Polymer AM Integration and Standards

Dr. Scott Fish

University of Texas at Austin

Advanced Manufacturing and Design Center

Mechanical engineering department

Polymer AM Growth

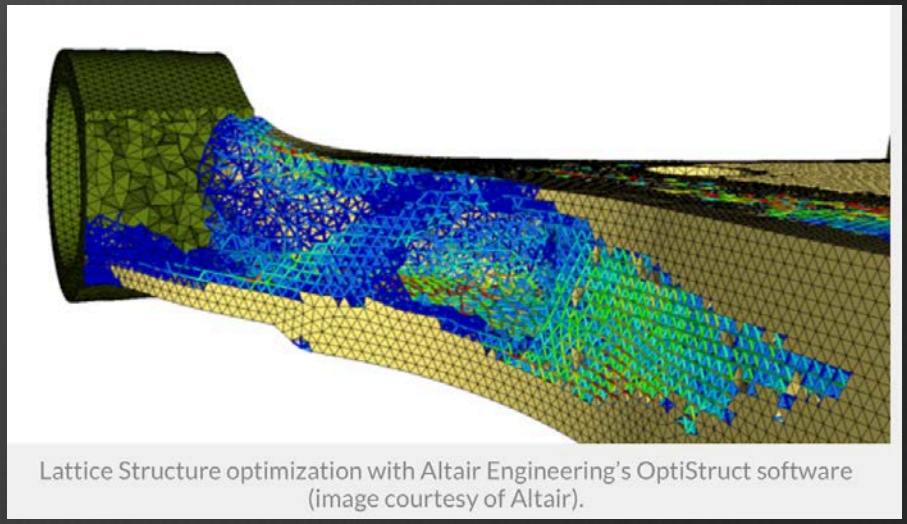
- Caveats:
  - Lots of AM methods (FDM, SLA, SLS, Jet Fusion, and variants)
  - Each has their own strengths and limitations

What I'd like to cover:

- Technical and Non-Technical Barriers to growth
- How can Measurement Science and Standards help?

Technical Barriers

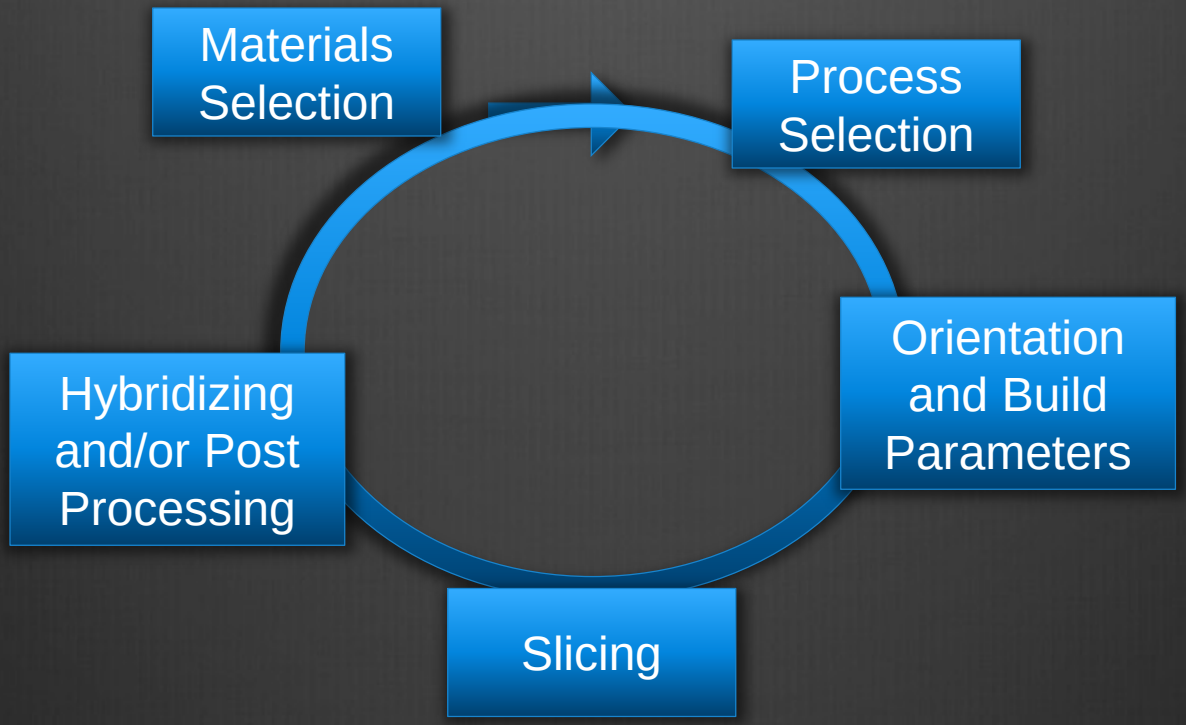
- Lack of Tools for product Design
  - Topological Optimization (not just mass reduction)
    - Handling cellular/fiberous/porous geometry with consideration for basic process characteristics (layer based construction, for instance)



Lattice Structure optimization with Altair Engineering's OptiStruct software (image courtesy of Altair).

Technical Barriers

- Lack of Tools for Fabrication Planning/Optimization



Foundations of Technical Barriers

- Lack of Sufficient Process/Material Understanding to "Model" constitutive systems as an enabler for Tool creation
  - Data generation is growing
  - New research is growing (both private and public)

- Improvement of Sensing specific to AM data needs
  - In-situ thermal and geometric sensing *are a start*
  - Real-time material characterization at small scale Subsurface properties (inter-layer) assessment
  - Rapid low cost inspection methods (geometry, microstructure) Non-destructive more critical for low part count products.

Non-Technical Barriers

- Lack of understanding for application opportunities and associated economic benefits paces capital investment for many in the larger manufacturing landscape
  - Because AM is somewhat disruptive, it will grow from niche markets until more of the technical barriers are reduced
- Lack of widespread design experience with AM. This is being mitigated by expanded education, particularly at the HS and College levels and workforce development efforts at early adopter organizations. Public and private initiatives are leading the way.
- Stigma of Rapid Prototyping, “not for *REAL* manufacturing”. Natural progression, don’t fight it, work with it.

Measurement Science

- Measurement methods MUST become more prolific and tailored with the growth in materials and process understanding to surmount the Technical Barriers
  - Feedstock history and characterization (including recycling)
  - Equipment condition monitoring and automated maintenance (preparation, execution, and cycling)
  - In-situ part formation assessment and control
  - Post process monitoring and control
  - Quality assessment/Inspection (for low part counts)
  - In-service part condition monitoring and automated recycling (including embedded monitoring)

Standards

- This is hard work, requiring significant understanding AND agreement among standards developers with a focus on OEM implementation feasibility and customer safety
- Intellectual Property is both a motivator and a hindrance to success
  - Standards should address ”Evidence of quality” first
  - ”How” standards driven hardest by:
    - Public investment best practice development (less IP Restriction)
    - Private investment by those willing to share: typically motivated by ecosystem and overall market building

That aught to create some questions… yes?

Thanks to my collaborators on this: *Dave Bourell, David Leigh, Carolyn Seepersad, and Austin Regional Manufacturers Association*