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

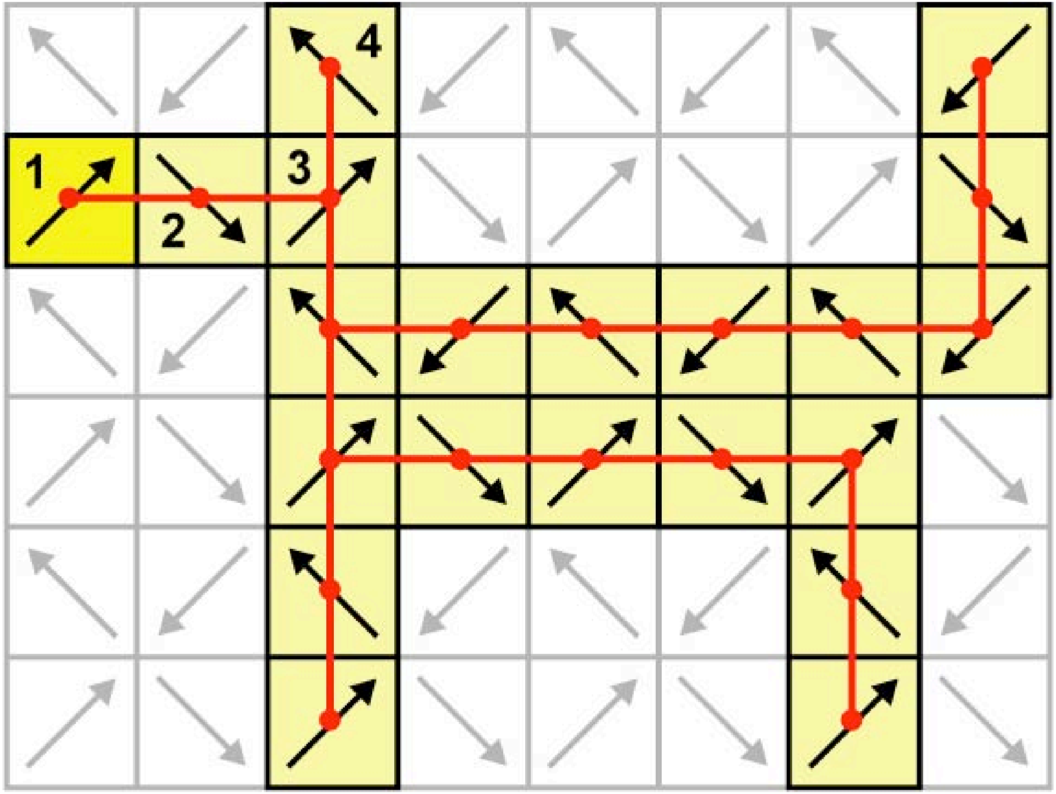


Figure 1b. A dog comprising square tiles without a Hamiltonian path. A spanning tree is shown in red lines connecting the nodes (red dots) at the centroid of each 'pixel'.

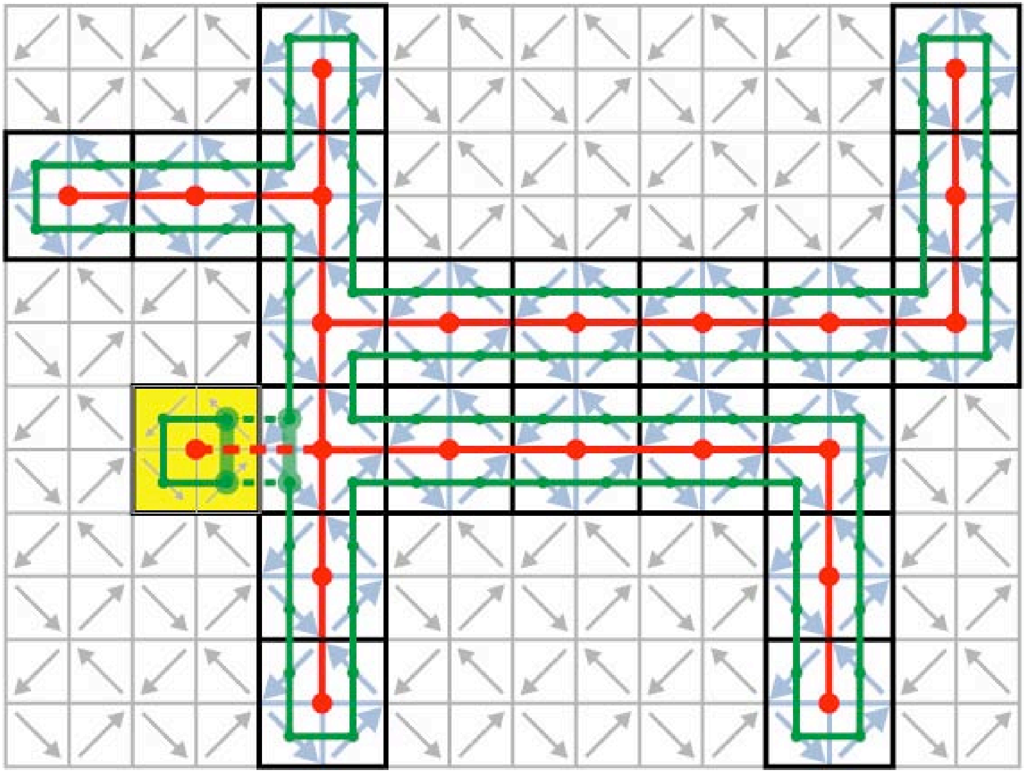
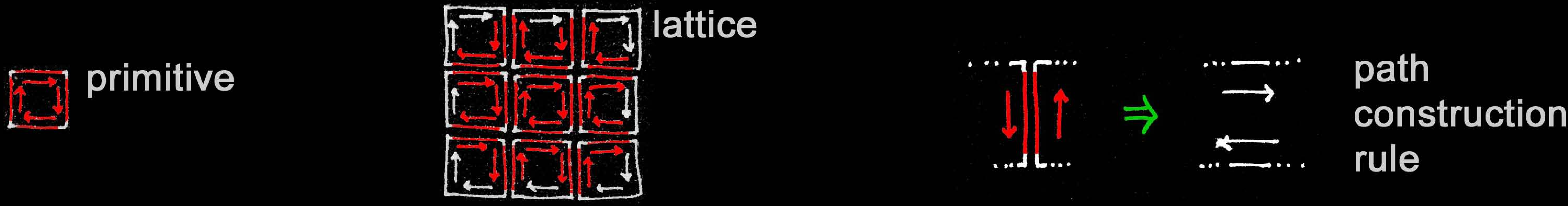
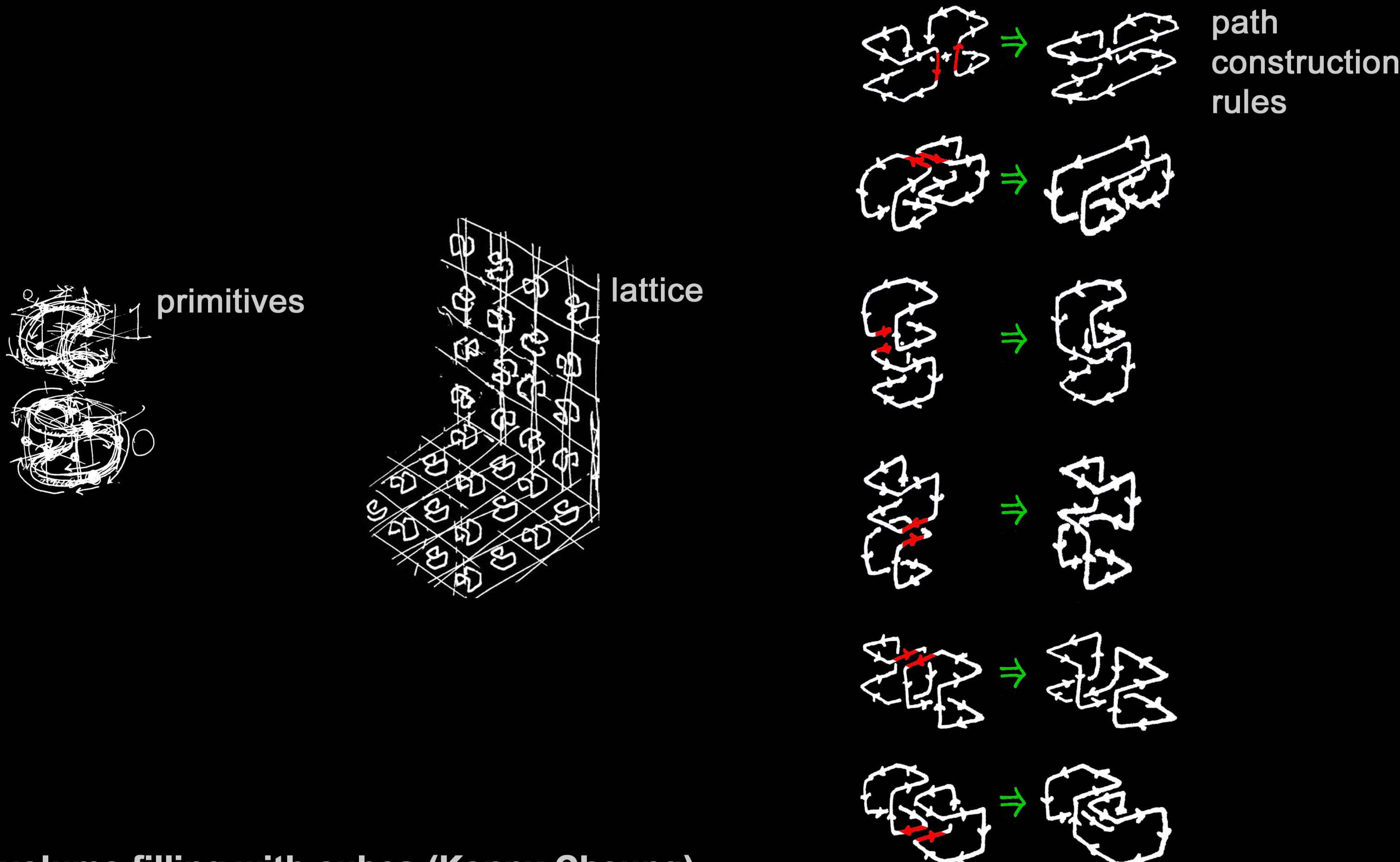


Figure 1c. The same dog where each pixel has been divided into 4 'sub-pixels' enabling a Hamiltonian path or circuit one pixel wide around the perimeter of the spanning tree. The yellow tile shows the construction by addition of new tiles.



2D area filling with squares (Saul Griffith)

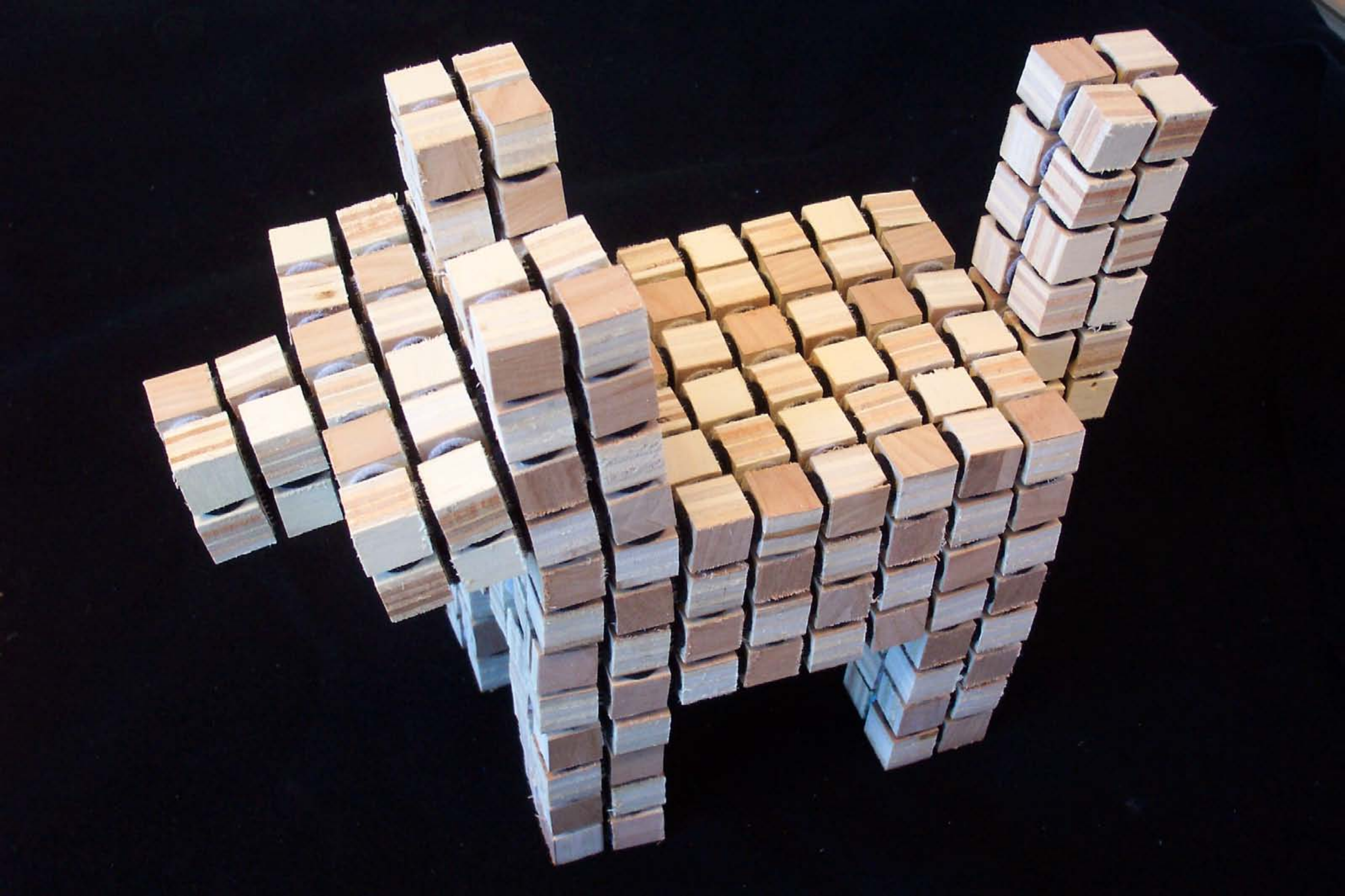


3D volume filling with cubes (Kenny Cheung)

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

(Kenny Cheung - 2006)


input: binary stereolithography file
...pathfinding...
output: code
Kenny
Cheung
2006



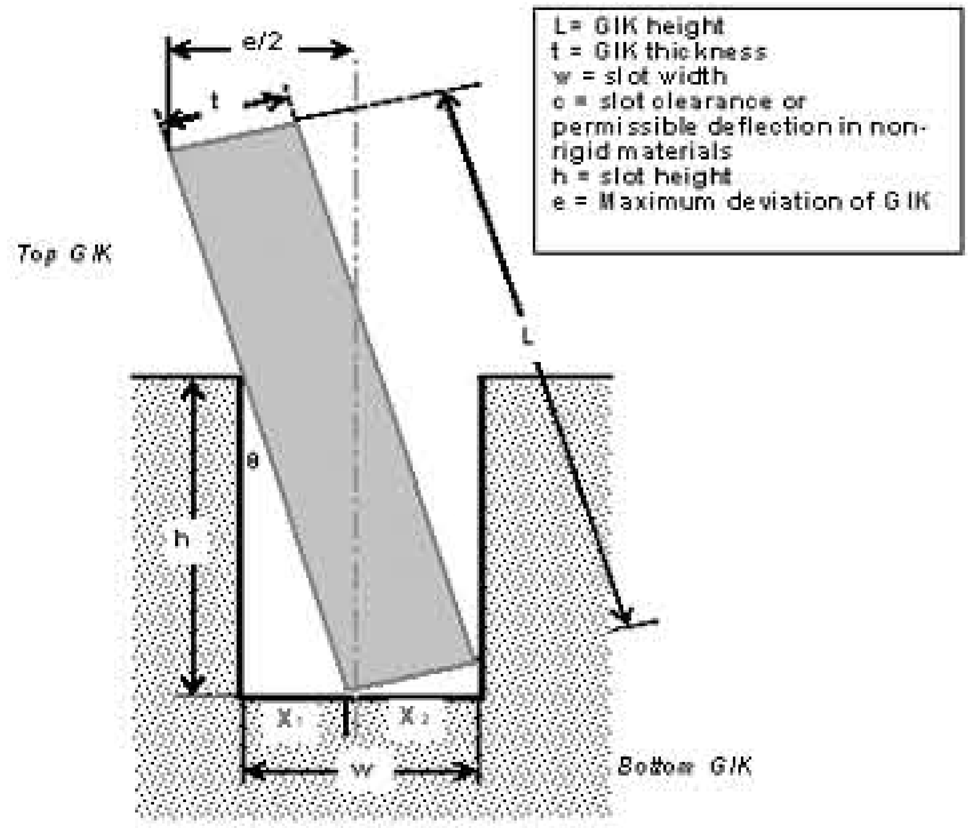
Communications underwent a revolution from analog to digital (1945); Computation also underwent a revolution from analog to digital (1955); Now, fabrication is undergoing a revolution from analog to digital materials and processes.

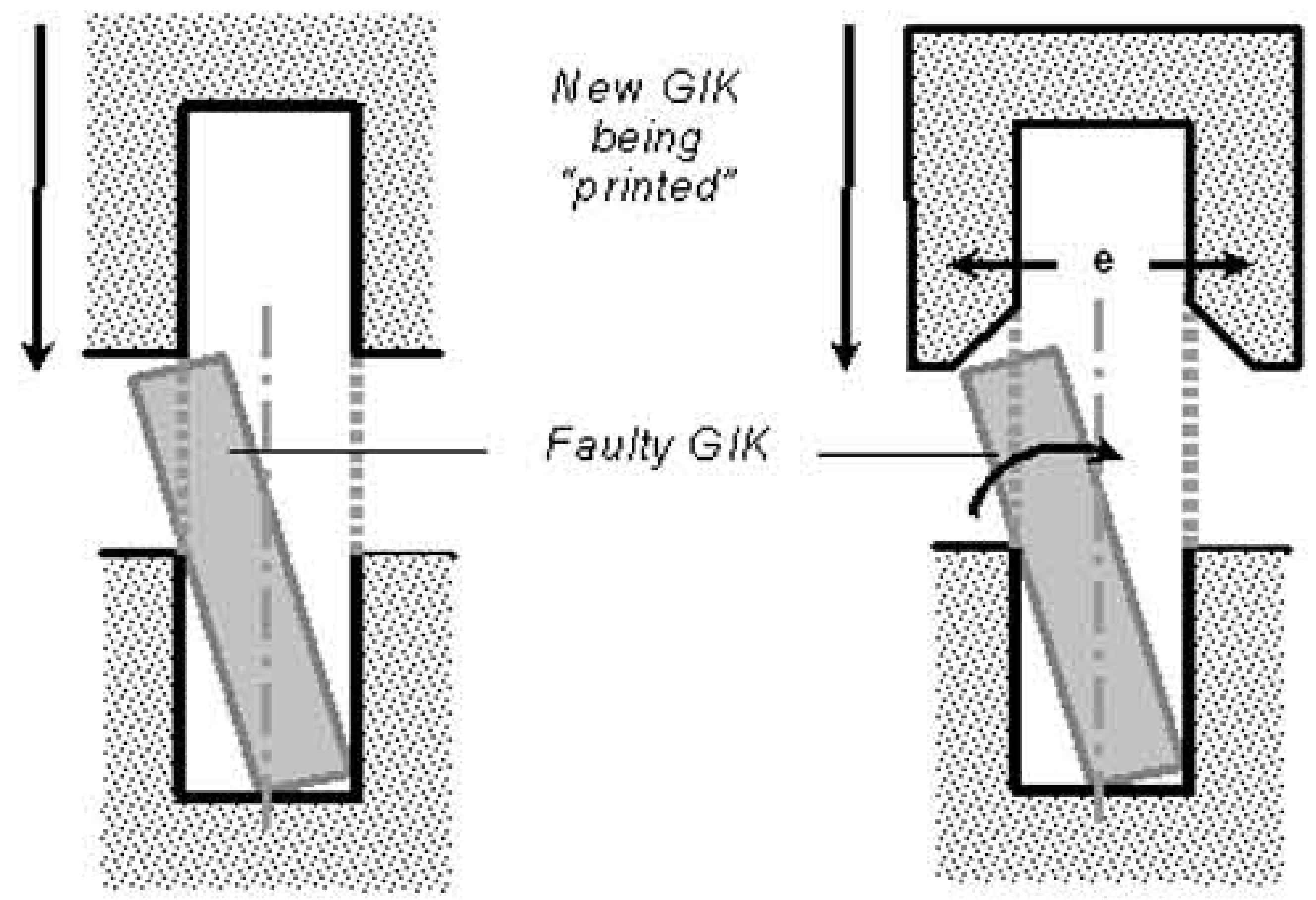
(Grace Gershenfeld, George Popescu, Tushar Mahale)
GIK; material properties; digital material printer

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)

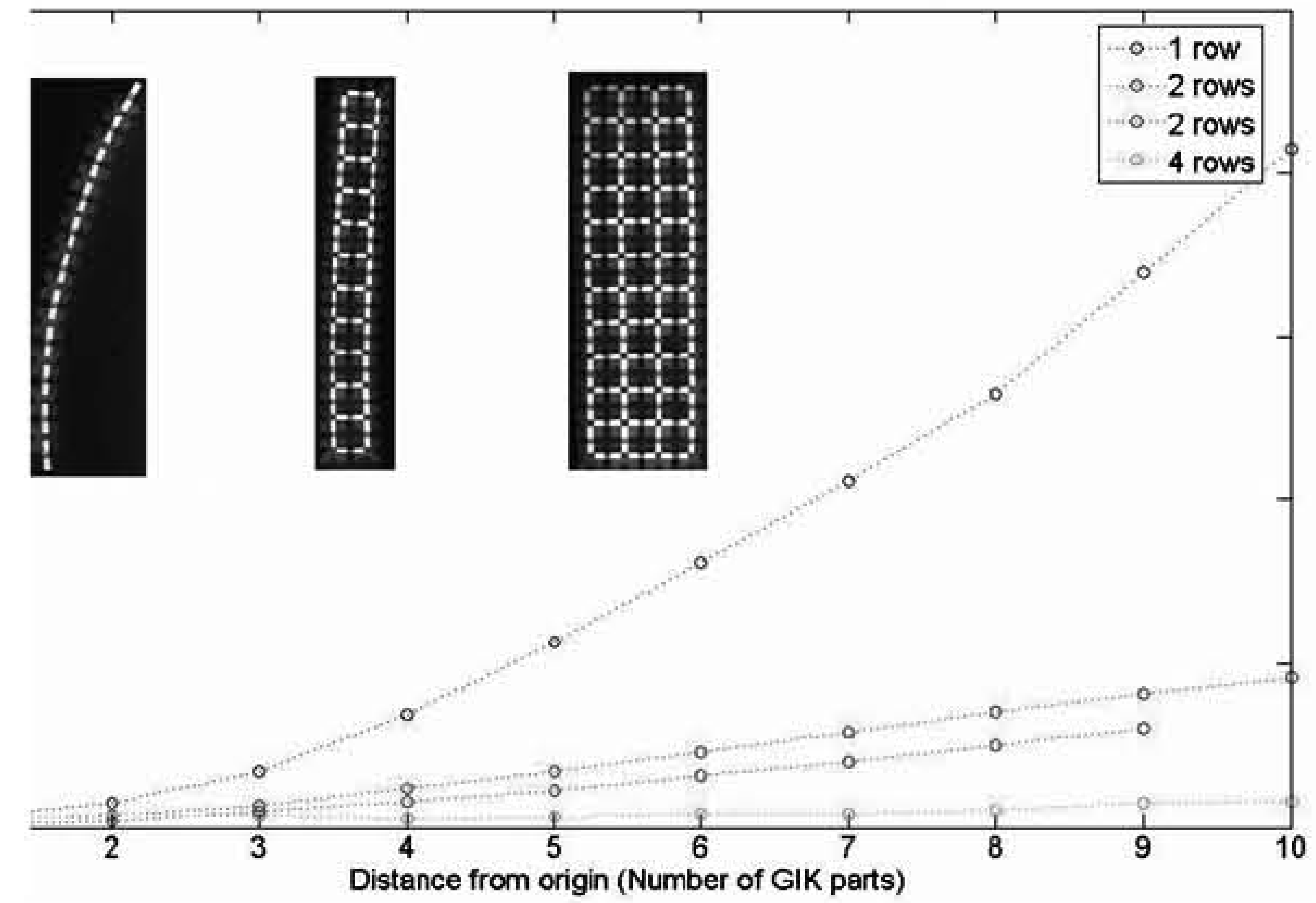
Error Tolerance, Error Reduction



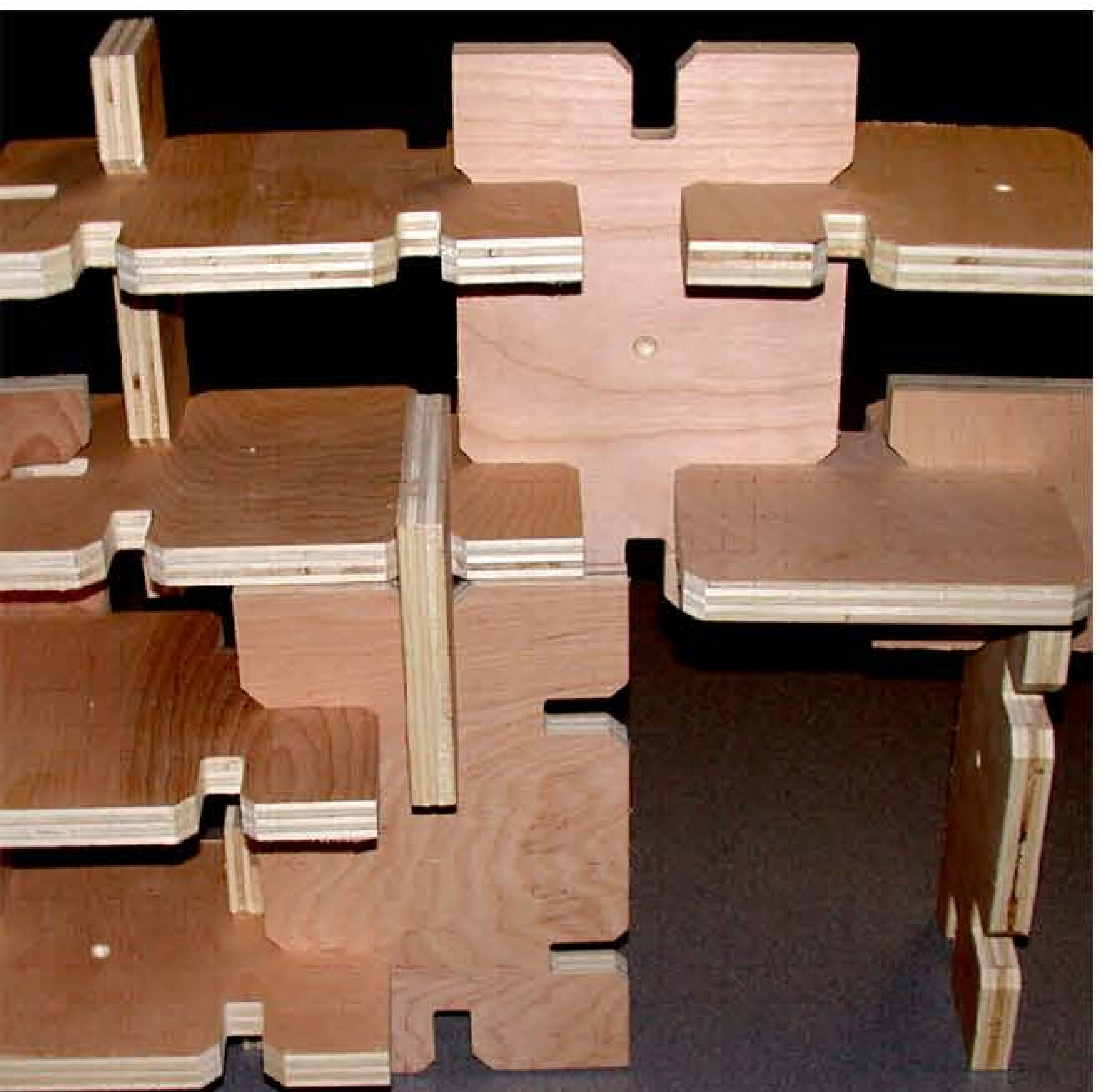


GIK without error correction allowance
Fig. 9a

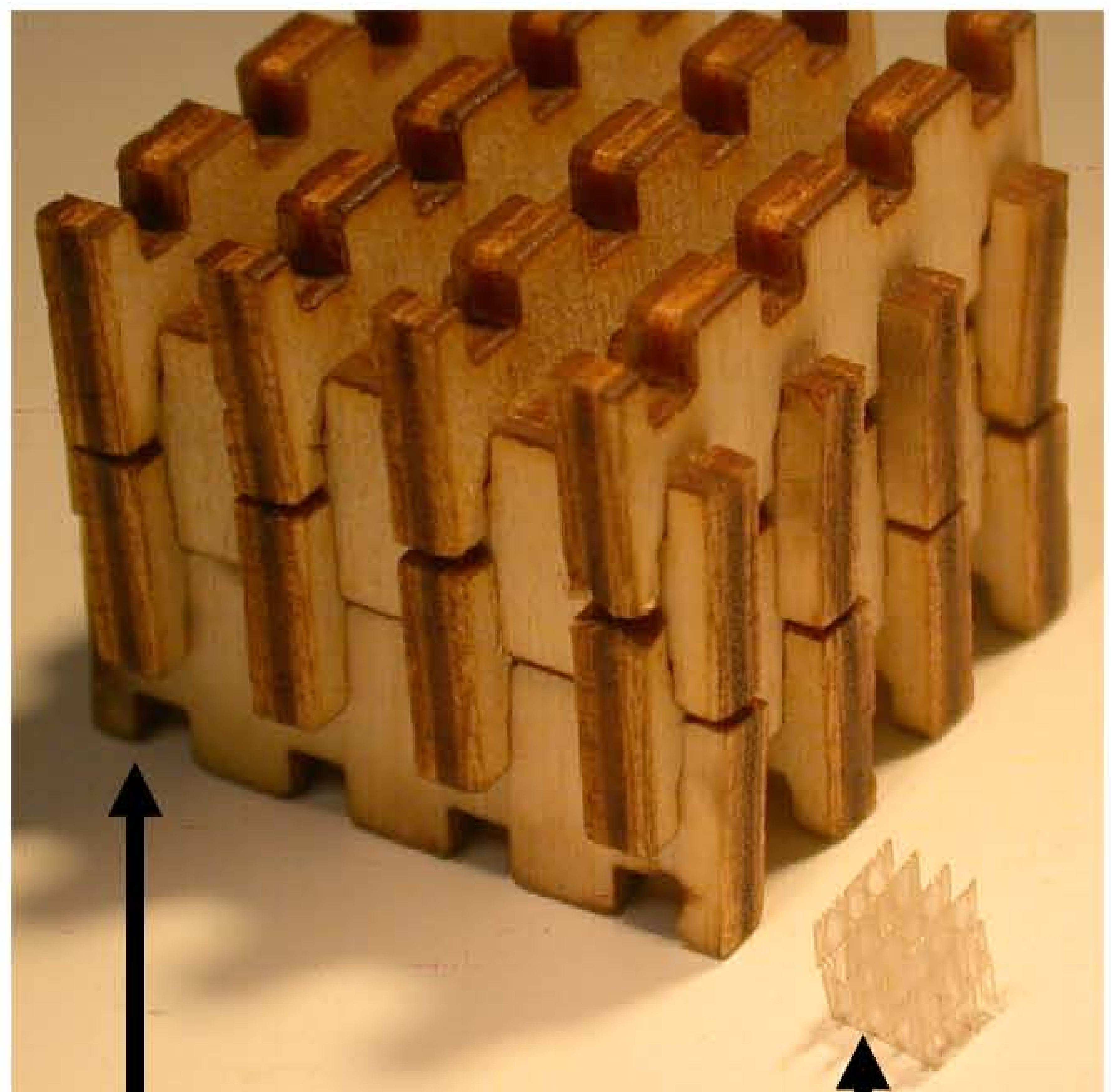
GIK with error correction allowance
Fig. 9b



Multi-scale

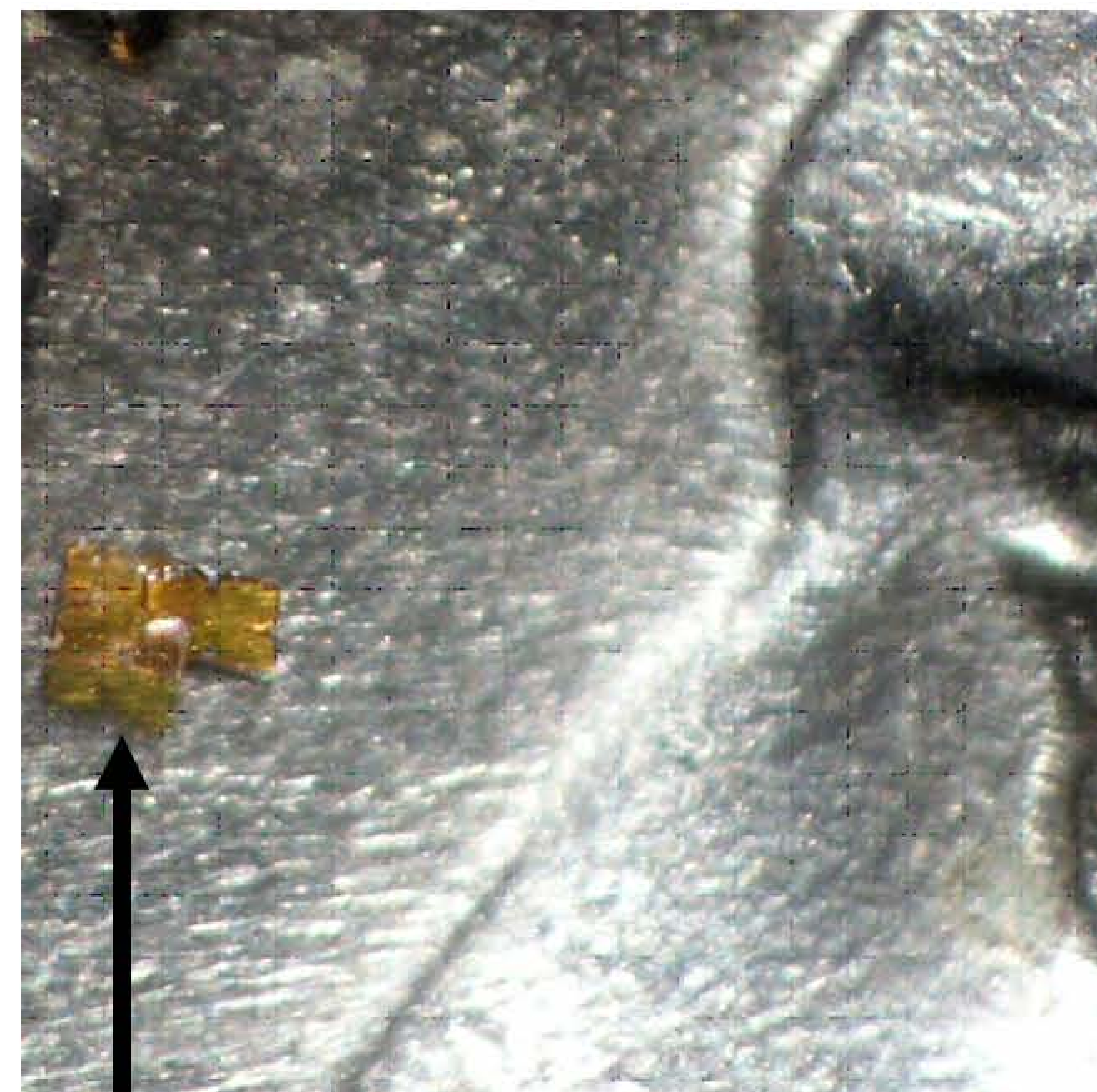


1m



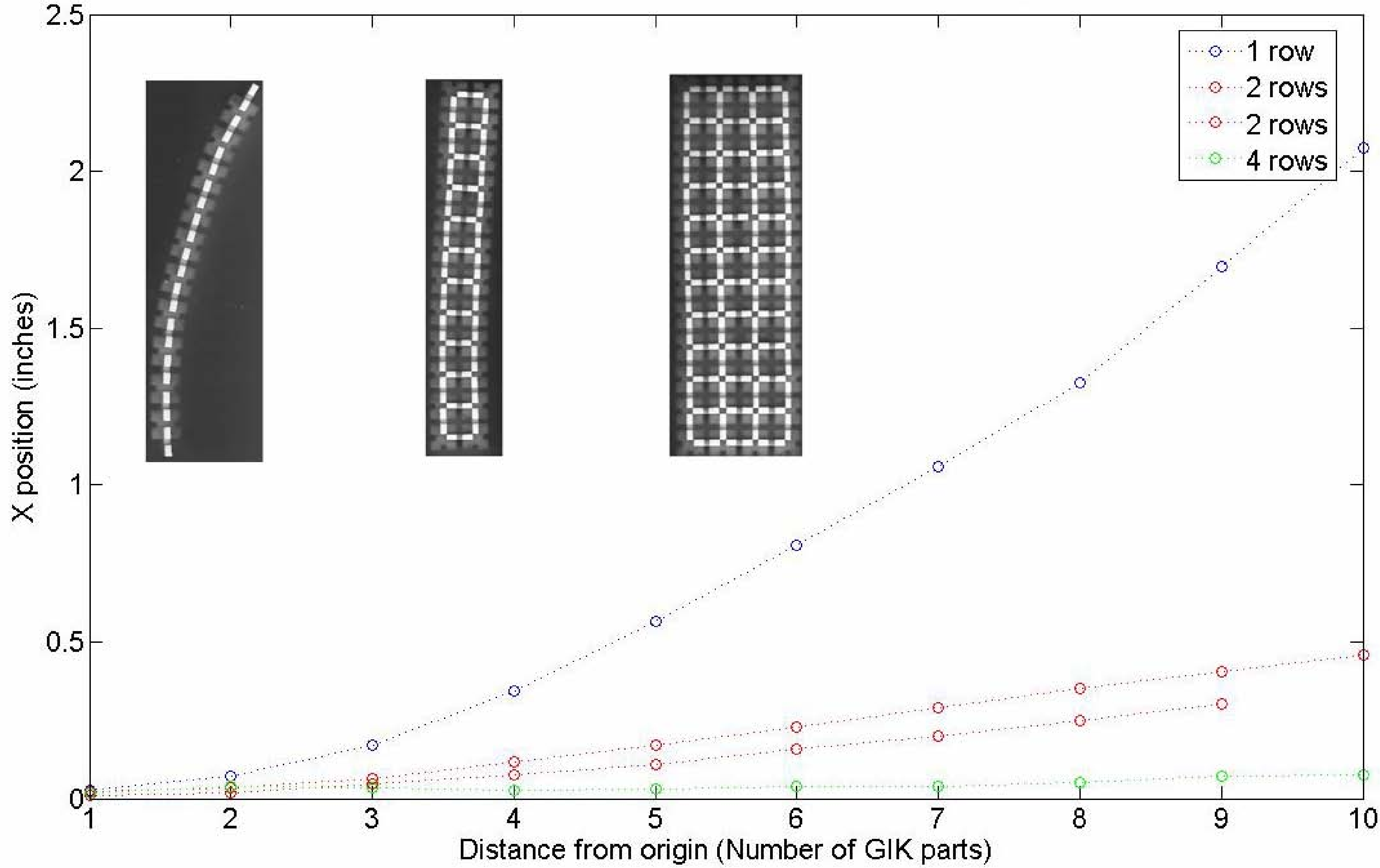
1cm

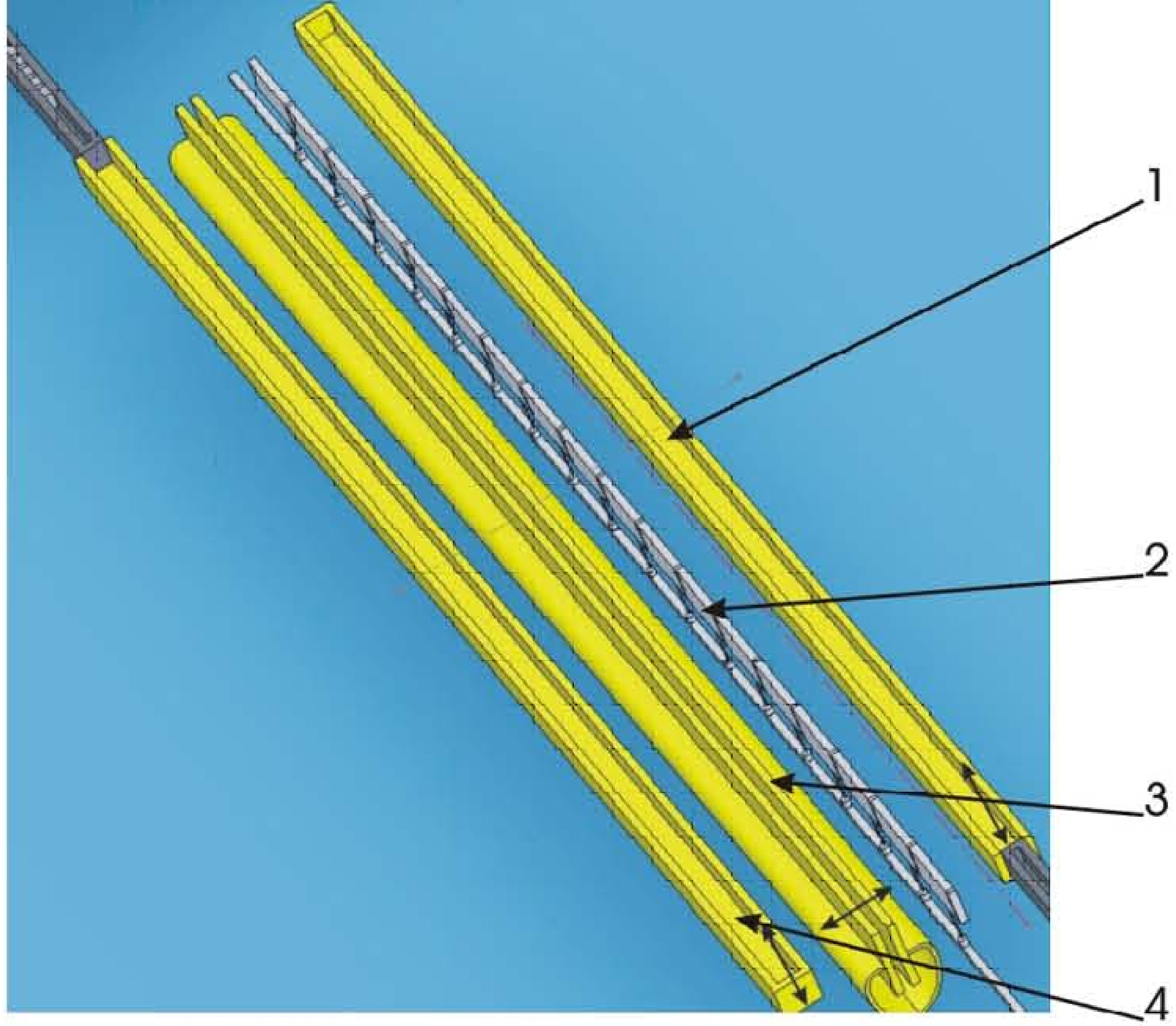
1mm



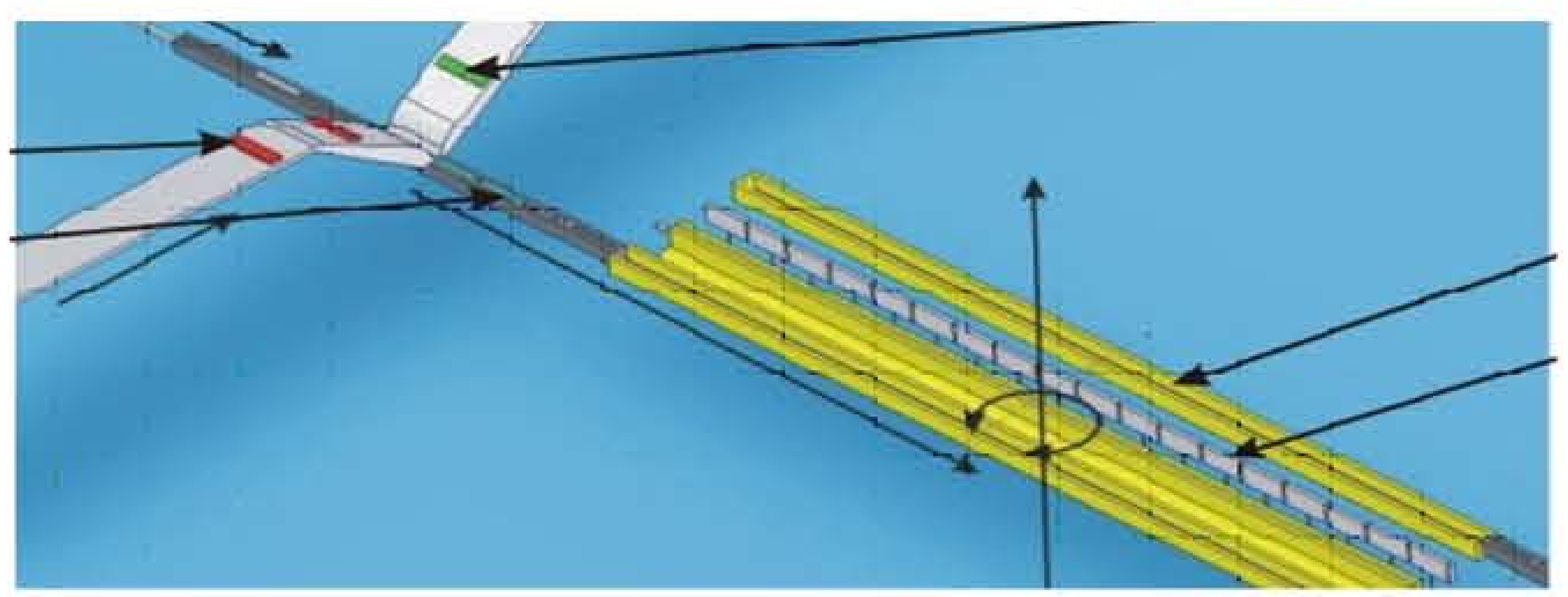
200μm

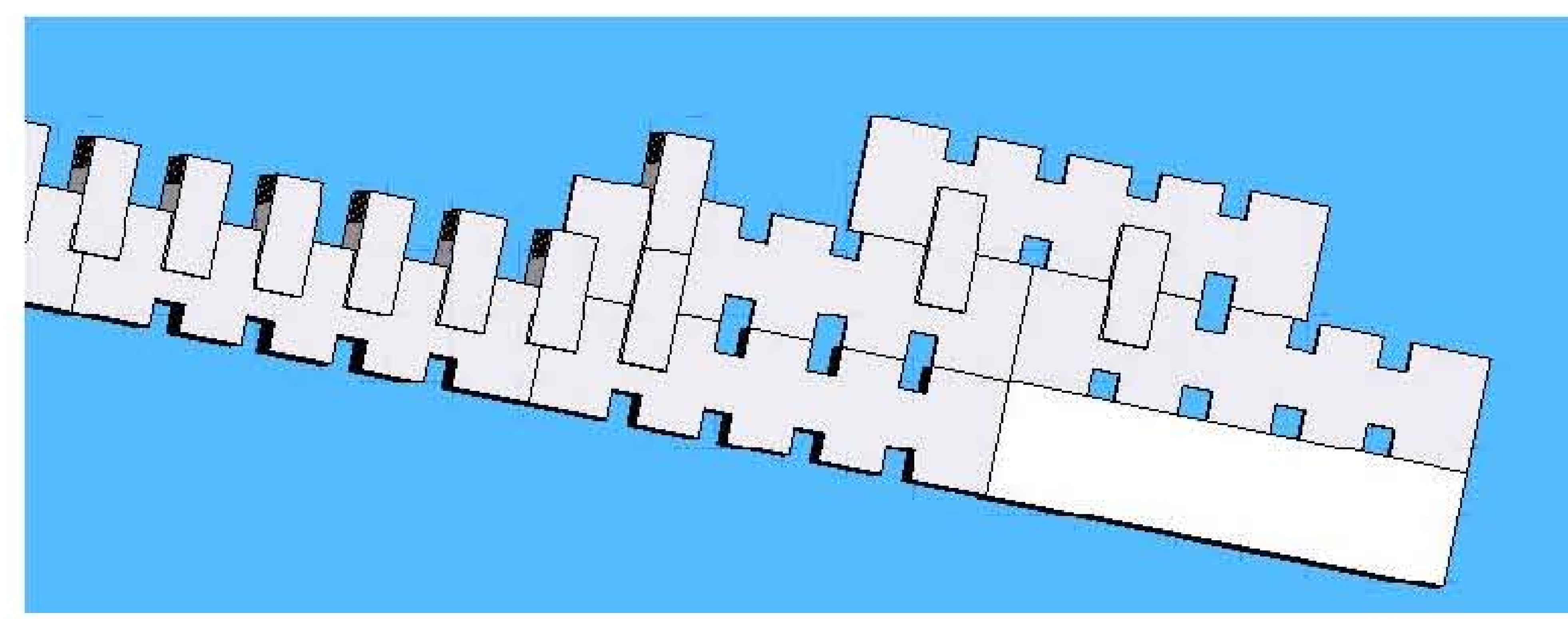
Error Reduction

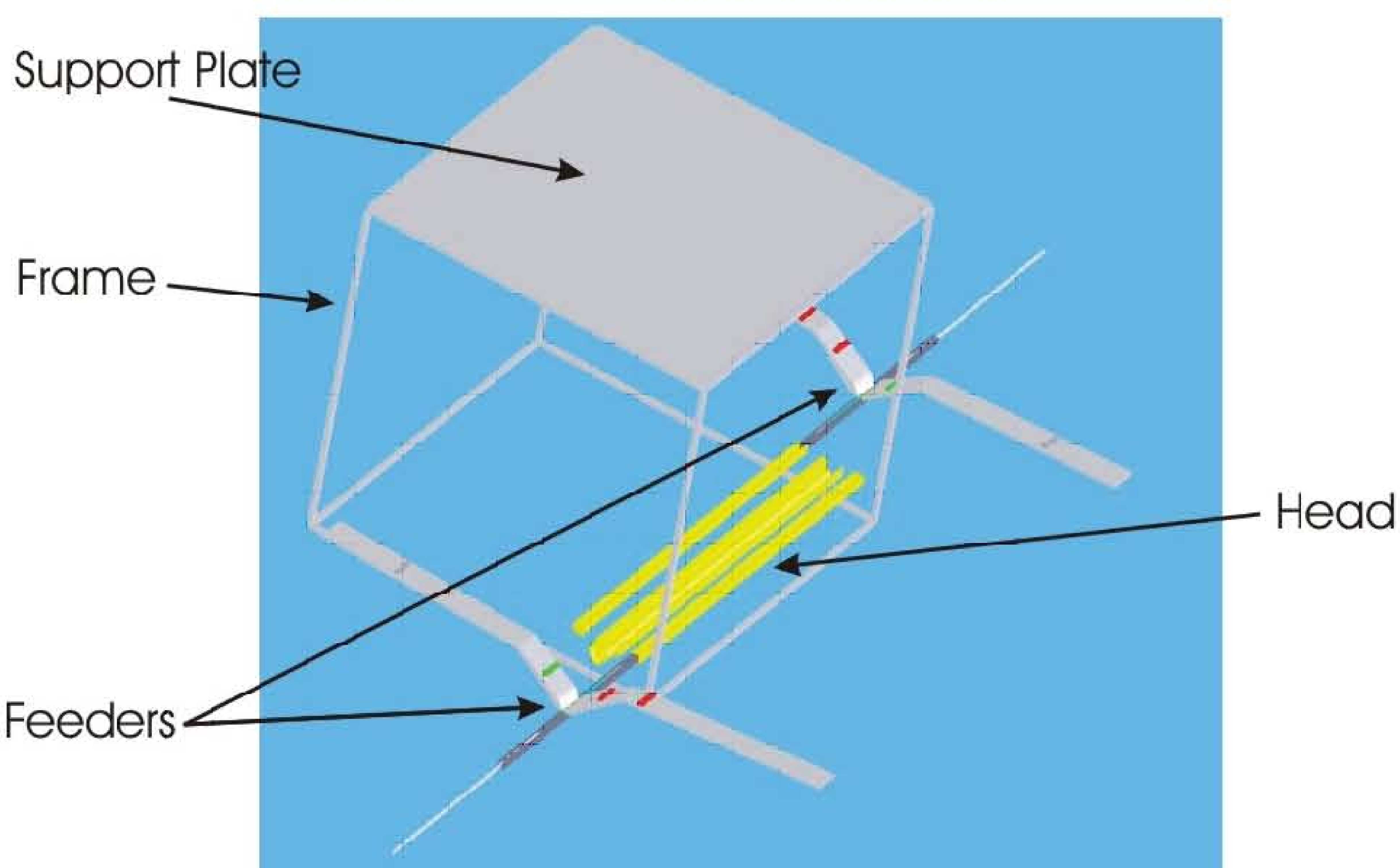




(1) building
(2) detecting errors
(3) removing errors
(4) rebuilding







Digital Material (GIK) Printer
(George Popescu)