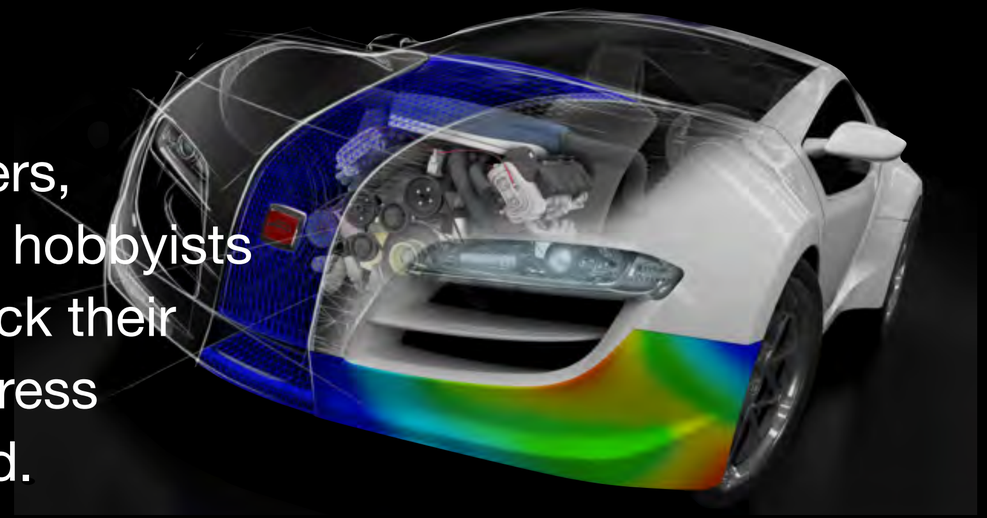
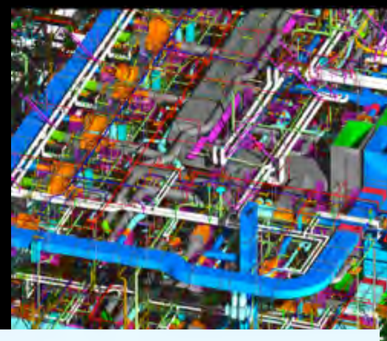
Design tools for programming matter across domains and scales

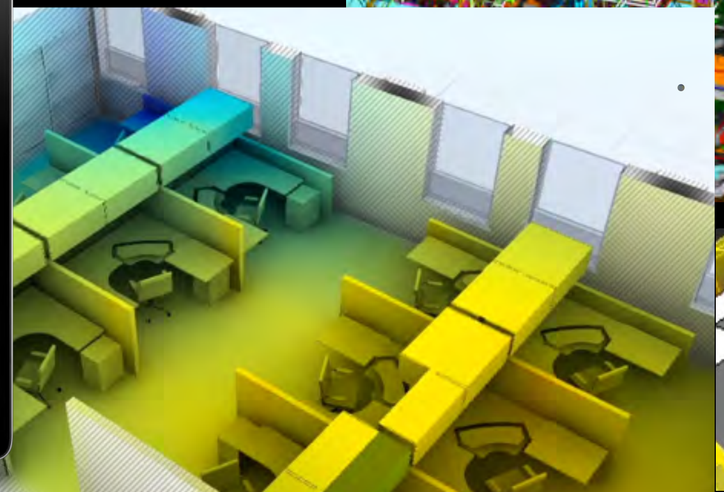
Carlos Olguin
bio/nano/programmable matter group
Autodesk Research

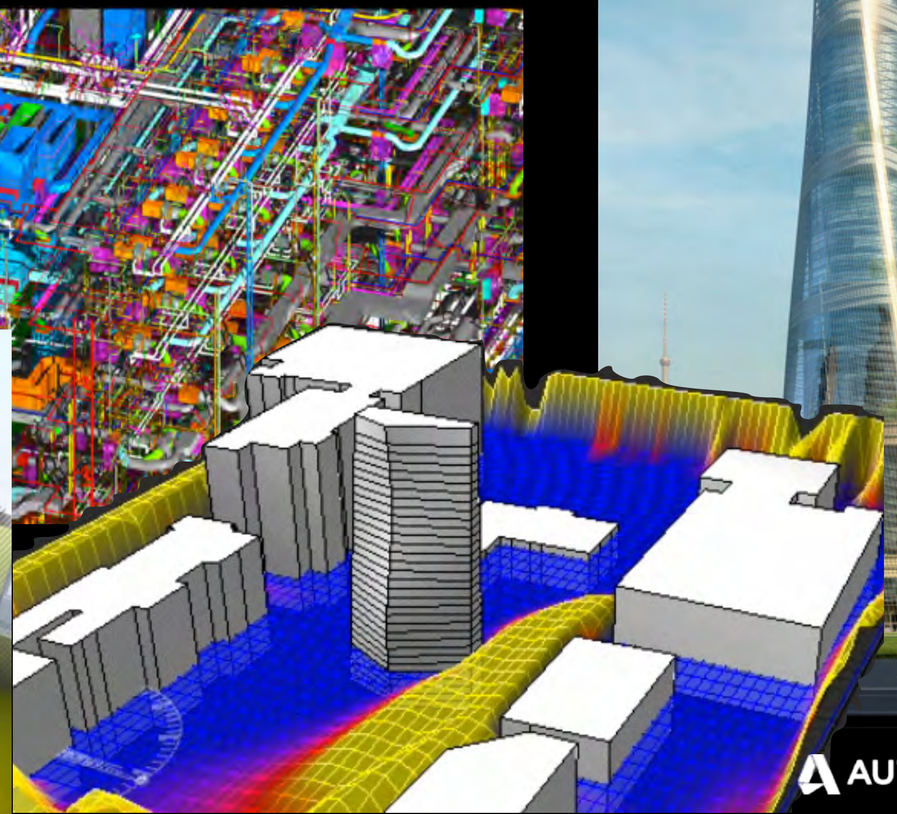
AUTODESK.

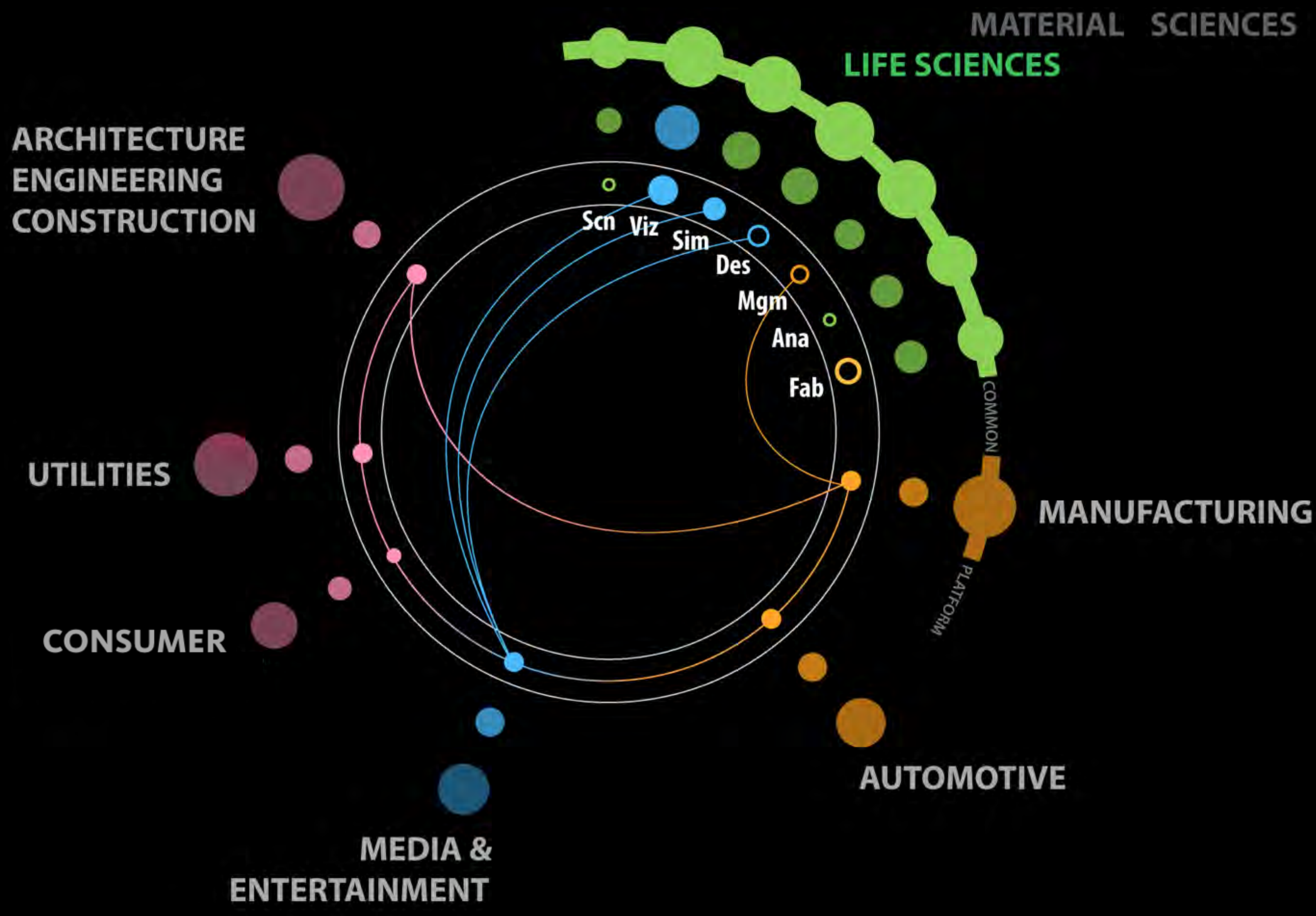
More than 180 million designers, engineers, architects, creative artists, students, and hobbyists use Autodesk software and apps to unlock their creativity, build better products, and address important challenges impacting the world.










MATERIAL SCIENCES
LIFE SCIENCES
ARCHITECTURE
ENGINEERING
CONSTRUCTION
Scn
Viz
Sim
Des
Mgm
Ana
Fab
COMMON
PLATFORM
UTILITIES
CONSUMER
MANUFACTURING
AUTOMOTIVE
MEDIA &
ENTERTAINMENT

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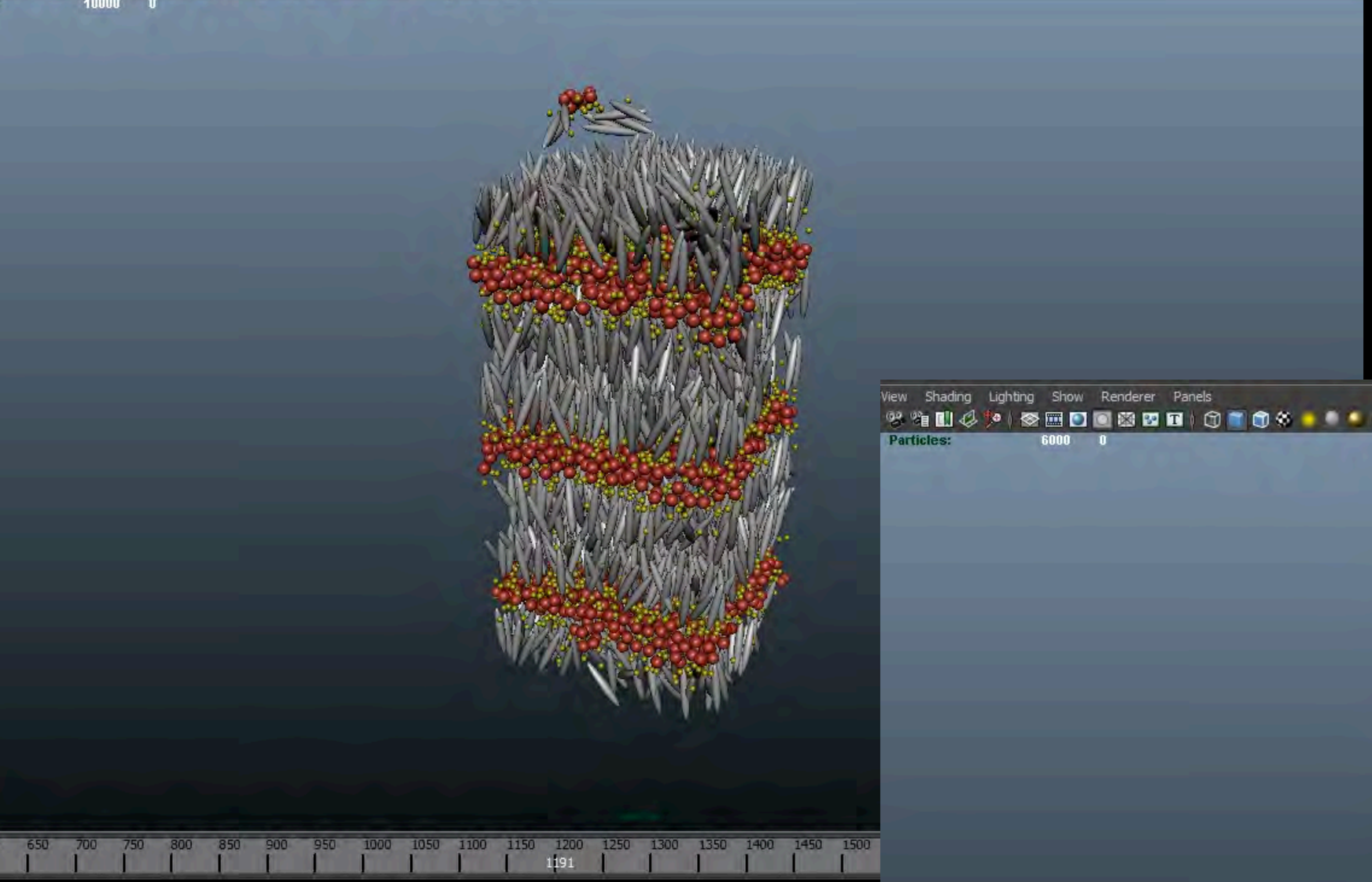
bio/nano/programmable matter group

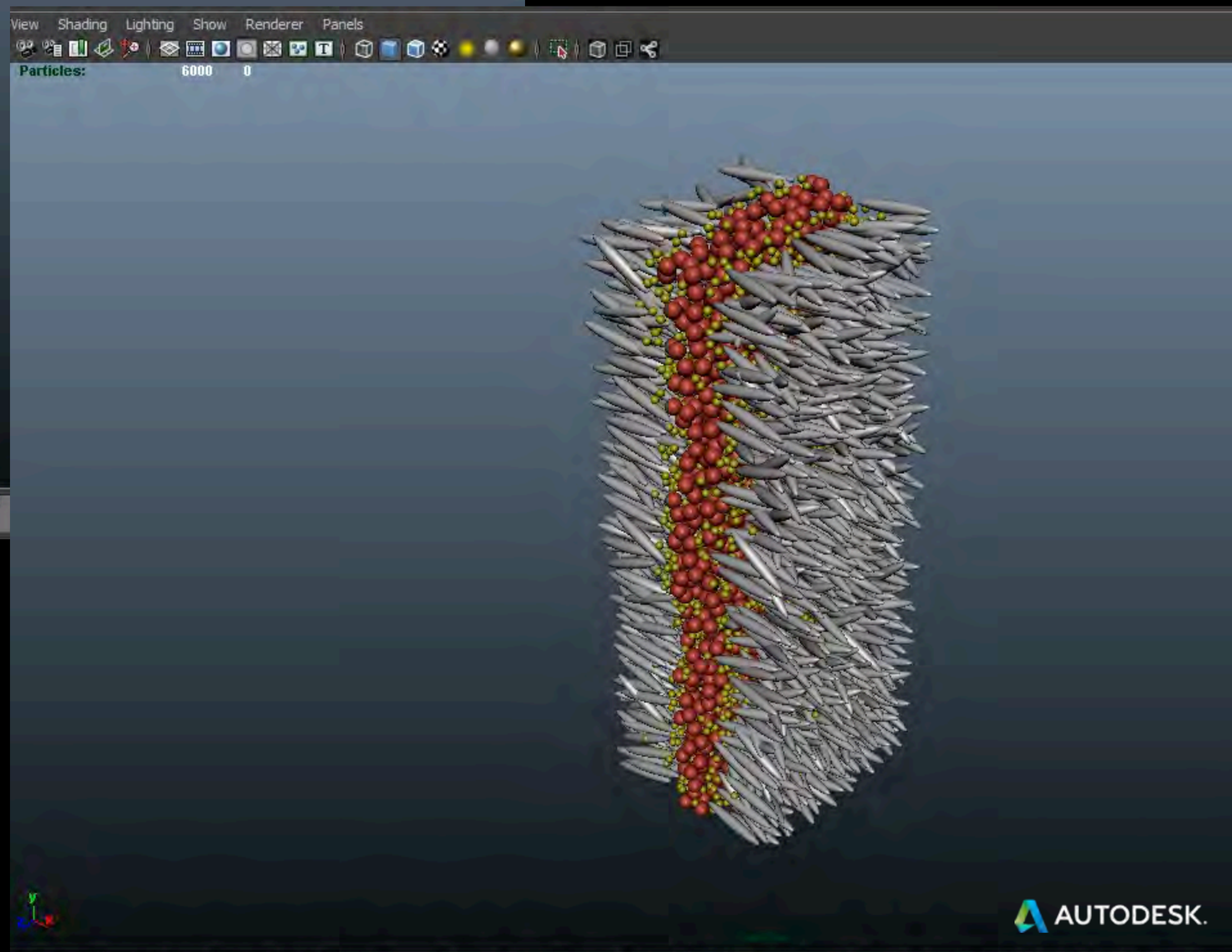
Mission

We collaborate with world-class researchers in industry and academia to co-envision and co-implement the design paradigms and tools needed to program matter across scales and domains.



Wei Zhao
Autodesk
Research

Liquid crystalline polymer simulation



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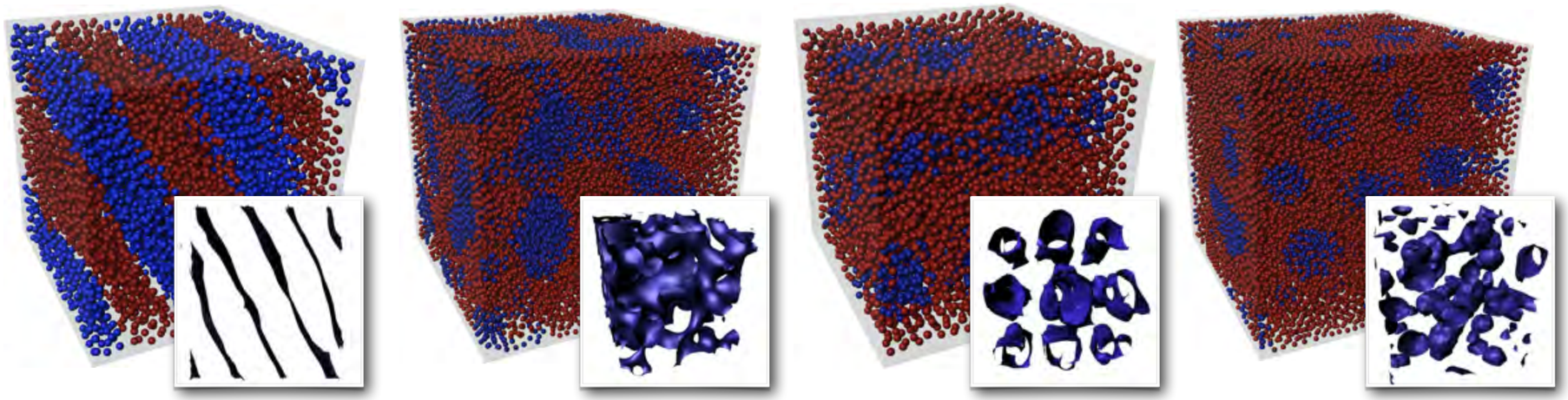
Diblock copolymer simulation



Lammellar
***f*=0.5**

Gyroid
***f*=0.4**

Cylindrical
***f*=0.3**

Spherical
***f*=0.16**

Wei Zhao, Carlos Olguin. Autodesk Research.

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CADNANO 2.0

First

Last

Rnum

Select

Pencil

Break

Erase

Insert

Skip

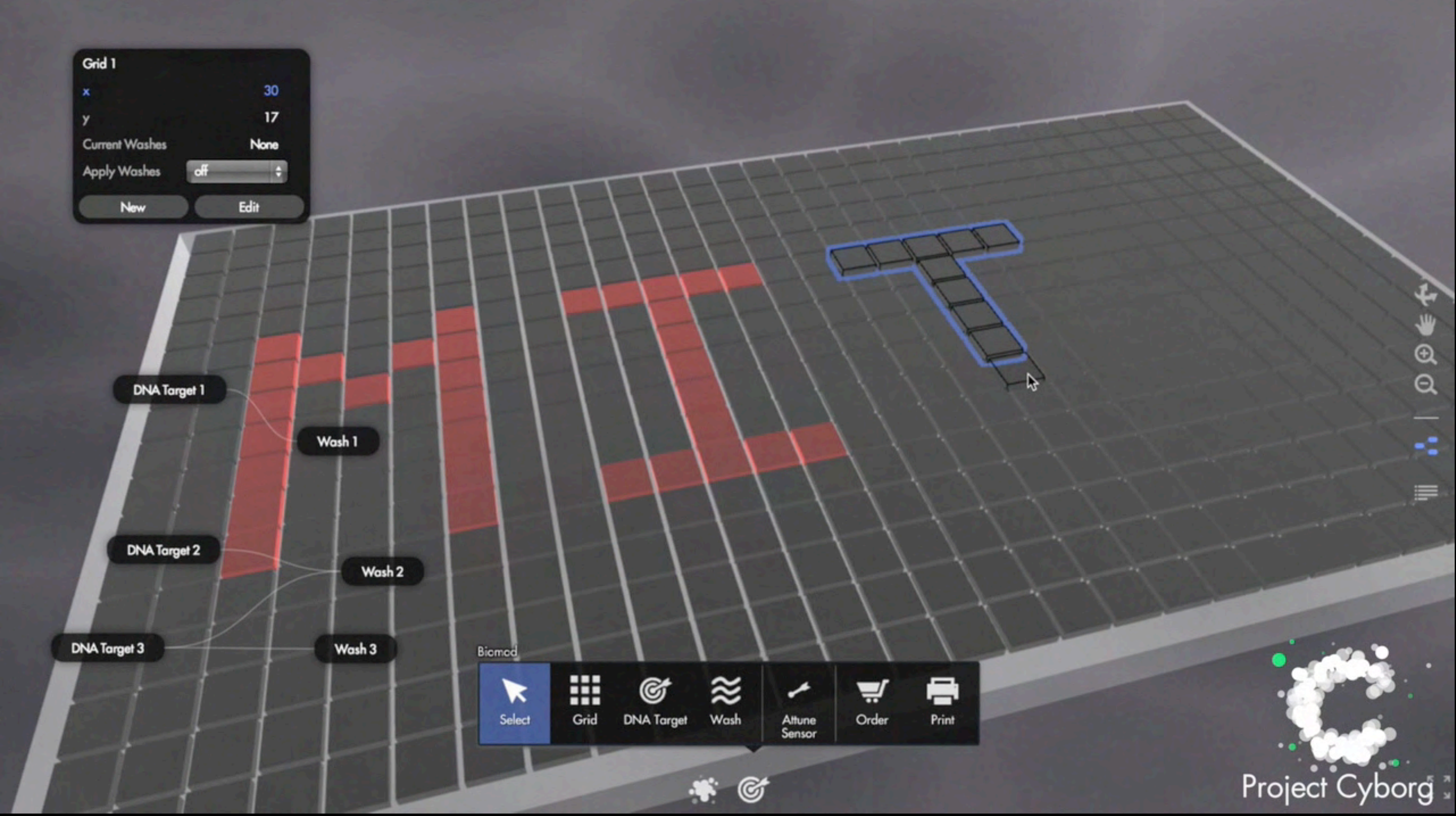
Paint

AC 19

Seq

Shawn Douglas
UCSF

Wyss Institute at Harvard: S. Douglas, N. Conway, J. deWerd. **Autodesk: A. Tessier, S. Breslav, M. Lee, F. Mazzoldi,**



Skylar Tibbits | The Self-Assembly Lab, MIT
Jose Gomez Marquez | Little Devices Lab + Gehrke Lab, MIT + Harvard
Autodesk Research

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BioCompiler on Project Cyborg

Jake Beal
Raytheon BBN Technologies

Raytheon
BBN Technologies

Synthetic Biology Group

Compiler Options

Authorship

Program

BioCompiler

miRNA sensors

More Small Molecule Sensors

TMP sensor

Feedback Library

Another Code Library

GRN Diagram

Visualization_URL		9a9f9a6f-f107-45
GraphViz_URL		9a9f9a6f-f107-45
Visualization	★	<a href="api/v1/
Graphviz	★	<a href="api/v1/
VisualizationPNG_URL		9a9f9a6f-f107-45

SBOL

SBOL

download file

ModelODE

ModelInterface

download file

Model

Warnings & Errors

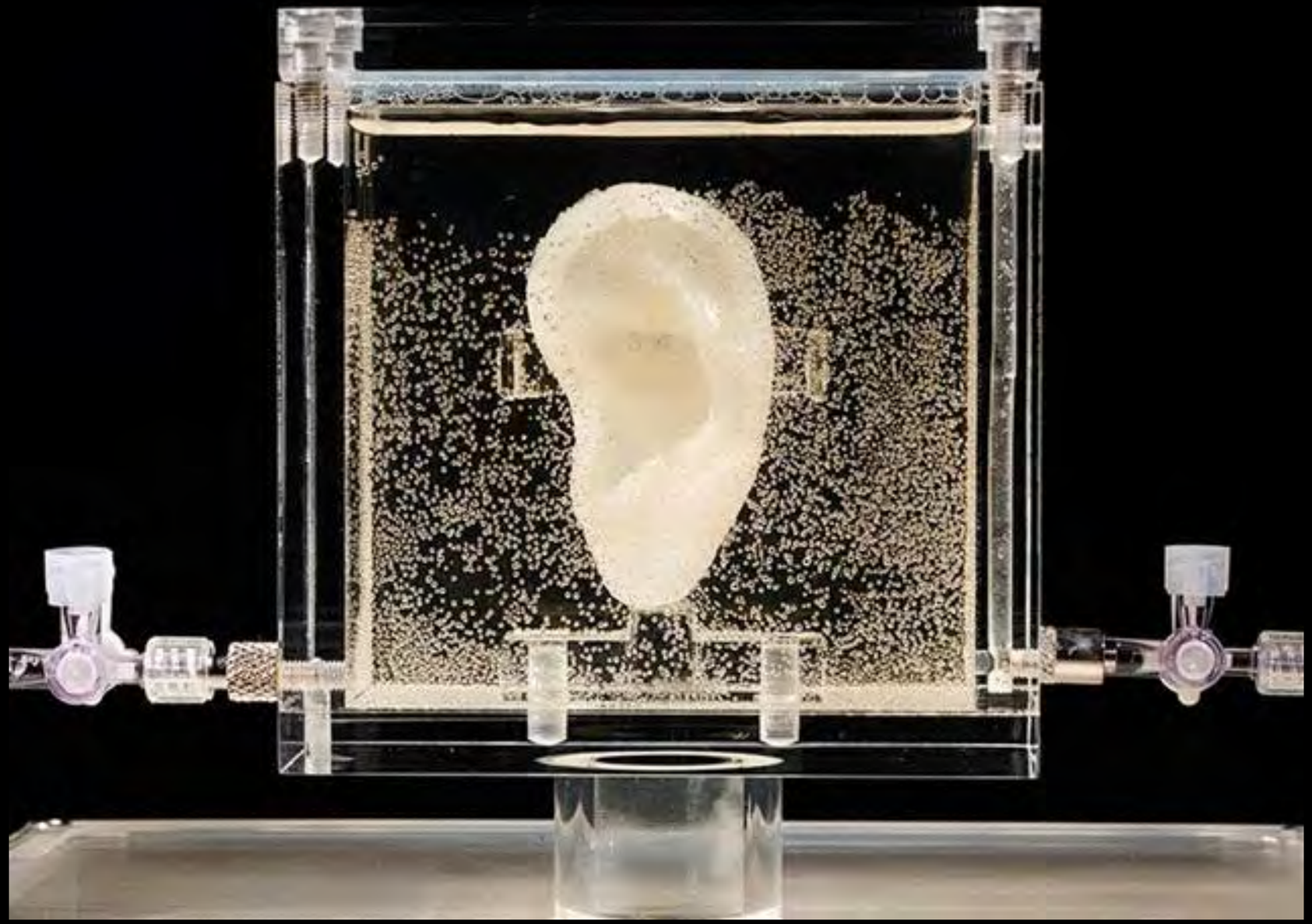
No warnings or errors

Warnings & Errors

Create

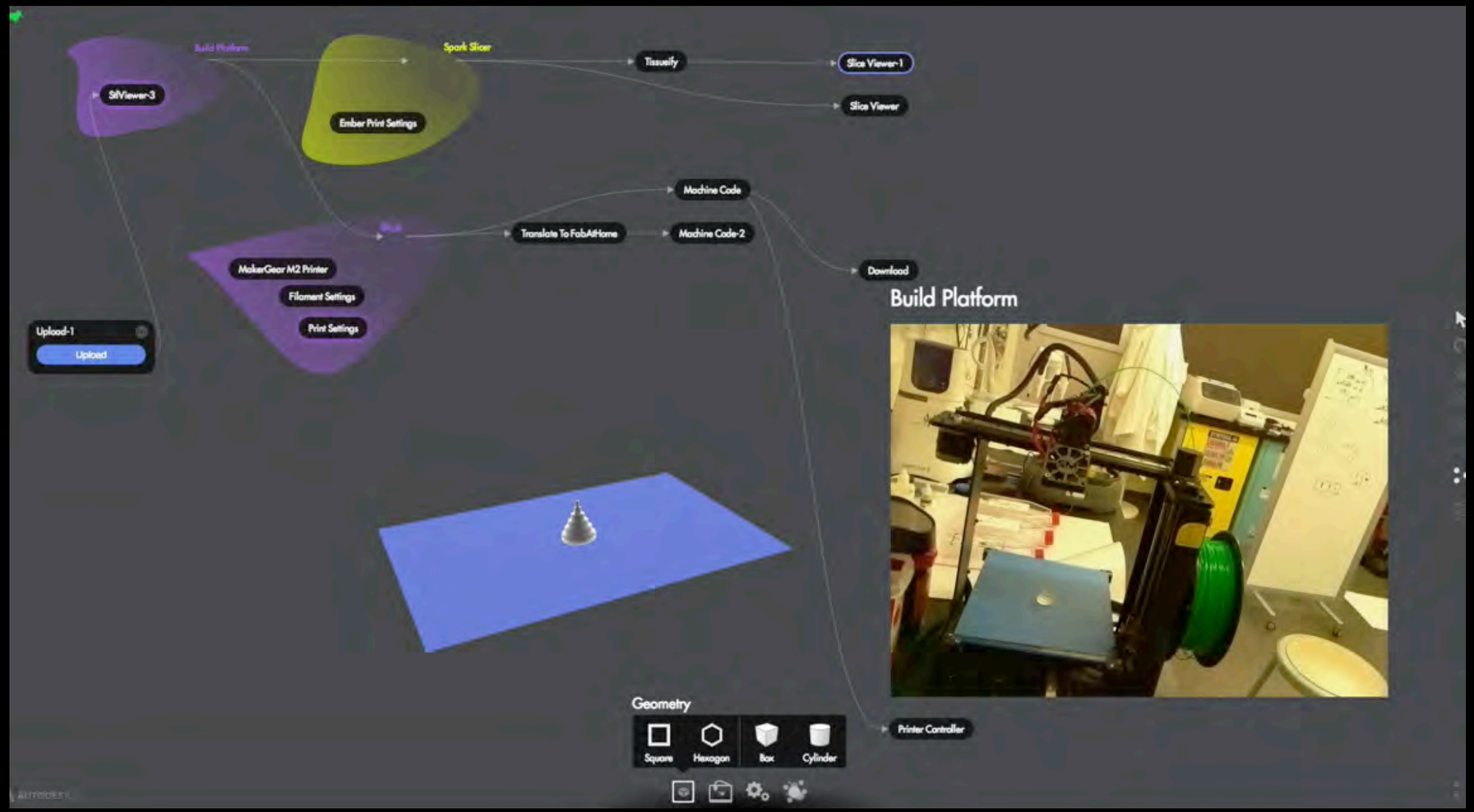
Block Sphere Cylinder Cone Capsule Empty Node Timer Node

Project Sugababe (first version)
Autodesk was not actively involved.



Diemut Strebe (concept), Robert Langer, Charles Vacanti, Ian Wilmut, Christian Gehrig, Jef Boeke, George Church, Tessa Hadlock, Joseph Vacanti, Peter Cariani, Bertrand Delgutte, Vincent Castella

Project Sugababe (second version)
Autodesk actively involved.



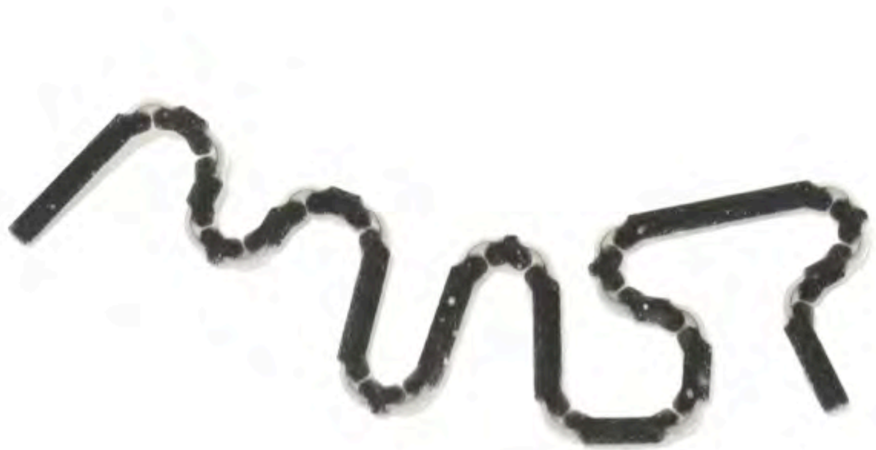
Diemut Strebe

Lawson Fulton

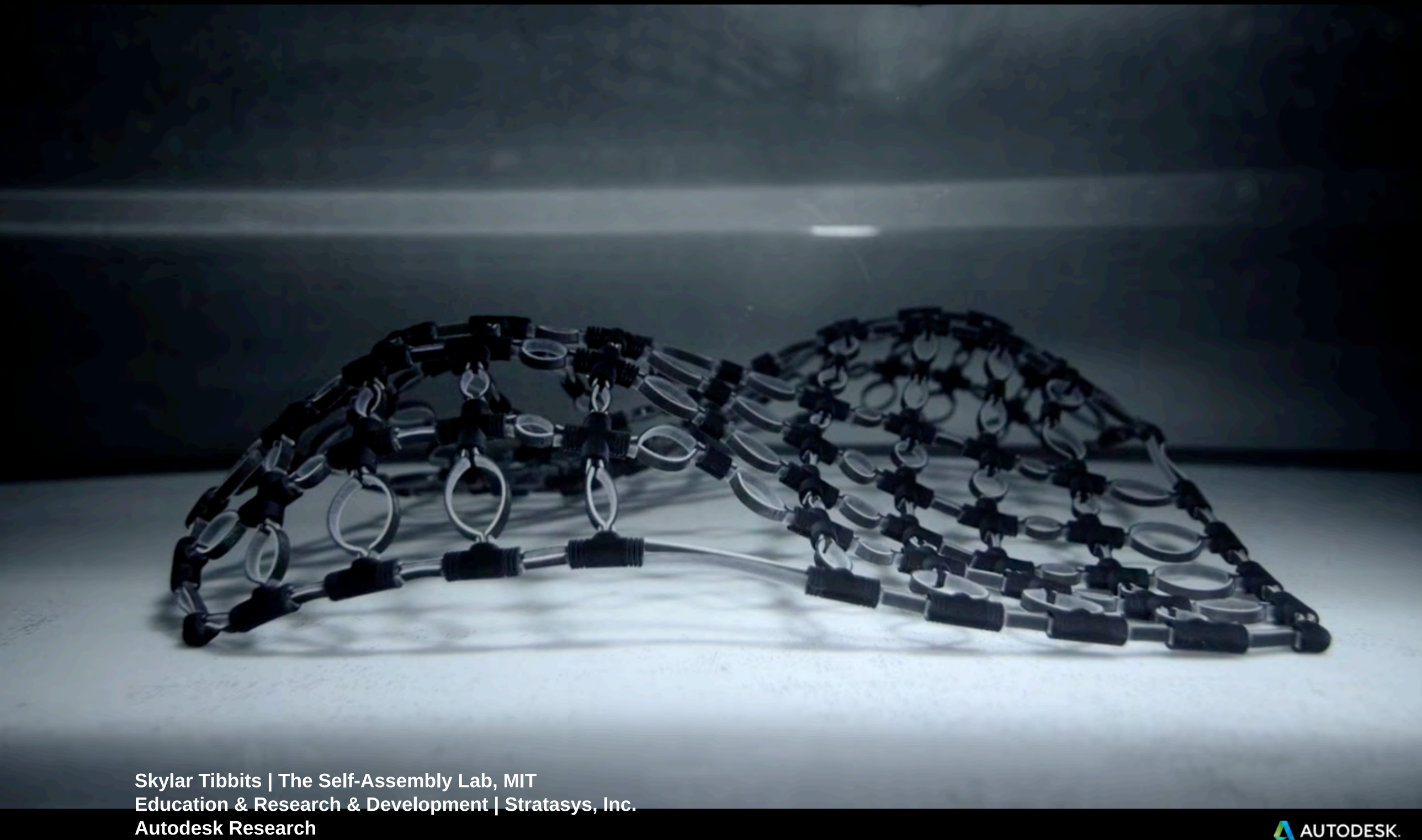
Chris Venter

Charles Vacanti

Aaron Berliner



Skylar Tibbits | The Self-Assembly Lab, MIT
Education & Research & Development | Stratasys Inc.



Skylar Tibbits | The Self-Assembly Lab, MIT
Education & Research & Development | Stratasys, Inc.
Autodesk Research

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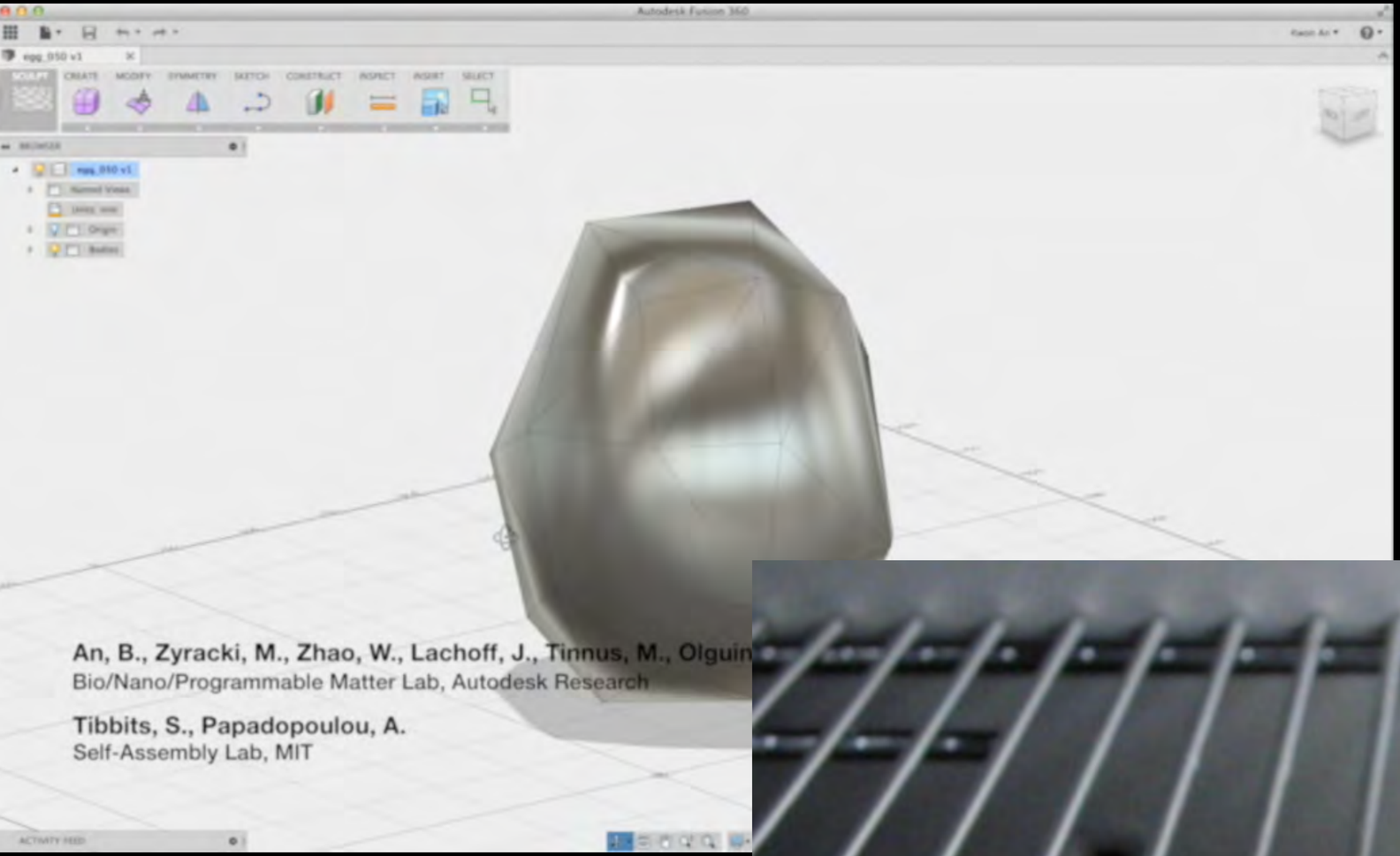
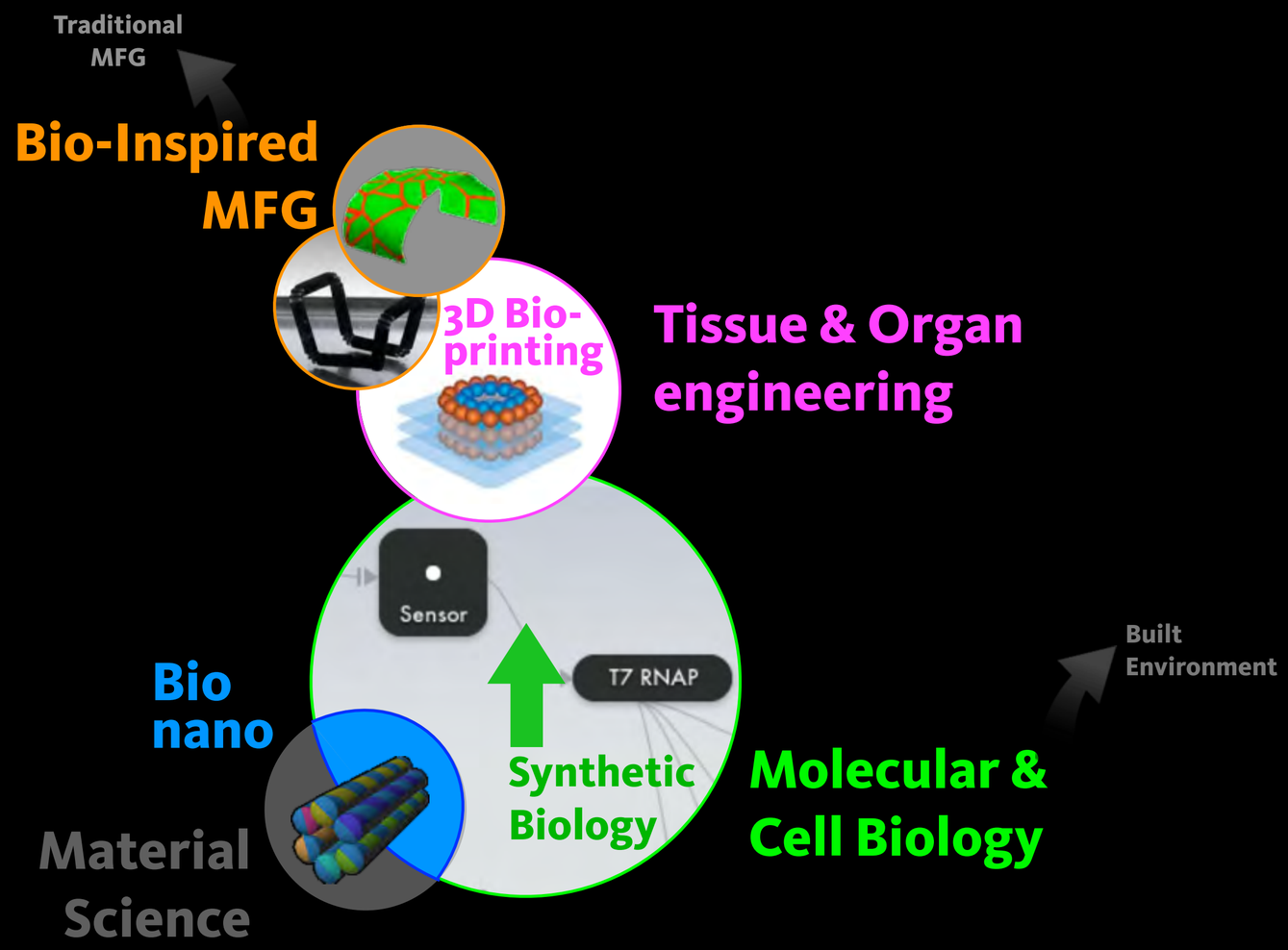

An, B., Zyracki, M., Zhao, W., Lachoff, J., Tinnus, M., Olguin
Bio/Nano/Programmable Matter Lab, Autodesk Research
Tibbits, S., Papadopoulou, A.
Self-Assembly Lab, MIT


An, B., Miyashita, S., Tolley, M., Aukes, D., Meeker, L., Demaine, E., Demaine, M., Wood, R., Rus, D.
Computer Science and Artificial Intelligence Lab, MIT
Microrobotics Lab, Harvard University
ICRA 2014

- Multi-scale/multi-domain
- Modular



- Massive parallelization of an exploration space

- Programmable (bio | nano) matter is harnessed as another source of computation

Right image: Yizhi Cai – Edinburgh Genome Foundry

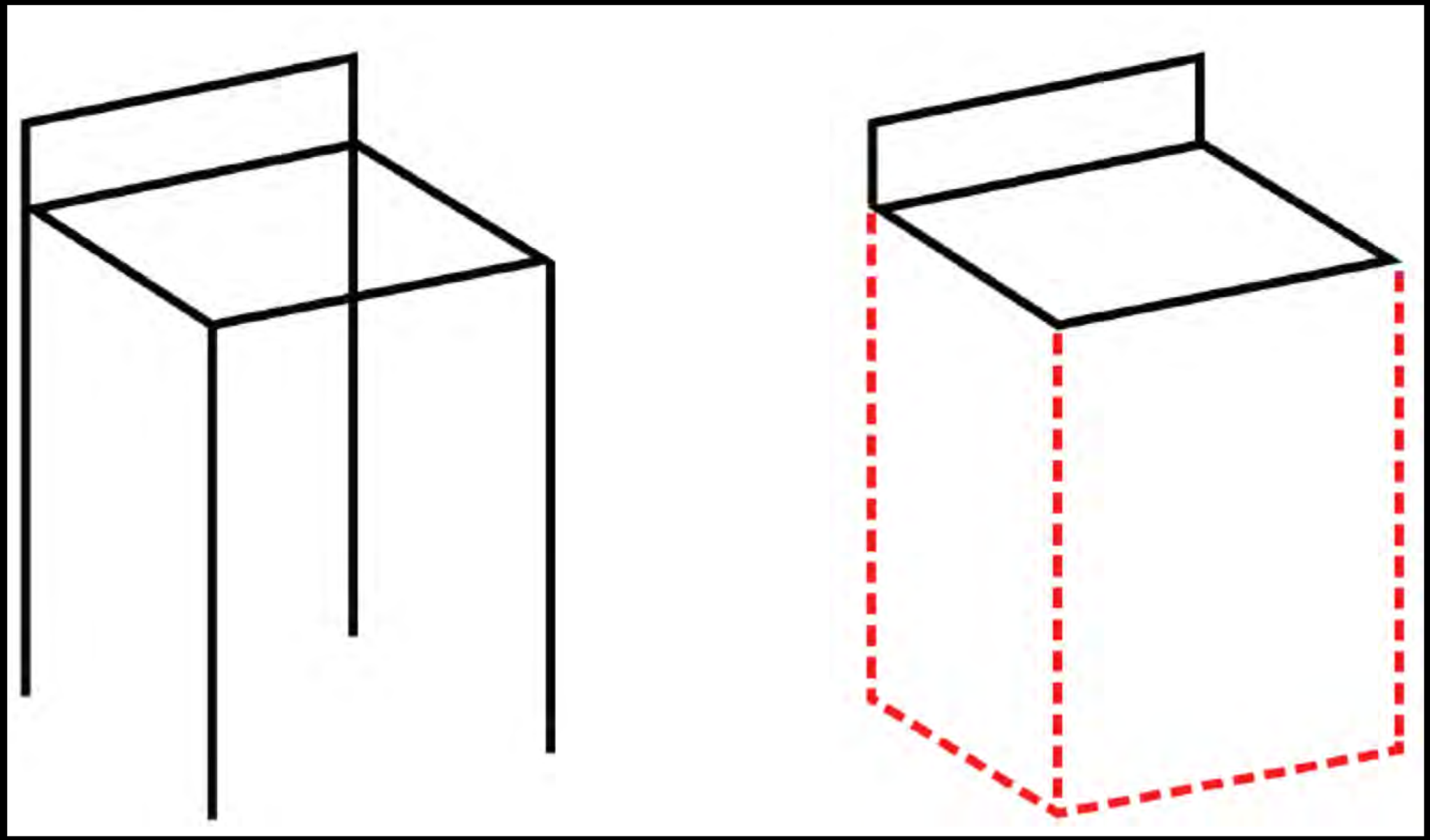
- Novice-to-master UX
- Open

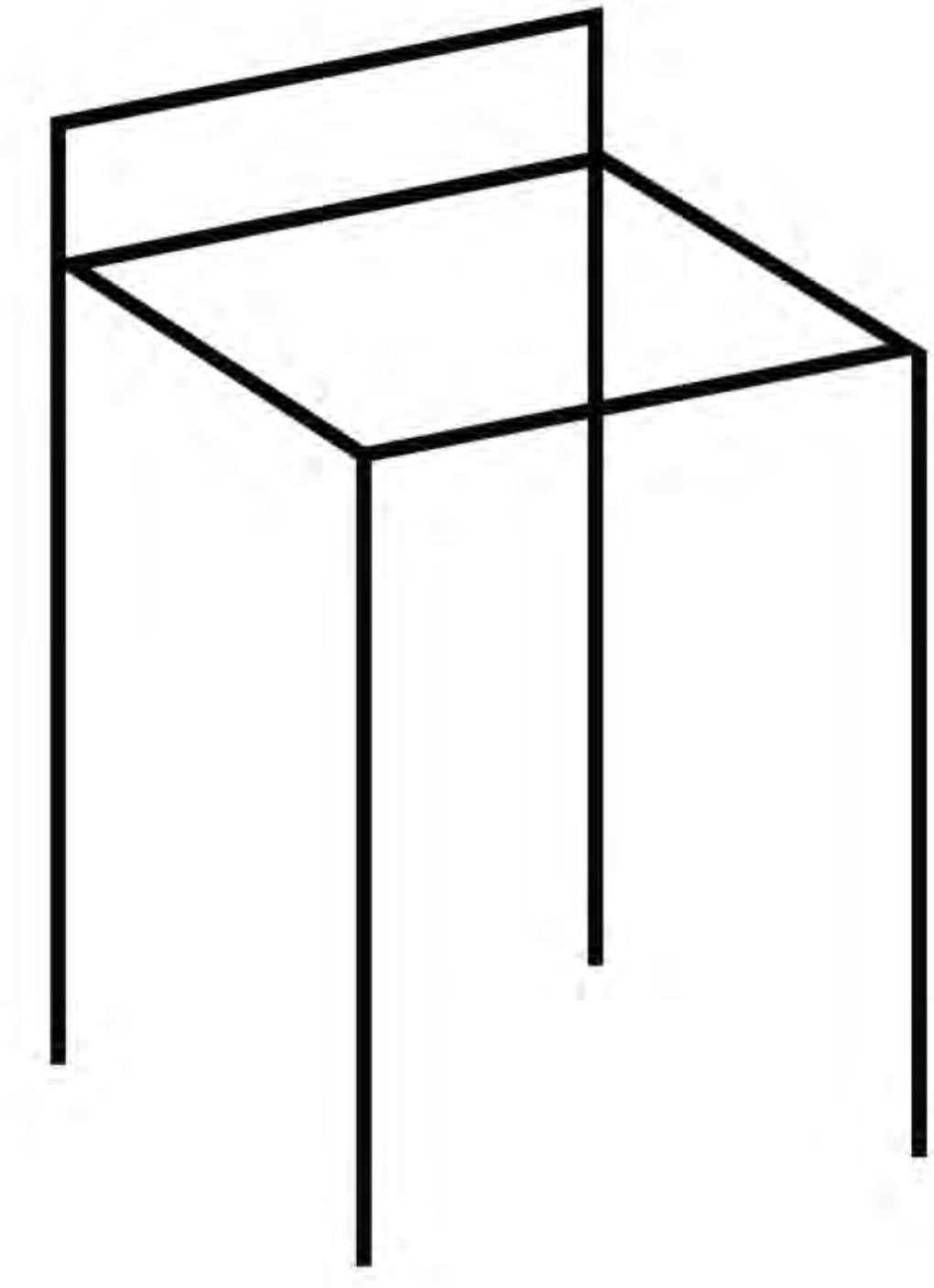
Coder

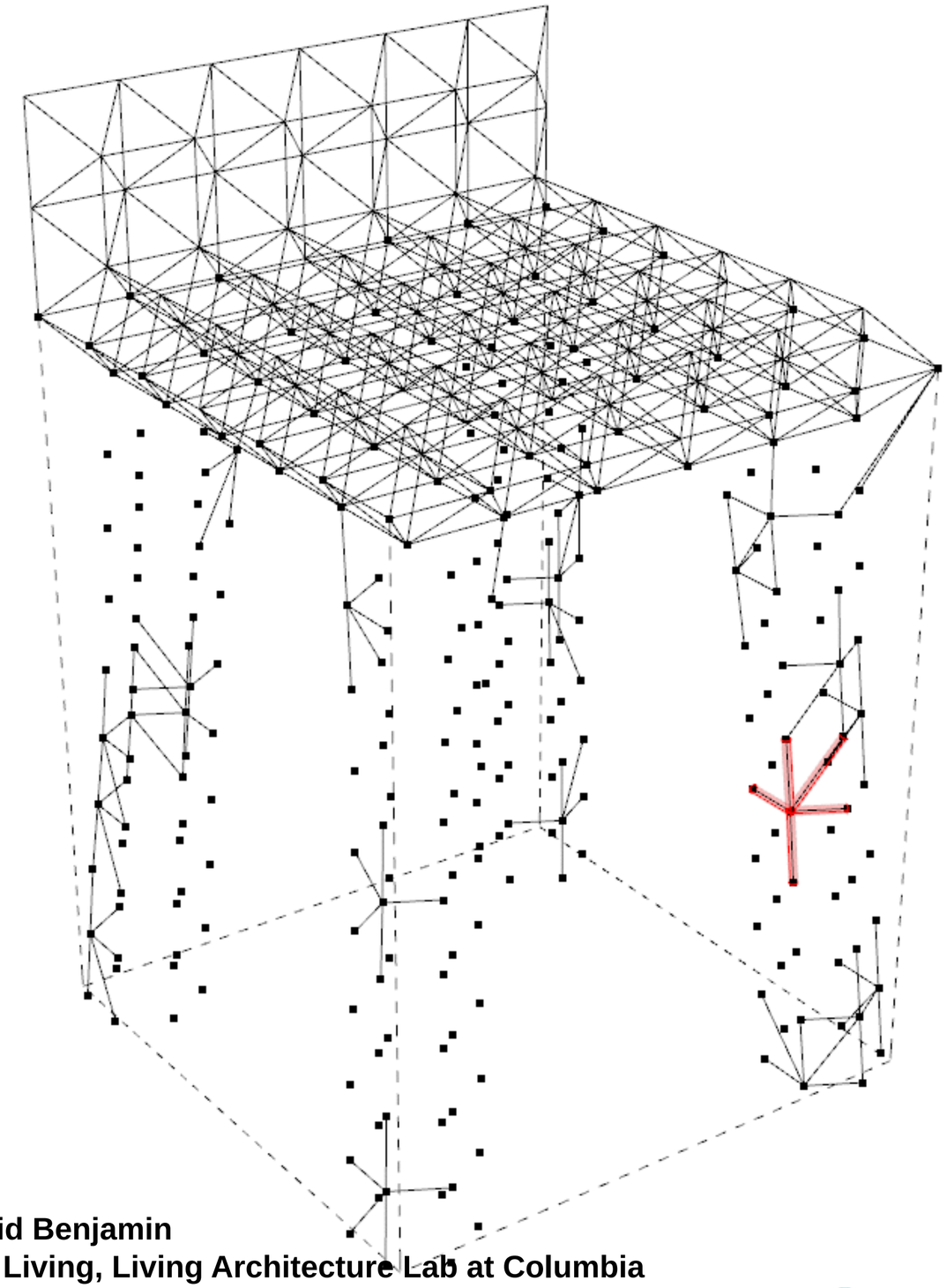
Visual programmer

End-user

- Intent-driven







David Benjamin
The Living, Living Architecture Lab at Columbia
Autodesk Research

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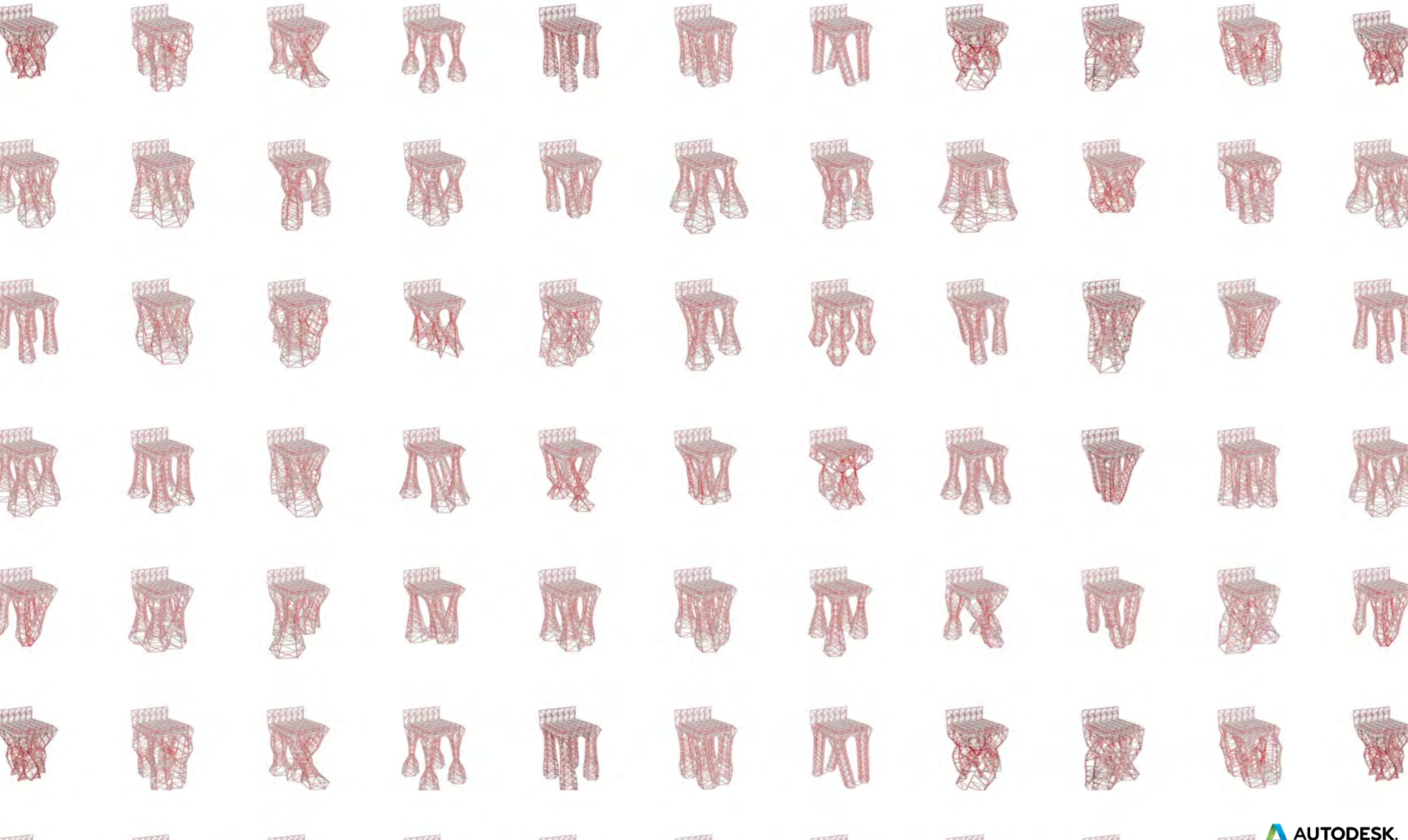

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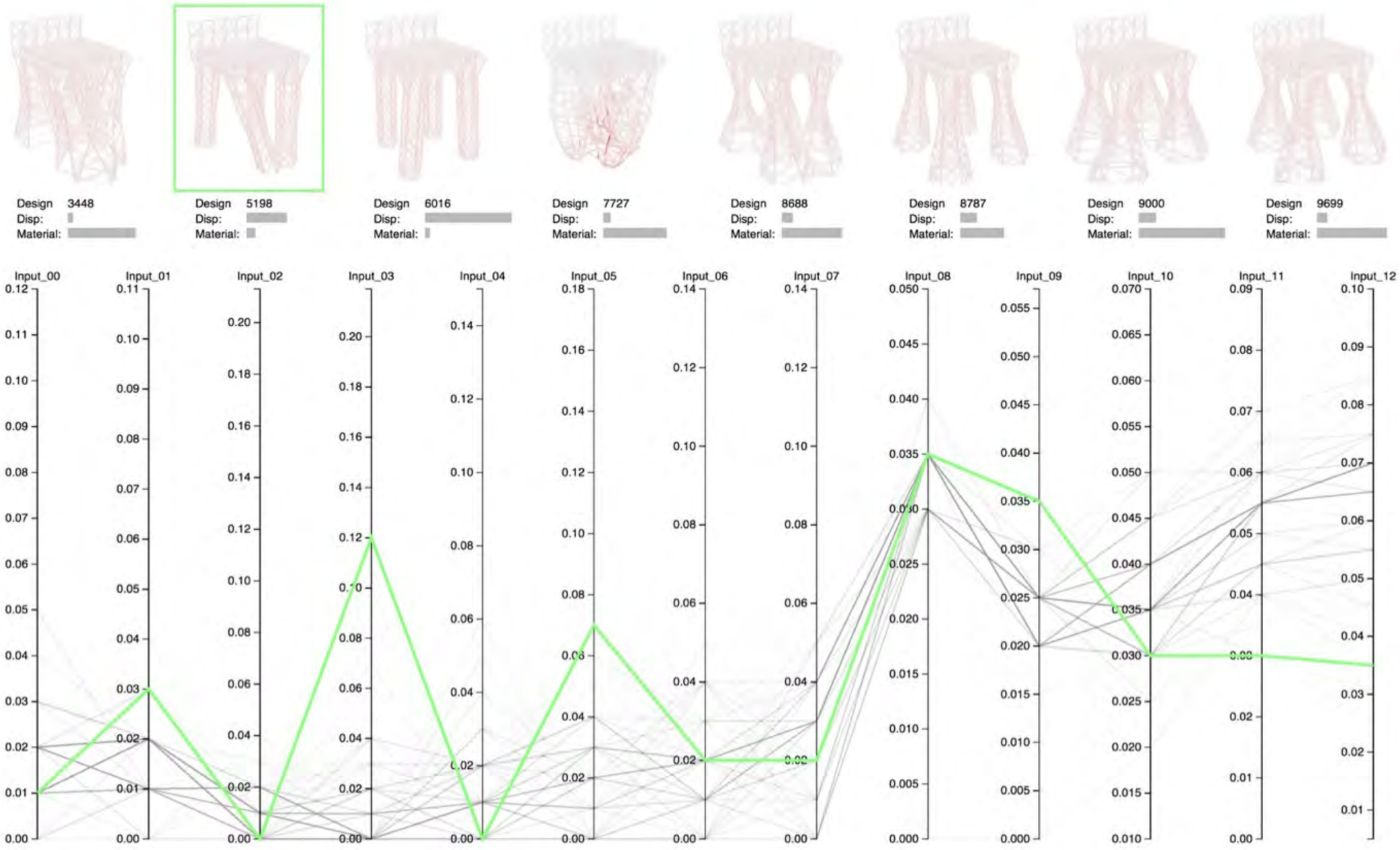

David Benjamin
The Living, Living Architecture Lab at Columbia
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MODEL 1
Solid bars
Traditional design
Weight:
10.3 kilograms
Displacement:
0.8 micrometers

MODEL 2
Uniform lattice
Smart design with ALM
Weight:
4.1 kilograms
Displacement:
4.2 micrometers

MODEL 3
Evolved lattice
Evolutionary design with ALM
Weight:
2.9 kilograms
Displacement:
6.1 micrometers

David Benjamin
The Living
Living Architecture Lab at Columbia
Autodesk Research

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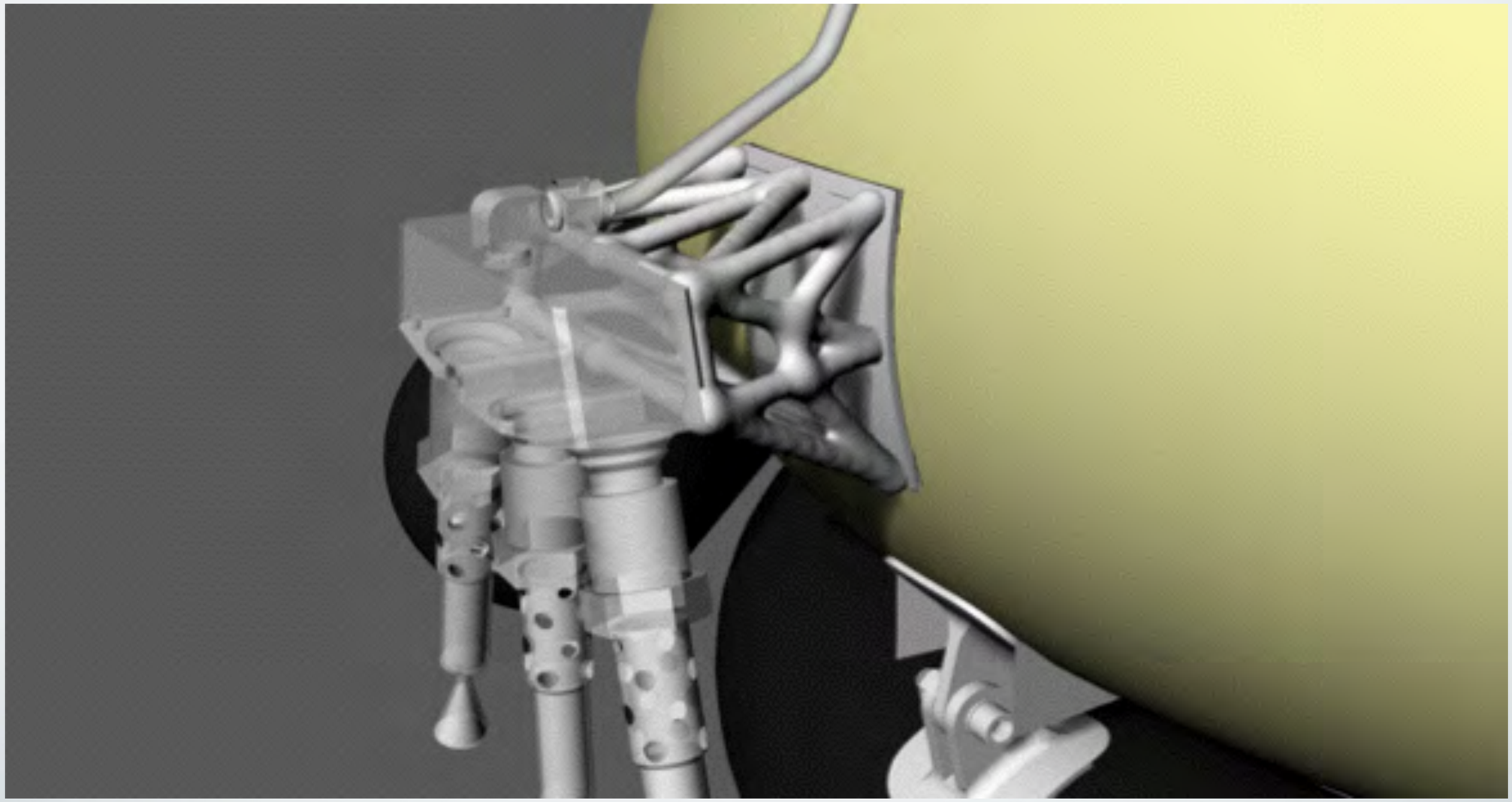
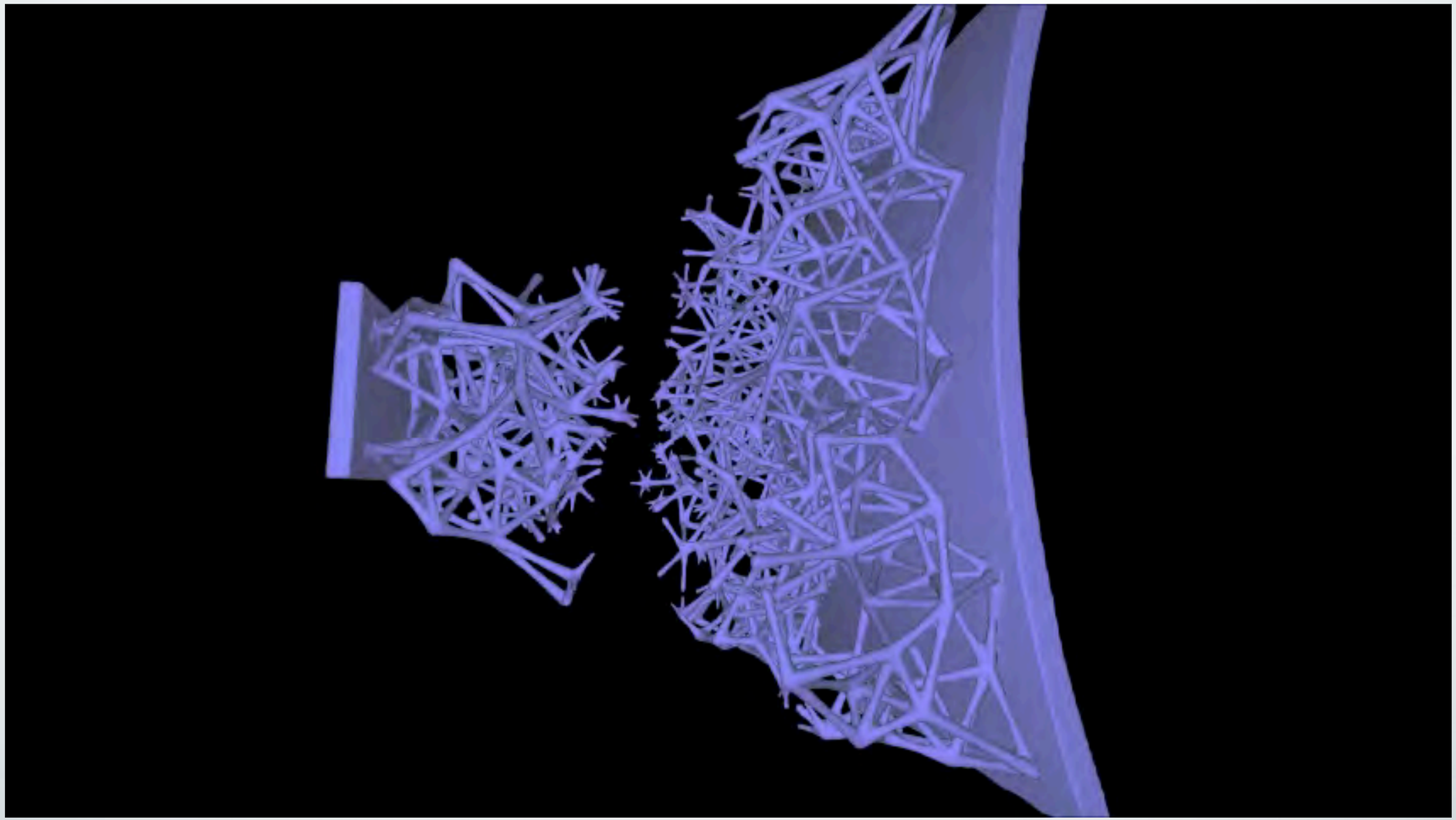
DreamCatcher

Generate: Procedurally Generate & Simulate Solution



DreamCatcher

Generate: Procedurally Generate Geometry



20X

Make It Lighter

A Cyborg optimization application.

INSTRUCTIONS:
Upload your own 3D geometry in STEP or STL format. (Don't have a file of your own? Use one of our sample files, or use Autodesk Fusion 360 to create a new design.)

WHAT'S GOING ON:
Cyborg will iteratively generate tessellated versions of your design, simulate their weight and structural performance, and reveal a set of optimized solutions representing the lightest, strongest results for you to explore and download.

START HERE
Upload It

Completed 2 of 2, 100.00%

OPTIMIZE
PRO
tessellate
simulate
build
visualize

RESULTS
Download It

Weight 234.01 g
203.8 MPa
1.31 mm
Result 1

308 g
157.7 MPa
1 mm
Result 2

Make it lighter

Upload | Download | STEP Translator | Tessellate | Build | Simulate | Optimize | Visualize

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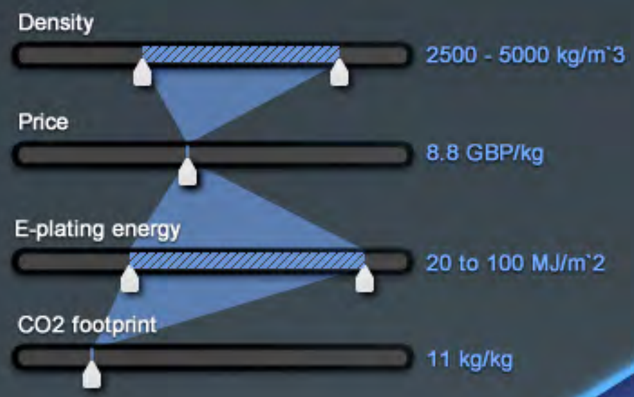
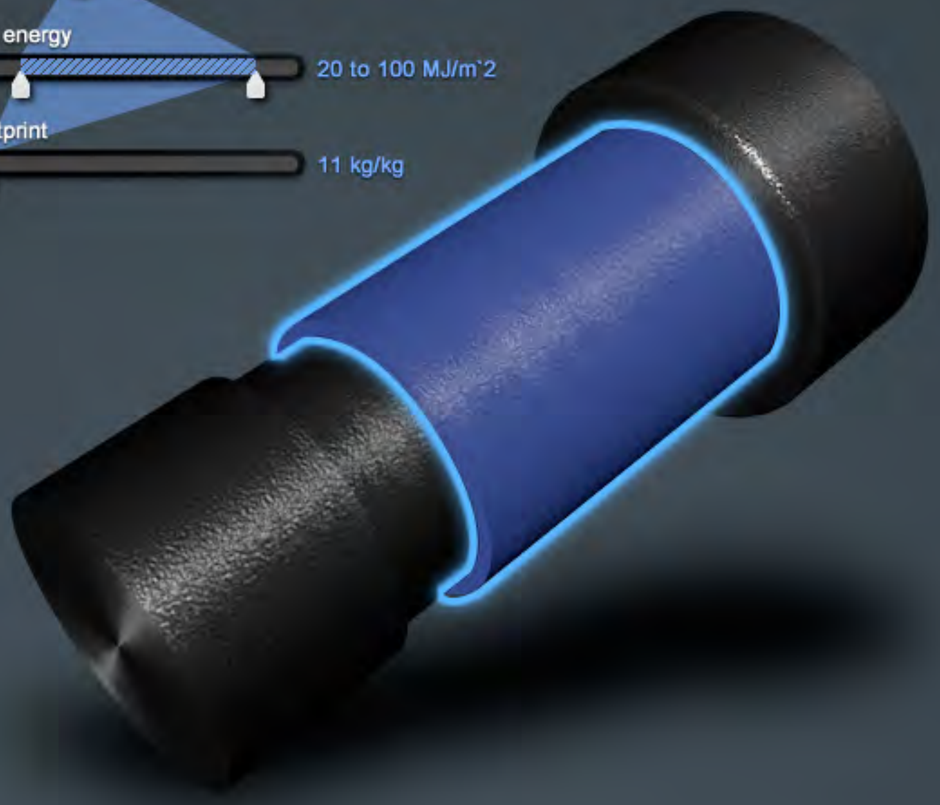
Workspace1
Carlos Olguin (787) - 7/15/2014, 10:20:07 AM

gtpase
Megan Riel-Mehan - 7/25/2014, 2:20:31 PM

MIL - Squish.stp
Joseph Schaeffer - 8/29/2014, 10:25:58 PM

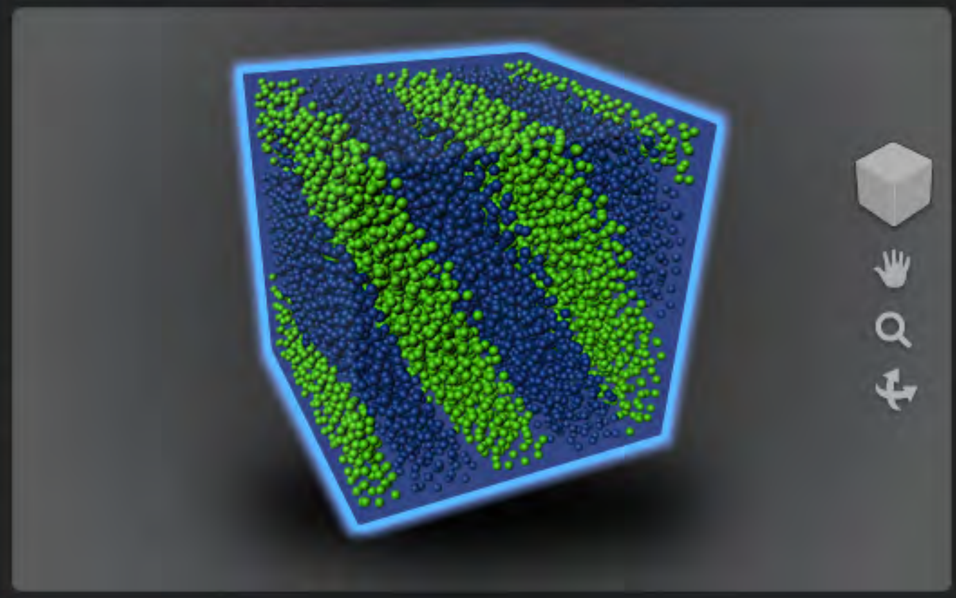
Workspace2
Carlos Olguin (787) - 10/27/2014, 12:53:17 AM



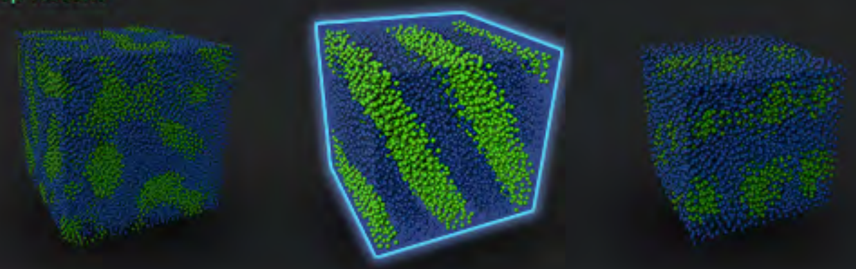


▼ Material

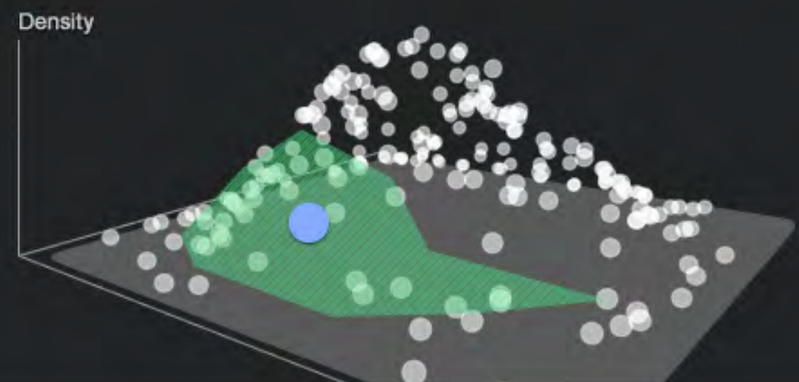
Density	3764 kg/m`3
Price	8.8 GBP/kg
E-plating energy	54 MJ/m`2
CO2 footprint	11 kg/kg

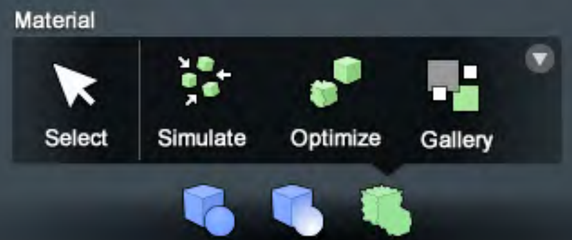


▼ Top Results



▼ Results





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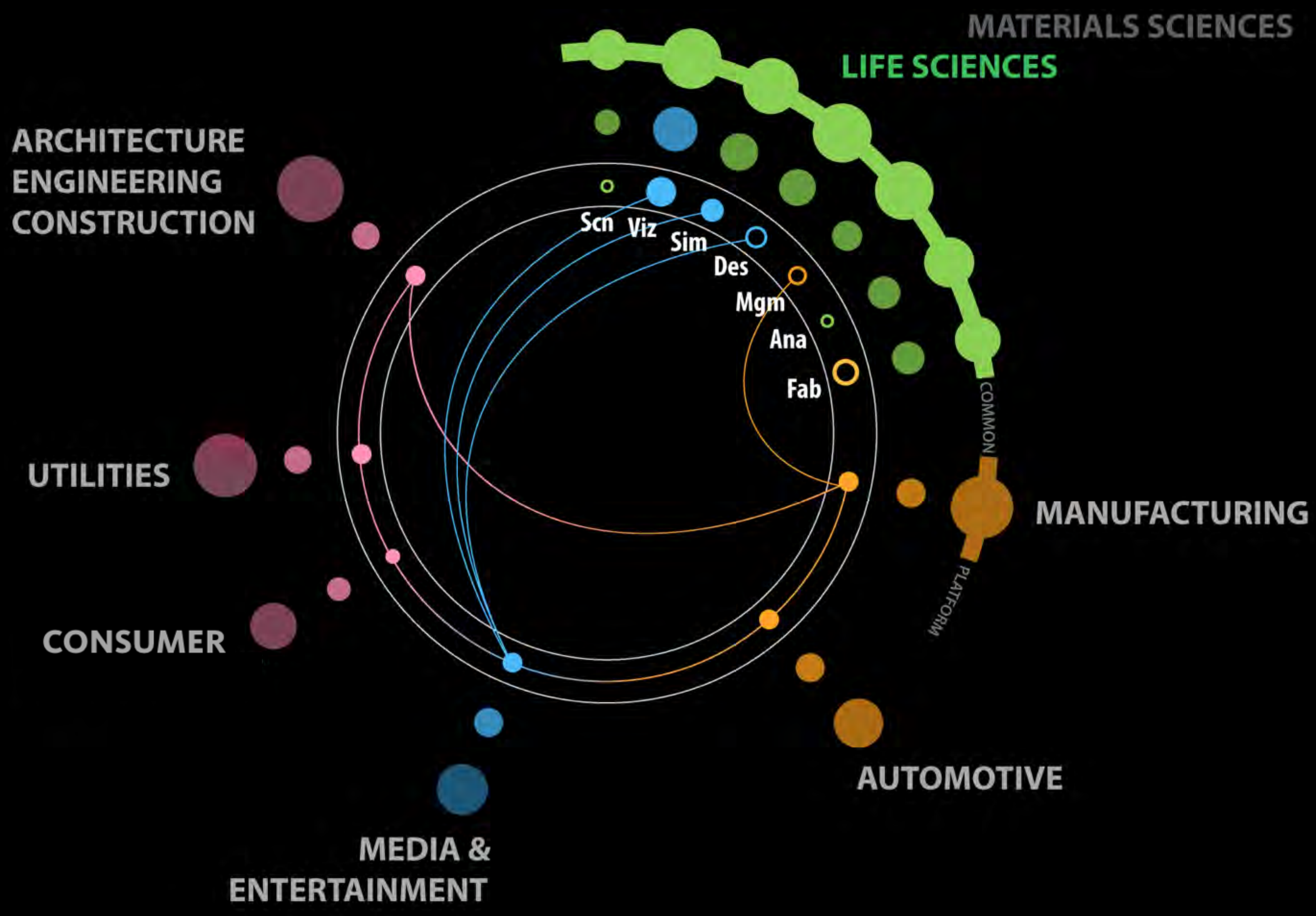

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LIFE SCIENCE

Scn Viz Sim Des Mgm Ana Fab

COMMON PLATFORM

MANUFAC

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