Design modeling and optimization for Additive Manufacturing

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Research Fields on Additive Manufacturing

- Design for AM – developing CAx tools and procedures to improve the digital design chain in the respect of:
  - *Lightweight design*
  - *Part reduction*
  - *Costumization and Innovative Design*

- CAD-CAE methods: Topological Optimization; Surface and Syncronous Modeling; Reverse Engineering

- Design methods: Design for Assembly and Disassembly; Design for AM (process and material oriented); Robust Design and metamodeling; Benchmarking analysis.

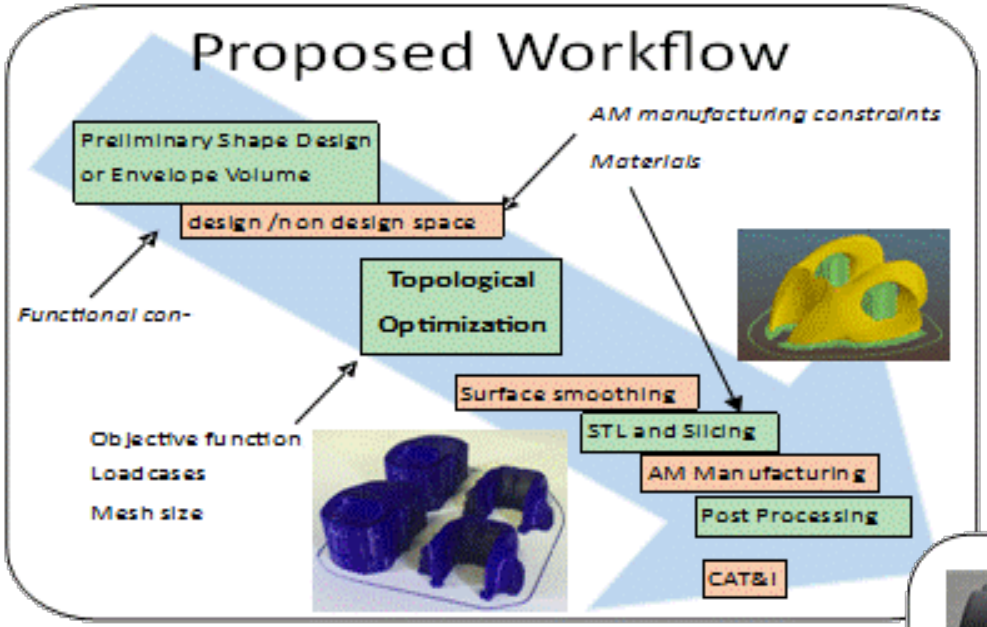
- Multidisciplinary research related to applications in automotive, aerospace, mechanical and medical fields.

Developed Applications

Design for AM – Topological Optimization

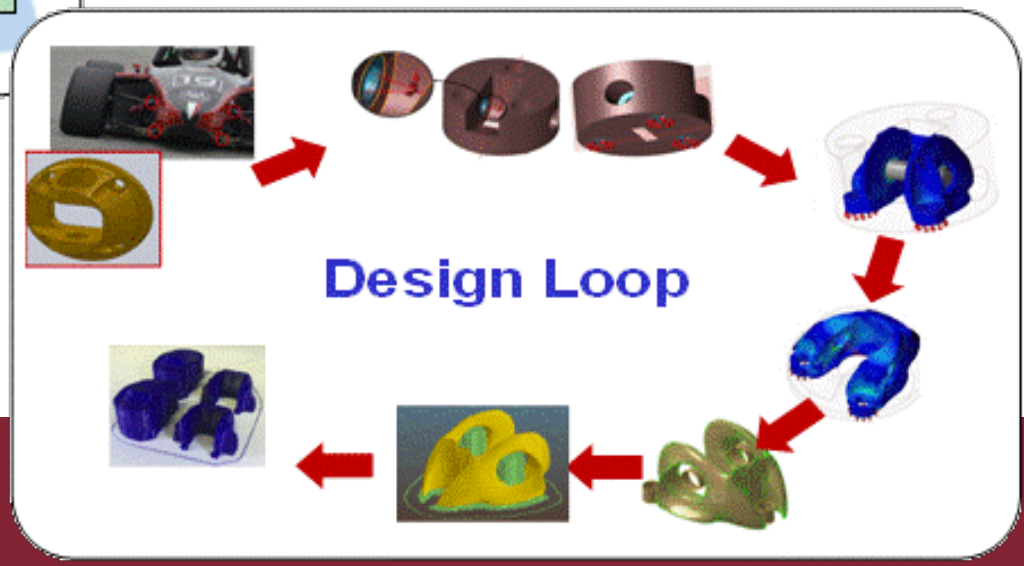
AIM: Topological Optimization as concept design tool, Integration of Design for Additive Manufacturing rules and Topological Optimization

TOOLS: CAD/CAE systems, Surface modeling, Additive Manufacturing



TO software comparison in terms of theory/results/operability

Pre-processing set-up: analysis of related problems

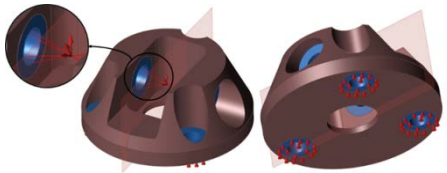


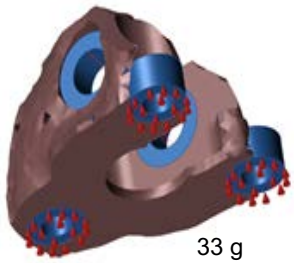
Developed Applications

Design for AM – Topological Optimization

"Experimental Case"

Incremental design





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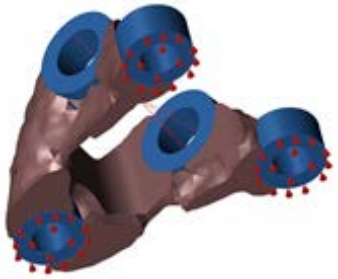

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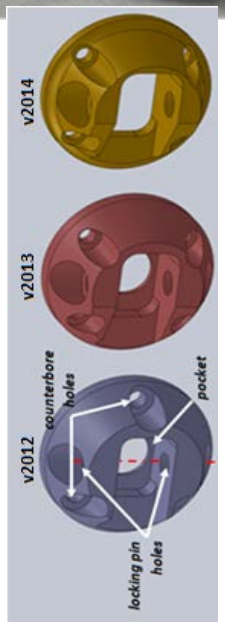

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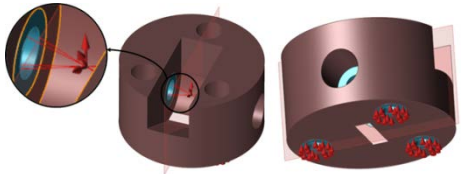
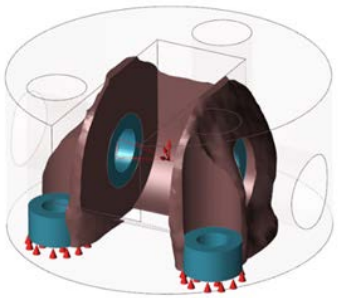
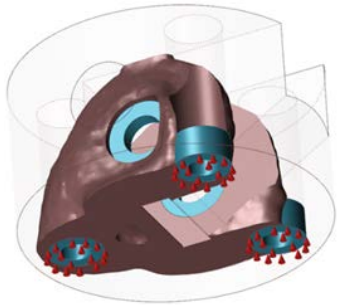
"Blind start"







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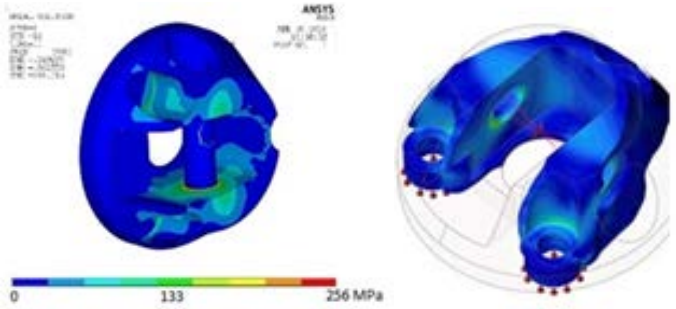


From:
"rough concept first, then the optimization"
towards ….
"optimal concept design first, manufacturing constraints, if any, later".

Developed Applications

Next Targets

Full integration of TO into the design process

Templates for translating of functional, manufacturing and performance constraints into TO constraints and/or design/non design spaces

Evaluation of manufacturing errors (shrinkage) as design cointraints

Optimization of smoothing and slicing process

***CAT&I**: tool to close the design loop*

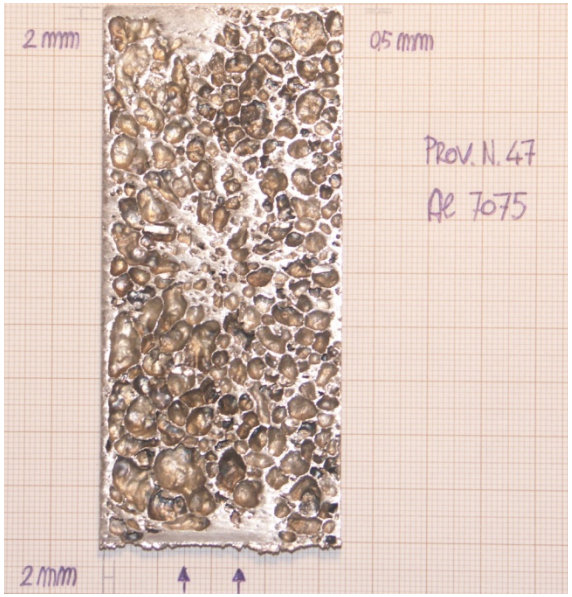
Cellular Materials for lightweight design and crashworthiness

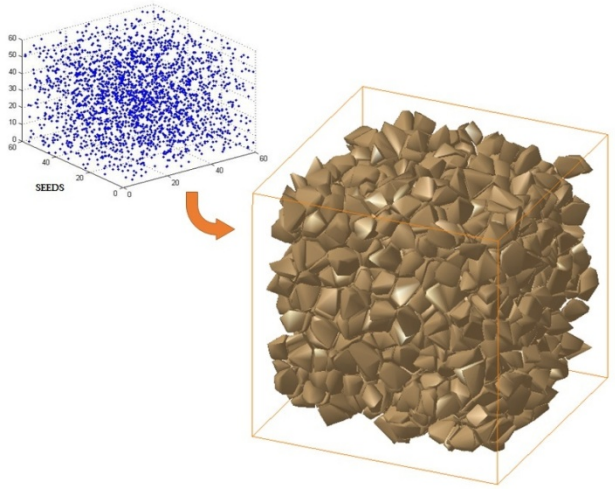
- Aluminum foam: stochastic cells

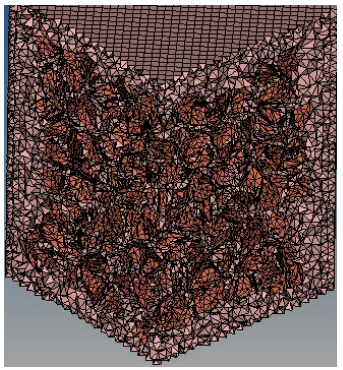
- Validation of FEA to improve design CAE tools: via mesoscale modeling (Voronoi cells), image analysis or reverse engineering.

- CAD problems to join meso-macro scale (like for lattice structure)

- Product-process design problem

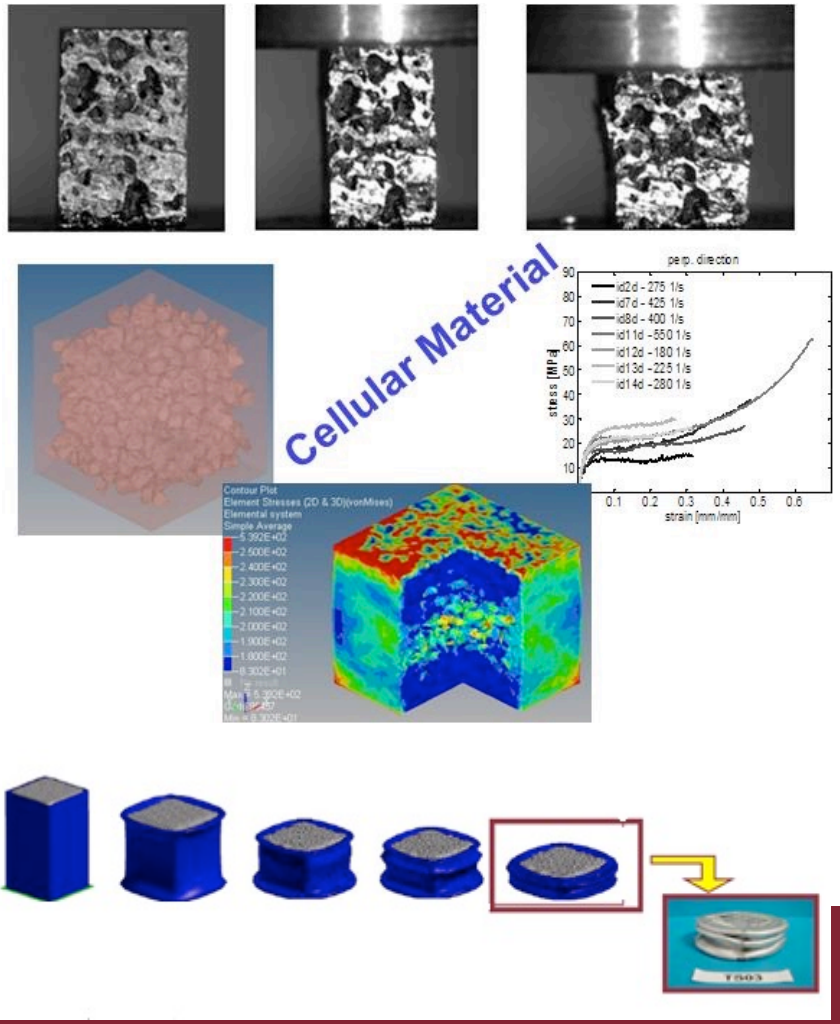




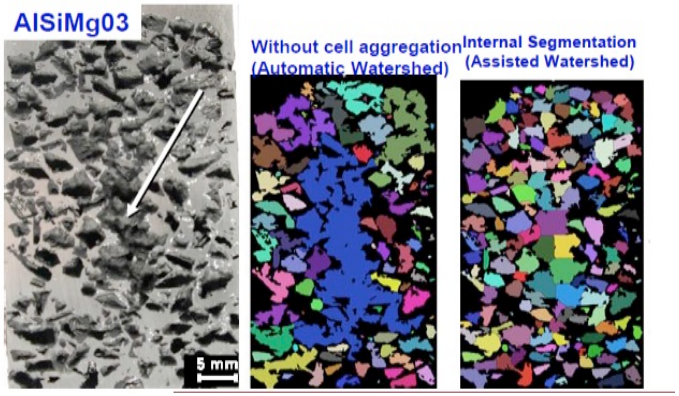


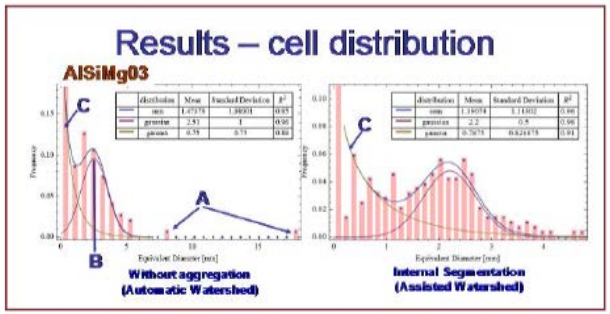
Cellular Materials for lightweight design and crashworthiness

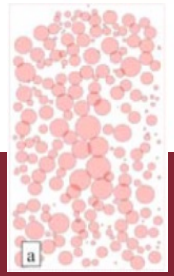
Testing and modeling for lightweight design



Morphological Analysis for integrated design assessment







A – Large agglomerations
B – mean value 2 mm =salt size
C – small porosities

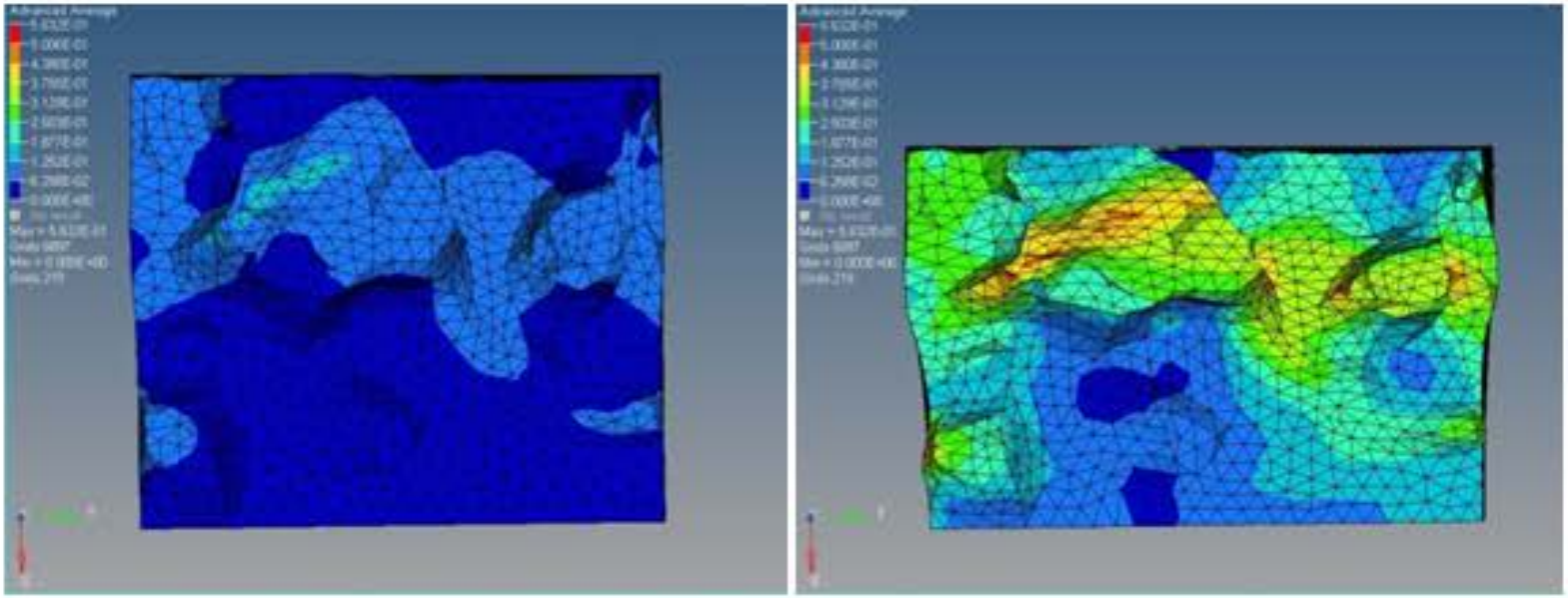
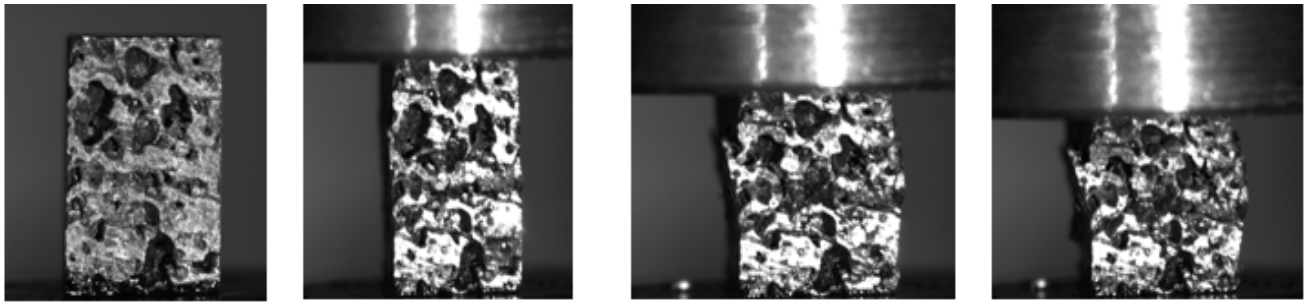


Fig. 10: Strain contour at 1.5% and 20%



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- *Mechanical Design*
- *CAD, CAE, CAT&I Systems*
- *Additive Manufacturing*
- *Topological Optimization*

Collaborators, Students and ex-students involved:

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Daniele Cortis, Ph.D Student – *Multibody simulation, CAD-CAE model data exchange for lattice structure design*

Alessandro Dughiero, *Reverse engineering and CAT&I systems*

Marianna Crimeni, *Virtual modeling of medieval war machines*

Robinson Guachi, Ph.D. Student - *Virtual prototyping of bioengineering problems*

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