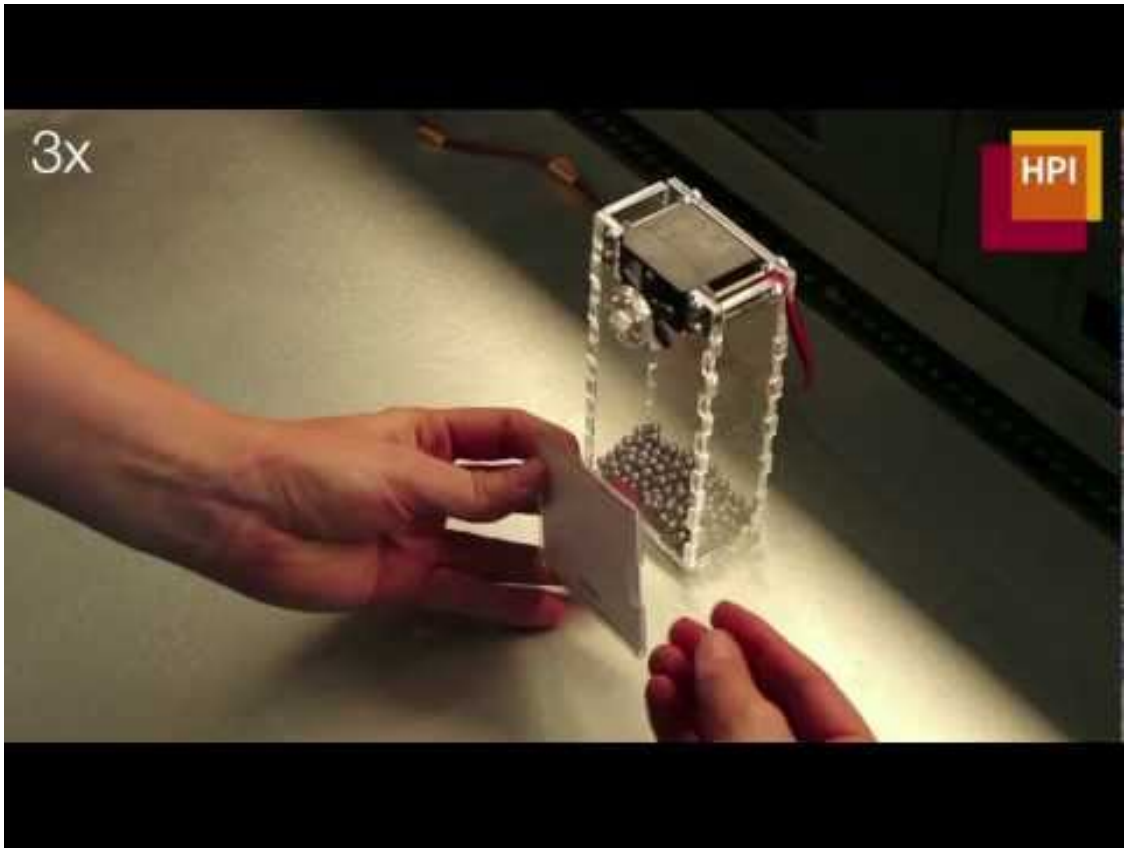
Computational Fabrication

CS 491 and 591
Professor: Leah Buechley
https://handandmachine.cs.unm.edu/classes/Computational_Fabrication_Spring2021/

CS Researcher: Stephanie Mueller

https://hcie.csail.mit.edu/stefanie-mueller.html
https://hcie.csail.mit.edu/

Laser Origami



https://www.youtube.com/watch?v=arjRtCjI9AQ&ab_channel=StefanieMueller

Hidden 3D Printed Tags

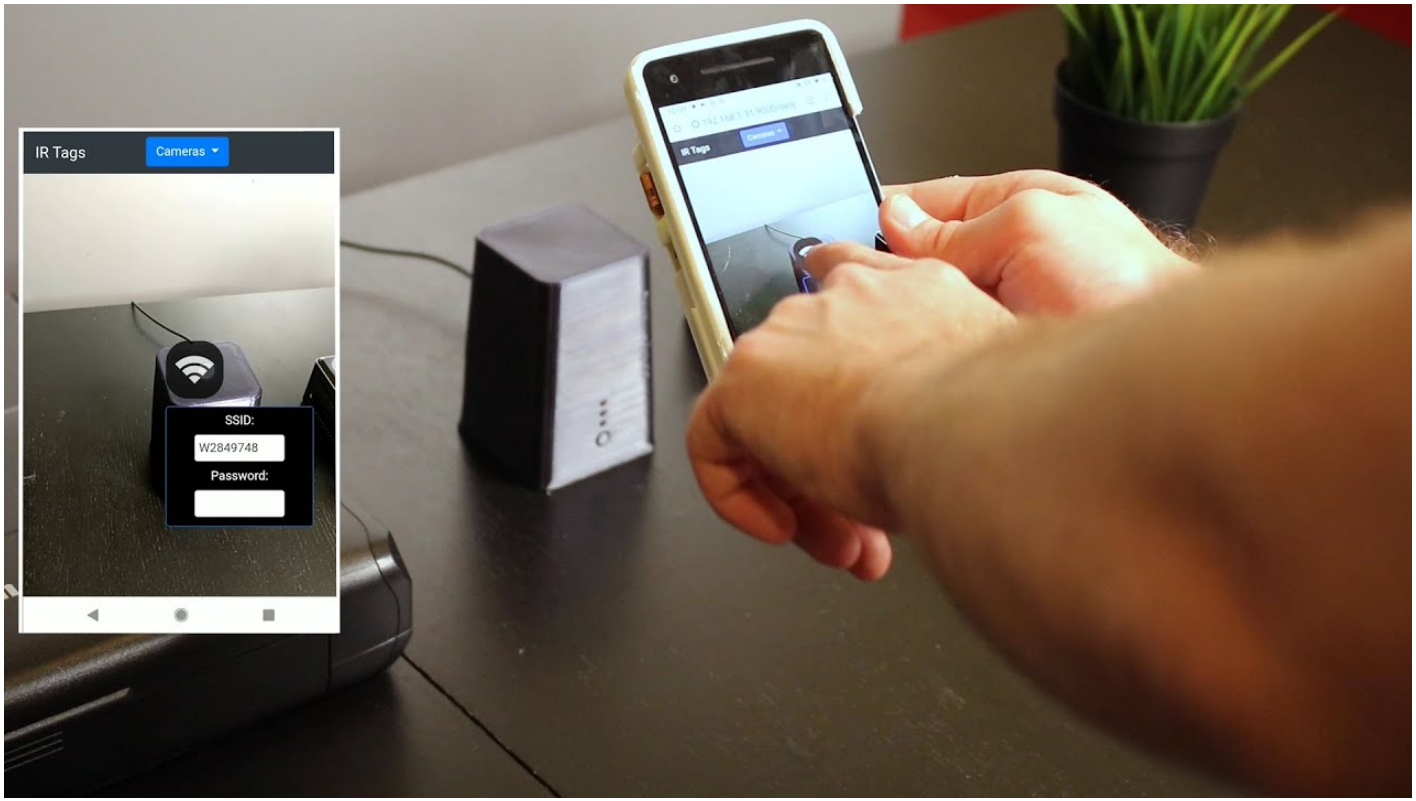
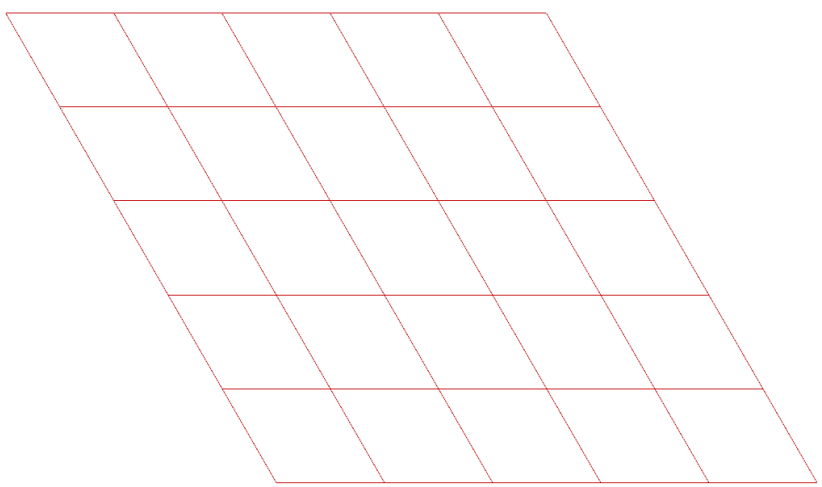
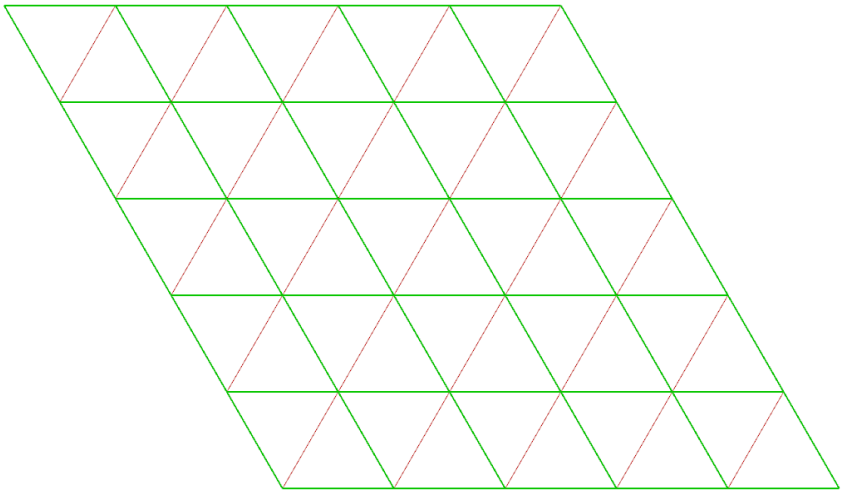


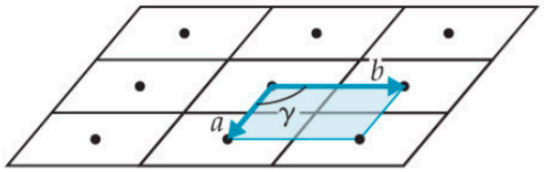
Photo-Chromeleon

Tiling Assignment

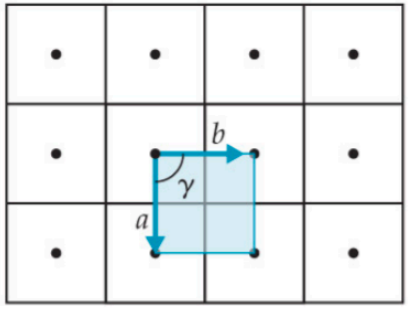




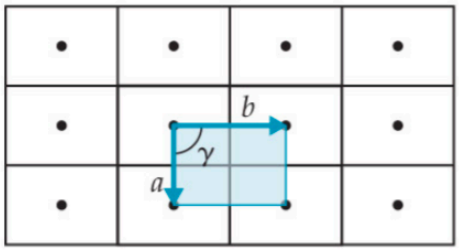
Tiling Assignment: Bravais Lattices



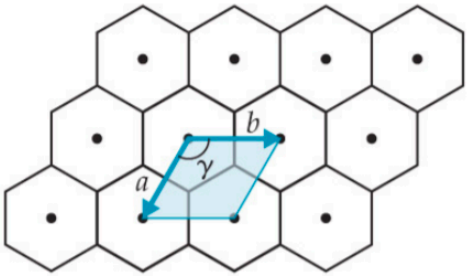
Oblique lattice ($a \neq b, \gamma =$ arbitrary)



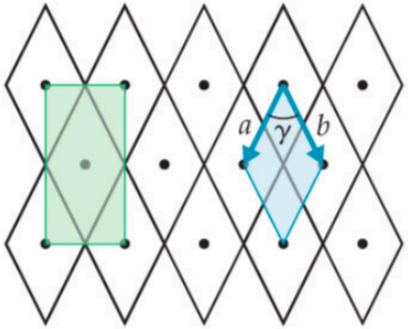
Square lattice ($a = b, \gamma = 90°$)



Rectangular lattice ($a \neq b, \gamma = 90°$)



Hexagonal lattice ($a = b, \gamma = 120°$)



Rhombic lattice ($a = b, \gamma =$ arbitrary)
Centered rectangular lattice

questions?

Schedule

Discrete Fabrication

A Different Kind of Computational Fabrication

Discrete Fabrication

Fabrication by combining discrete elements (ie: blocks) instead of continuous ones (ie: extruded filament)

Discrete Fabrication, “Digital Materials”

Lego vs. Clay

Modular, reconfigurable, more repeatable

Potentially faster and easier construction

Ability to work with more complex materials (ie: materials with embedded electronics)

Different way of characterizing and designing structures

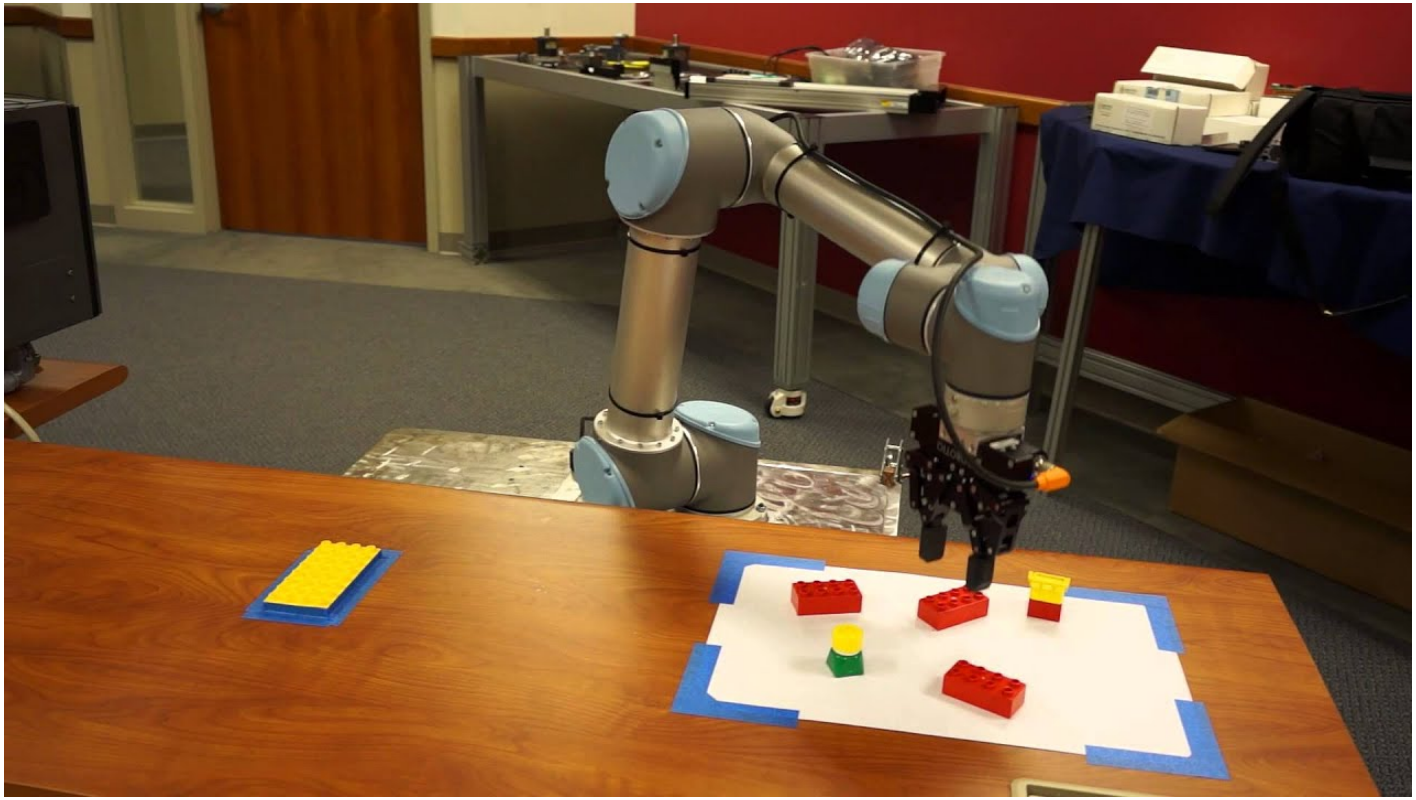
Centralized Discrete Fabrication

Discrete Fabrication: Maeda Lab

Fig. 20 3D Block Printing

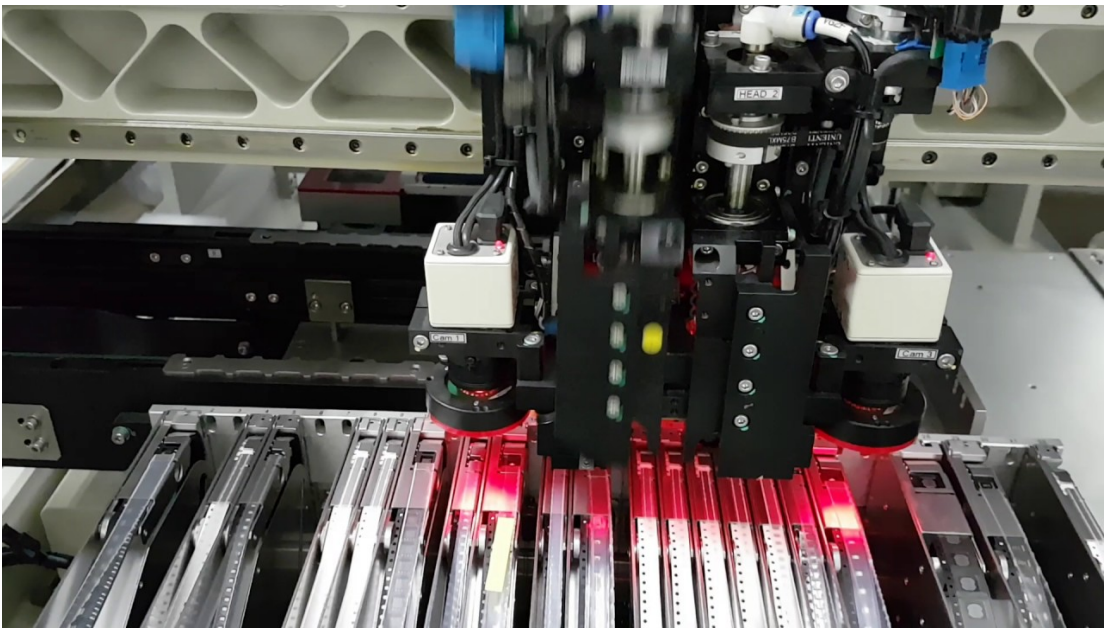
https://iir.ynu.ac.jp/
https://doi-org.libproxy.unm.edu/10.1080/24725854.2020.1755067

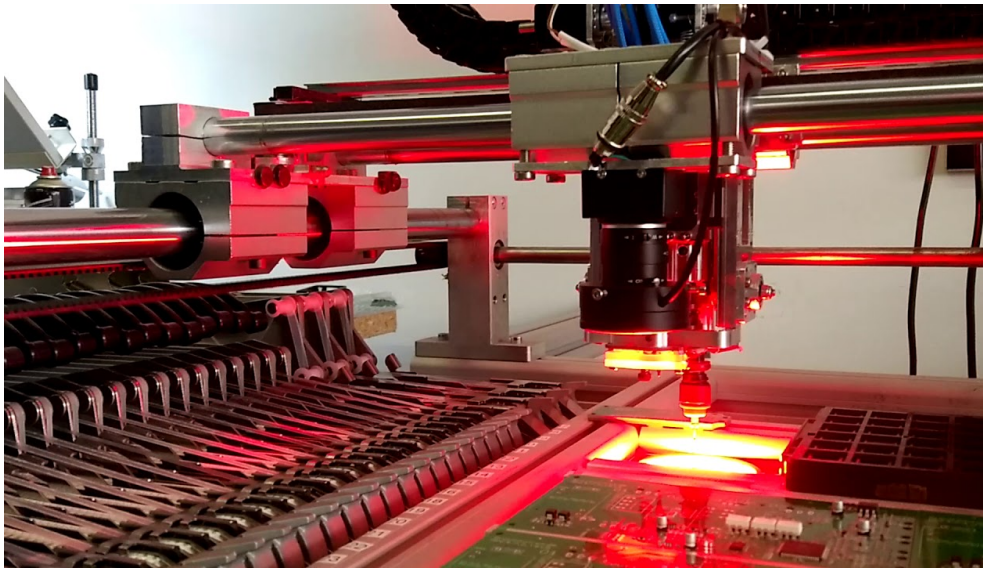
Simple assembly



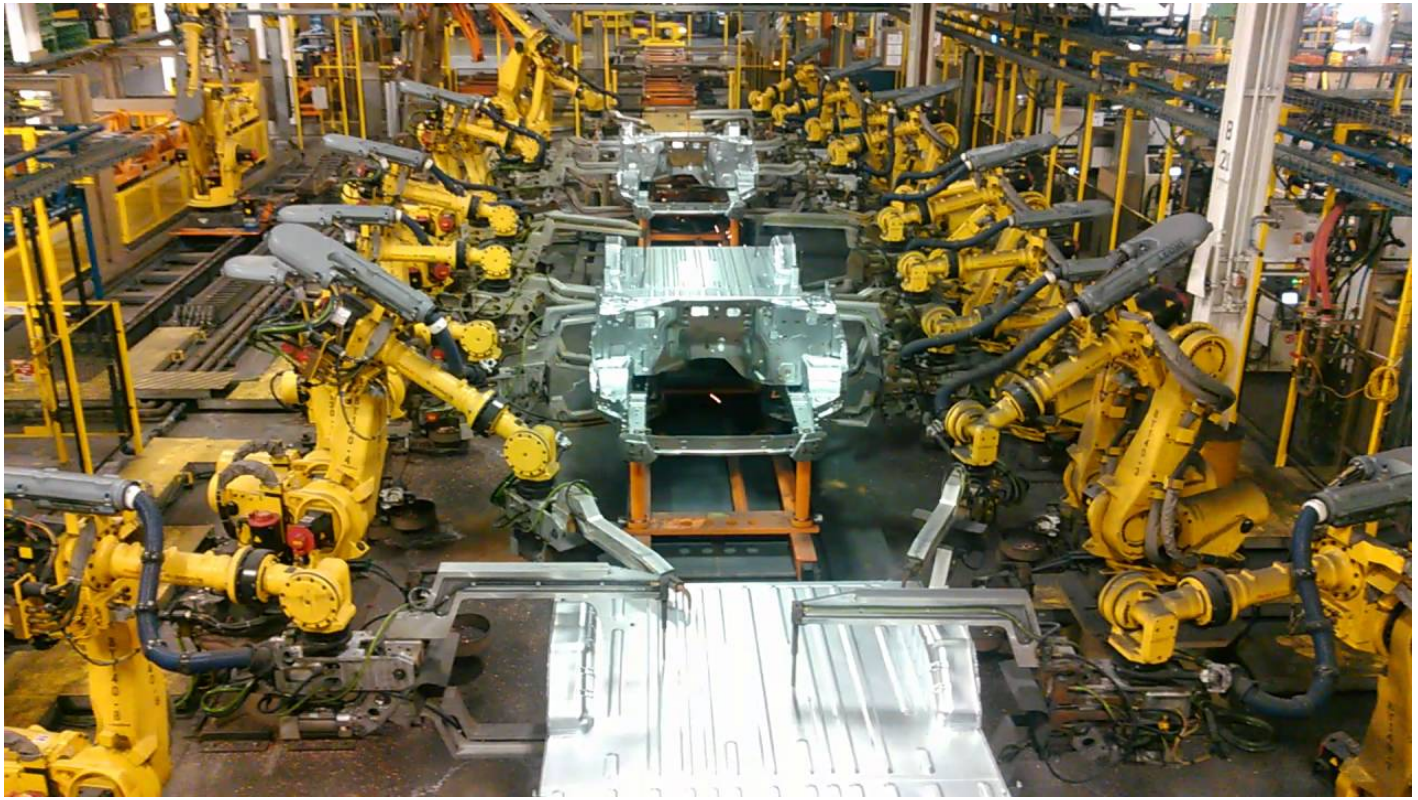
https://www.youtube.com/watch?v=Bn0Jg326drw&ab_channel=AxisNewEngland

Electronics Fabrication



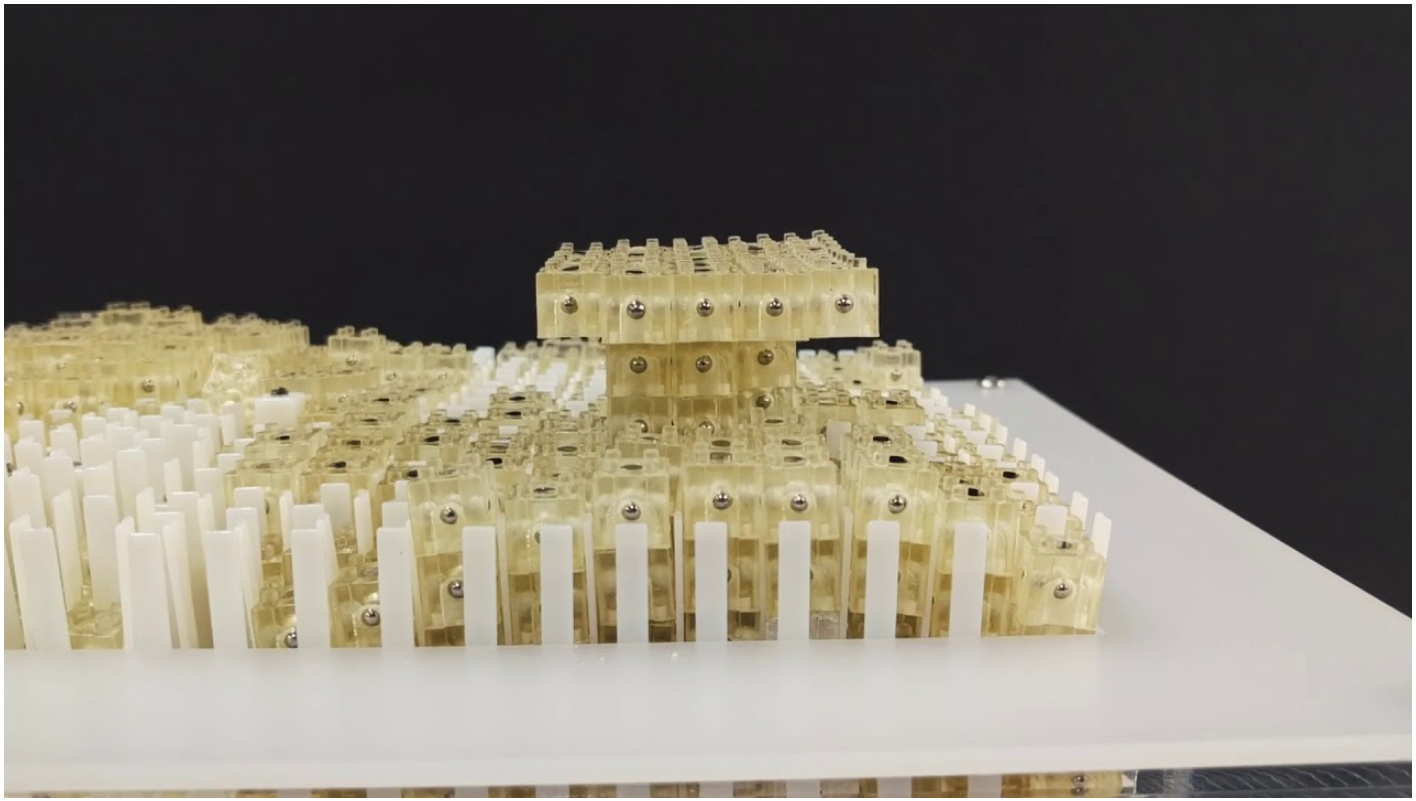


More complex assembly



https://www.youtube.com/watch?v=TzZHKEPqZ5I

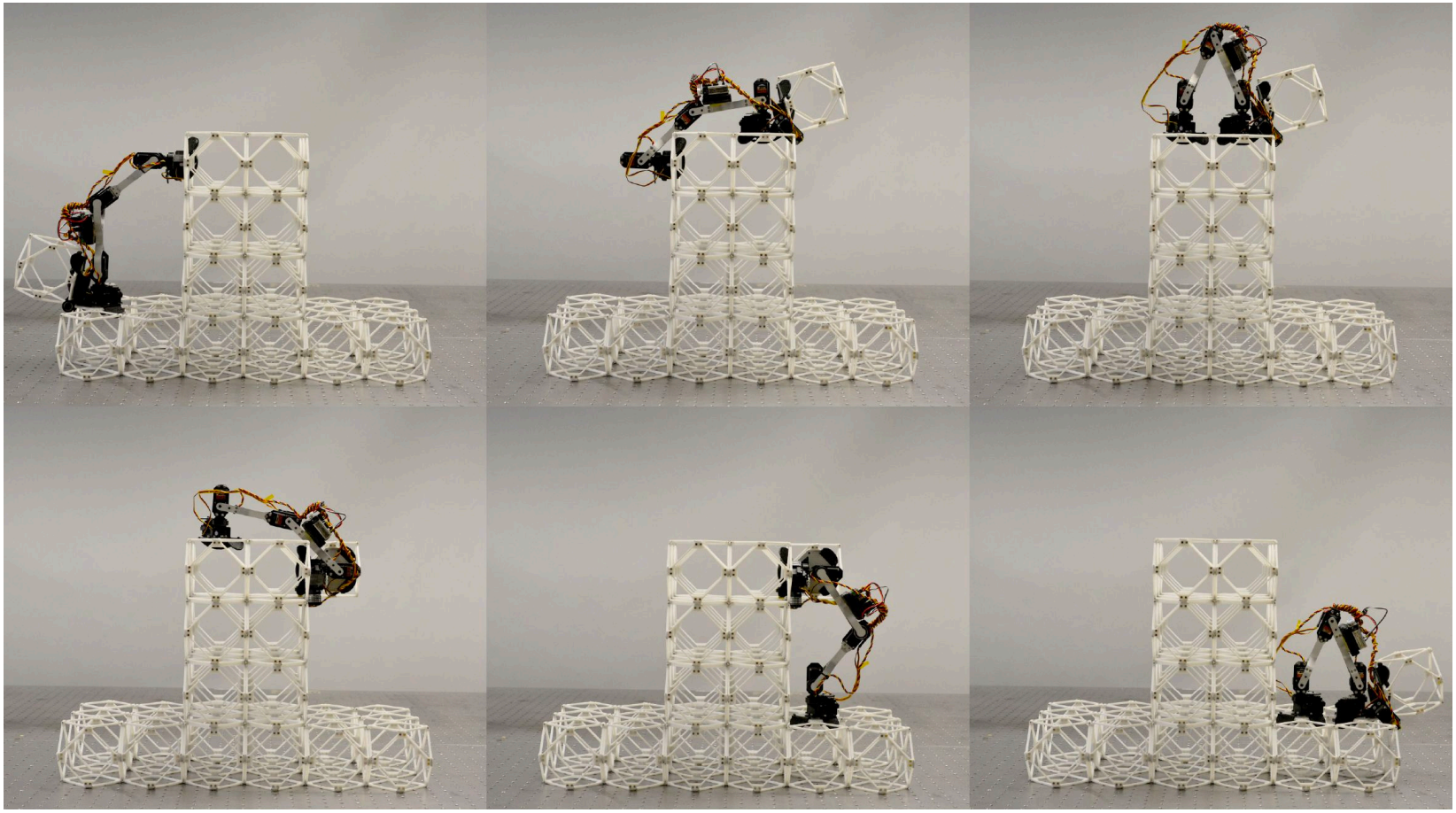
A different kind of example



Suzuki et al. https://ryosuzuki.org/dynablock/

https://www.youtube.com/watch?v=92eGI-gYYc4&t=1s

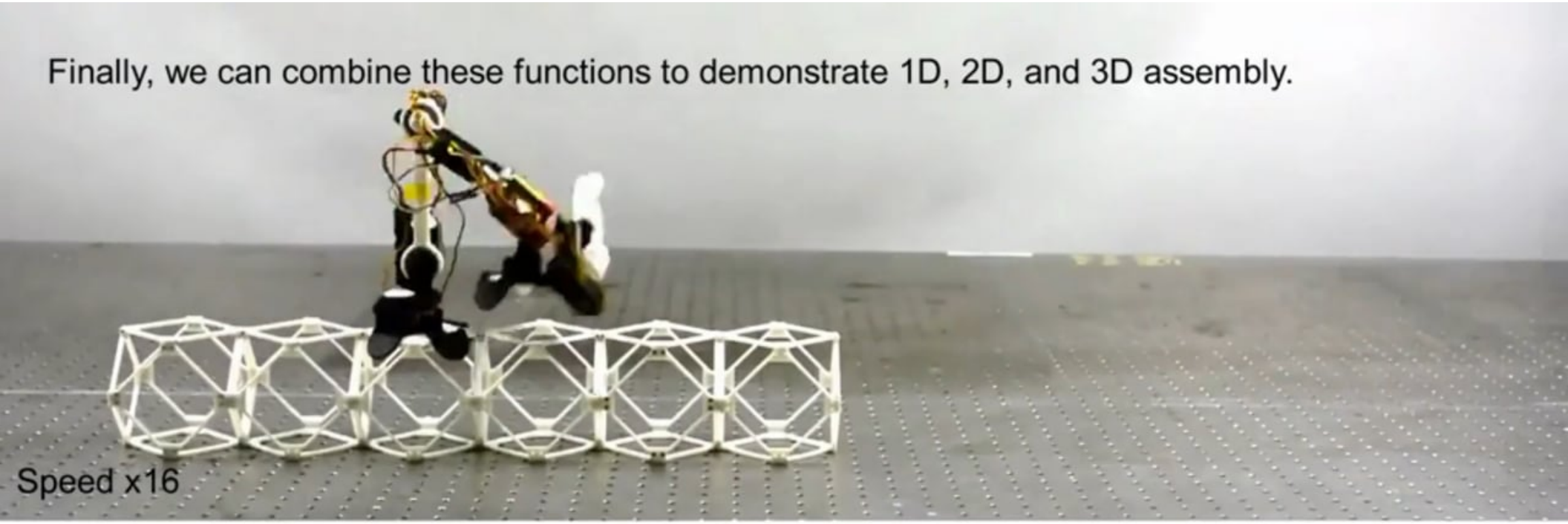
Benjamin Jenett, Center for Bits and Atoms

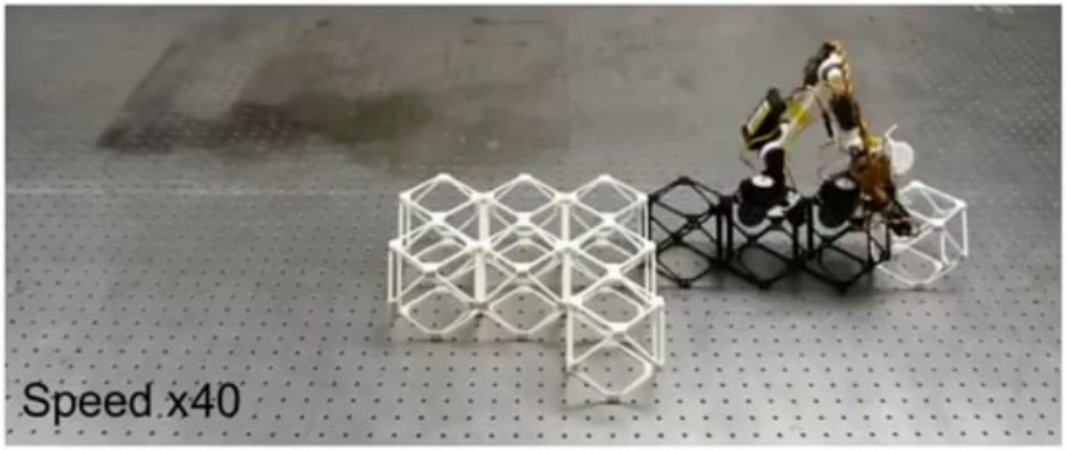


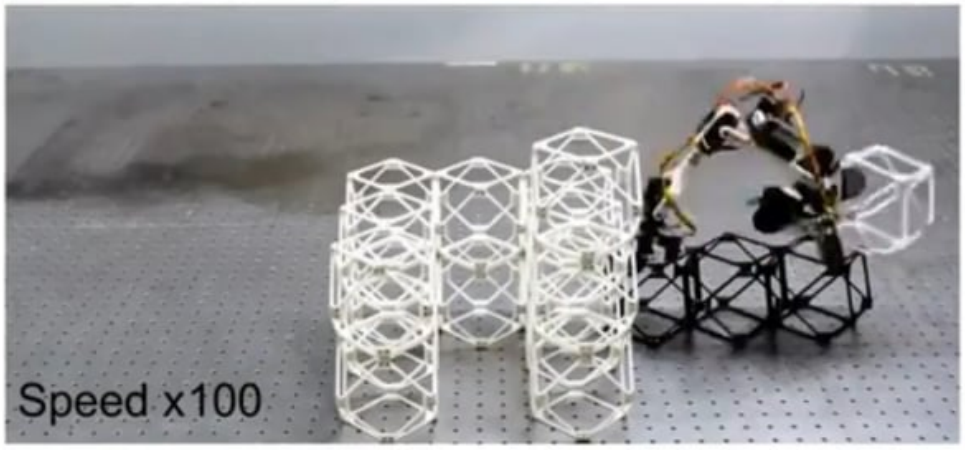
https://vimeo.com/366238474

https://bej.pages.cba.mit.edu/home/ , http://cba.mit.edu/docs/papers/17.06.scitech.bille.pdf

Finally, we can combine these functions to demonstrate 1D, 2D, and 3D assembly.







Decentralized Discrete Fabrication

Radhika Nagpal & the Self Organizing Systems Research Group

https://science.sciencemag.org/content/343/6172/754
https://www.youtube.com/watch?v=LFwk303p0zY&ab_channel=HarvardUniversity

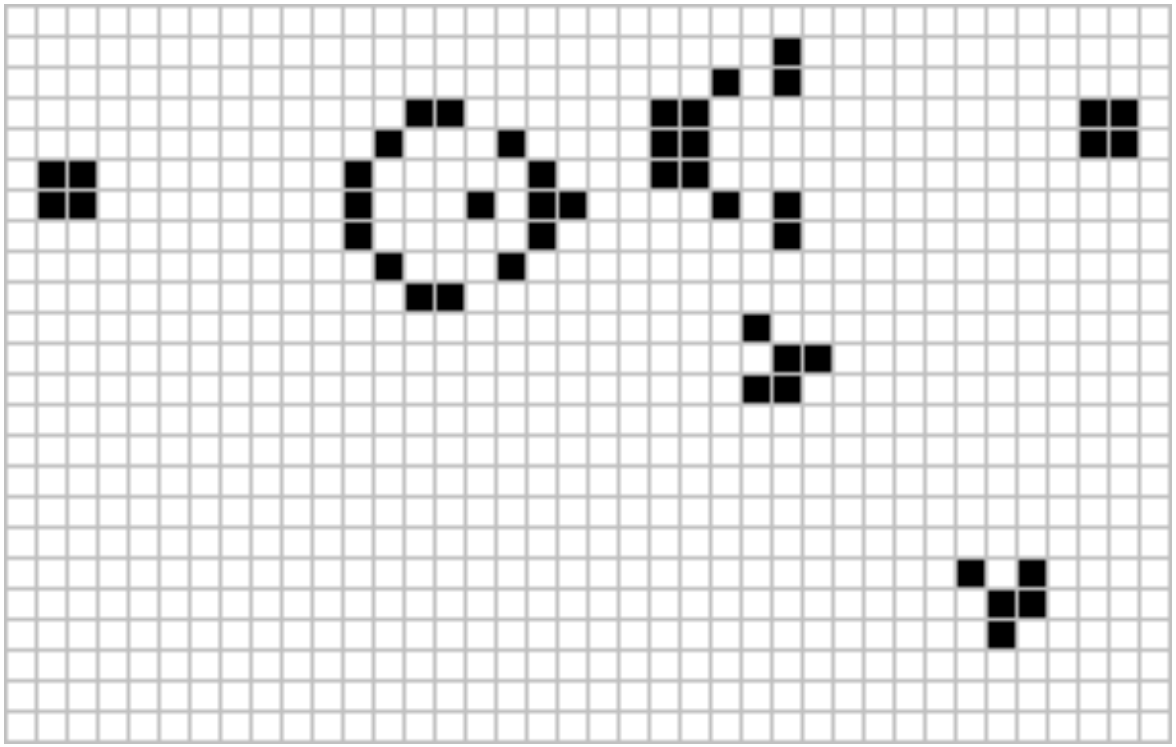
Self Assembly

How do many natural structures form?

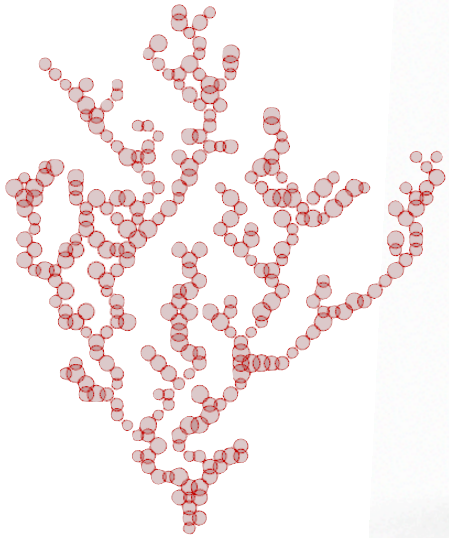
Discrete components (atoms, molecules, animals, etc.) interact and sometimes form complex structures

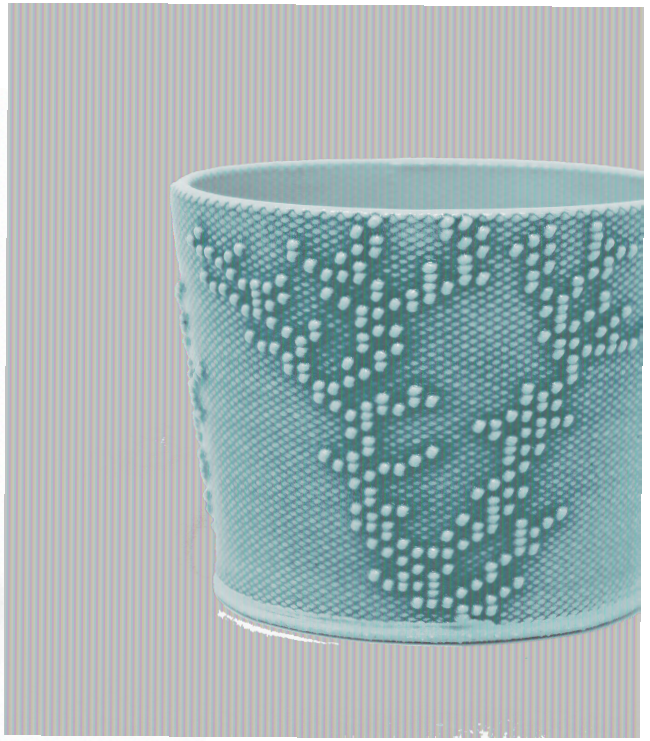
Cellular automata are good at modeling this kind of behavior

Self Assembly



Self Assembly





https://www.complexity-explorables.org/explorables/particularly-stuck/

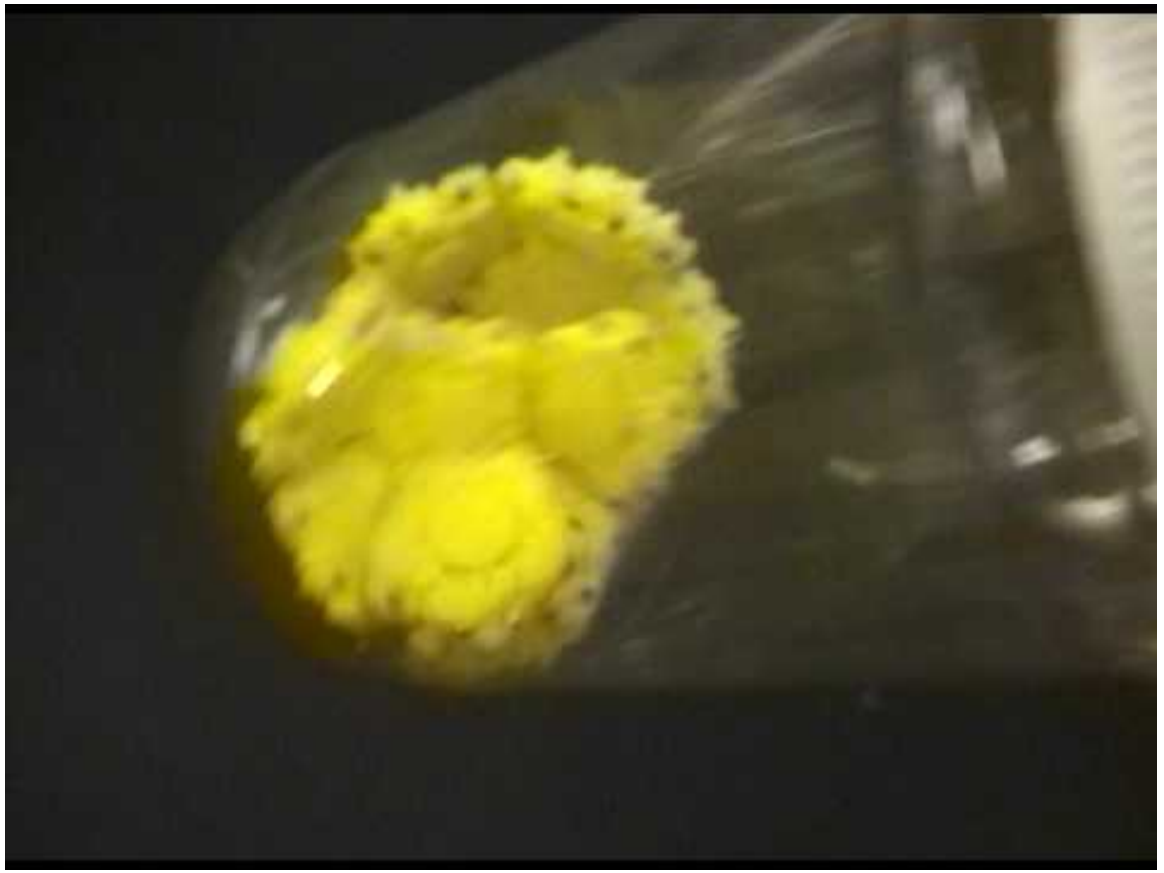
Self Assembly

Can we build physical structures that have some of these characteristics?

Potential energy (stored in objects) + energy from the environment (heat, movement, etc.) = new forms

Mimics chemical and biological processes.

Self Assembly: Arthur Olson et al.



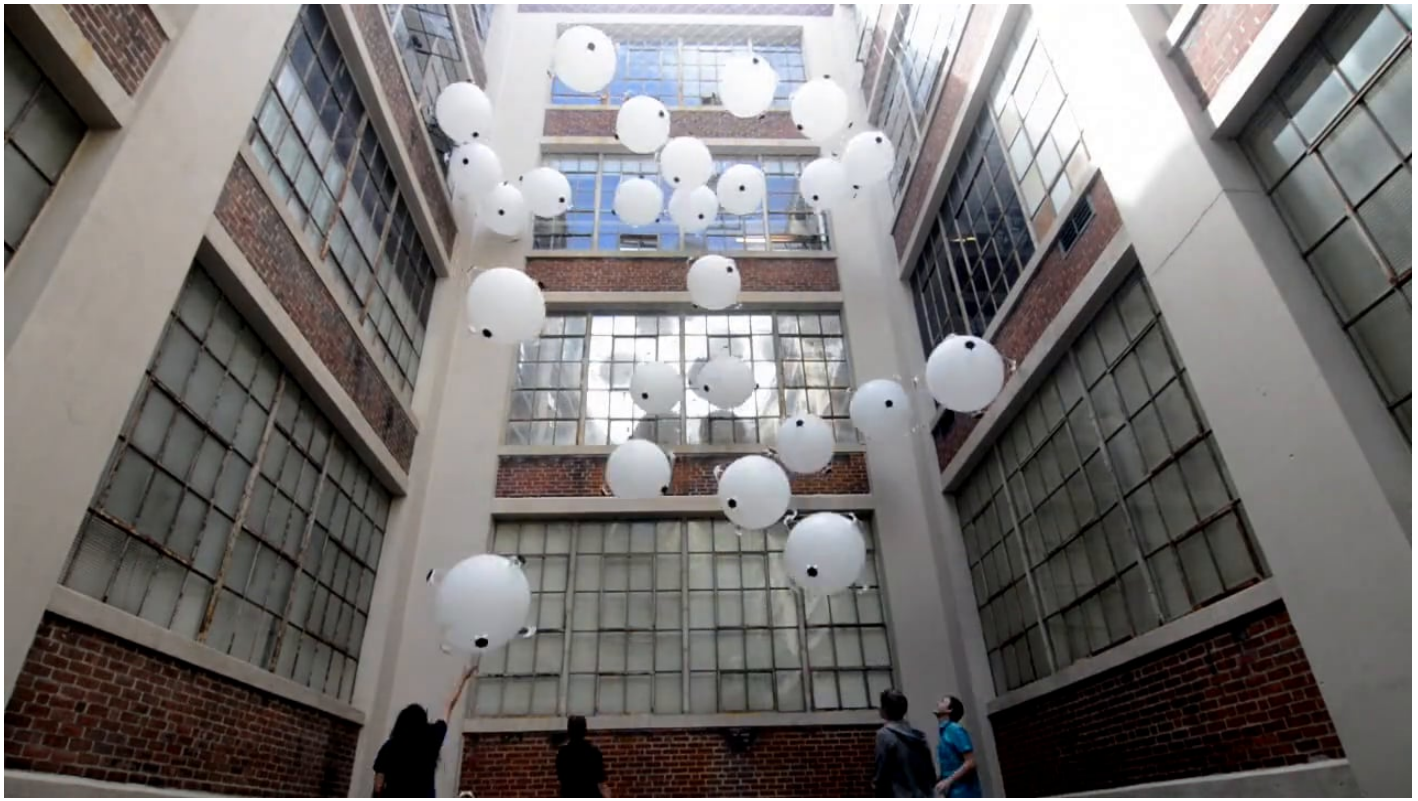
https://www.pnas.org/content/104/52/20731

https://www.youtube.com/watch?v=X-8MP7g8XOE&t=41s&ab_channel=ArthurOlson

Self Assembly: DNA Modeling

https://www.pnas.org/content/116/49/24402
https://news.cornell.edu/stories/2019/11/self-assembling-system-uses-magnets-mimic-specific-binding-dna

Skylar Tibbits and the Self Assembly Lab

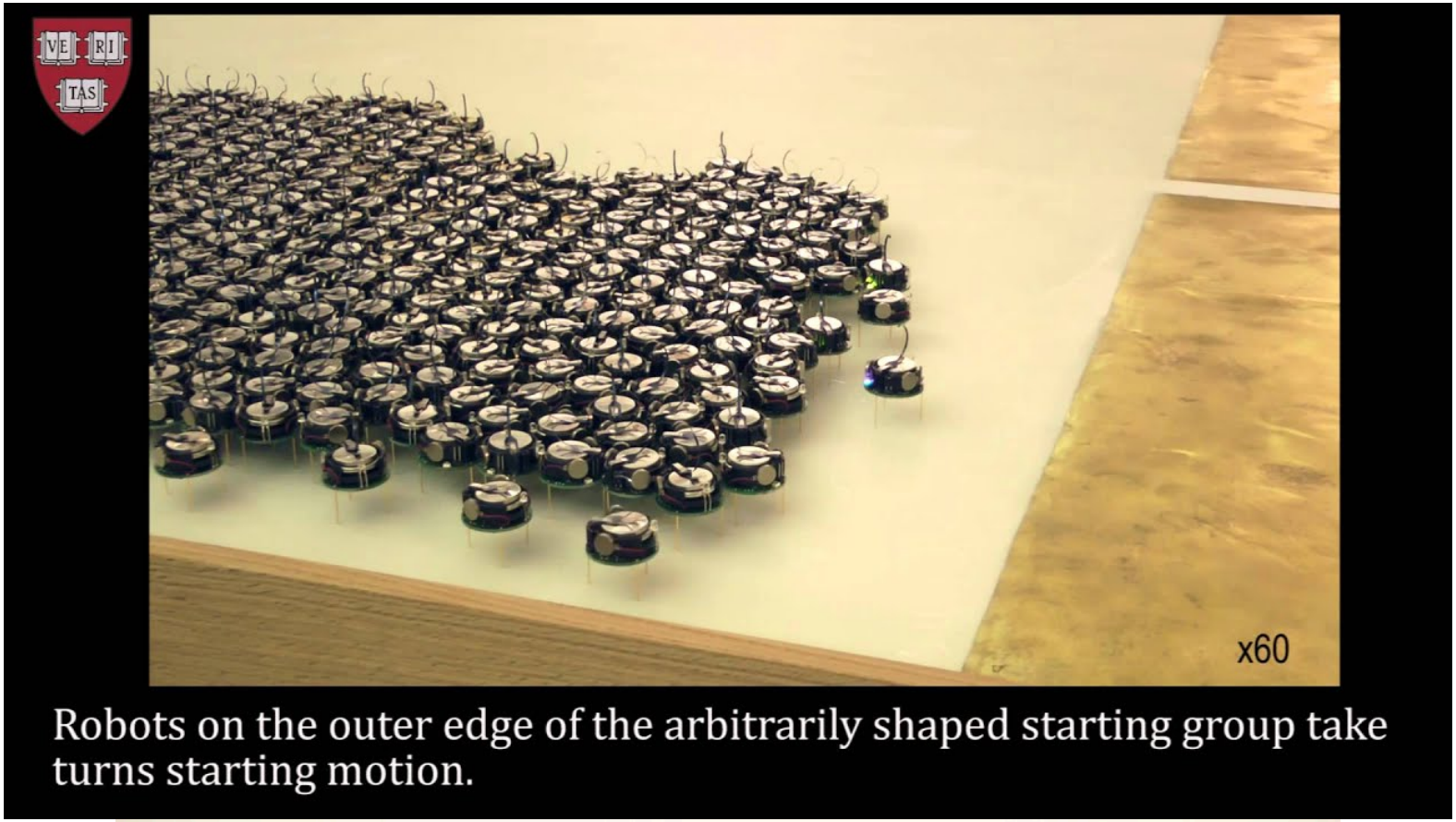


https://selfassemblylab.mit.edu/
https://www.youtube.com/watch?v=MxCfB-ar7M4&ab_channel=BSHHomeAppliancesGroup

Self Assembly + Robotics

What if more energy and “intelligence” is in the blocks?

Radhika Nagpal & the Self Organizing Systems Research Group



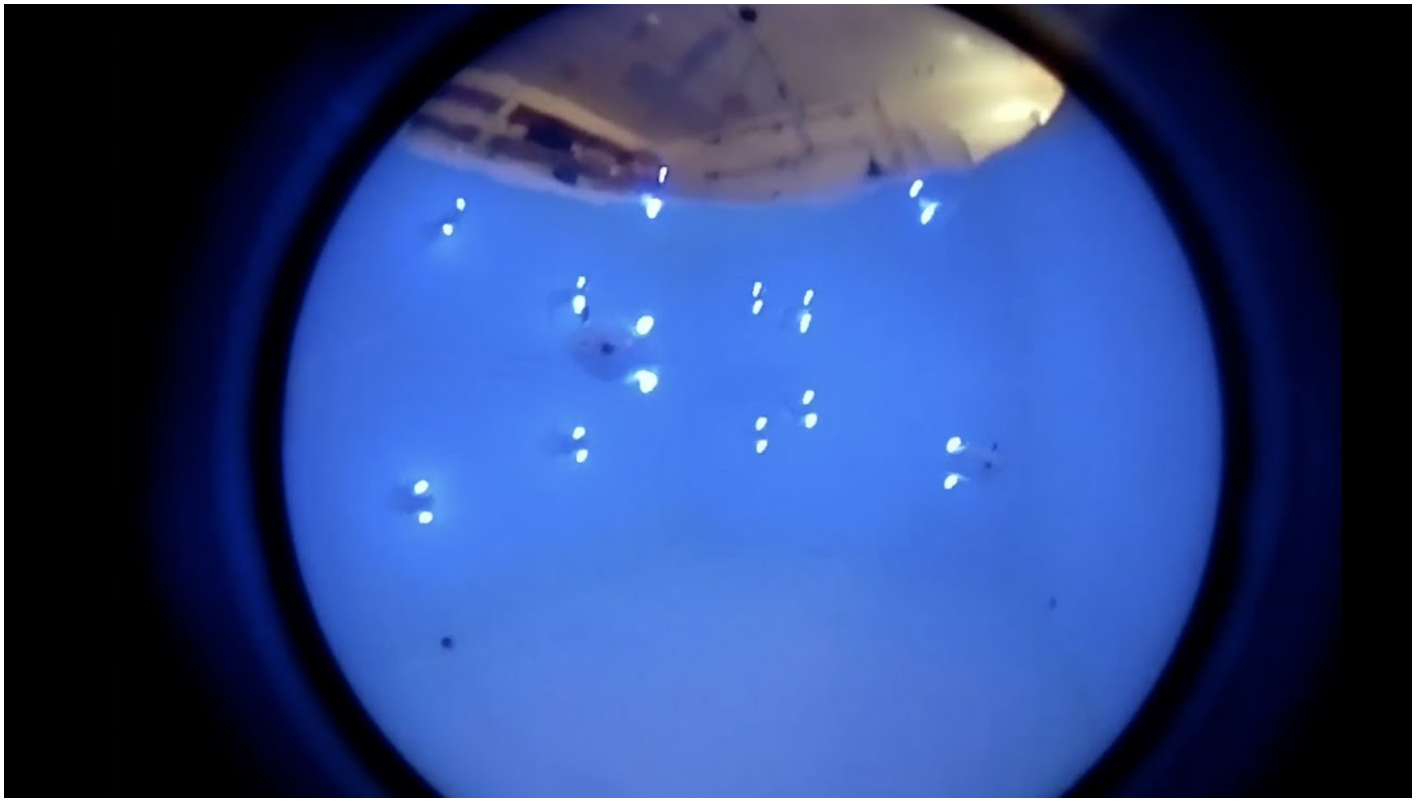
https://ssr.seas.harvard.edu/

https://www.youtube.com/watch?v=xK54Bu9HFRw&ab_channel=HarvardUniversity

Hod Lipson and the Creative Machines Lab

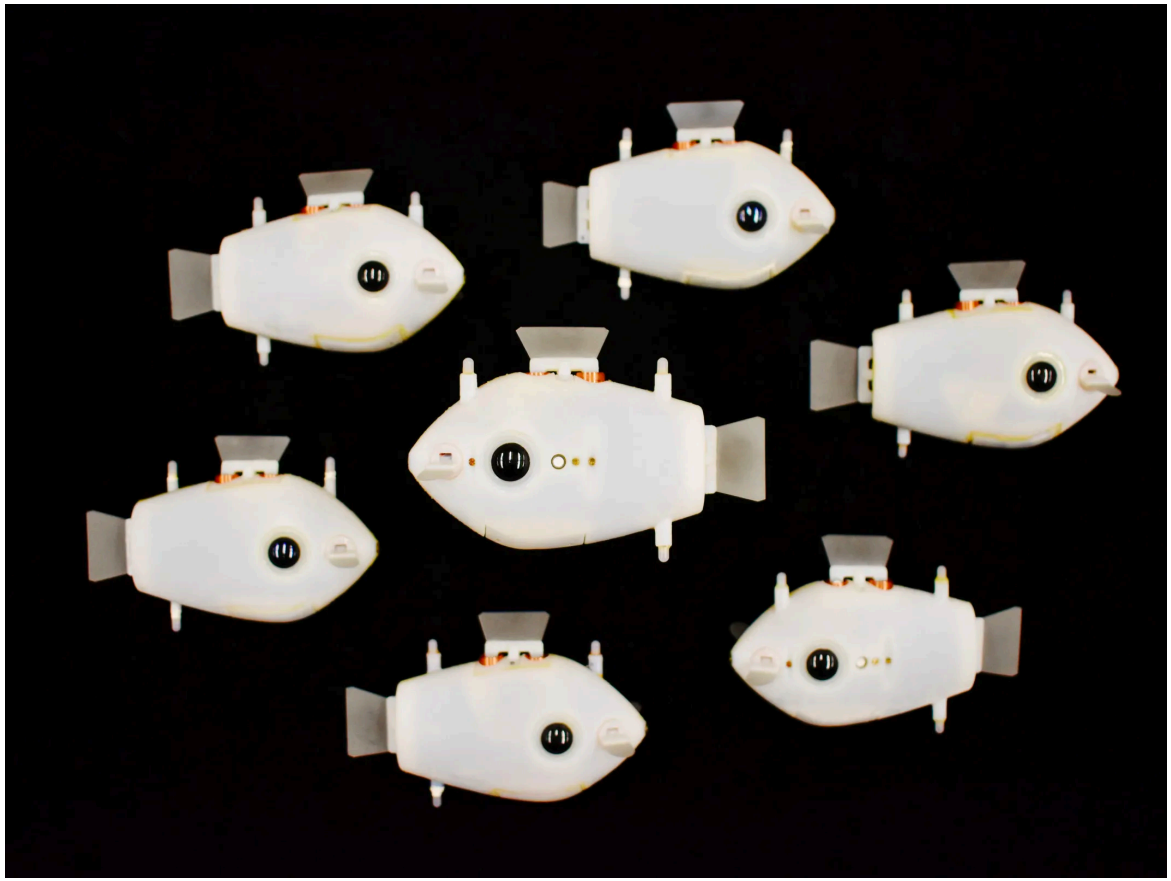
https://www.creativemachineslab.com/particle-robotics.html
https://www.youtube.com/watch?v=LczD_rvWtSY&ab_channel=naturevideo

Radhika Nagpal & the Self Organizing Systems Research Group



https://ssr.seas.harvard.edu/
https://www.youtube.com/watch?v=bcVa0PcIl_o&ab_channel=SSRLabHarvard

Radhika Nagpal & the Self Organizing Systems Research Group



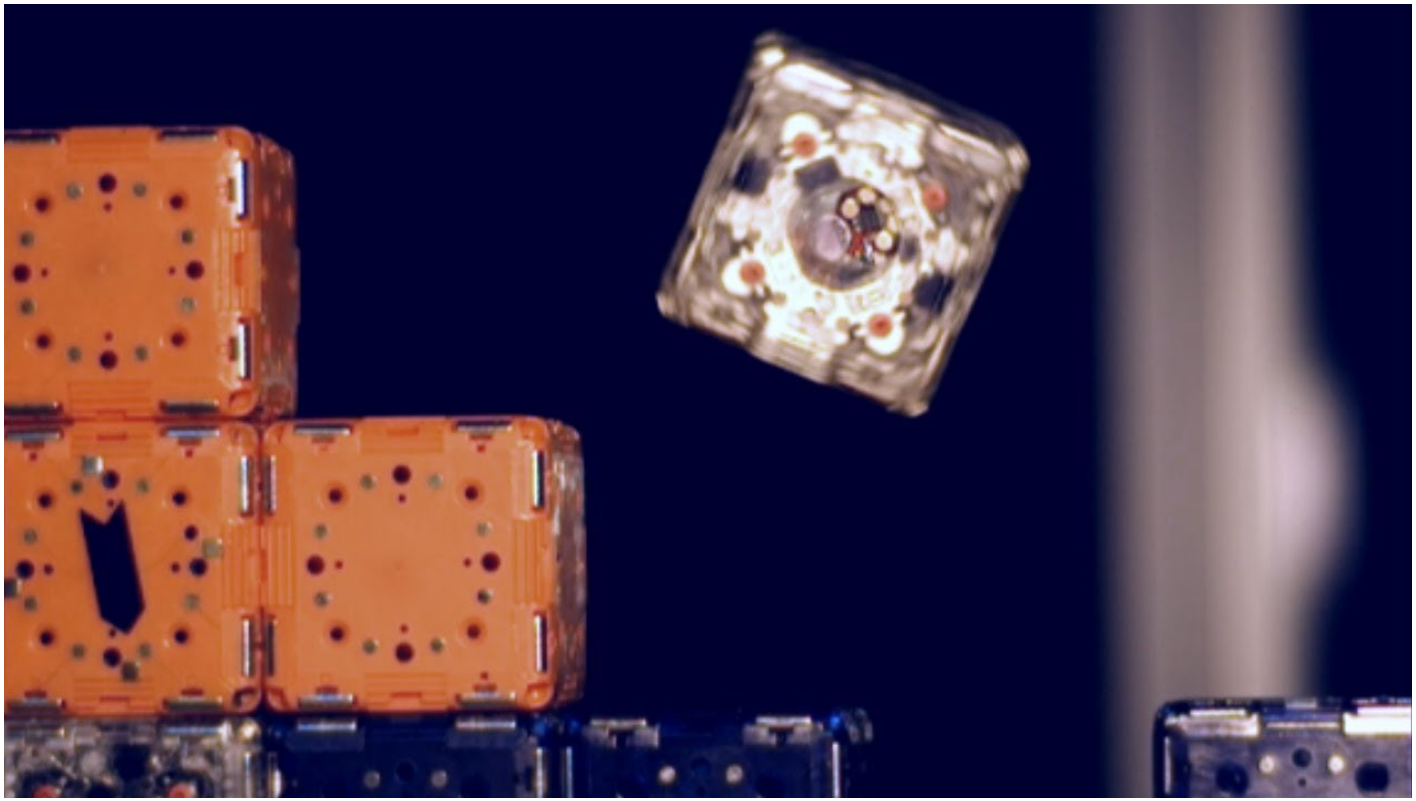
https://ssr.seas.harvard.edu/
https://www.youtube.com/watch?v=bcVa0PcIl_o&ab_channel=SSRLabHarvard

Cubelets: A kit for kids

https://modrobotics.com/

https://www.youtube.com/watch?v=YPAOCOJibfQ&ab_channel=modrobotics

Daniela Run and the Distributed Robotics Laboratory



https://www.csail.mit.edu/research/distributed-robotics-laboratory
https://www.youtube.com/watch?v=hI5UDKaWJOo&ab_channel=MITCSAIL

questions?

Thank you!

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