Converting Multi-Axis Machine Tools into Subtractive 3D Printers by using Intelligent Discrete Geometry Data Structures Designed for Parallel and Distributed Computing

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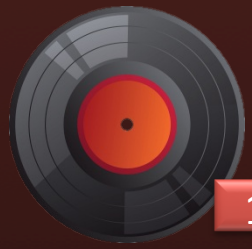
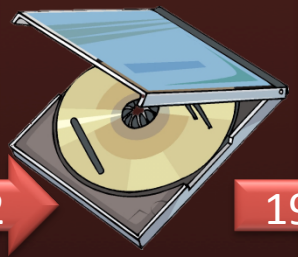
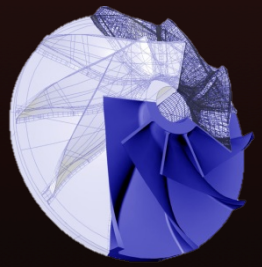
TIME

	Analog	Digital	Compressed	Distributed
1D: Sound				
2D: Image				
3D: Volume				

1982 → 1991 → 201x

1987 → 1992 → 201x

201x

BREP, CSG, Triangular mesh

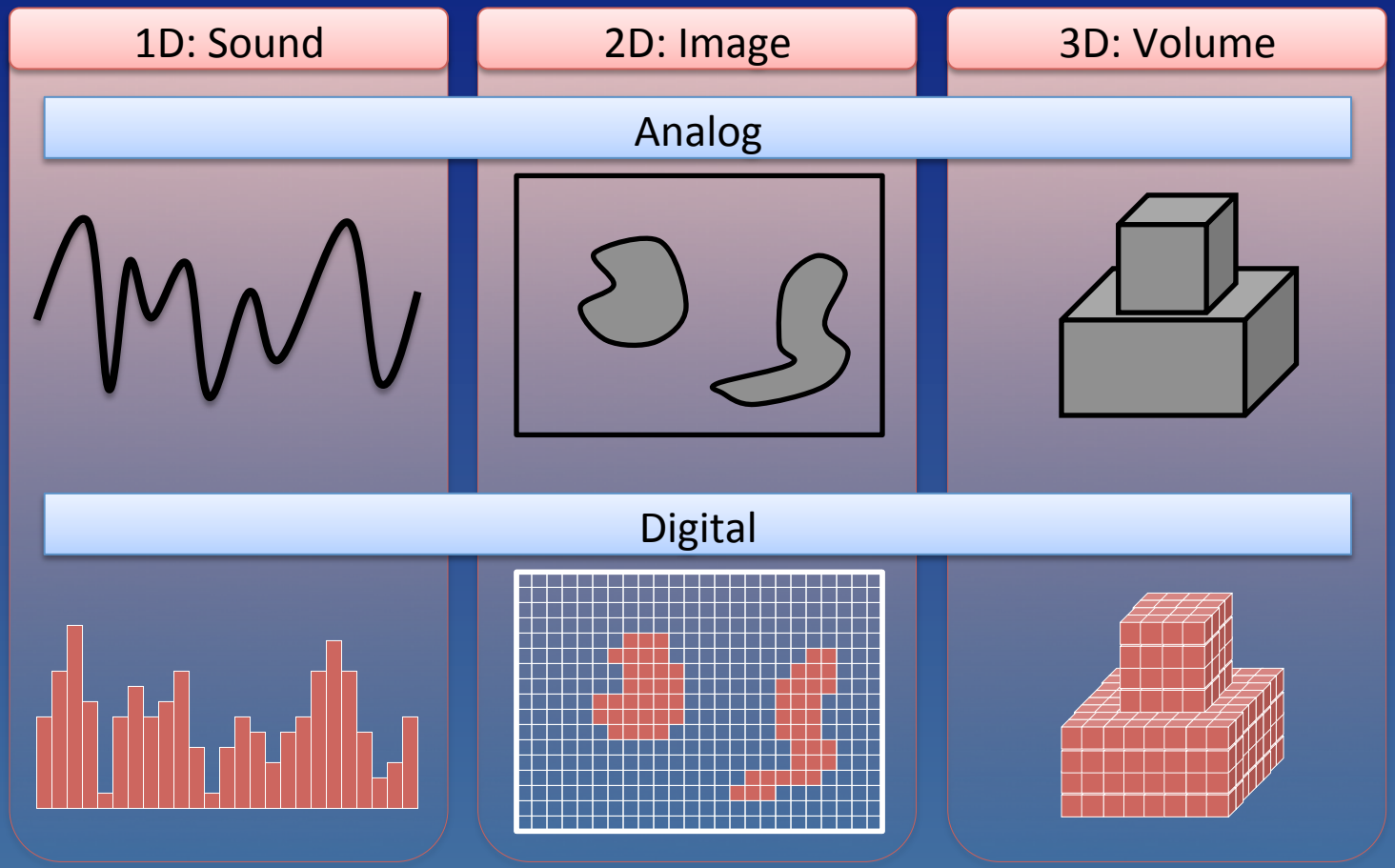
Voxel model

New volume representation and compression technology

Cloud computing, Parallel processing, GPGPU

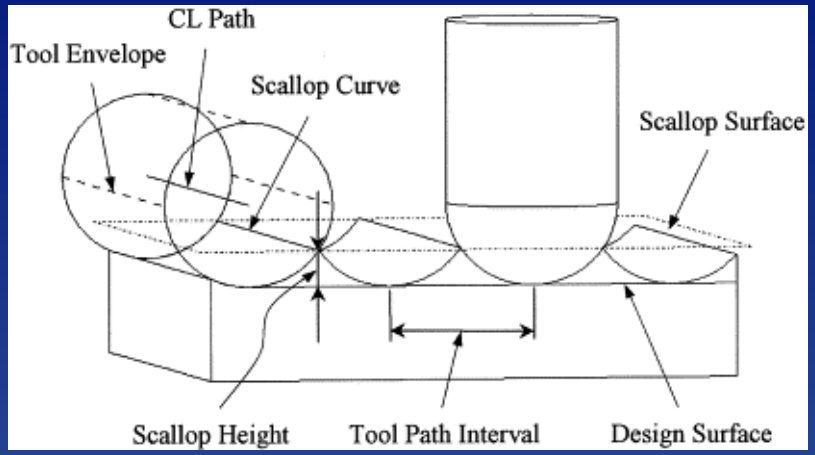
Research goal

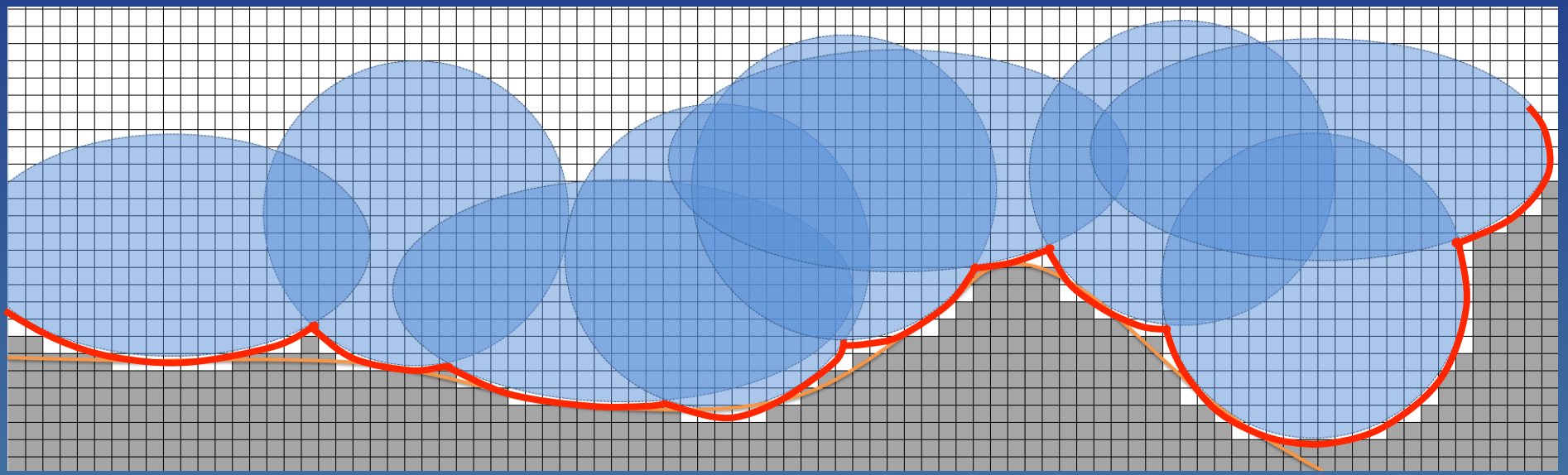
The Digital World



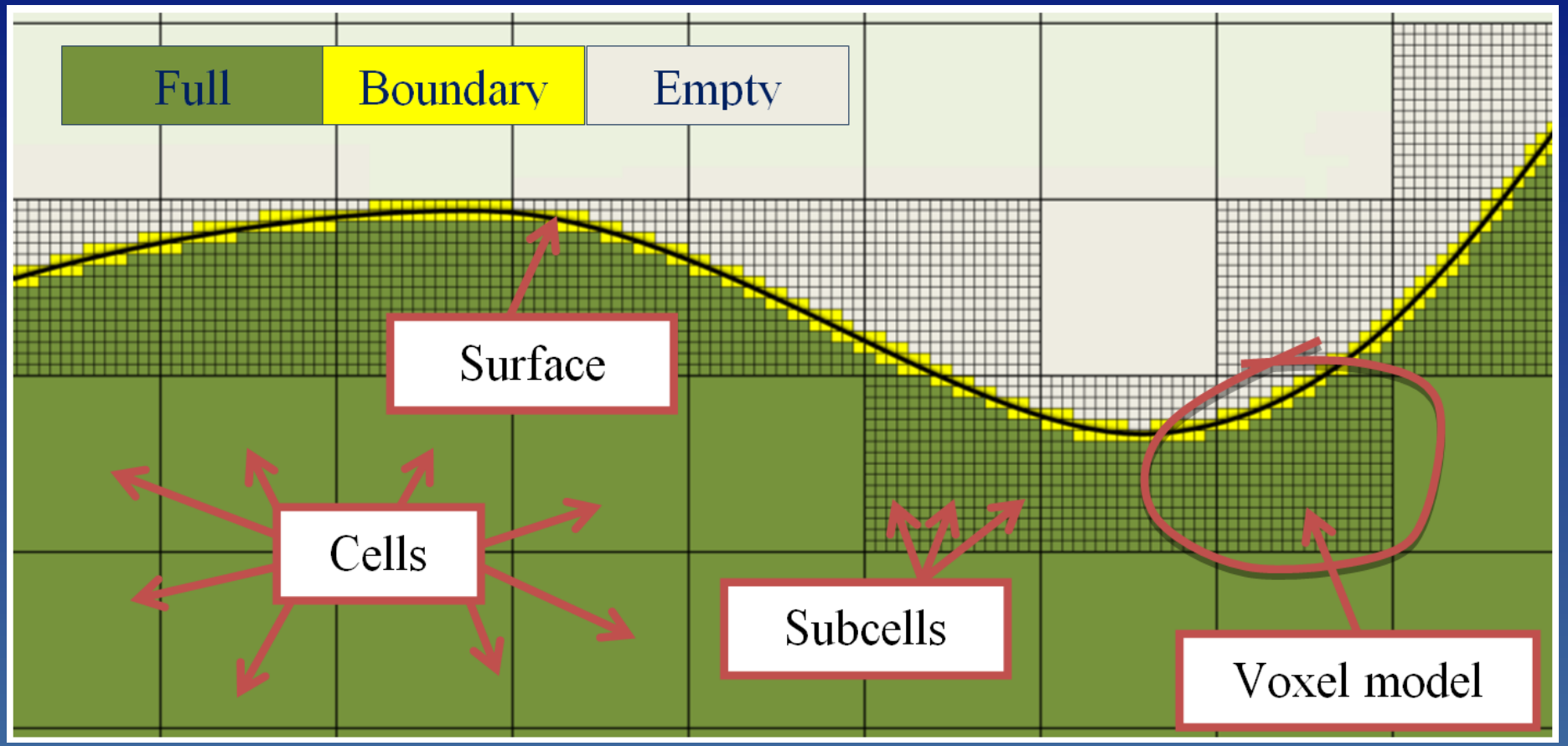
Digital vs. Analytic

- Identify surface
  - Analytical approach
  - Discrete approach

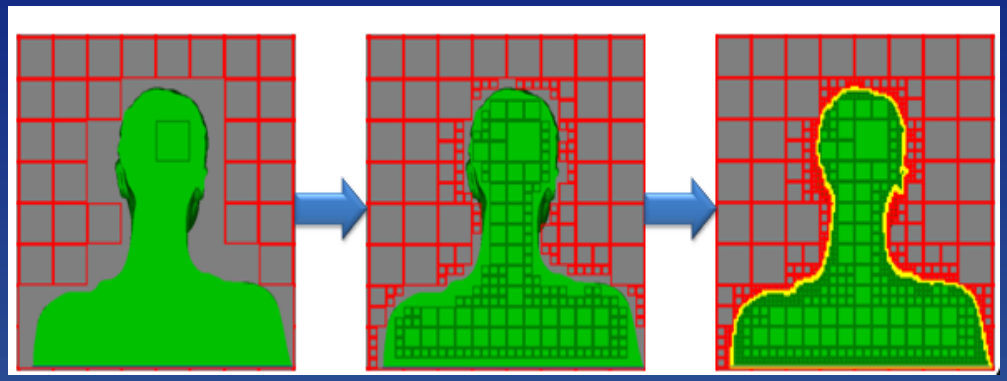


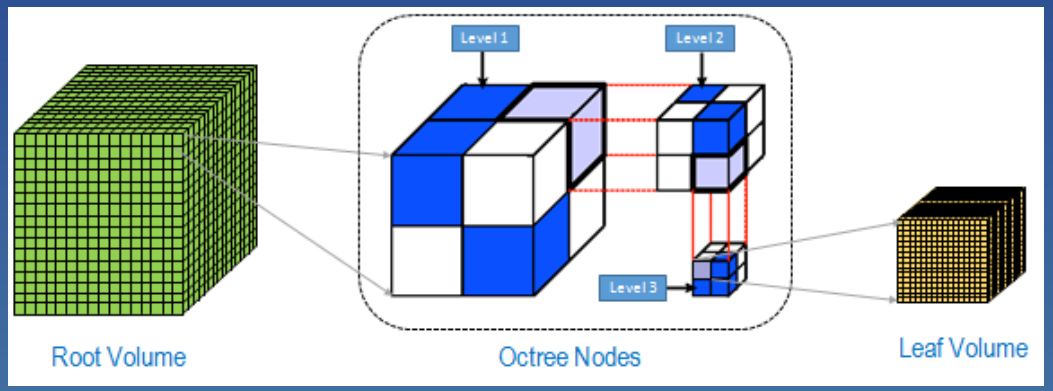


Geometry Representation



Storage-Efficient Voxel Representation for GPUs





- Grid-based volume modeling → ***O(n^3) memory***
- Octree memory consumption is optimal → height ***$\log_2$ (Resolution)***

- Hybrid Dynamic Tree (HDT) integrates Octree and Grid layout
- A 4-level HDT represents up to 16 x 2^4 x 16 = 4K resolution

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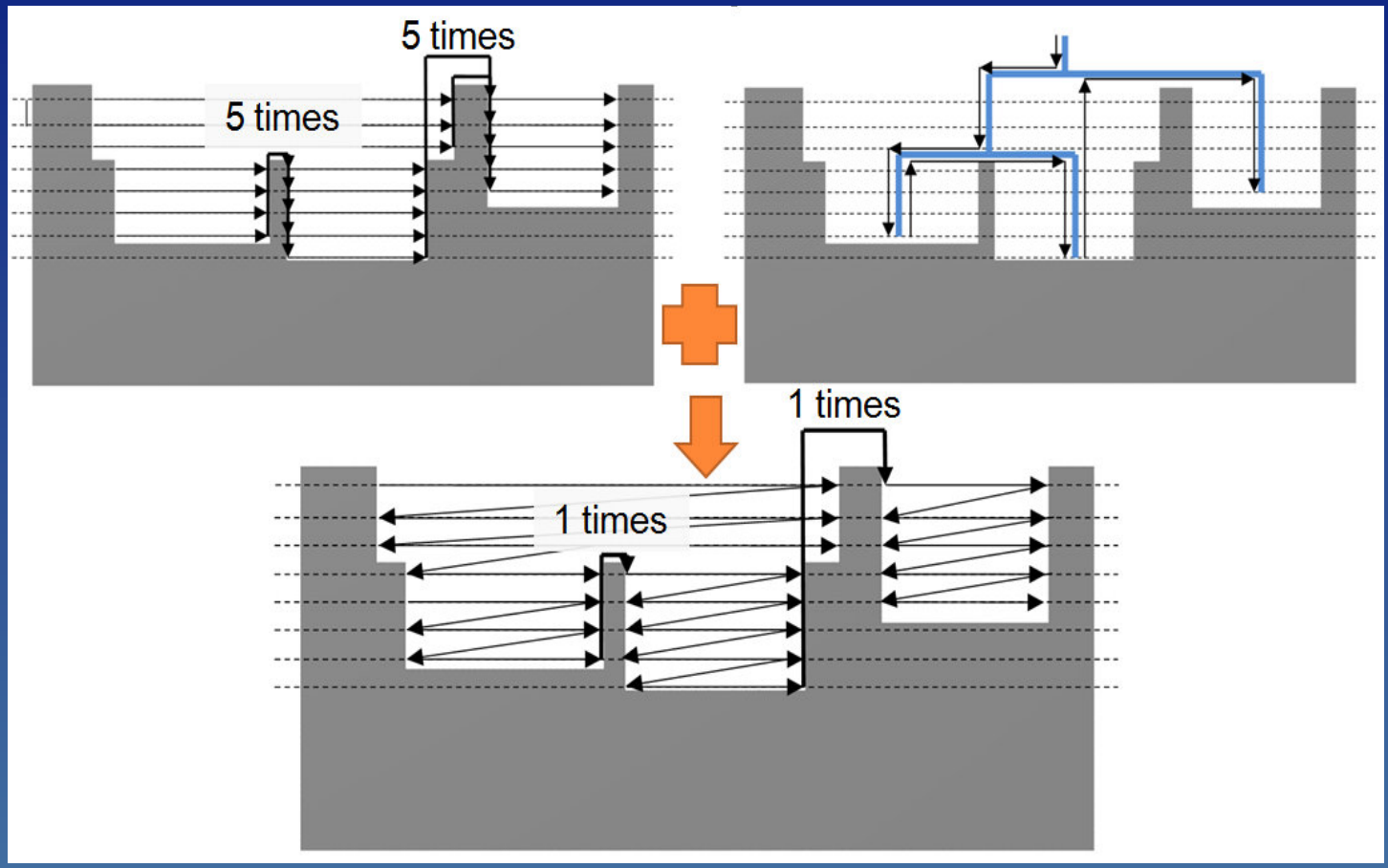
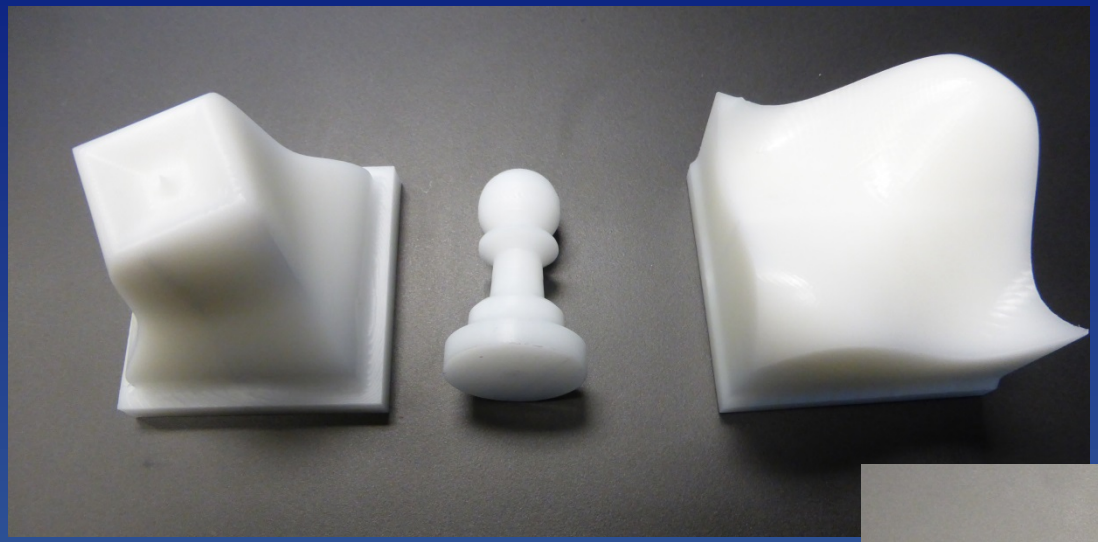
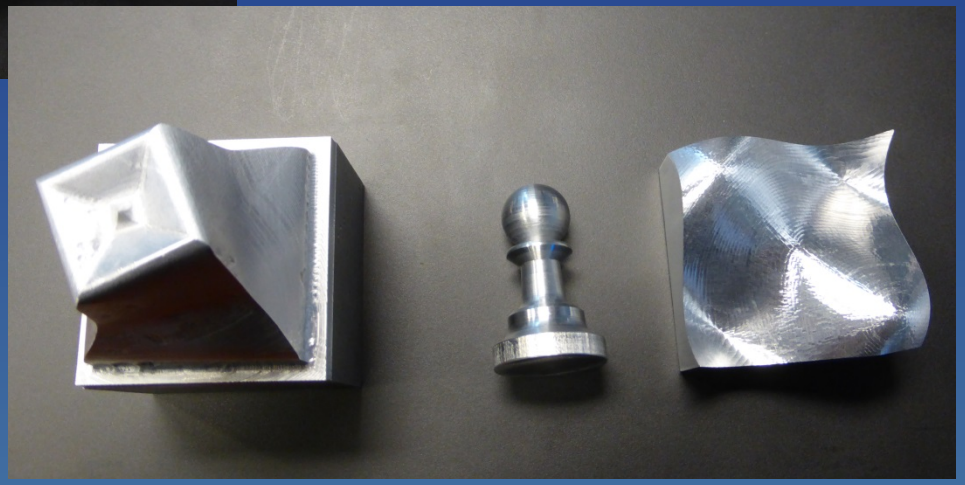
Parallel Formulation – Part Tree Optimization



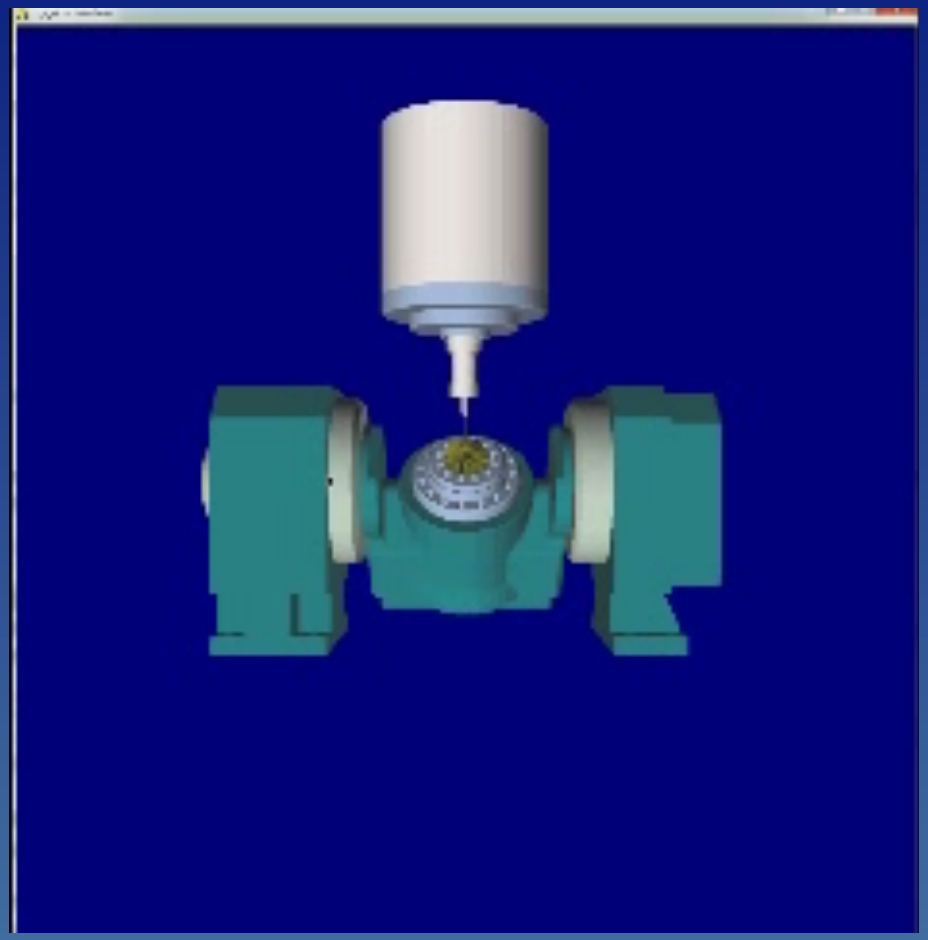
Making Chips – The Part





Making Chips – The Process

Next Steps – 5-Axis Machining



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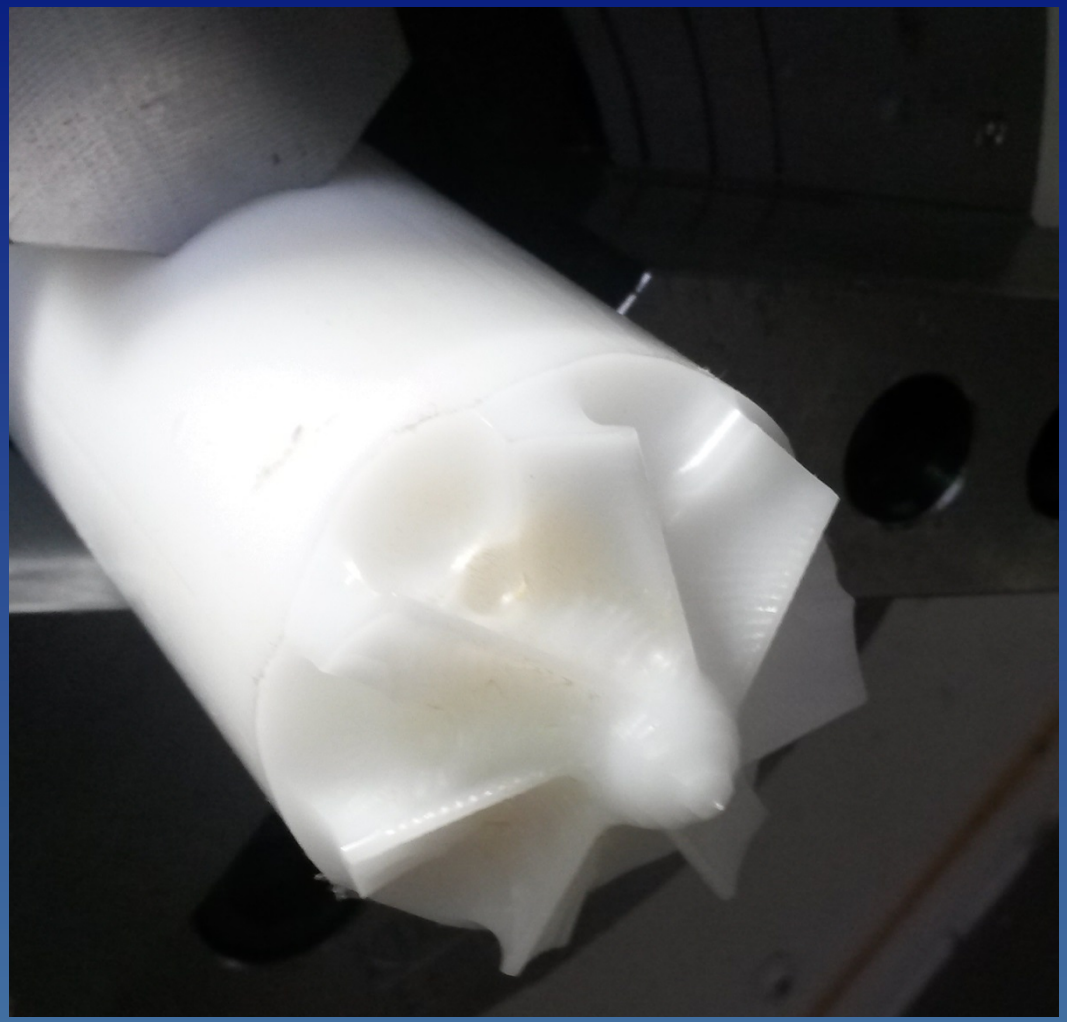
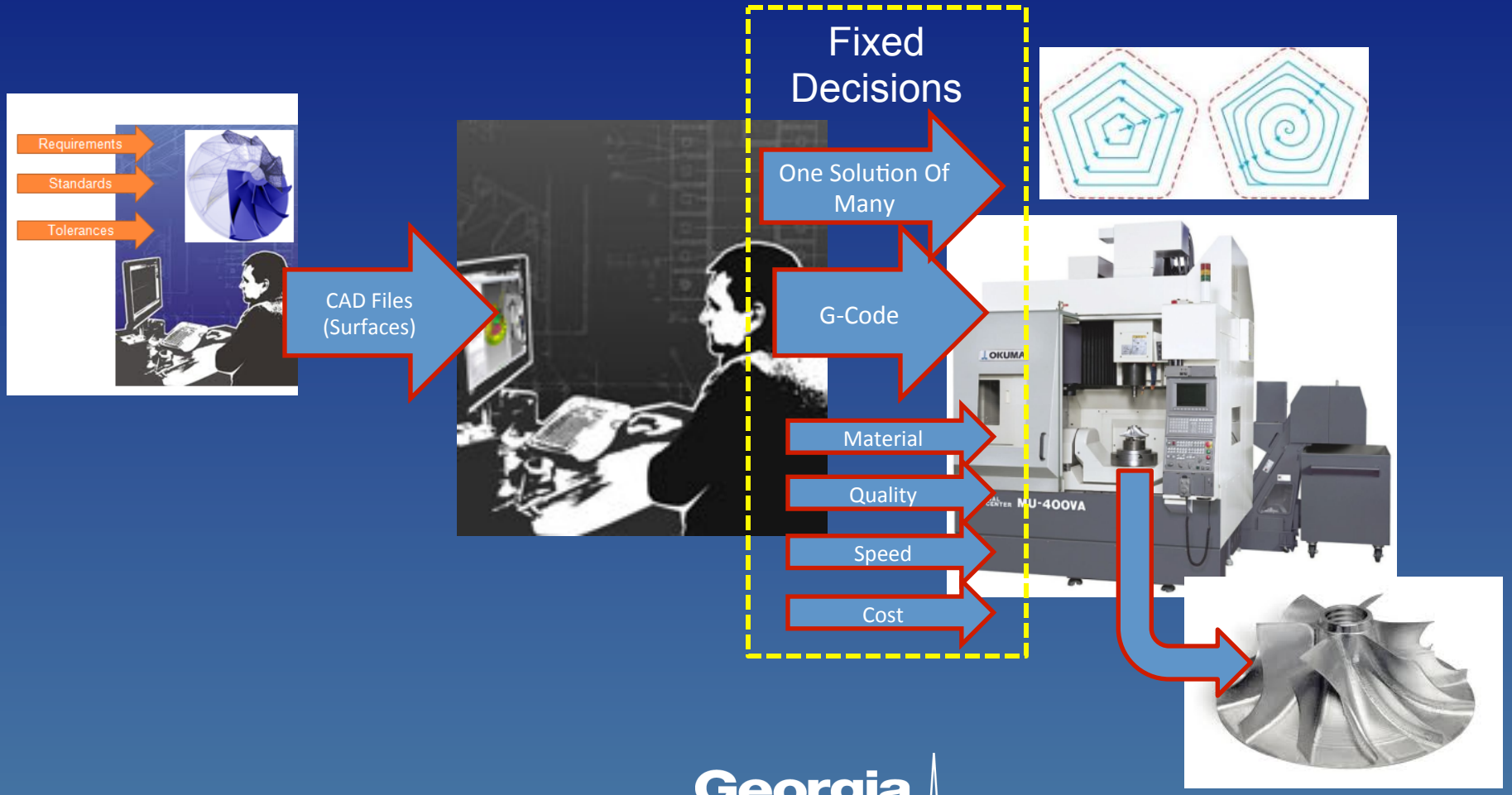
Reality – Taking it to the Limit!!!

Our First Fan



Implementation in the Classroom



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