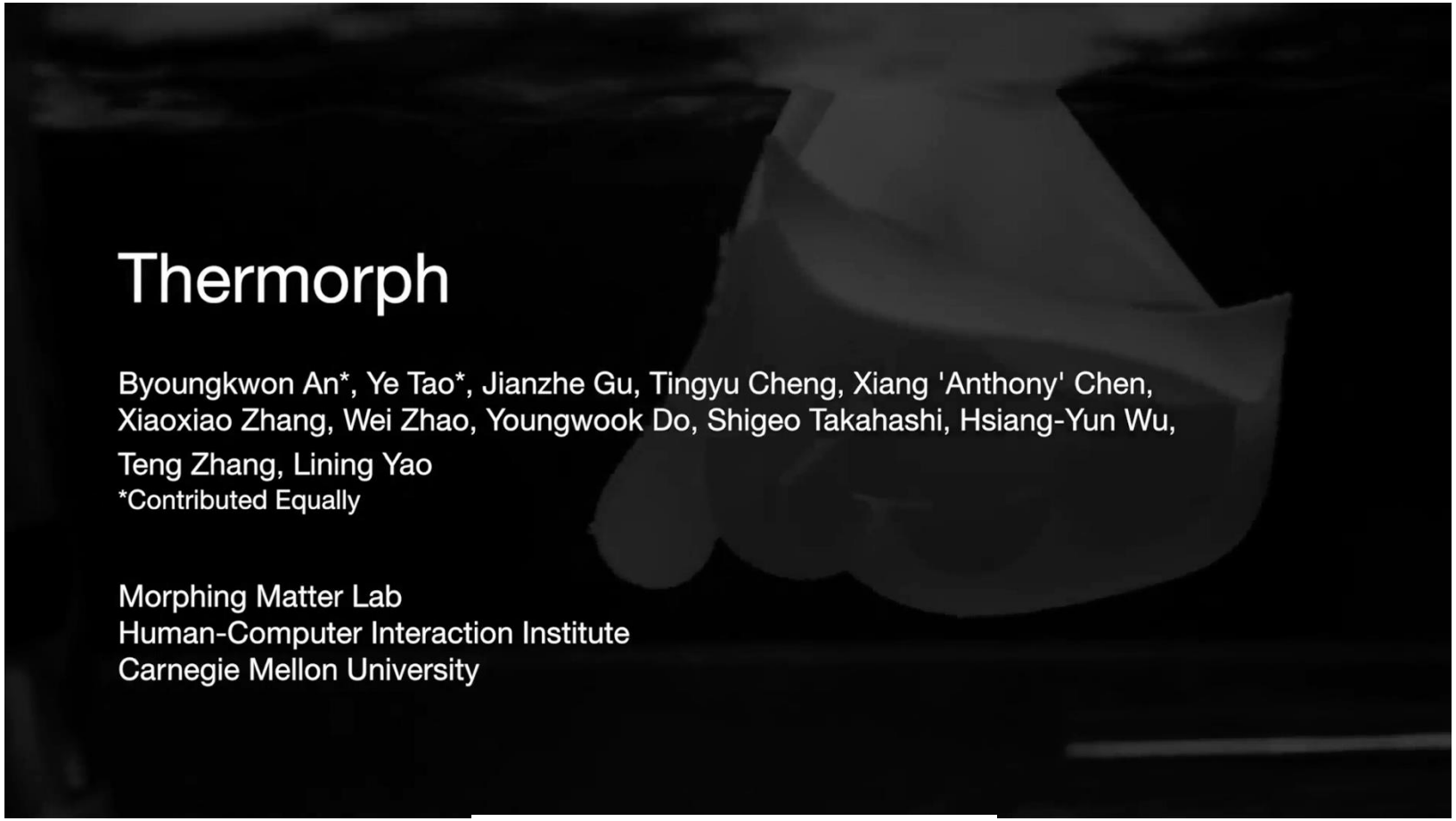
Tools to support computational fabrication

Inventing new types of fabrication

Studying/inventing new types of applications

Performing formative studies

4D PRINTING


Thermorph
Byoungkwon An*, Ye Tao*, Jianzhe Gu, Tingyu Cheng, Xiang 'Anthony' Chen,
Xiaoxiao Zhang, Wei Zhao, Youngwook Do, Shigeo Takahashi, Hsiang-Yun Wu,
Teng Zhang, Lining Yao
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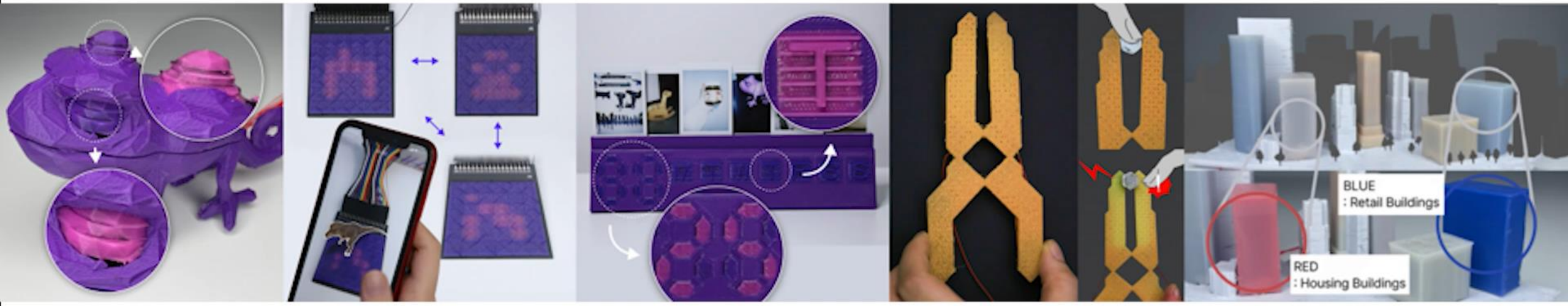
3D Printing Locally Activated Visual-Displays Embedded in 3D Objects via Electrically Conductive and Thermochromic Materials

Kongpyung (Justin) Moon[a*], Zofia Marciniak[a], Ryo Suzuki[c], Andrea Bianchi[a,b]

Industrial Design, KAIST[a]; School of Computing, KAIST[b]; Computer Science, University of Calgary[c]



*jkpmoon@kaist.ac.kr

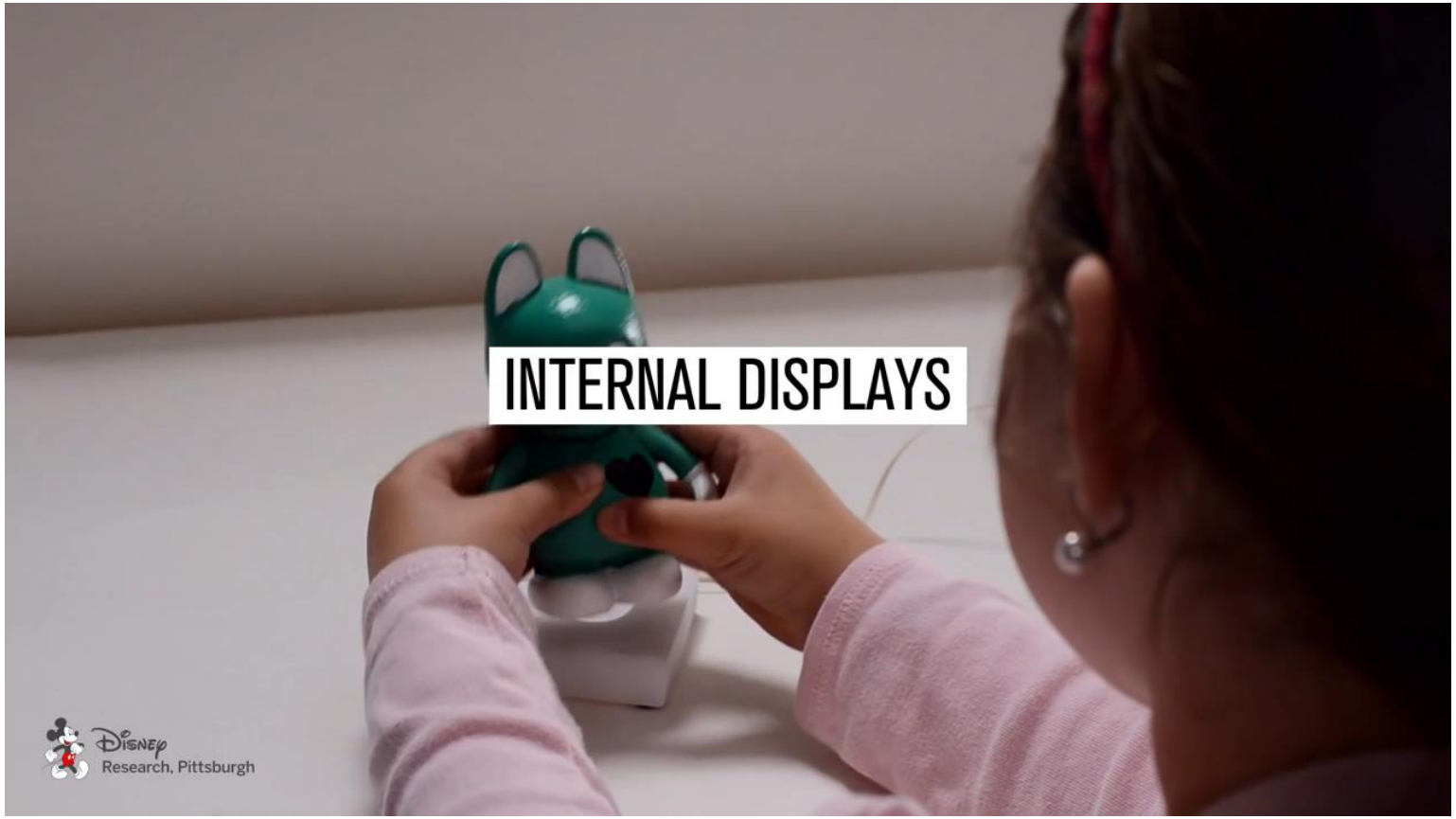
KAIST

UNIVERSITY OF CALGARY

CHI 2024
Surfing the World

PRINTED OPTICS: 3D PRINTING OF EMBEDDED OPTICAL ELEMENTS FOR INTERACTIVE DEVICES

Karl Willis, Eric Brockmeyer, Scott Hudson, and Ivan Poupyrev



3D PRINTED INTERACTIVE SPEAKERS

Yoshio Ishiguro and Ivan Poupyrev

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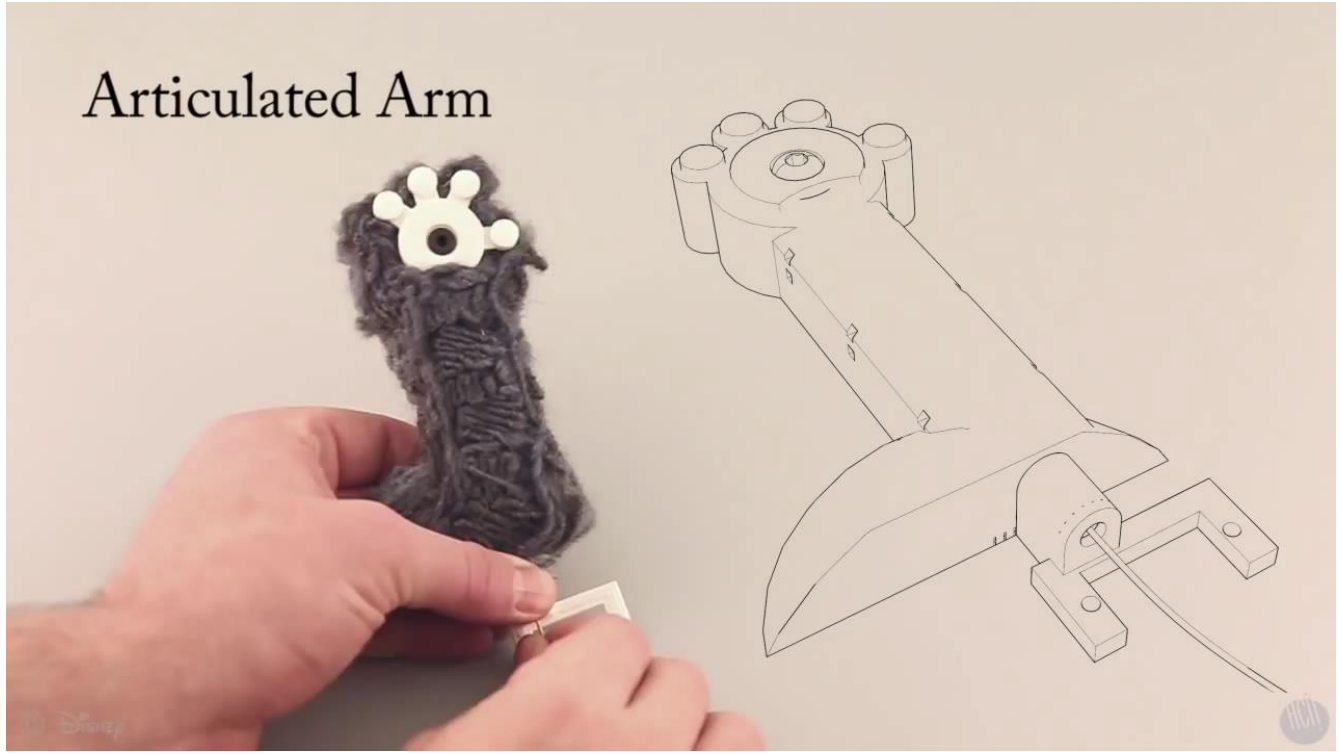
PRINTING TEDDY BEARS: A TECHNIQUE FOR 3D PRINTING OF SOFT INTERACTIVE OBJECTS

Scott Hudson

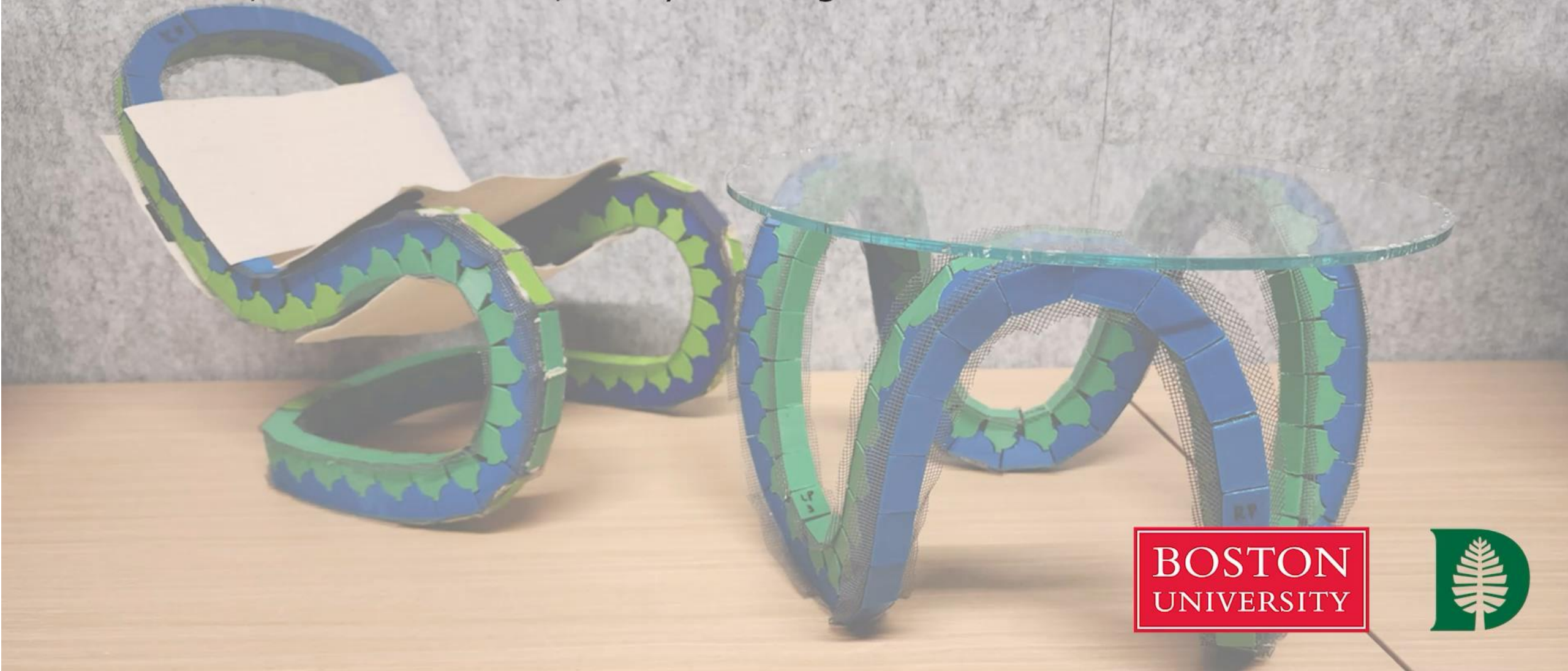


3D PRINTED TACTILE PICTURE BOOKS FOR CHILDREN WITH VISUAL IMPAIRMENTS: A DESIGN PROBE

Abigale Stangl, Jeeeun Kim, and Tom Yeh

StructCurves: Interlocking Block-Based Line Structures

Zezhou Sun, Devin Balkcom, Emily Whiting



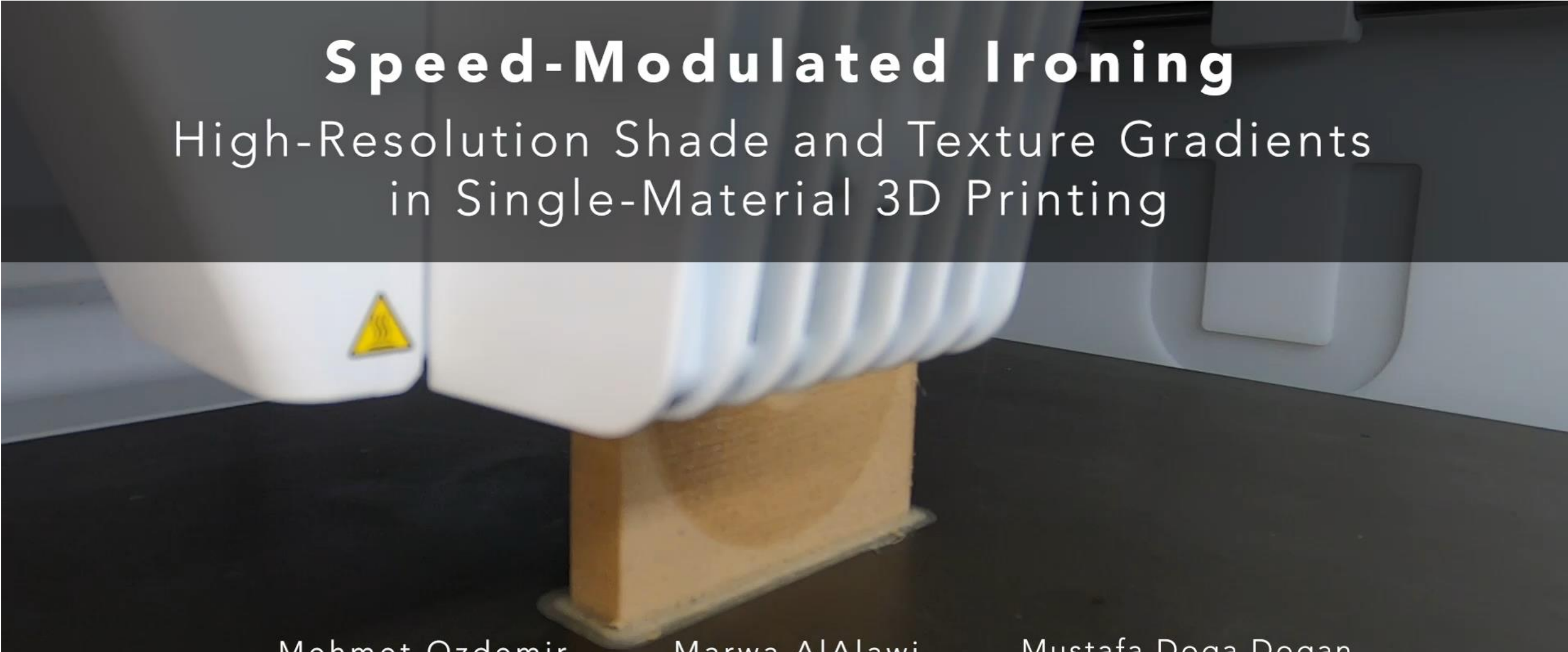
BOSTON UNIVERSITY

X-Hair

3D Printing Hair-like Structures with
multi-form,multi-property and multi-function

Speed-Modulated Ironing

High-Resolution Shade and Texture Gradients in Single-Material 3D Printing



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SUMMARY

Additive Methods

Subtractive Methods

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Additive Versus Subtractive

3D Prototyping Research

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