

Modeling Through Self-Assembly

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University of Tokyo workshop.

February 28, 2018

Standard Model

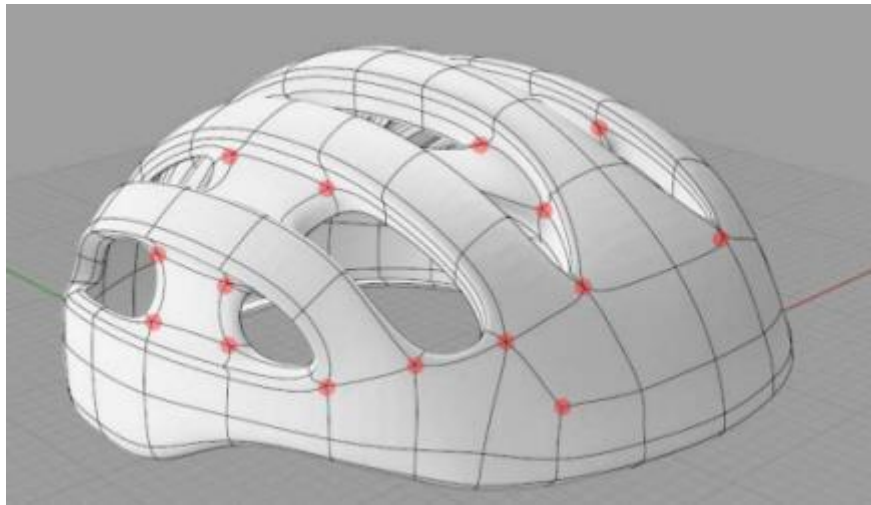


“Artist”



“Model”

Top Down Approach



“Control Points”



“Surface”

Top Down Approach

input



output

Data amplification

Bottom Up Approach

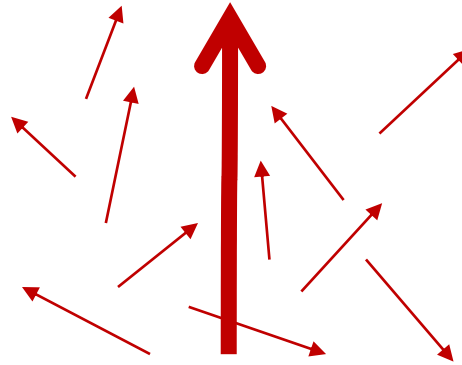
output



input

Shapes *Emerge* from locality

output



input

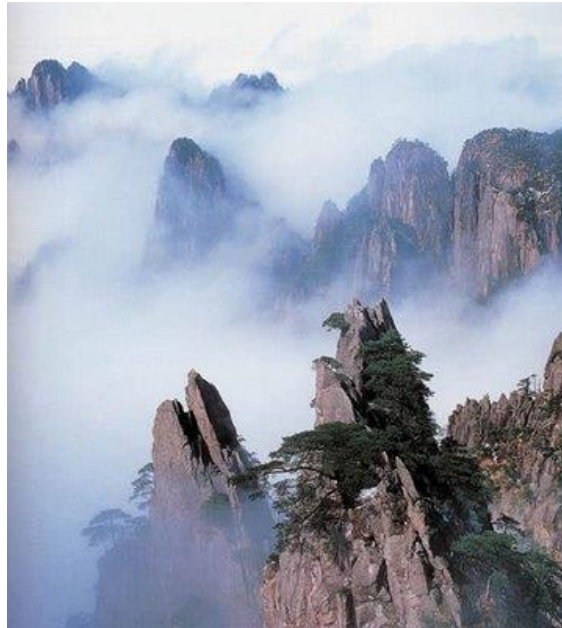
Need a simulator

Nucleus



Publication

Jos Stam. (2009). **Nucleus: Towards a Unified Dynamics Solver for Computer Graphics**. *2009 Conference Proceedings: IEEE International Conference on Computer-Aided Design and Computer Graphics*. pp. 1-11.

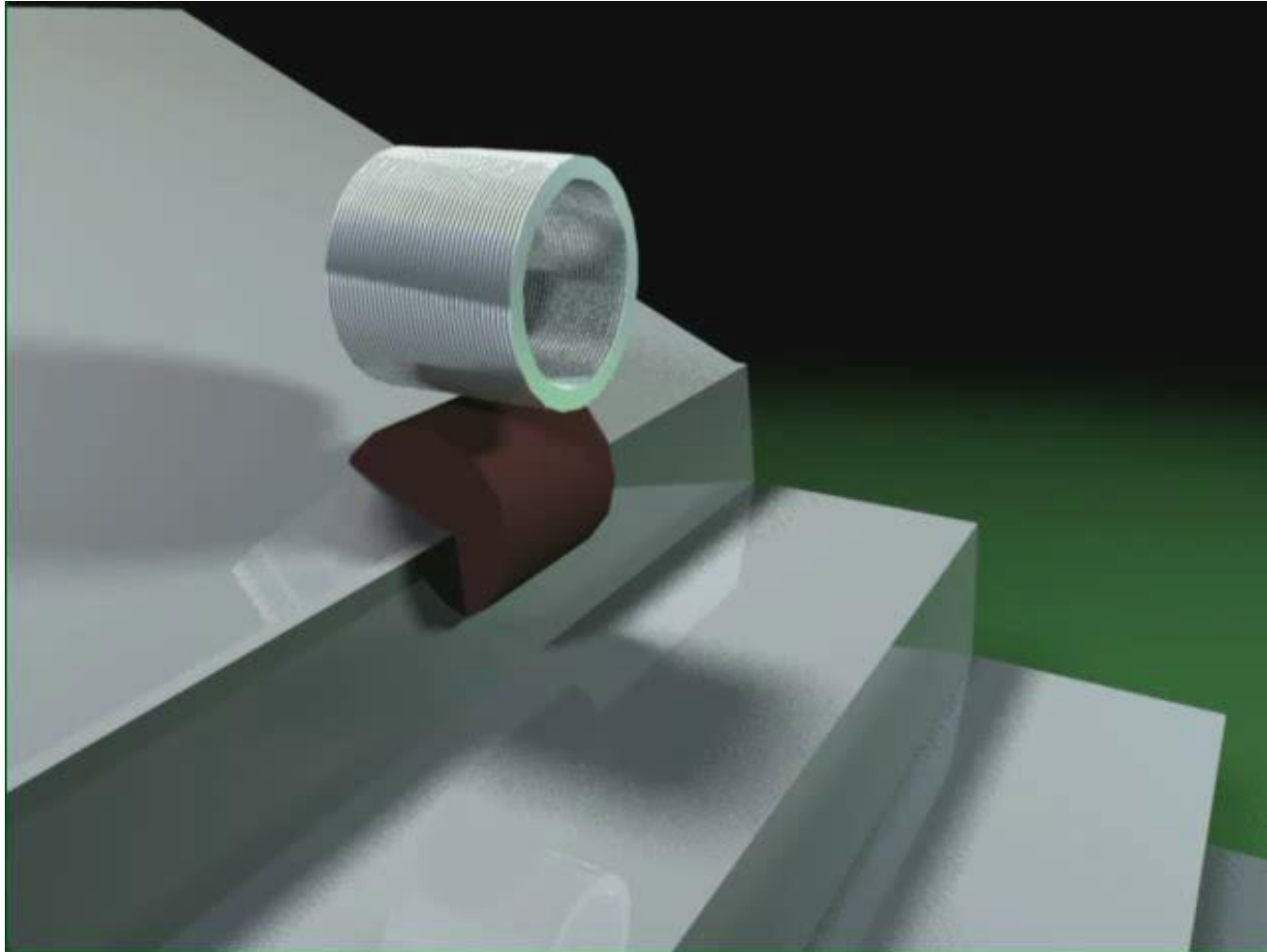


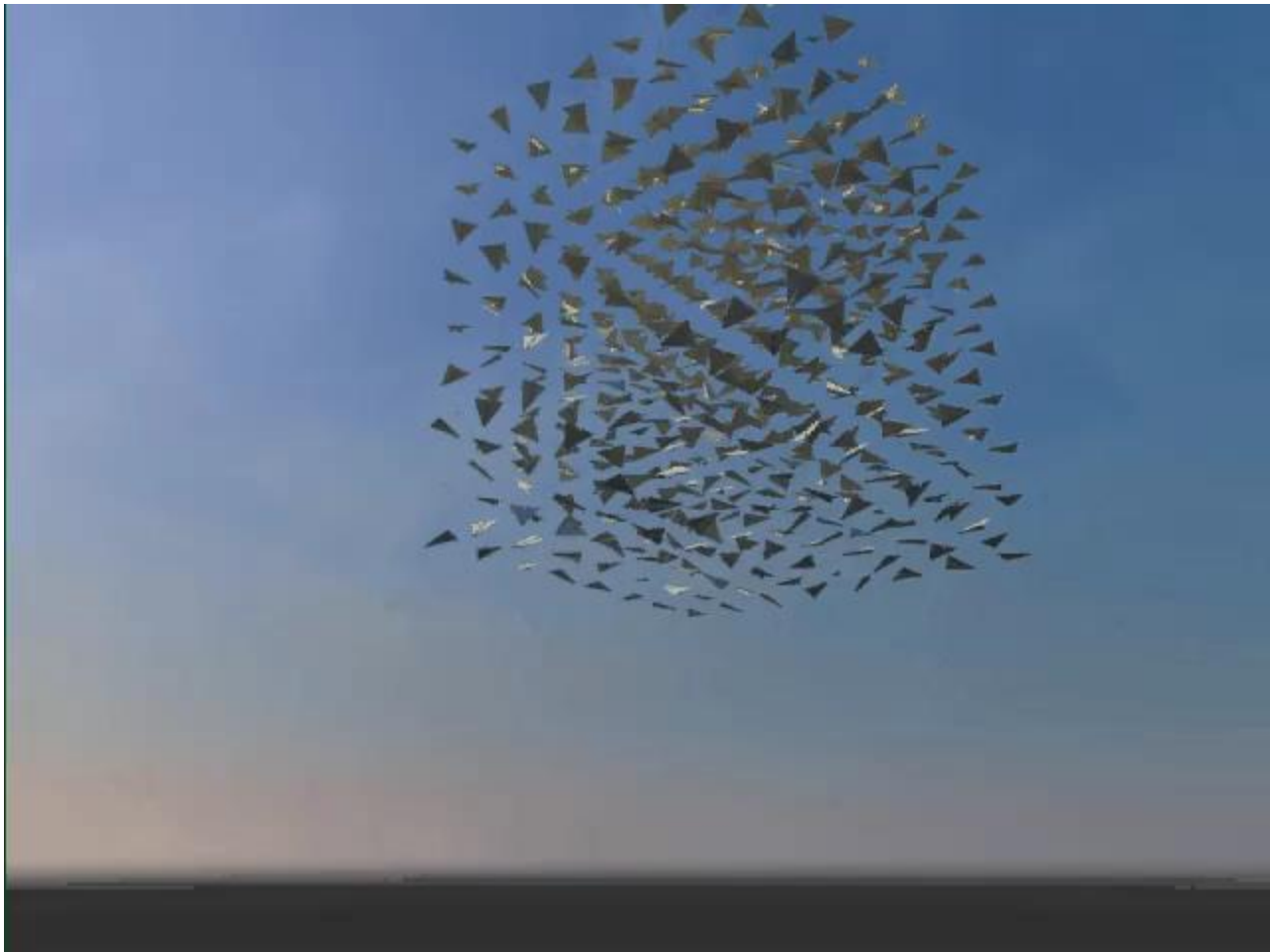
<https://www.autodeskresearch.com/publications/nucleus>

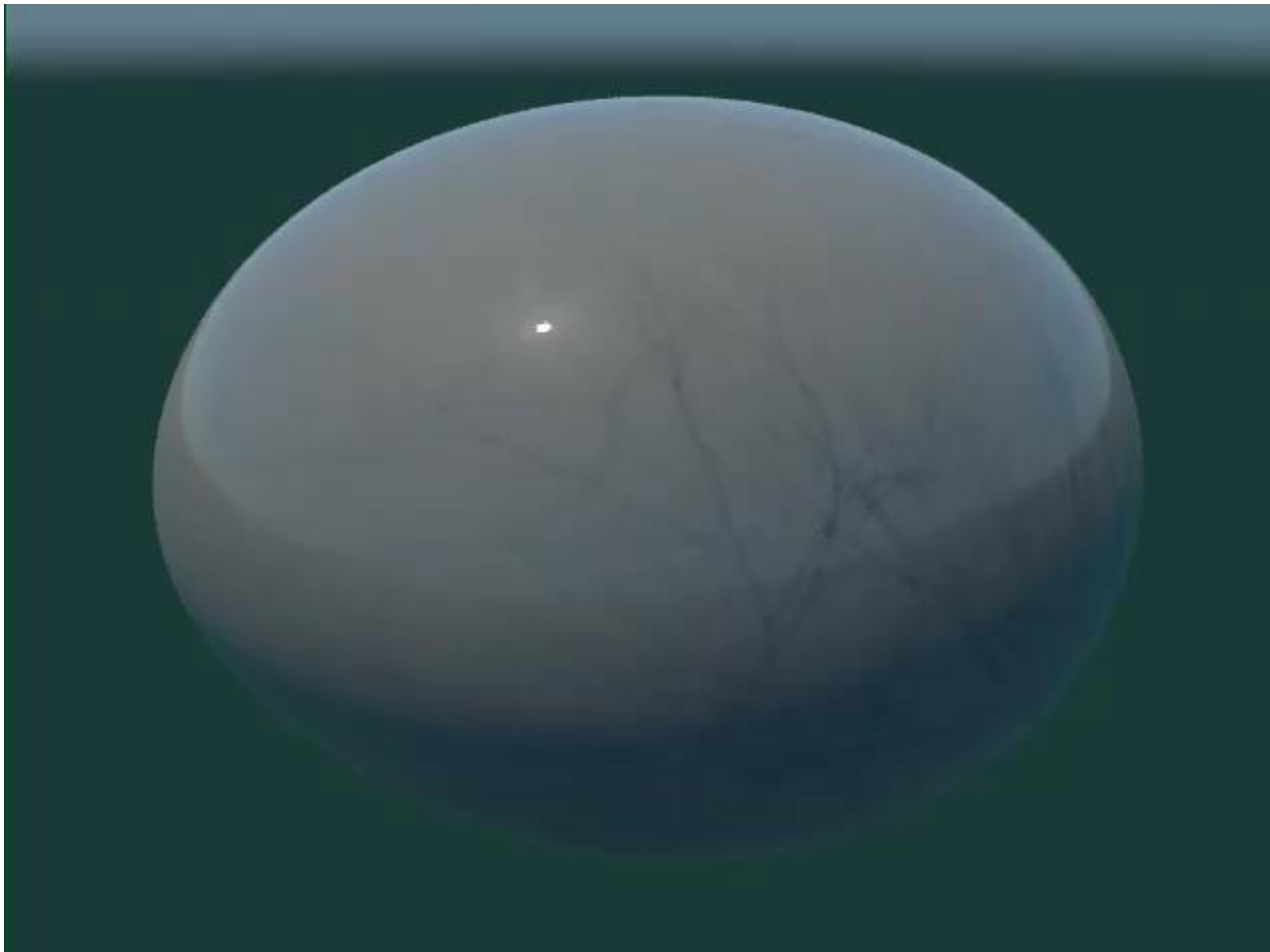
Brazil Nuts



Slinky







nParticles and MAYA Fluids

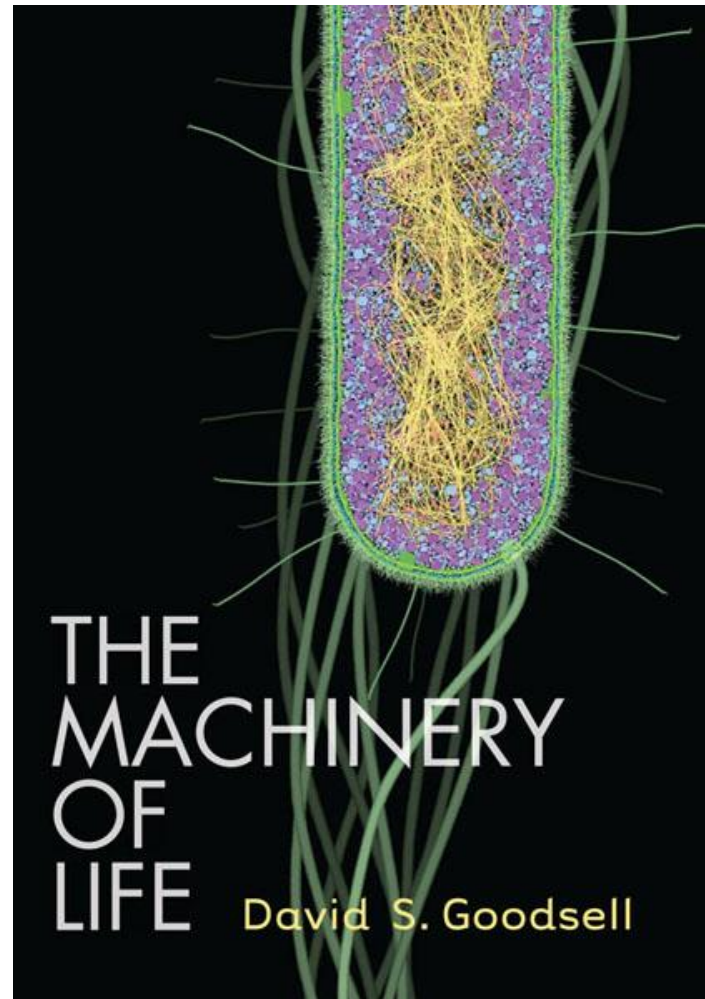


Used in Movies



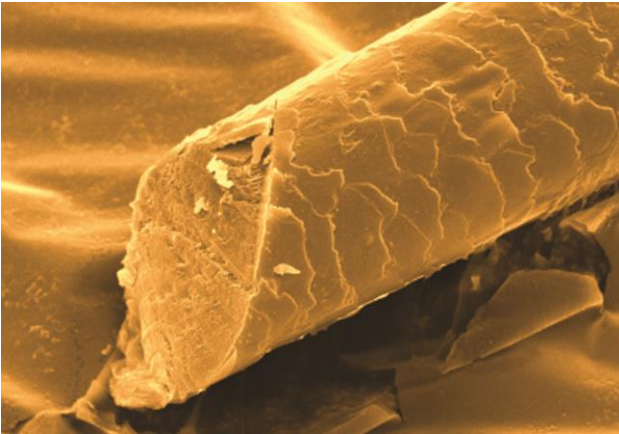
And many others...

Inspired by Micro-Biology



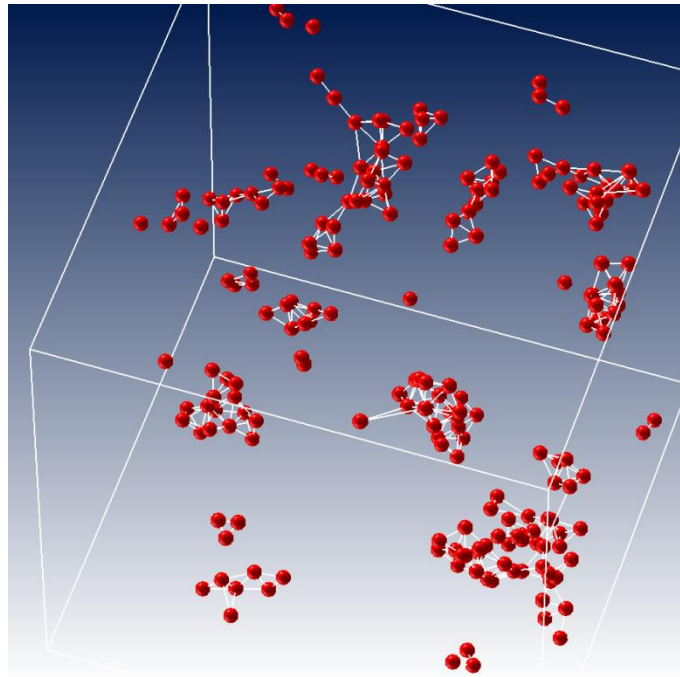
Micro-Biology

Physics at $\sim 10^{-9}$ meters



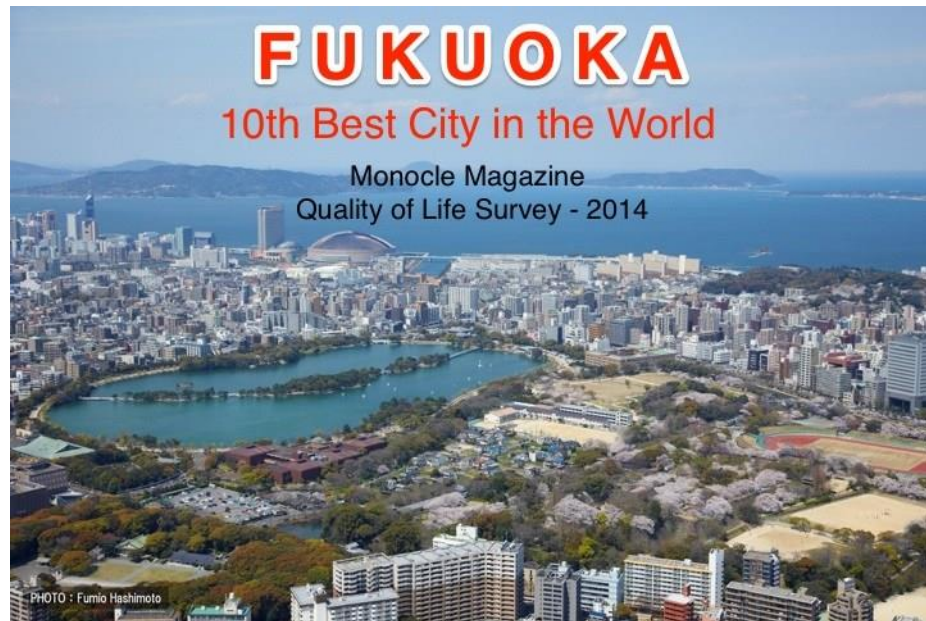
1 / 10,000 width of hair

Self-Assembly



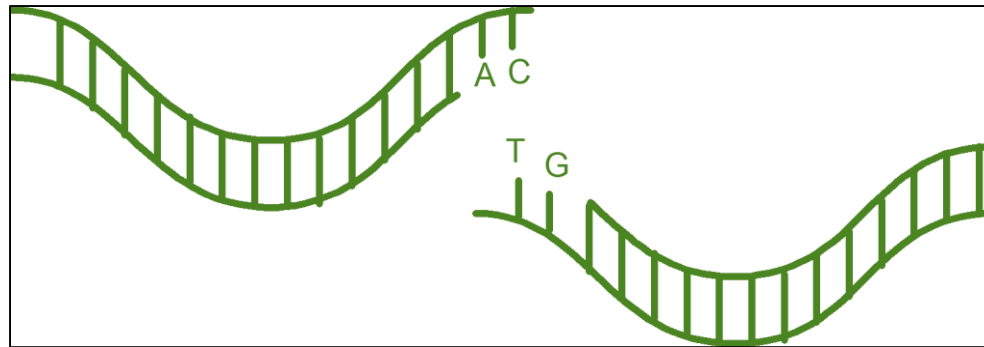
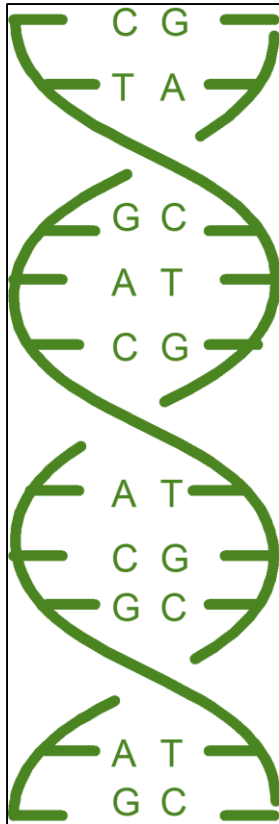
Publication

Jos Stam (2012) Modeling through self-assembly
Journal of Math-for-Industry
February 2012, Volume 4, pp. 49–53

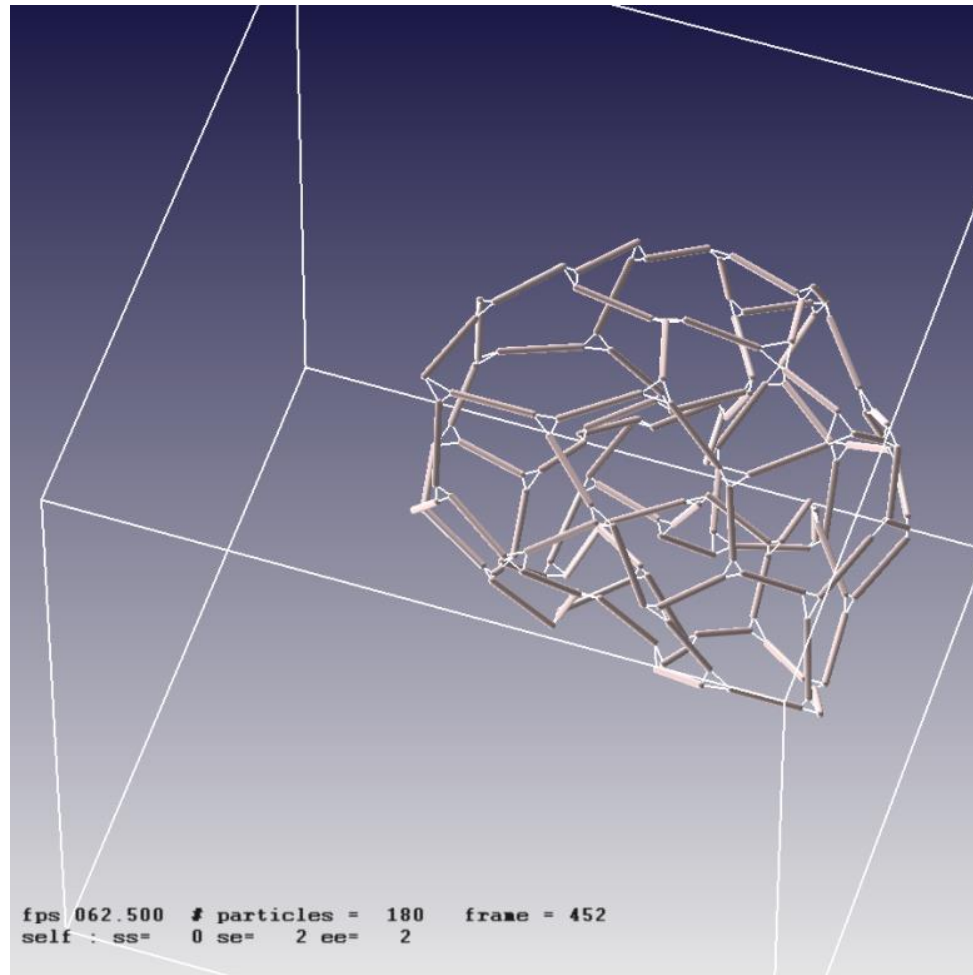


<https://www.autodeskresearch.com/publications/jmi2012>

Self-Assembly



Self-Assembly



Self-Assembly

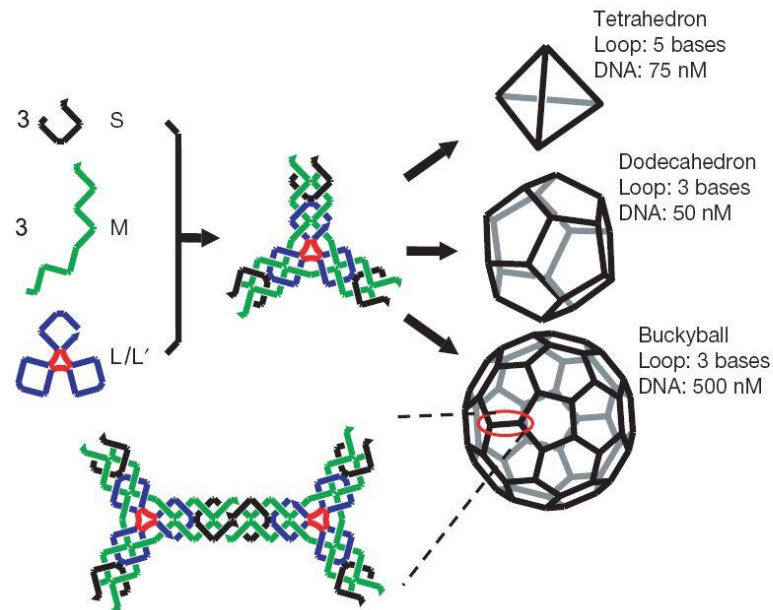
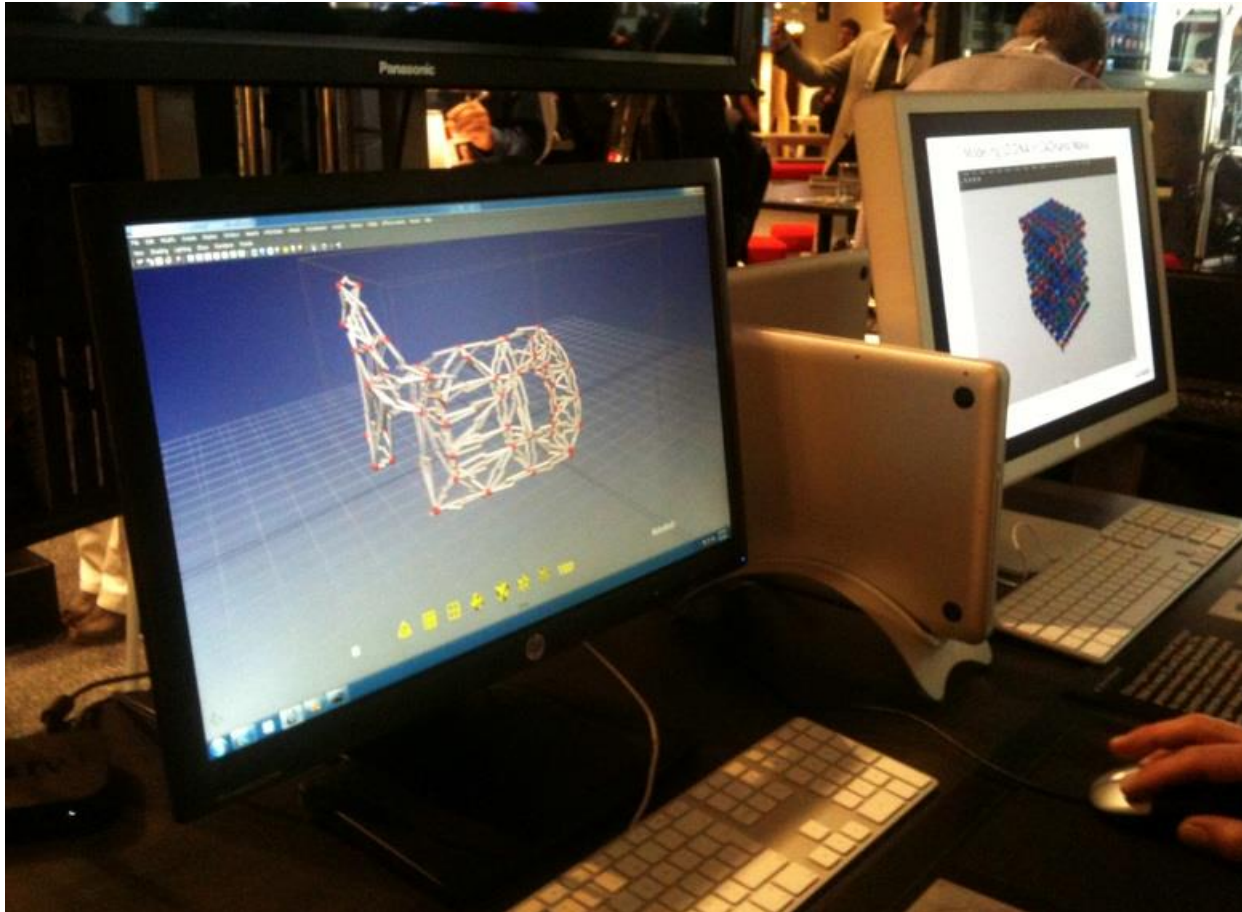


Figure 1 | Self-assembly of DNA polyhedra. Three different types of DNA single strands stepwise assemble into symmetric three-point-star motifs (tiles) and then into polyhedra in a one-pot process. There are three single-stranded loops (coloured red) in the centre of the complex. The final structures (polyhedra) are determined by the loop length (3 or 5 bases long) and the DNA concentration.

Hierarchical self-assembly of DNA into symmetric supramolecular polyhedra

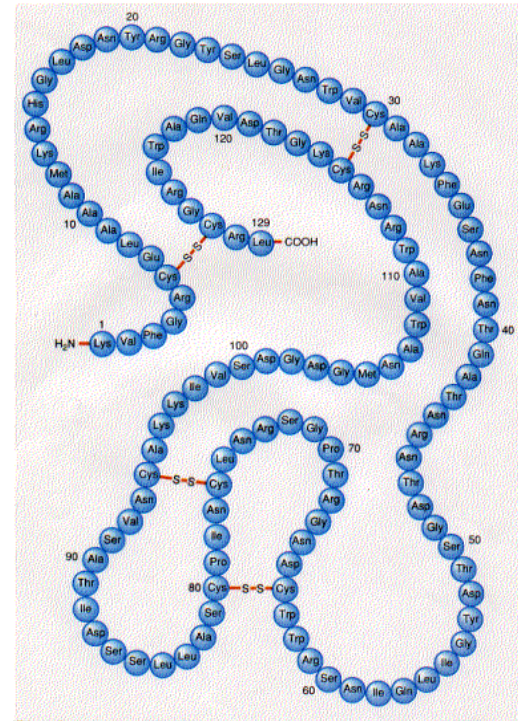
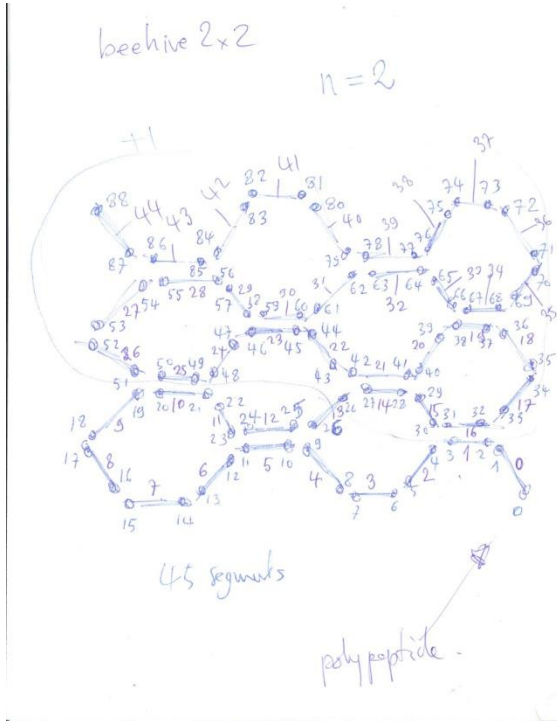
Yu He¹, Tao Ye¹, Min Su², Chuan Zhang¹, Alexander E. Ribbe¹, Wen Jiang² & Chengde Mao¹
Nature **452**, 198-201 (13 March 2008).

Self-Assembly



TED Global demo, Edinburgh, July 2011.

Self-Assembly



Polypeptides

4D-printing



https://www.ted.com/talks/skylar_tibbits_the_emergence_of_4d_printing

Skylar Tibbits, MIT

Discussion

New Paradigm for modeling

Depends on a dynamics solver

Related to Optimization

Emergence!

Potential to create novel unexpected shapes

... ?

Domo domo