SAND2008-3208C

"Methods for Preparing Geometry for Mesh Generation"

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Analysis Model Preparation

CAD Design

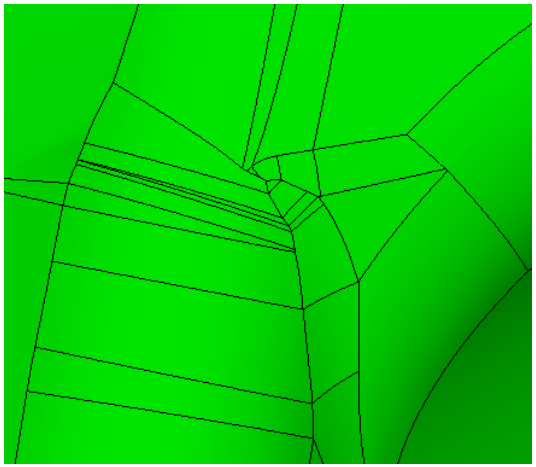
Many mesh generators are very sensitive to the topology in the CAD model—"Geometry-centric"

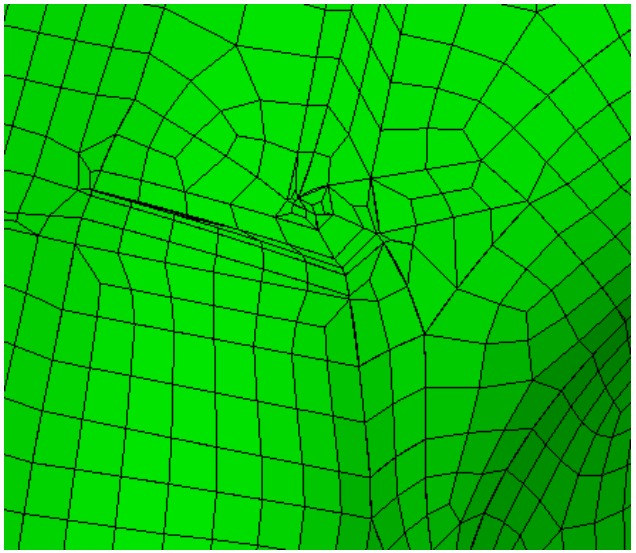
Translate
Generate Topology/Geometry
Fix Gaps
Remove Slivers
Defeature
Decompose

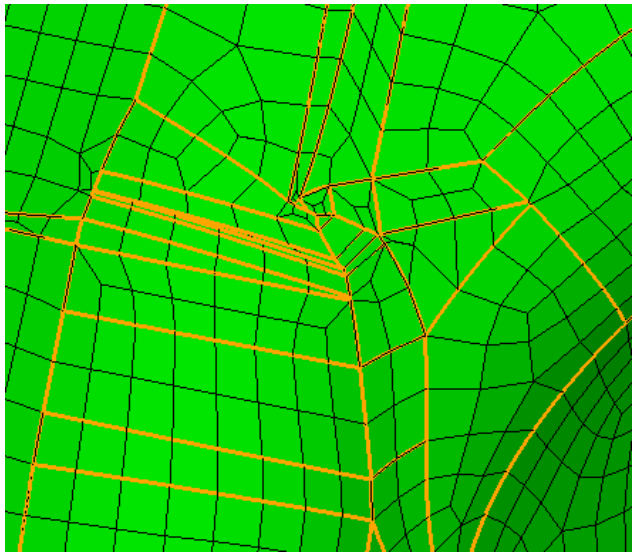
Generate Mesh

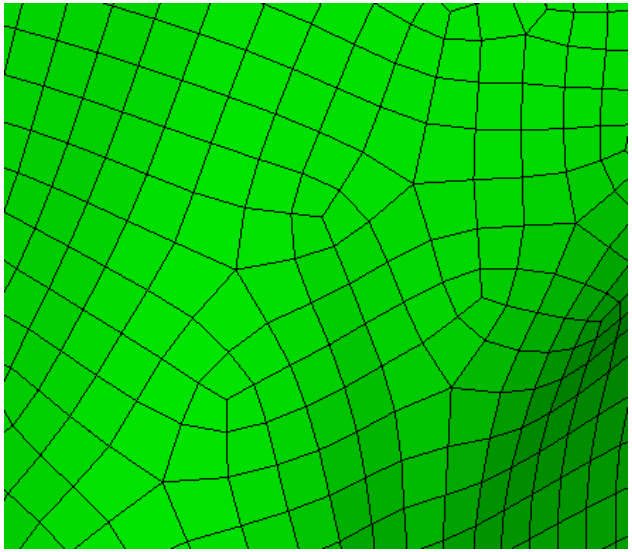
Geometry-Centric vs. Geometry-Tolerant

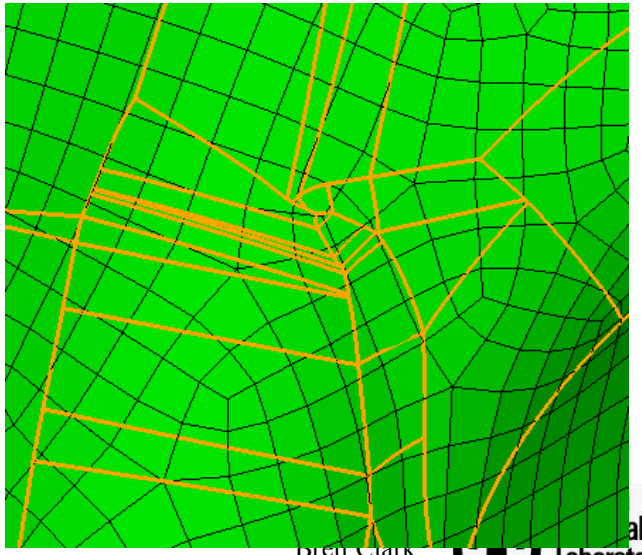
Geometry-Centric











Geometry-Tolerant

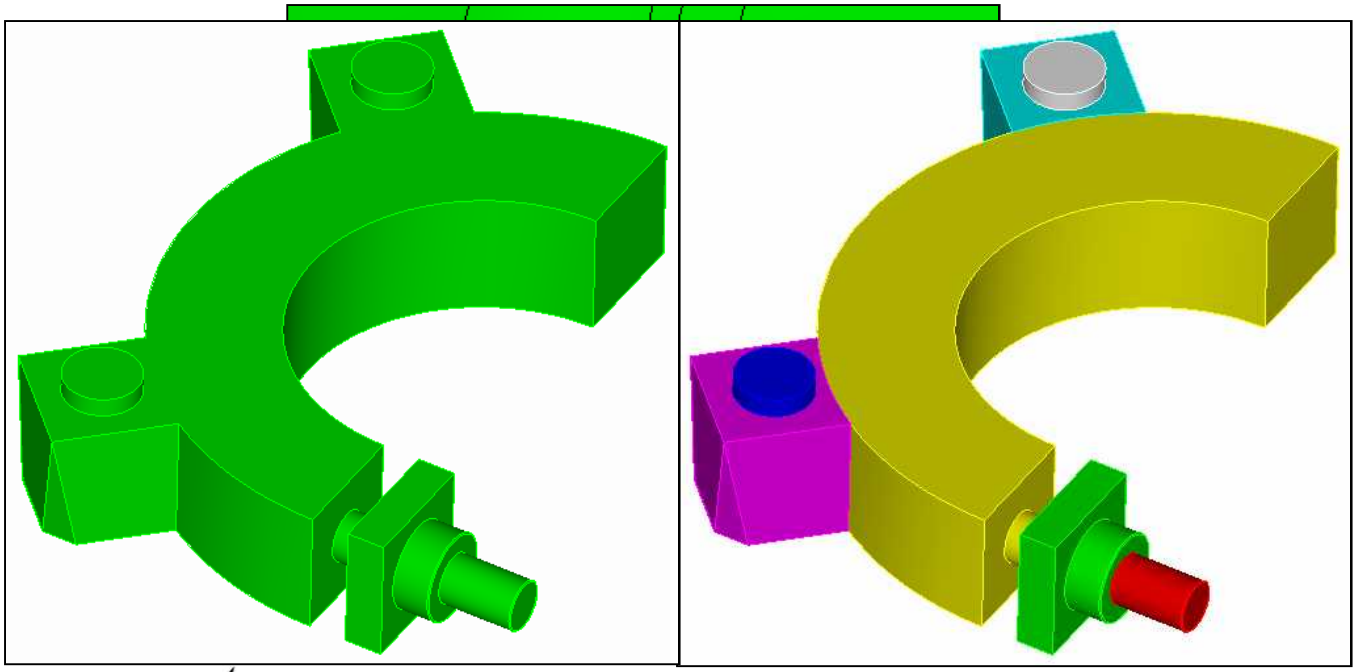
Geometry-Tolerant Meshing

- **Push-button capabilities exist in some commercial tet meshing packages**
  - Mesh quality and connectivity problems have been observed in meshes of sloppy assemblies
  - Users have little control
  - A fair amount of geometry cleanup is still required
- **Auto hex meshing still very geometry-centric**
  - Sweeping algorithm currently requires strong tie to CAD model topology
  - Topology modifications to a hex mesh are more global
  - Potential solutions exist in new approaches (sheet insertion algorithm-choose what topology to resolve)

*** Geometry cleanup/preparation continues to be necessary in FE model generation**

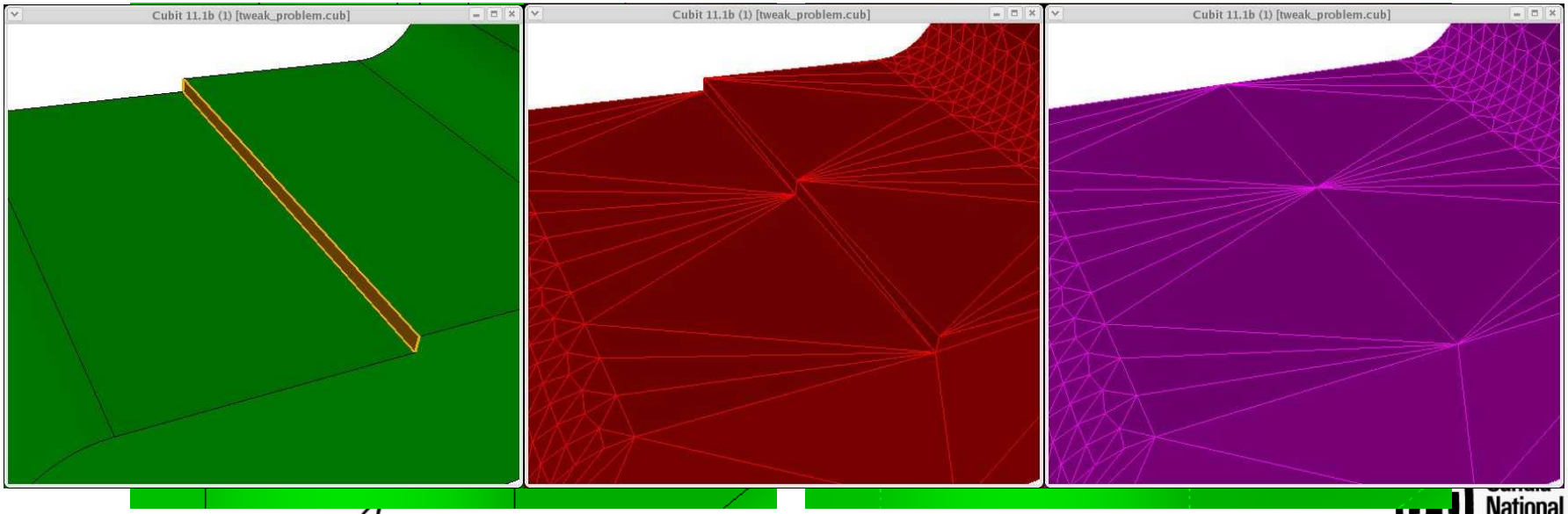
What are the issues?

- **Solid modeling kernels**
  - Great for global operations (general booleans)
  - Not great at local operations
  - Lack composite operator! ("virtual geometry" is often used)



What are the issues?

- **Virtual/Facetted Representation**
  - Very good at local operations/modifications
  - Composites!
  - Lack of robust boolean operations (critical for decomposition for hex meshing)
  - Inhibits subsequent solid-modeling (“real”) operations



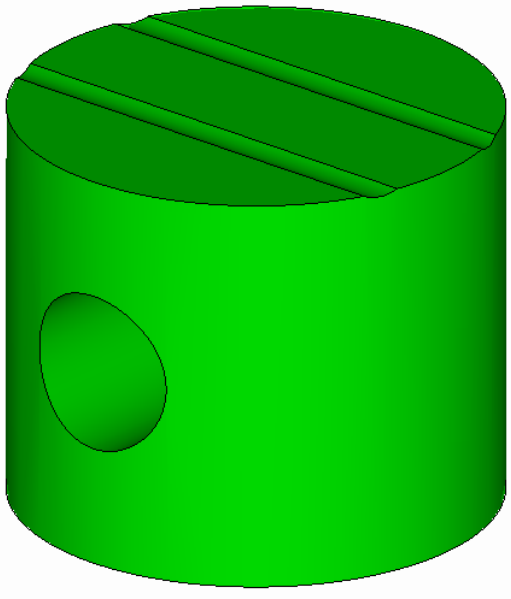
What are the issues?

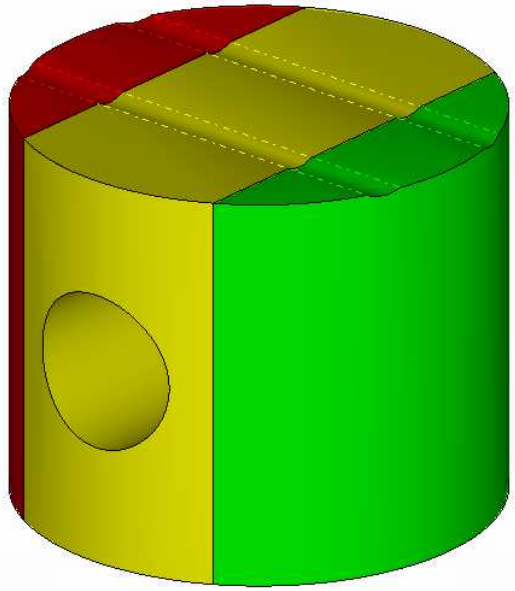
- **Automation**
  - It is very difficult in an algorithm to guess what the design intent is
    - **What should be considered "small"?**
    - **In an assembly with gaps/misalignments what should be connected?**

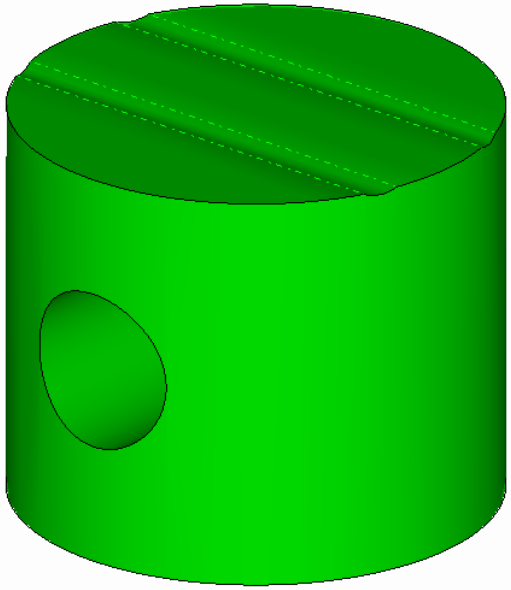
How are we addressing the issues?

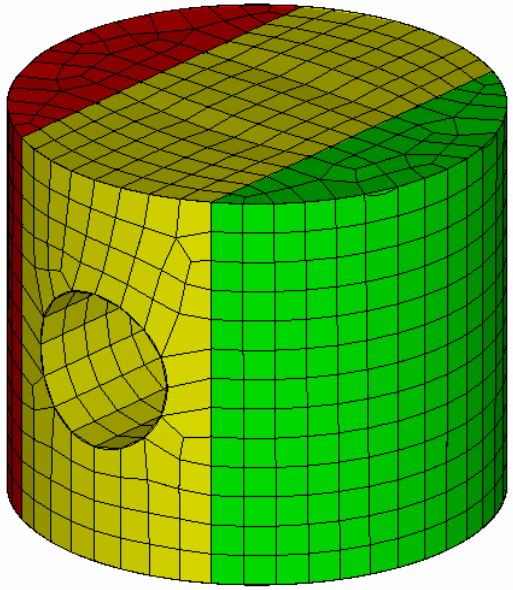
- **Model Representation**
  - Allow both "real" (solid modeling kernel) and "virtual" (faceted) representations
  - Both are needed because of their strengths
- **Modification Operators**
  - Add to the set of real operators
  - Provide interoperability between real and virtual operations
- **Automation**
  - Semi-automated Diagnostic/Solution approach in the ITEM user interface to facilitate geometry modification
  - Research in geometry-tolerant meshing algorithms

Interoperability of Virtual Composites

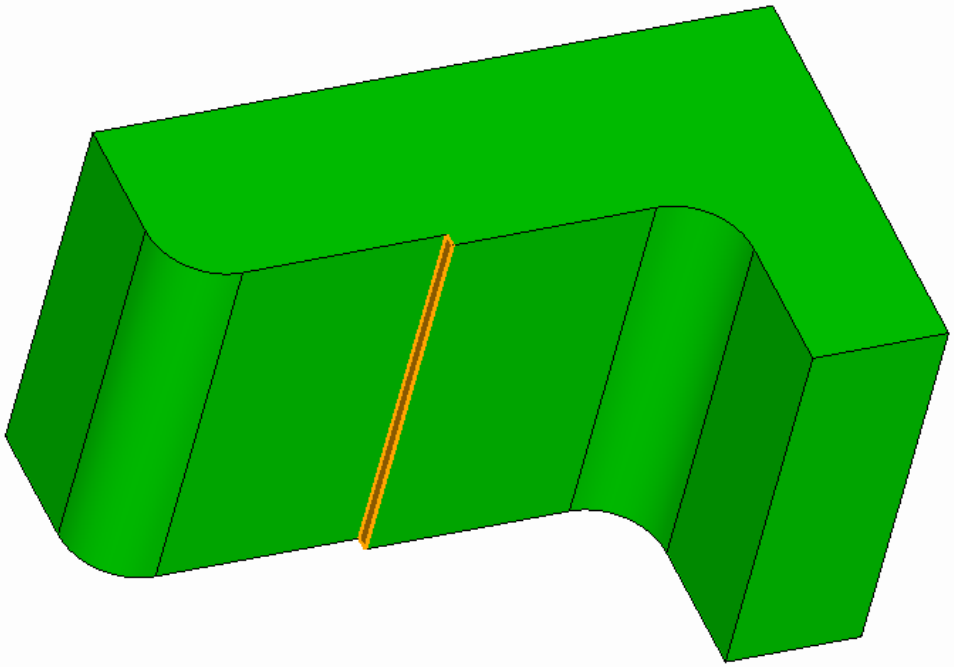


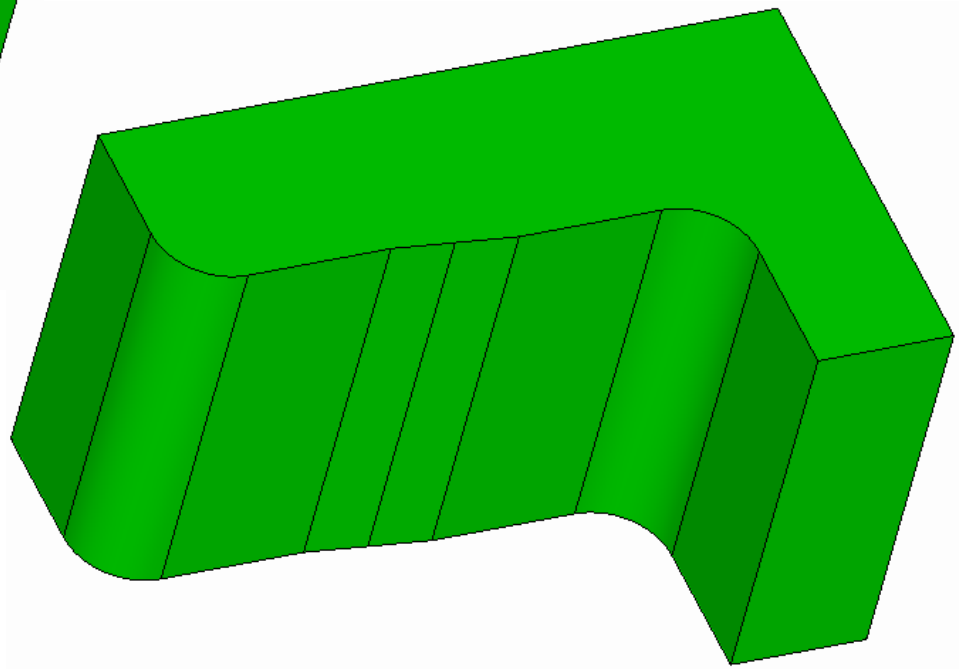






Custom Kernel (“real”) Operator





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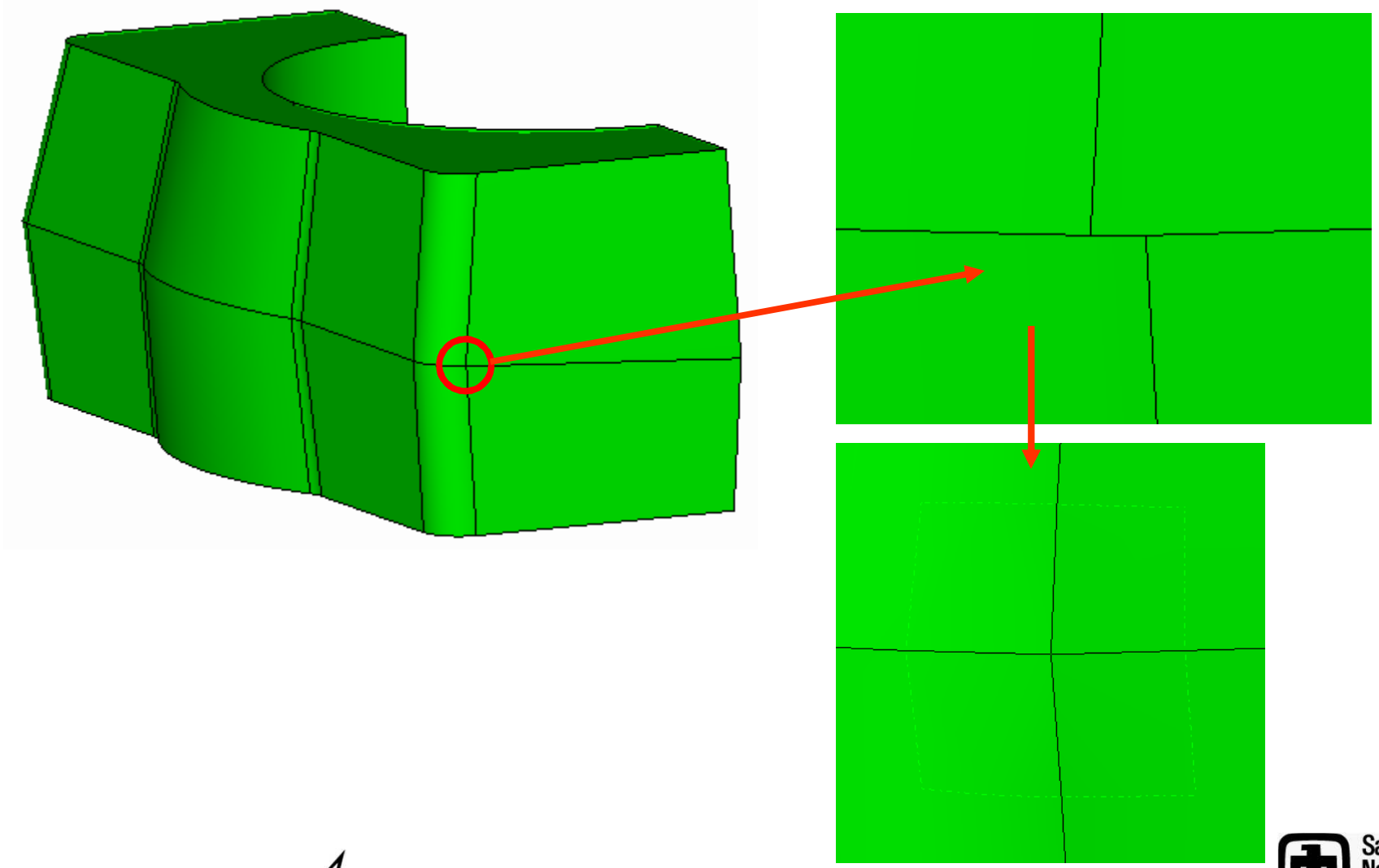

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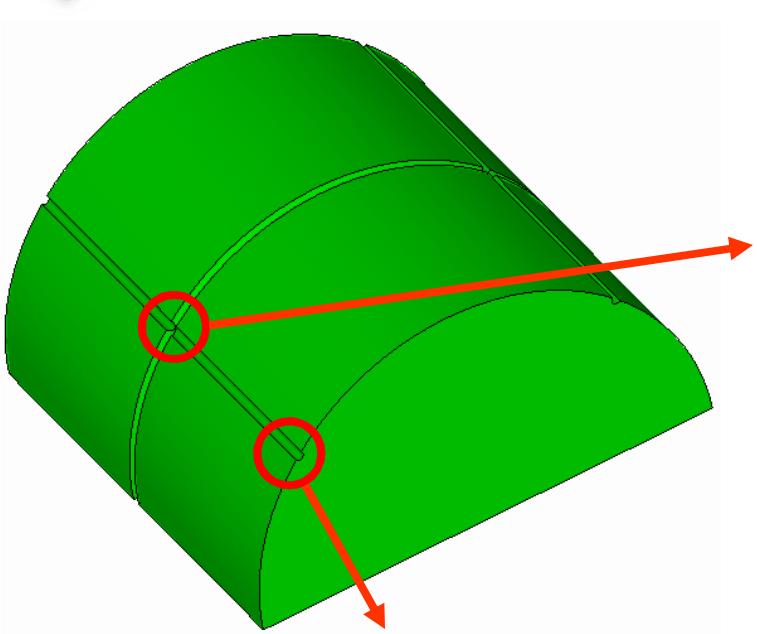
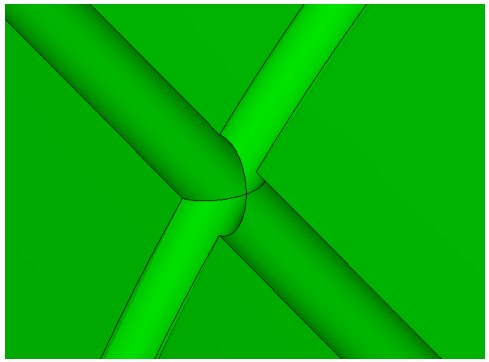
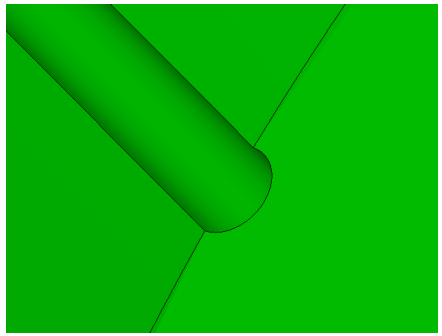
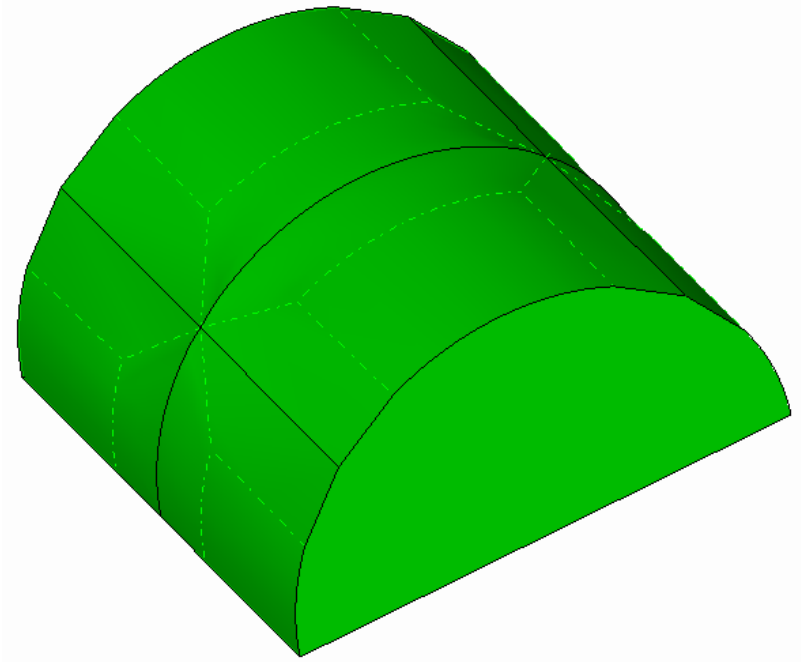


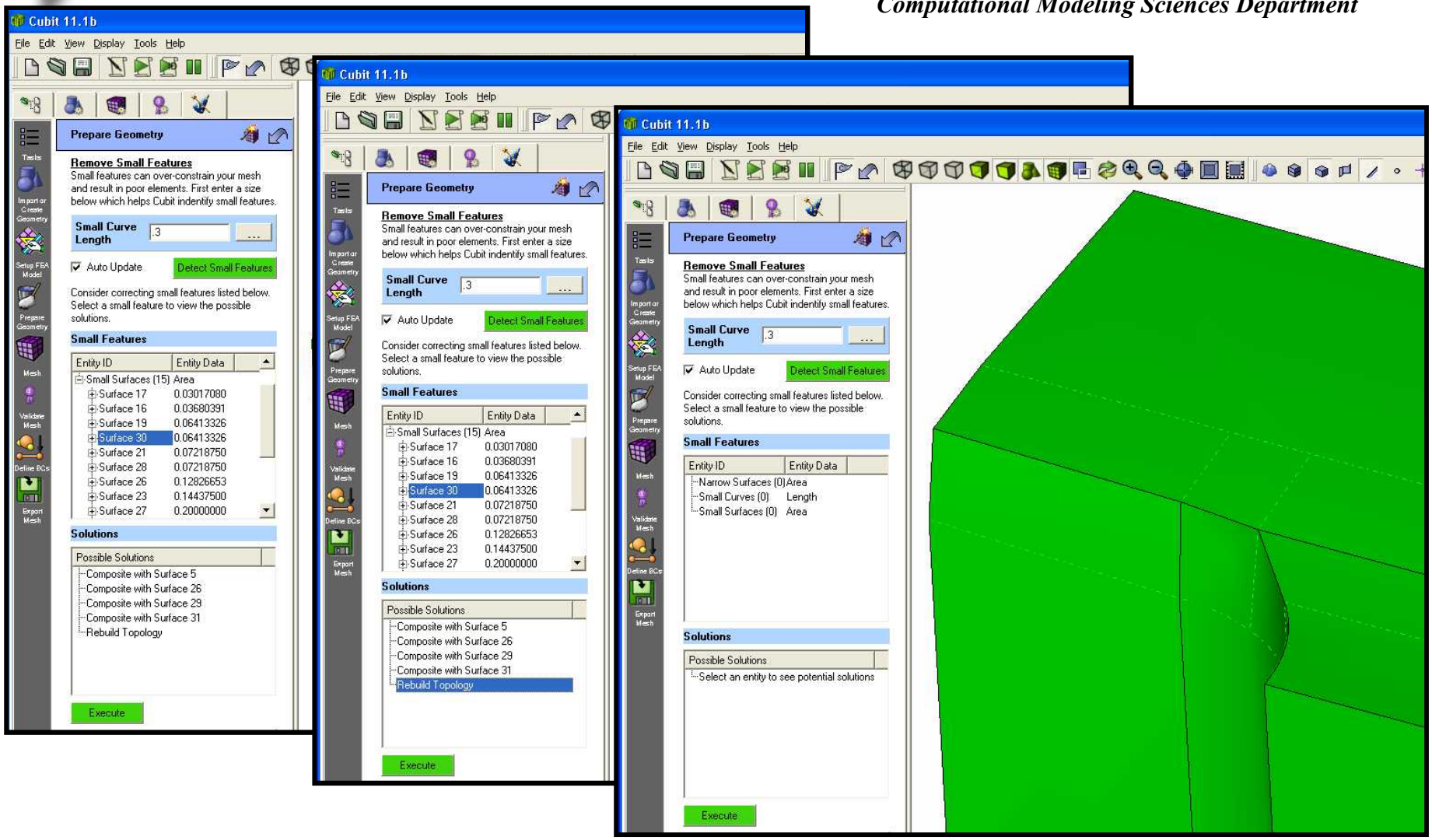






Diagnostic/Solution Paradigm using ITEM

Computational Modeling Sciences Department



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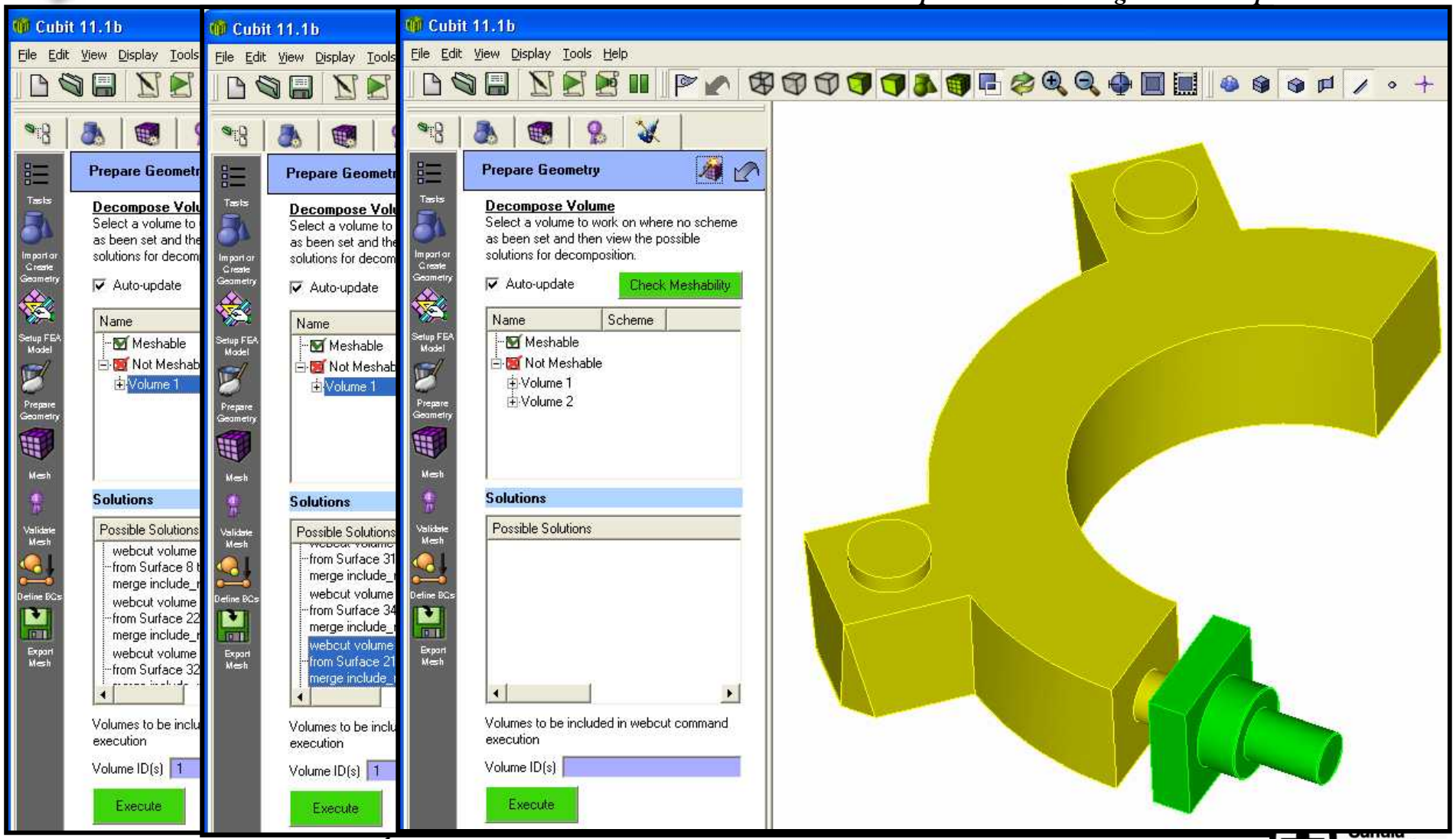
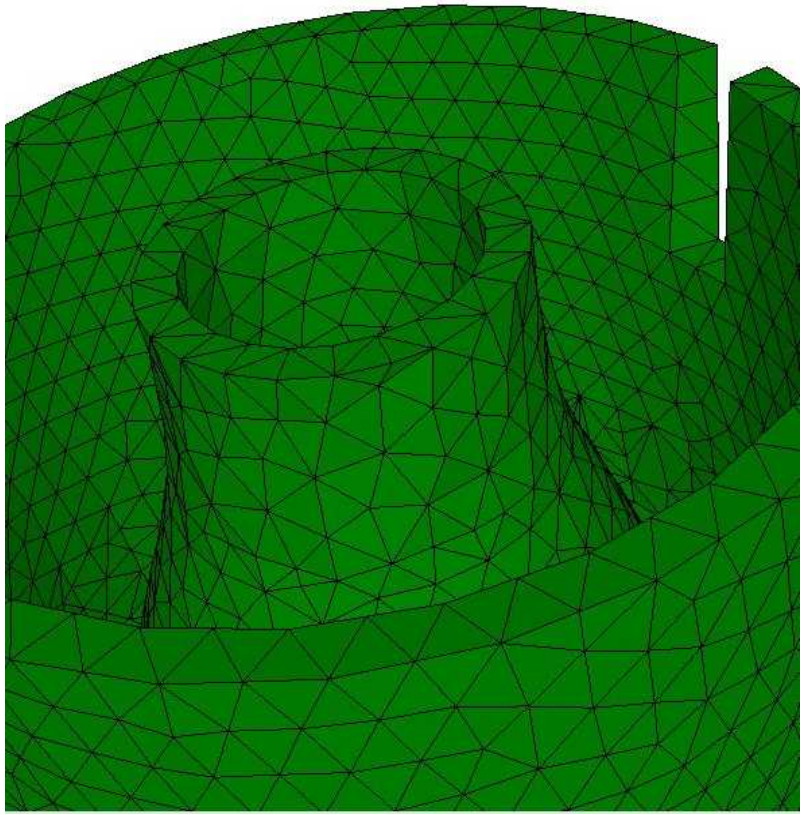


Geometry-tolerant Meshing



- **Initial work in tet meshing**
  - Similar to approach by Shephard et al. [1].

Summary

- **At Sandia we are working both the geometry cleanup problem and the geometry-tolerant meshing problem**
- **Open Issues**
  - Input CAD model is usually not generated with analysis in mind
  - There is not one CAD representation that provides all of the necessary geometry operators

References

- M S Shephard, M W Beall, and R M O'Bara. Revisiting the elimination of the adverse effects of small model features in automatically generated meshes. Proceedings of the 7th International Meshing Roundtable, pages 119-132, 1998.