

2006.10.12 CBA Program Review

Bits → Atoms: Form

Digital Design and Materials

Kenneth Cheung (kccheung@mit.edu) – 3d digital fab by folding

Grace Gershenfeld – GIK

Saul Griffith – universality of digital fab by folding

George Popescu – GIK material analysis, GIK printer

Tushar Mahale – GIK material analysis

How can we make (almost) anything from a string of information that specifies a literal string of units, selected from a small, discrete batch of primitives?

**(Saul Griffith – Ph.D. thesis, 2005)
universality of fabrication by folding**



Any continuous area or volume can be constructed from a single (one dimensional) string of units. The order, or sequencing of a small number of types of units along the string specifies the overall structure.

How can we get from a description of an object to the digital information needed to most efficiently fabricate the object?

**(Kenneth Cheung – 2006)
automation of sequence finding; binary *.stl to code**

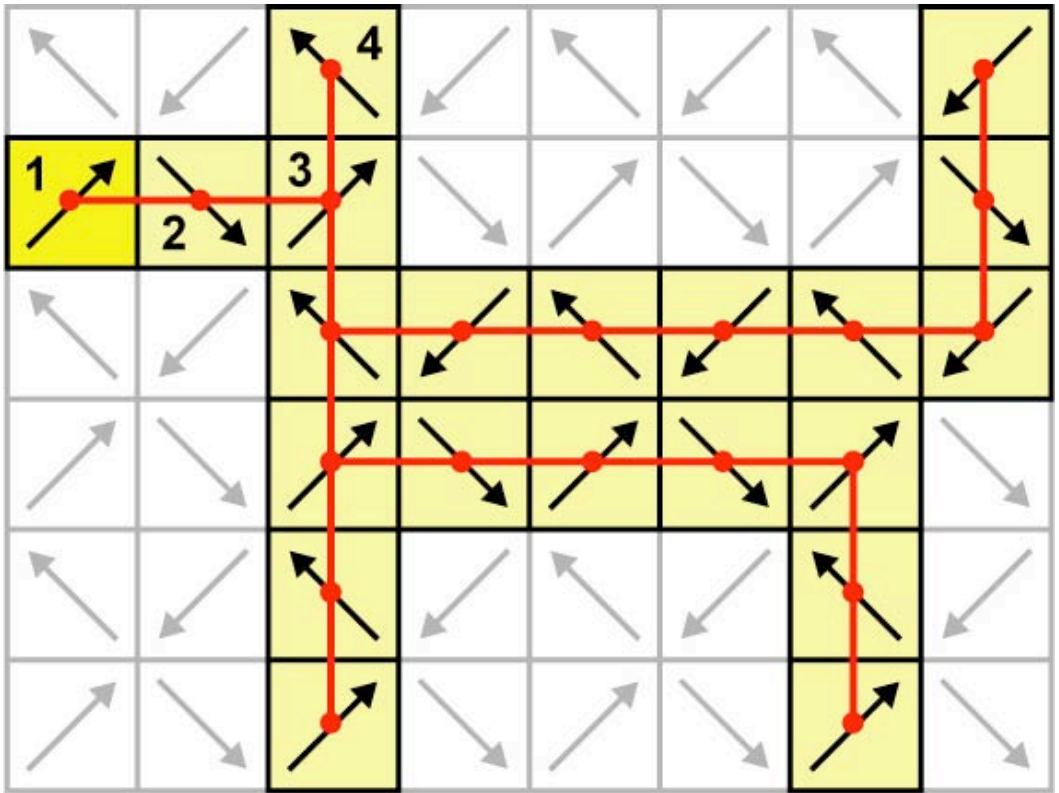


Figure 1b. A dog comprising square tiles without a Hamiltonian path. A spanning tree is shown in red lines connecting the nodes (red dots) at the centroid of each 'pixel'.

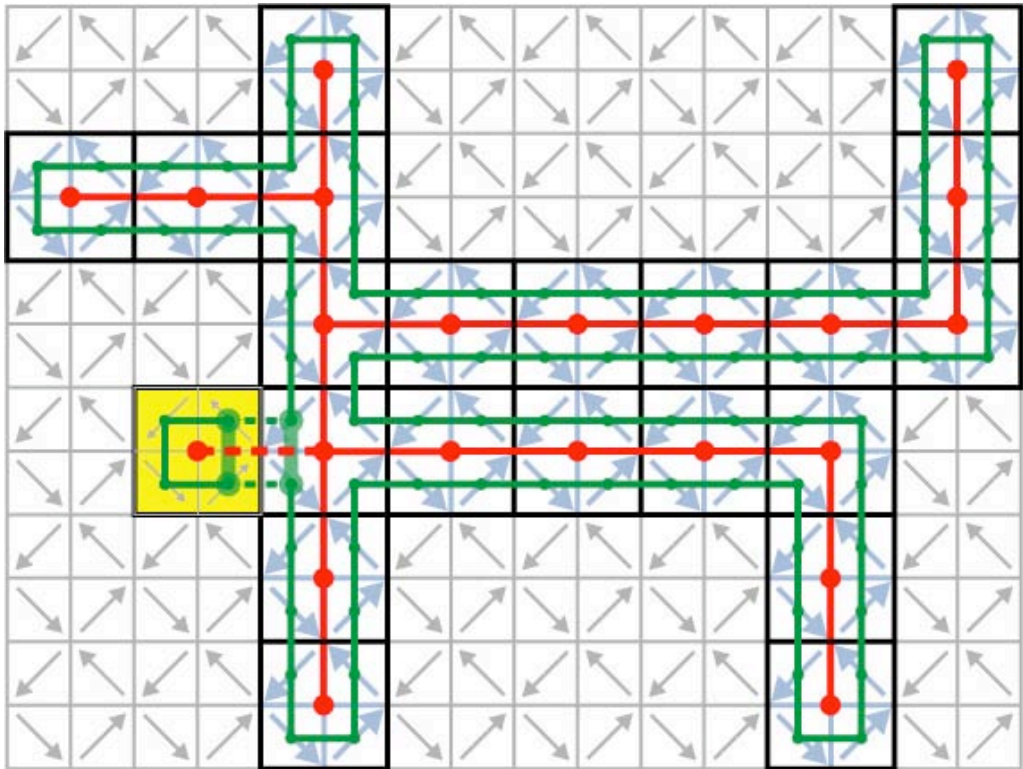
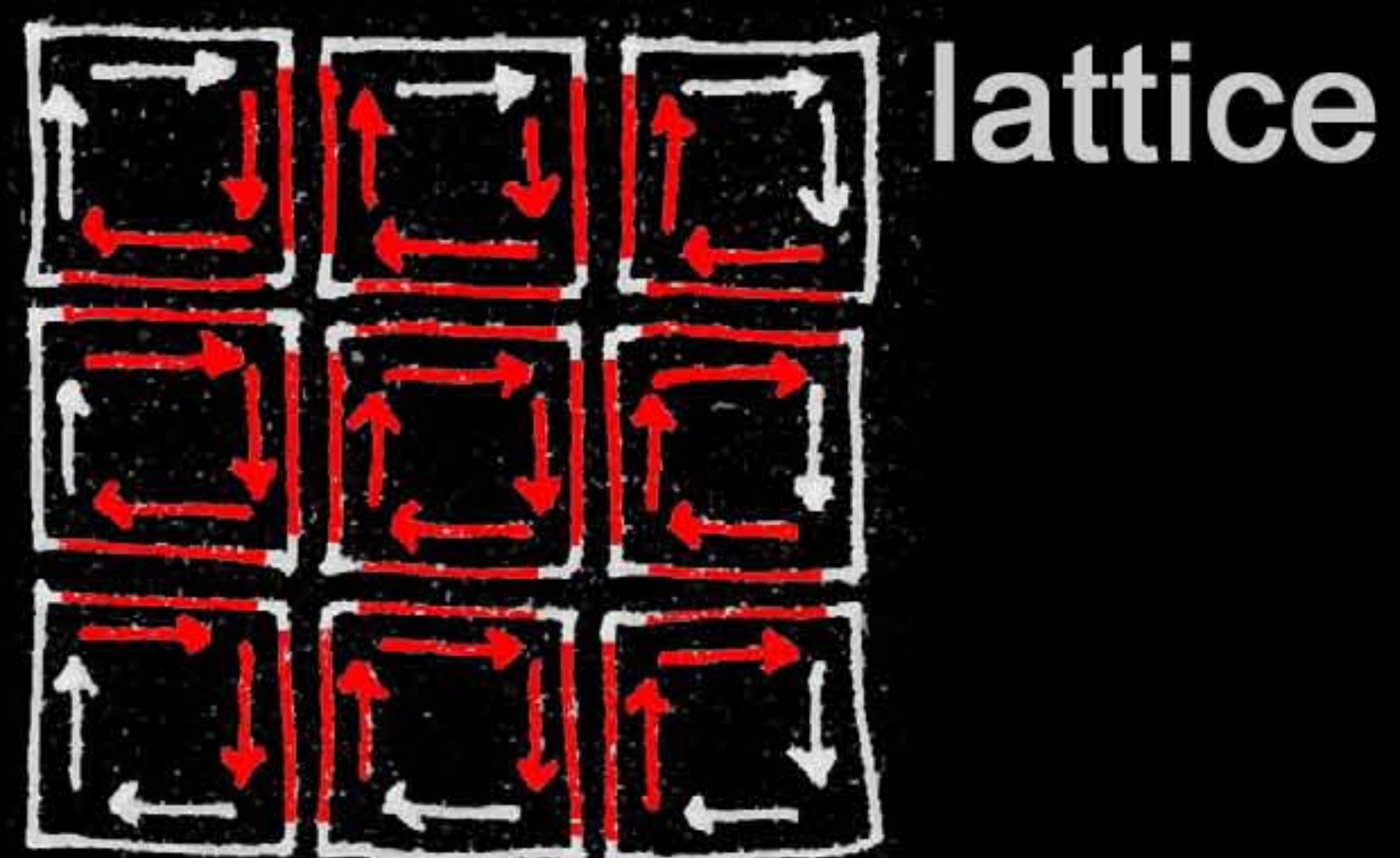


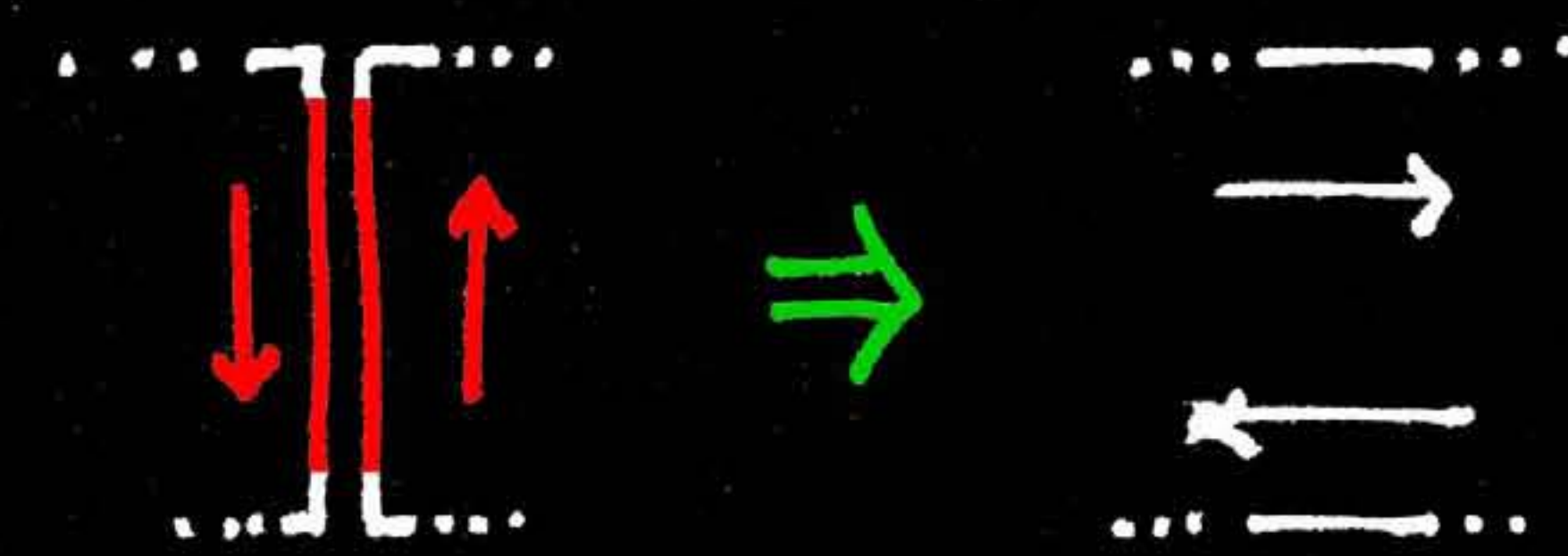
Figure 1c. The same dog where each pixel has been divided into 4 'sub-pixels' enabling a Hamiltonian path or circuit one pixel wide around the perimeter of the spanning tree. The yellow tile shows the construction by addition of new tiles.



primitive

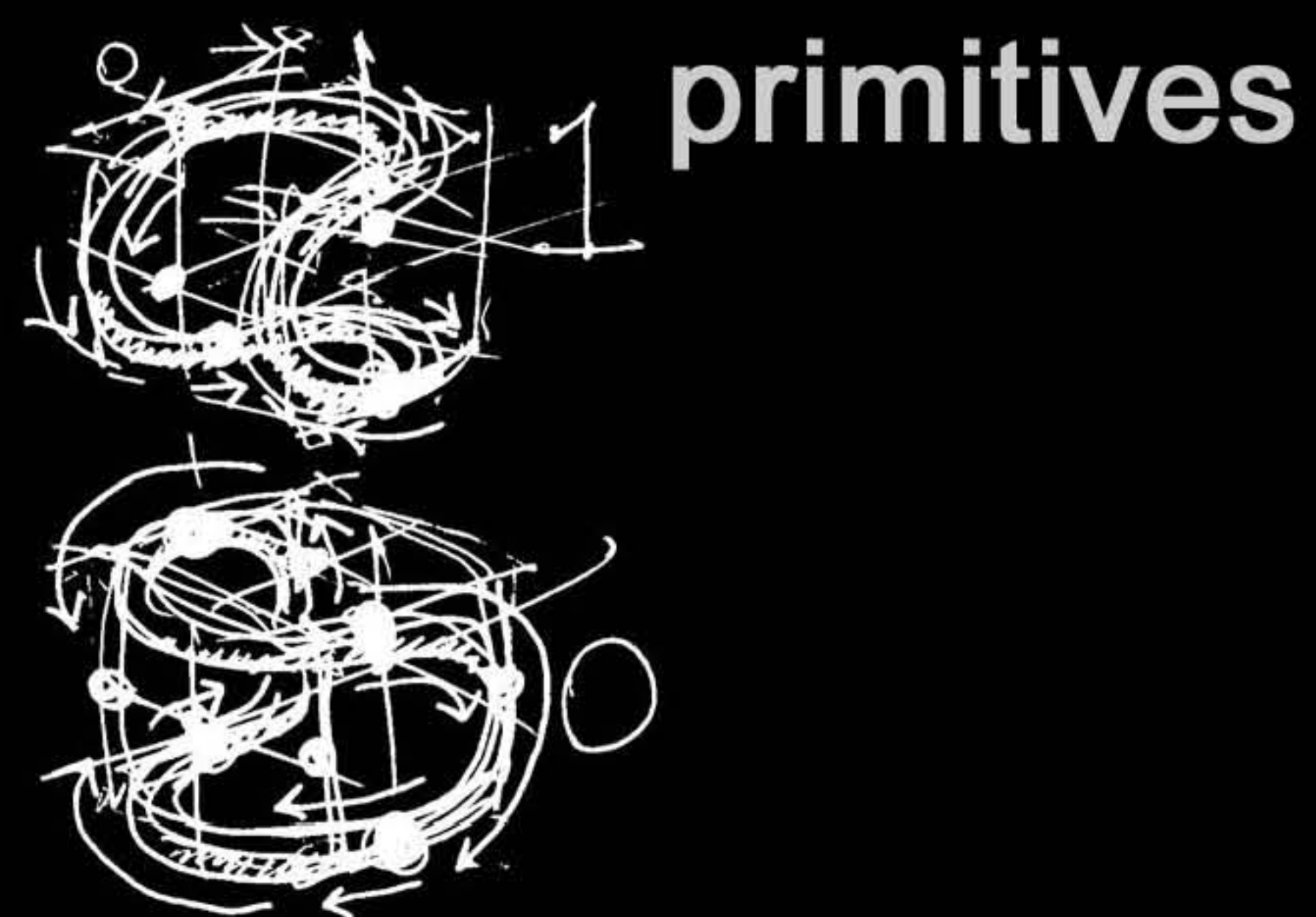


lattice

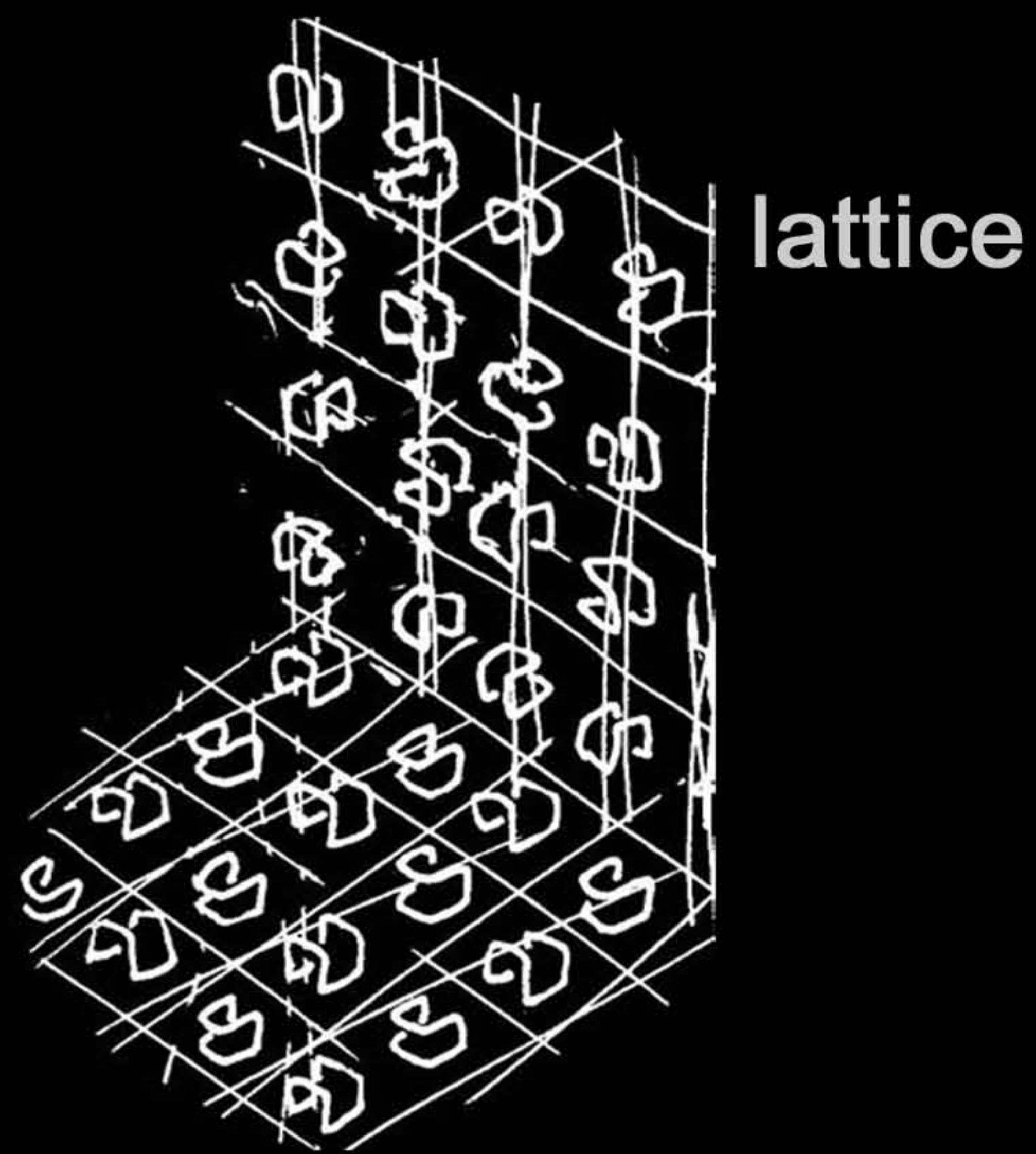


path
construction
rule

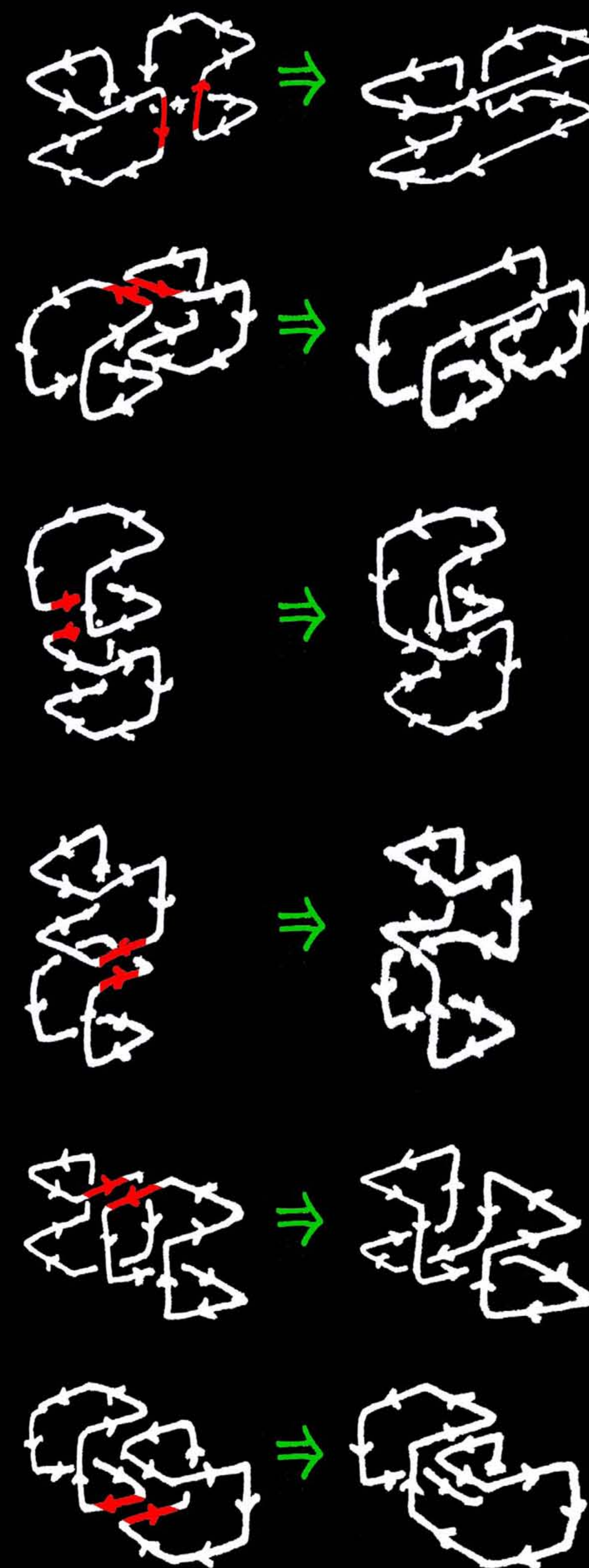
2D area filling with squares (Saul Griffith)



primitives



lattice

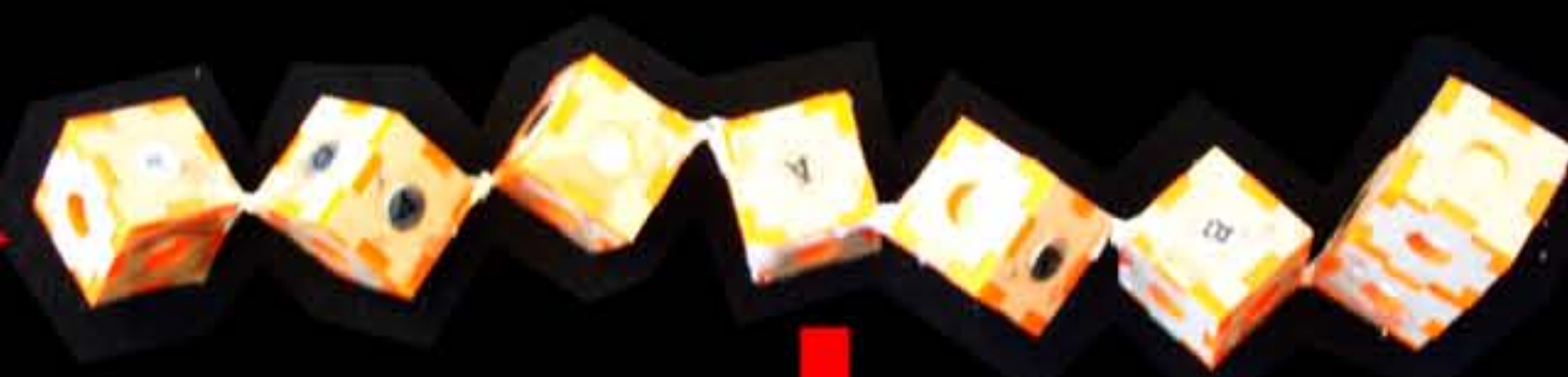


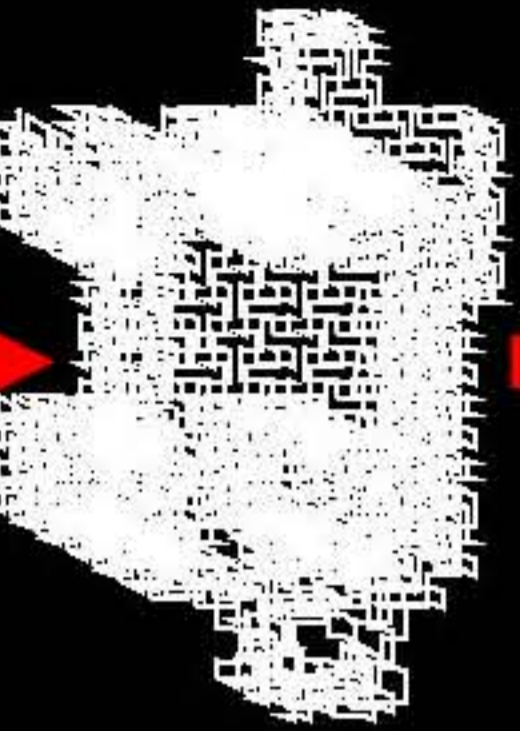
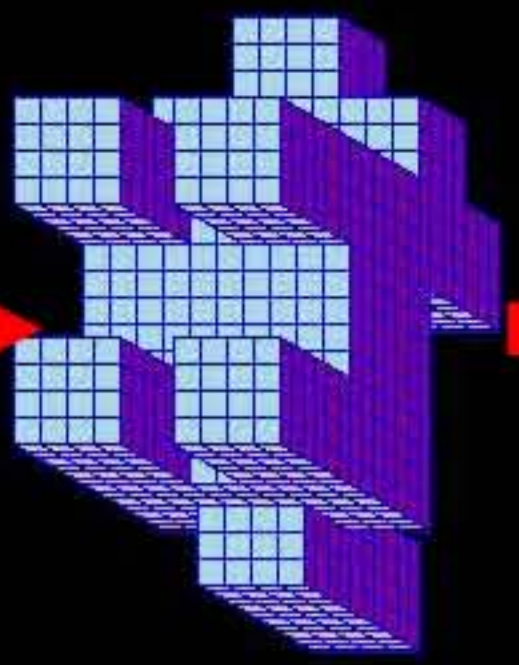
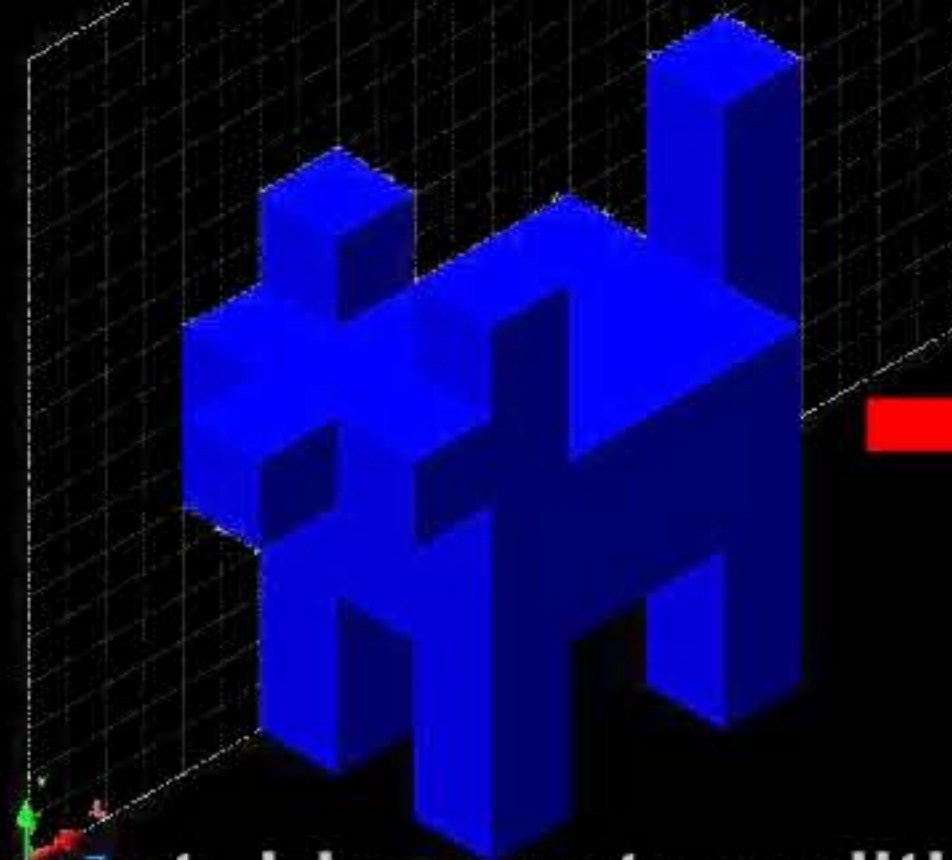
path
construction
rules

3D volume filling with cubes (Kenny Cheung)

fabrication by
sequential folding
(1D-->3D)

(Kenny Cheung - 2006)

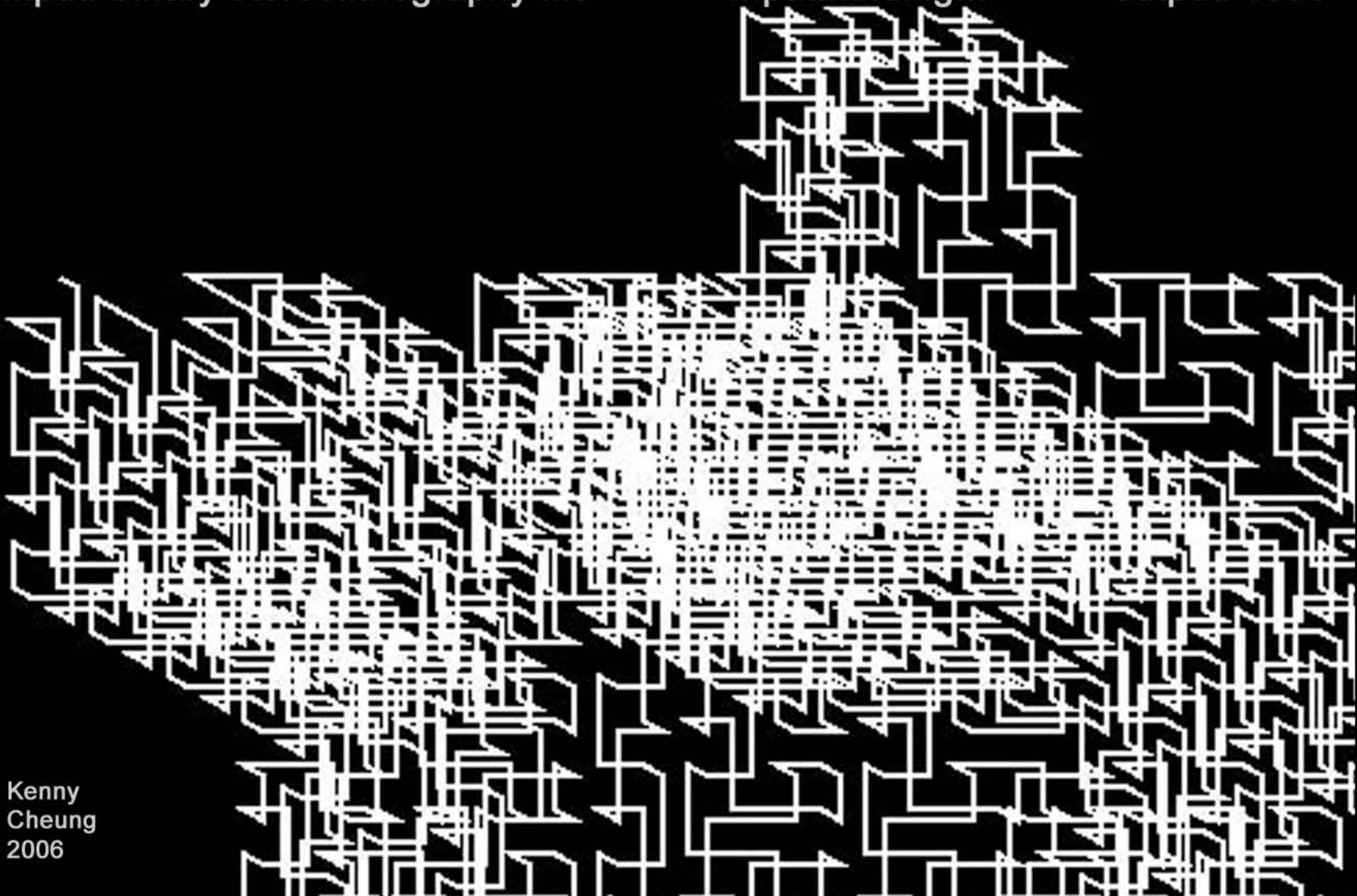




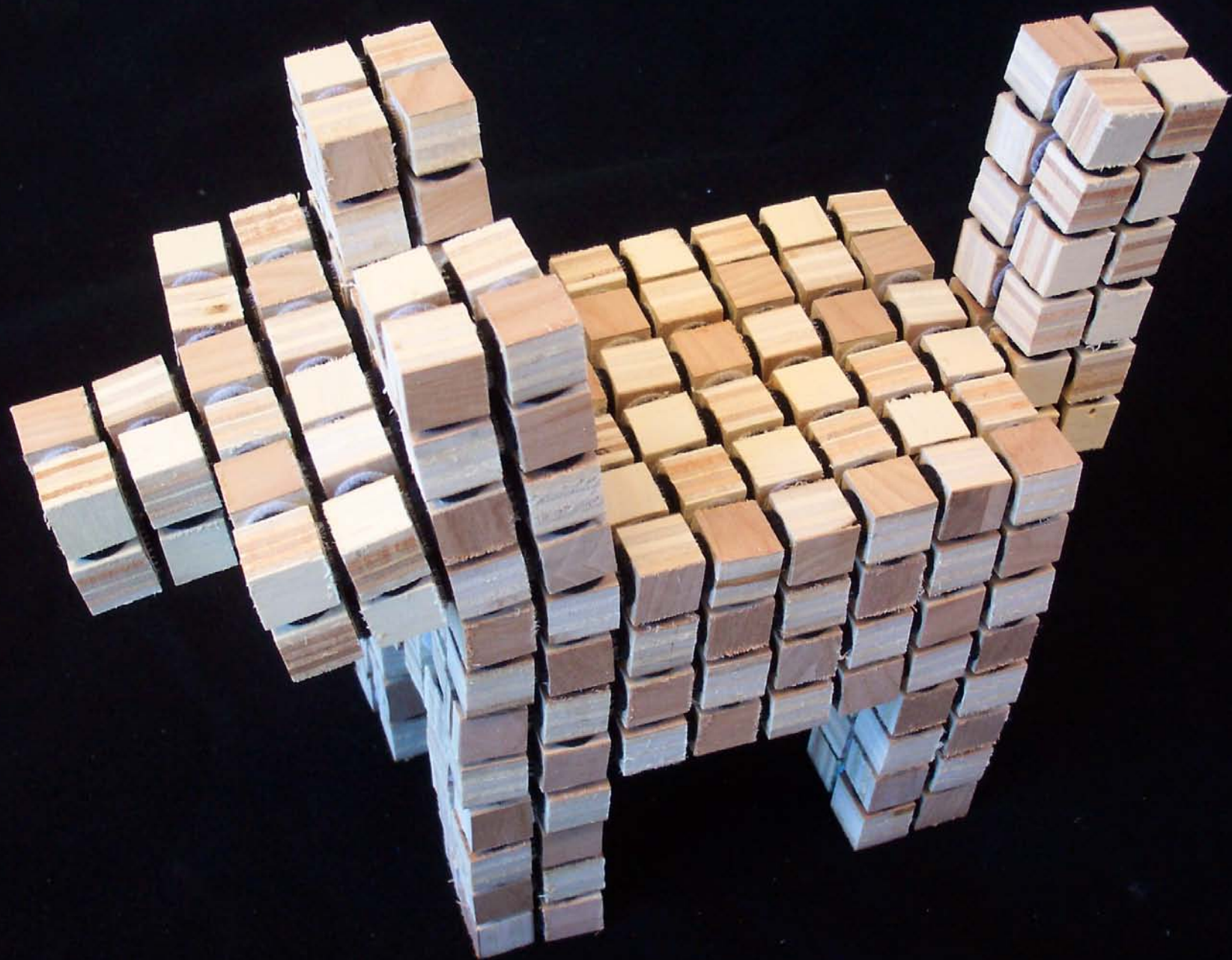
input: binary stereolithography file

...pathfinding...

output: code



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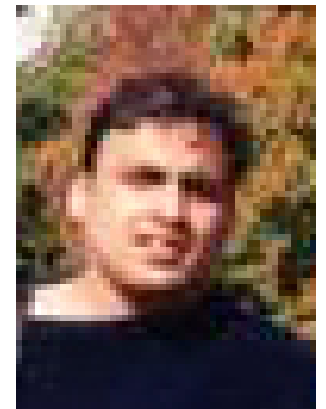


Communications underwent a revolution from analog to digital (1945); Computation also underwent a revolution from analog to digital (1955); Now, fabrication is undergoing a revolution from analog to digital materials and processes.

**(Grace Gershenfeld, George Popescu, Tushar Mahale)
GIK; material properties; digital material printer**

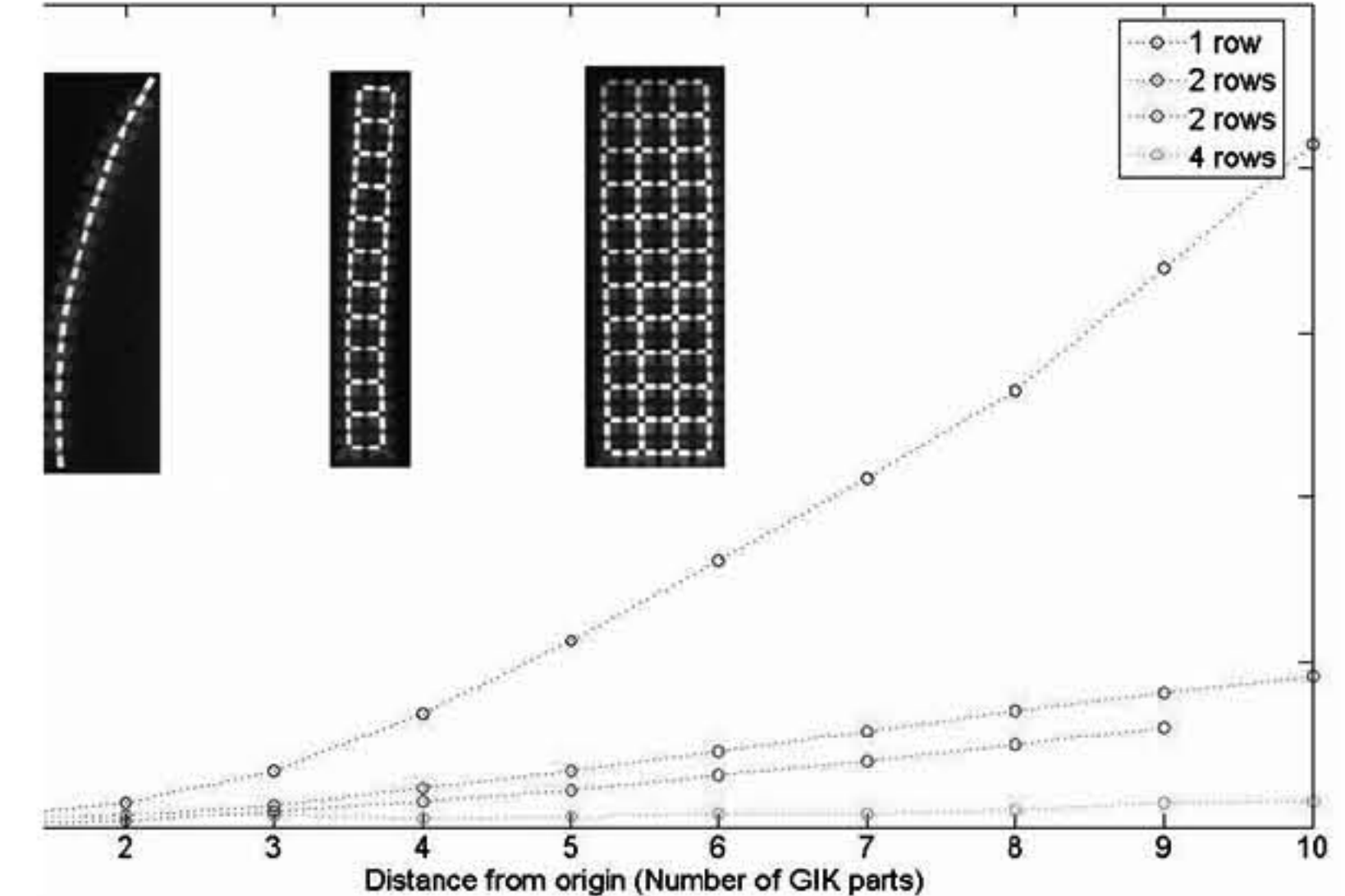
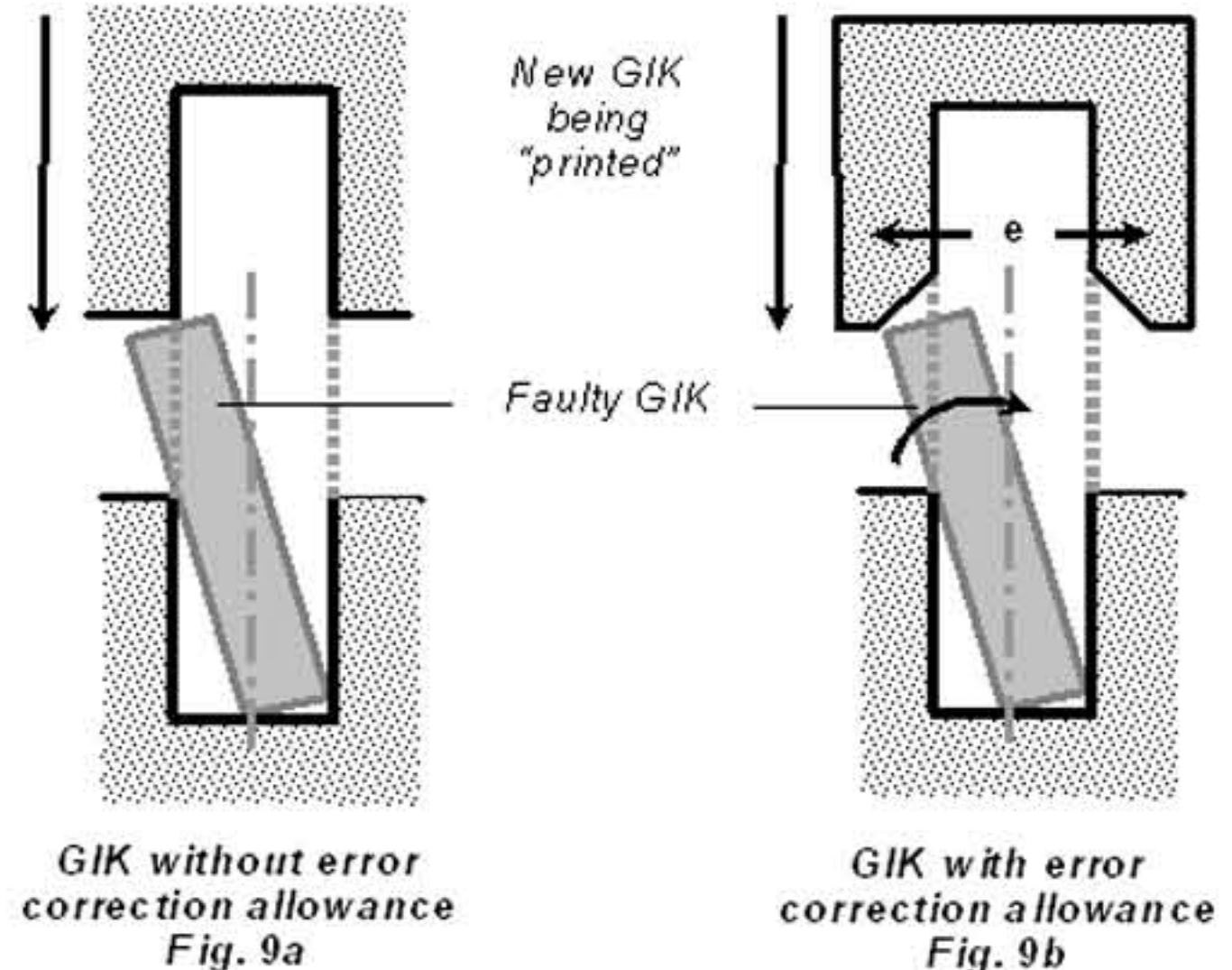
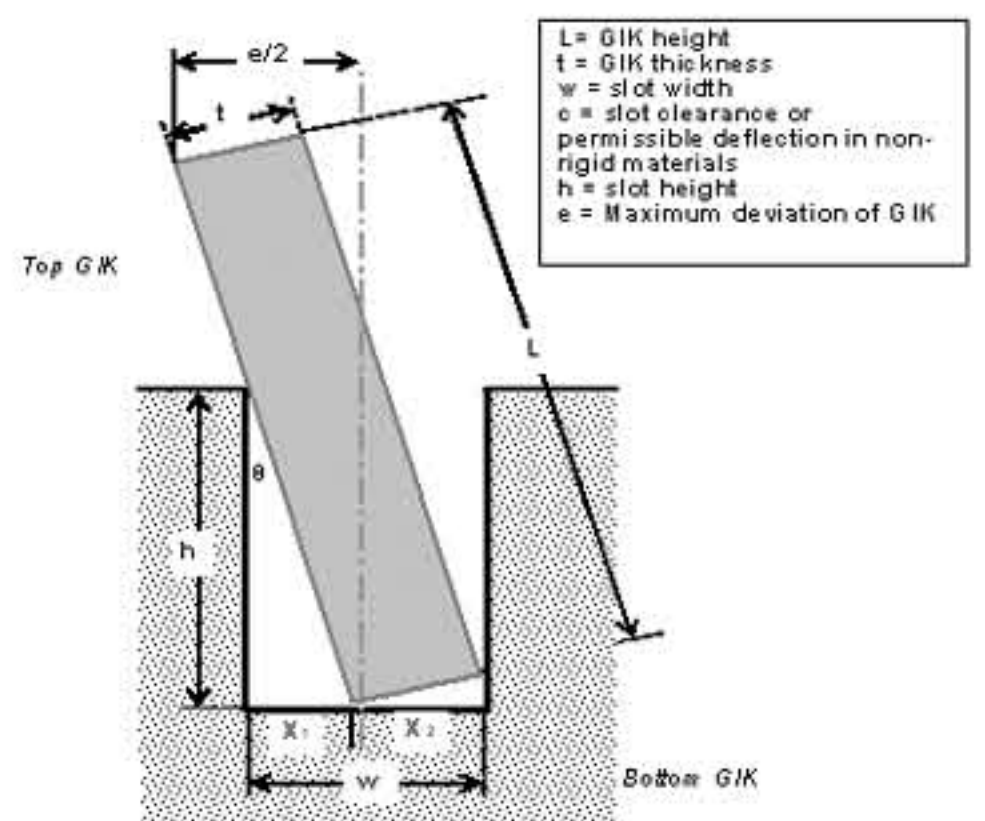


Digital materials for fabrication have the advantage of being low cost, reversible, and requiring low precision assembly methods. The latter is possible through error reduction, tolerance, and correction means, analogous to those that enable digital communication and computation.

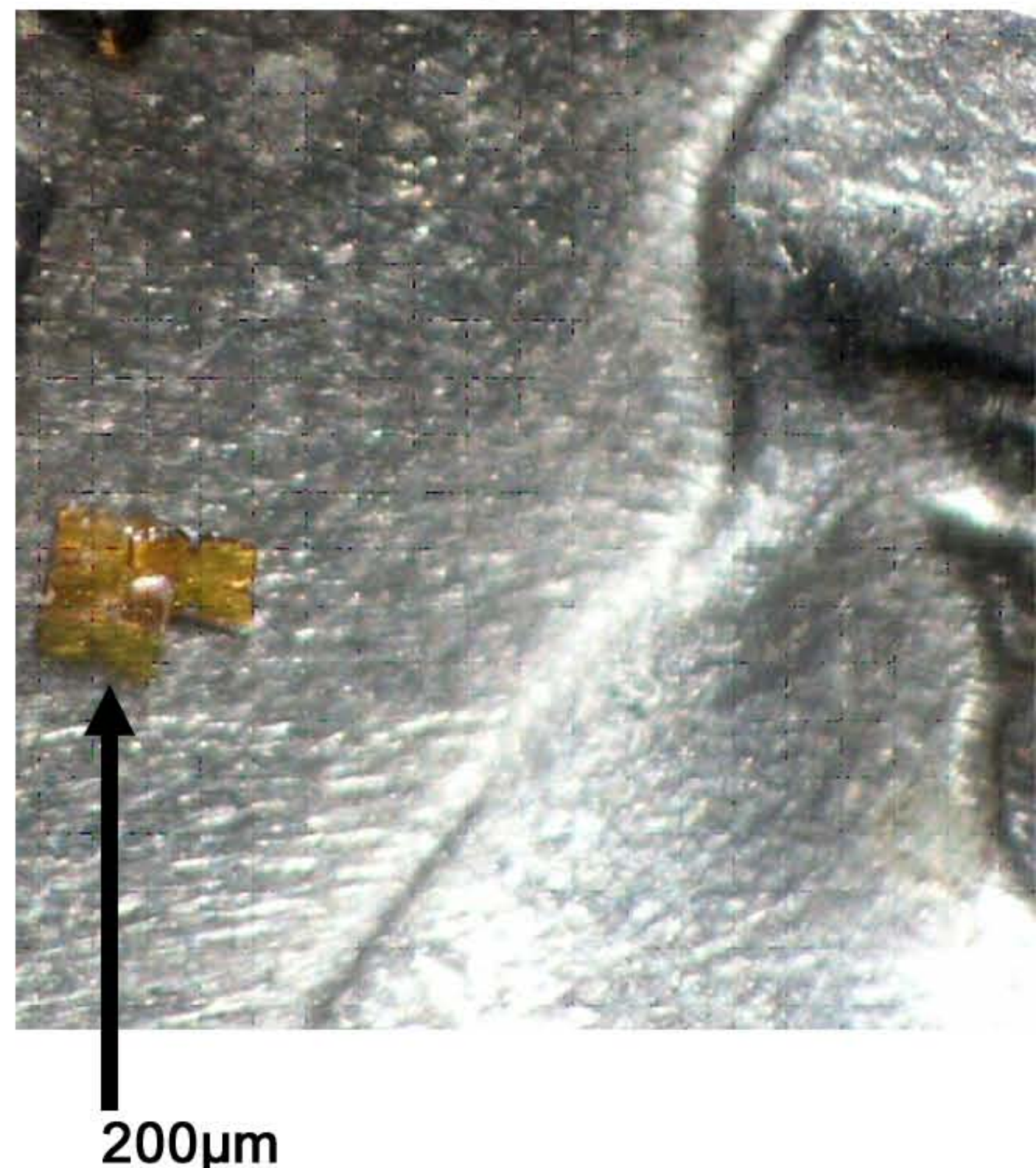
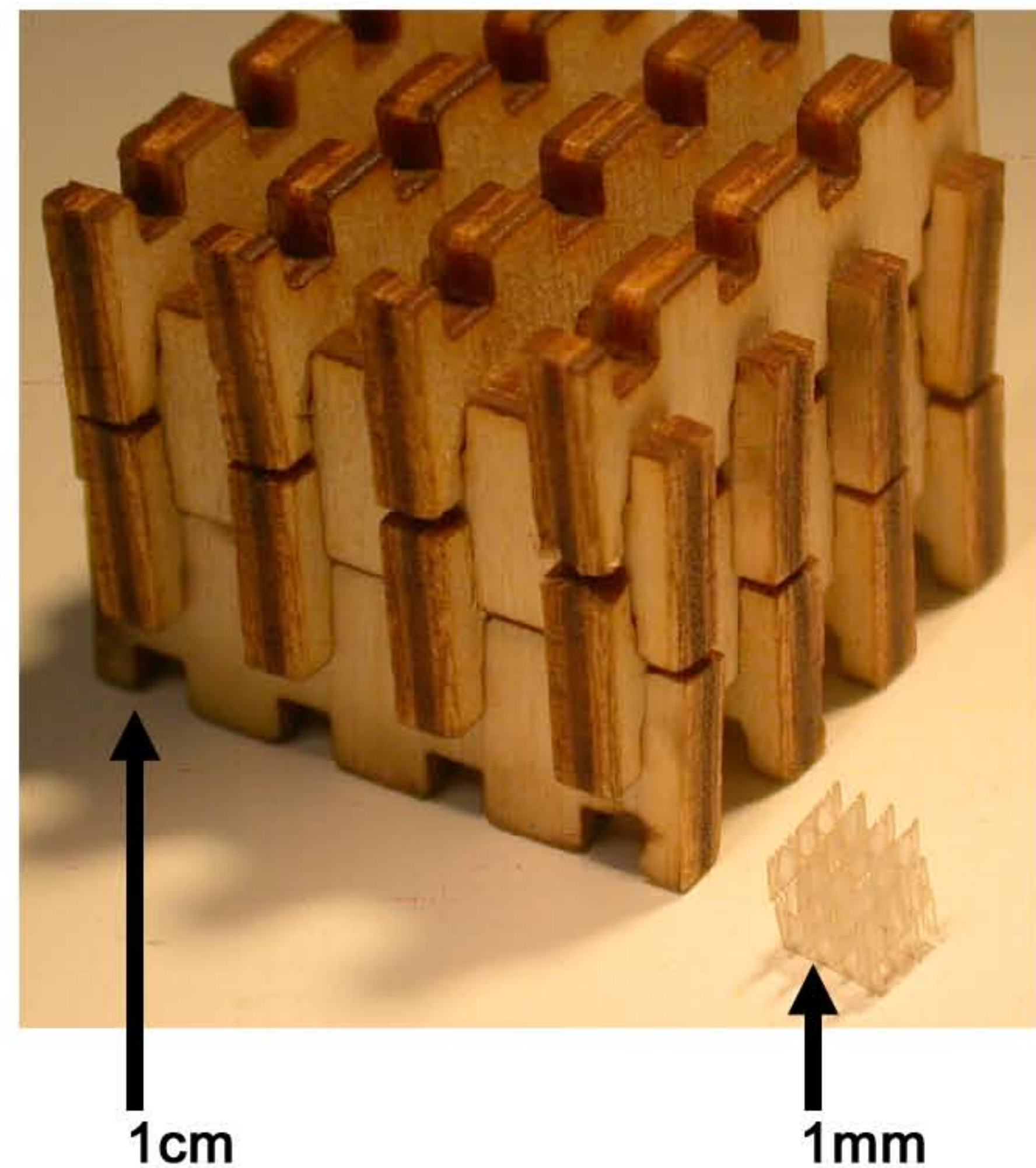
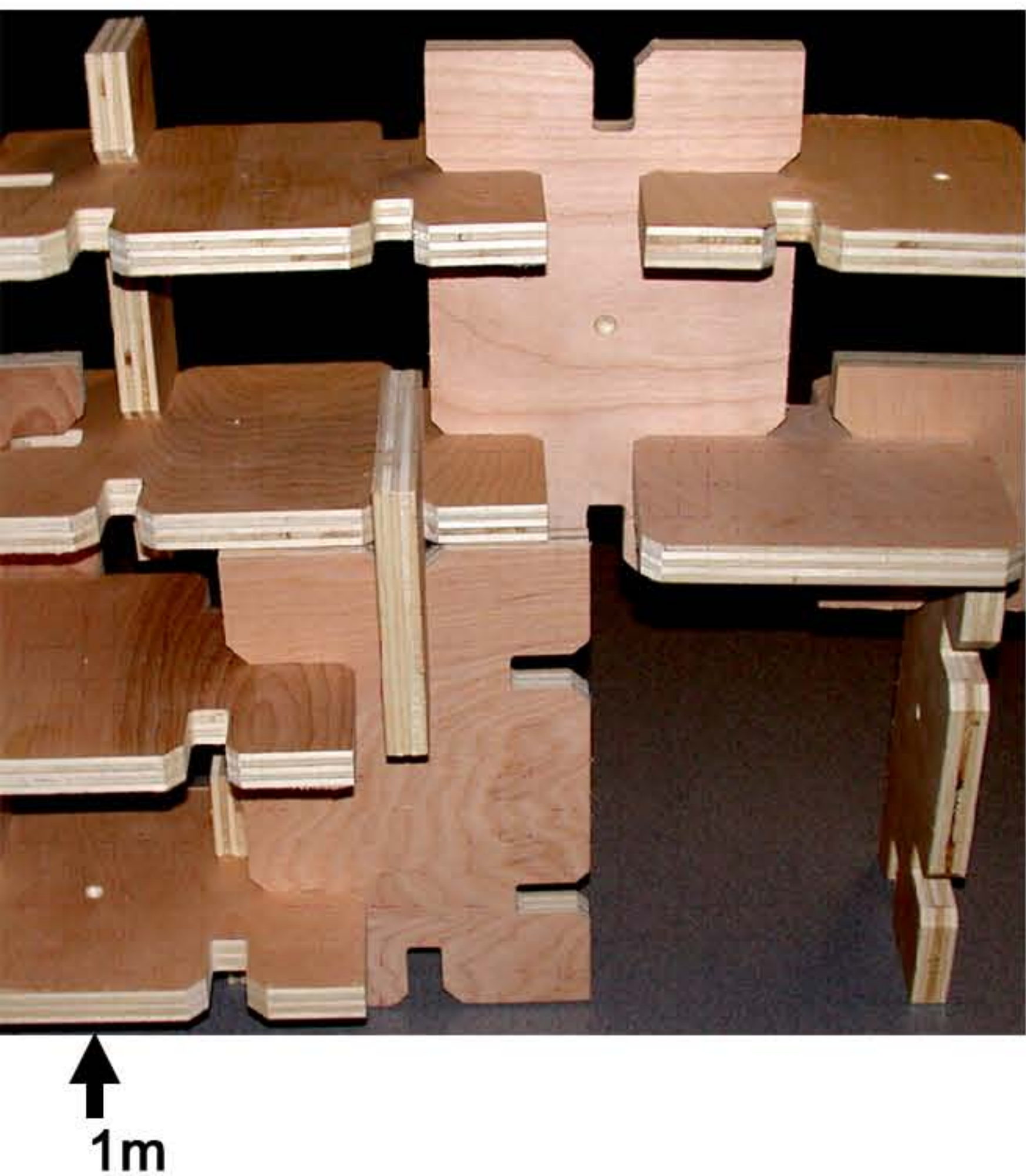


digital materials (eg., GIK) as the basis of a revolution from analog to digital fabrication (George Popescu)

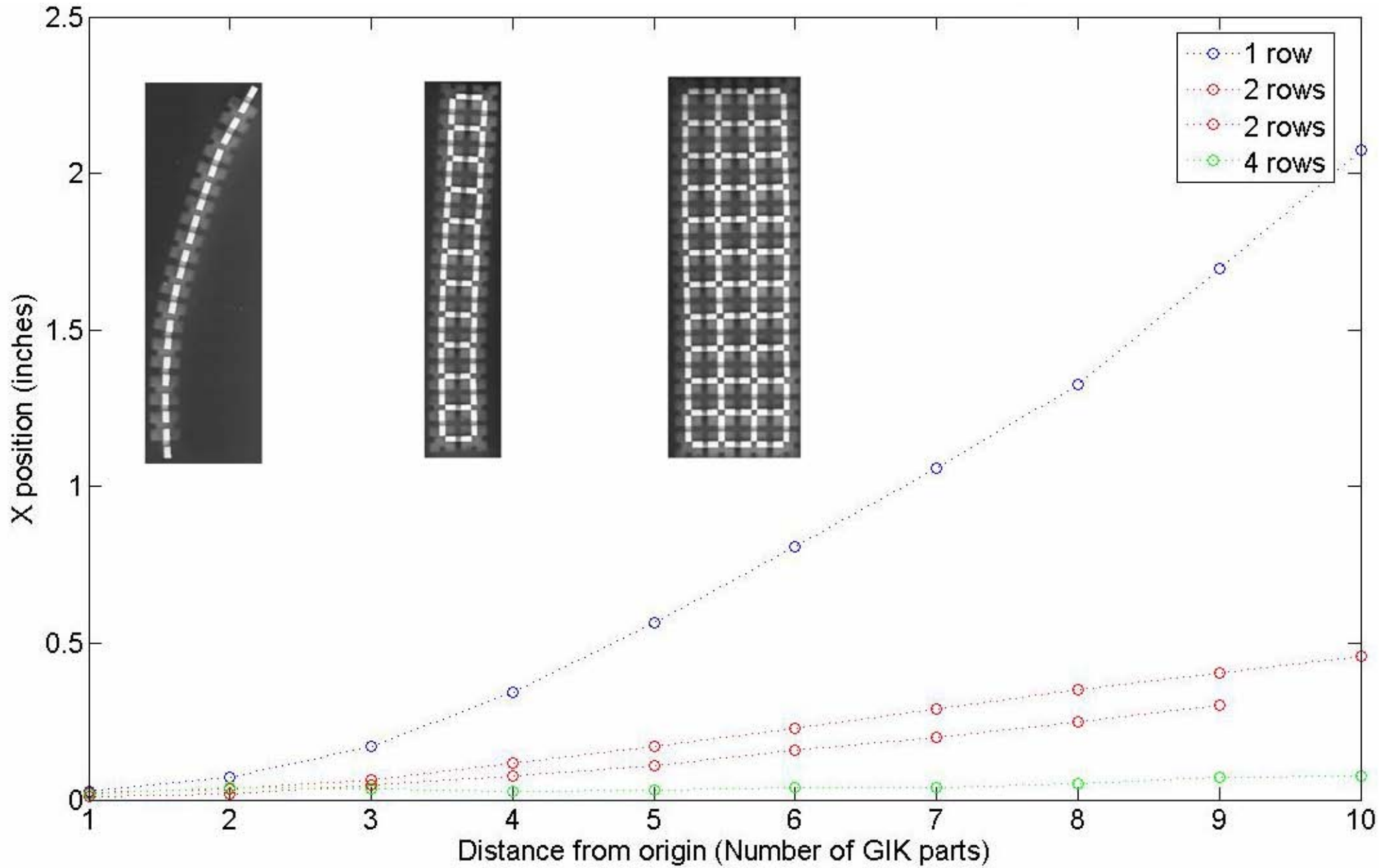
Error Tolerance, Error Reduction

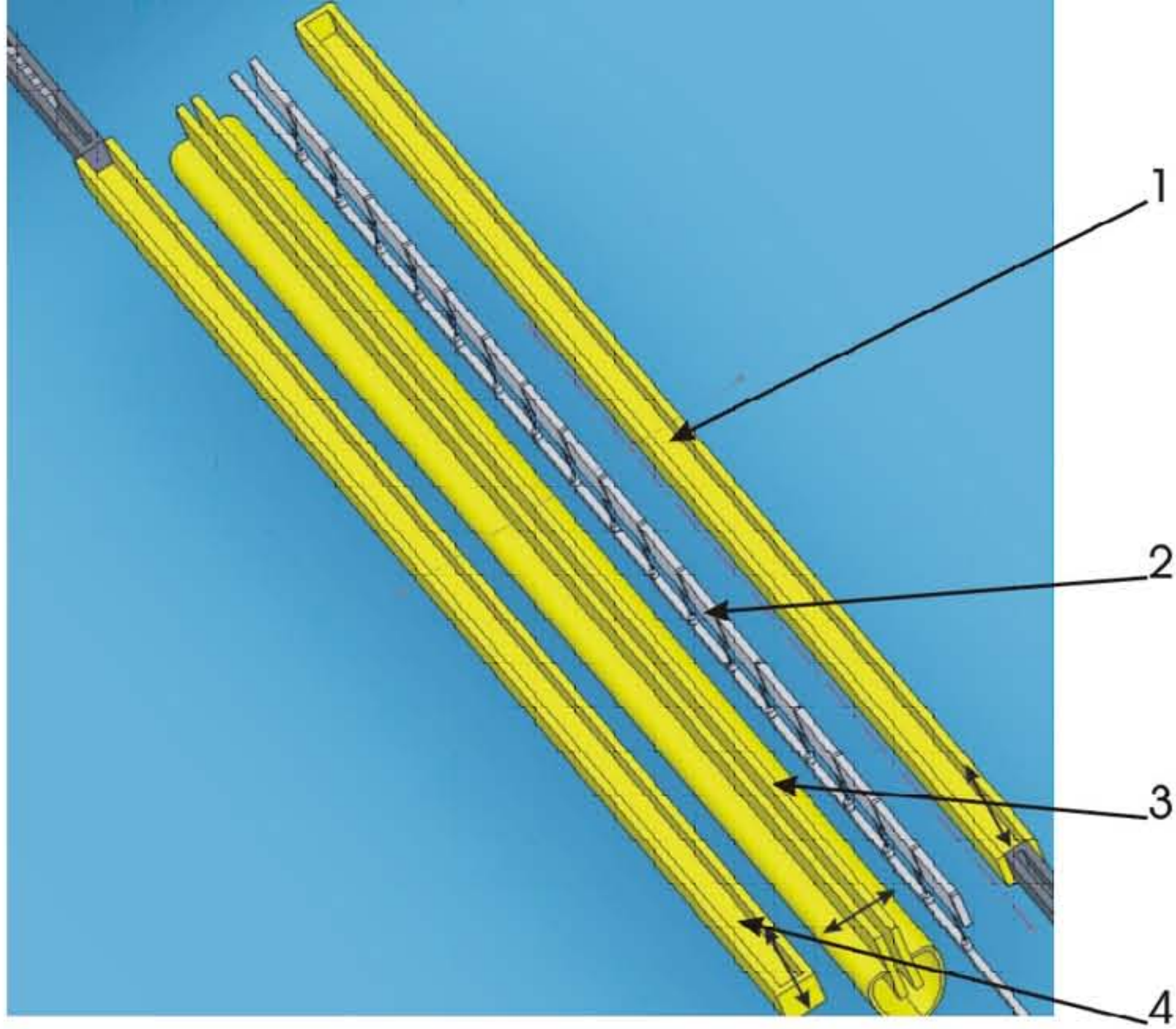


Multi-scale

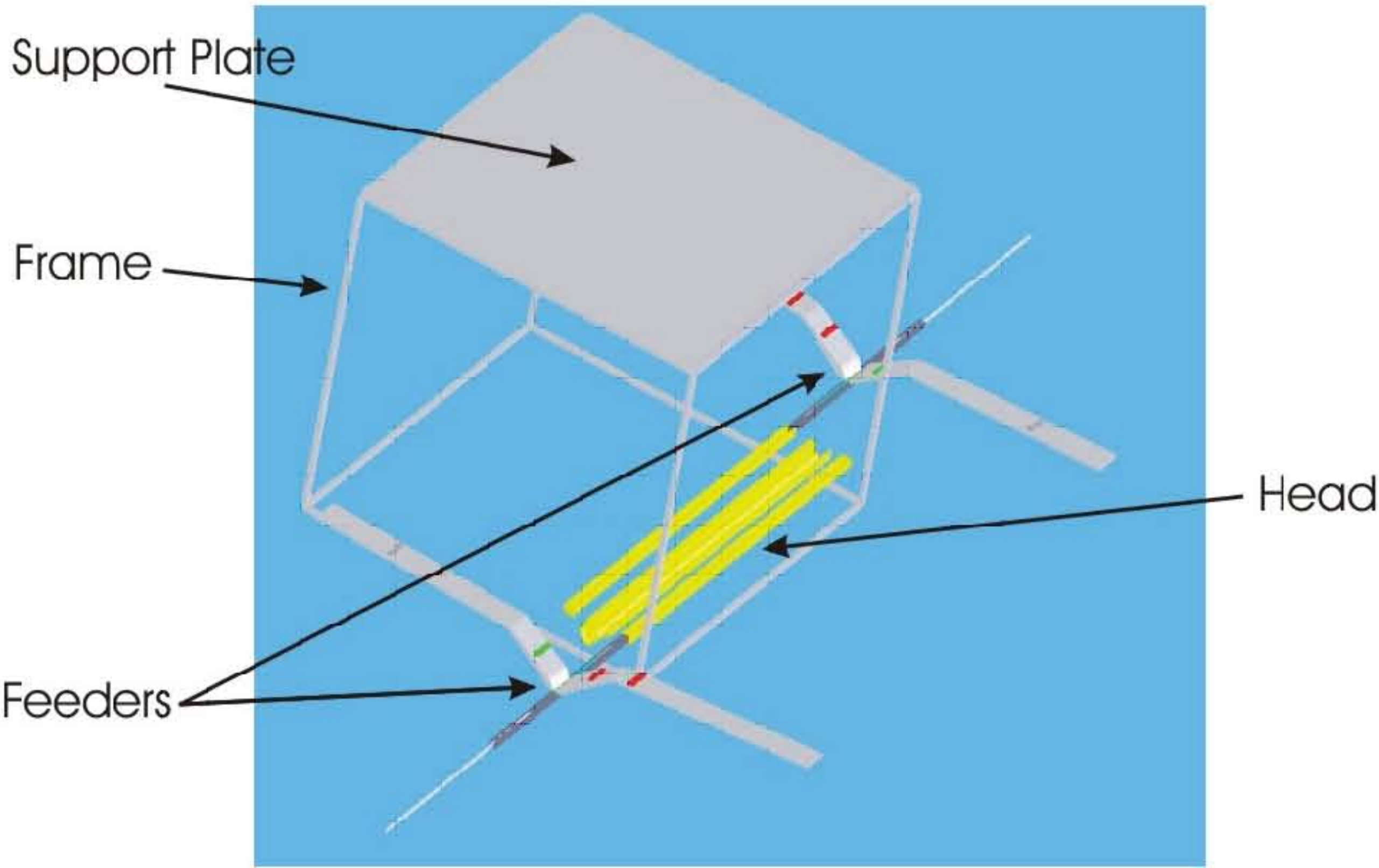
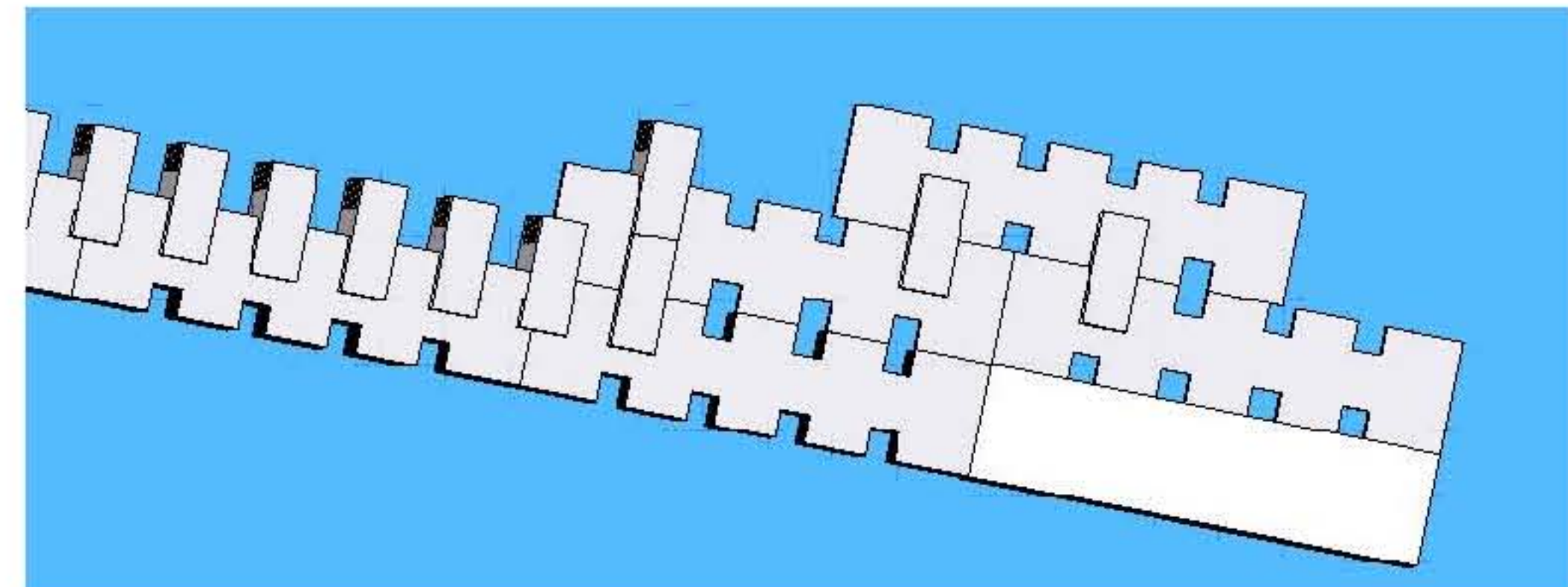
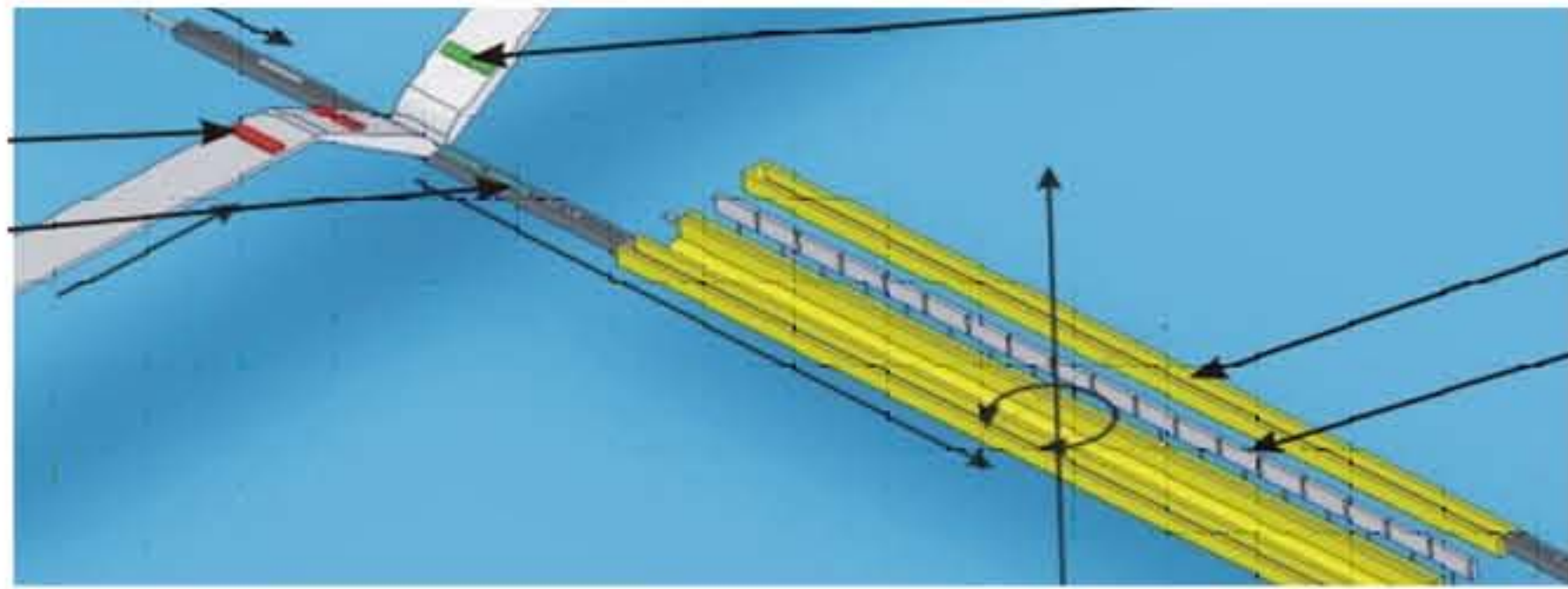


Error Reduction





- (1) building
- (2) detecting errors
- (3) removing errors
- (4) rebuilding



**Digital Material (GIK) Printer
(George Popescu)**