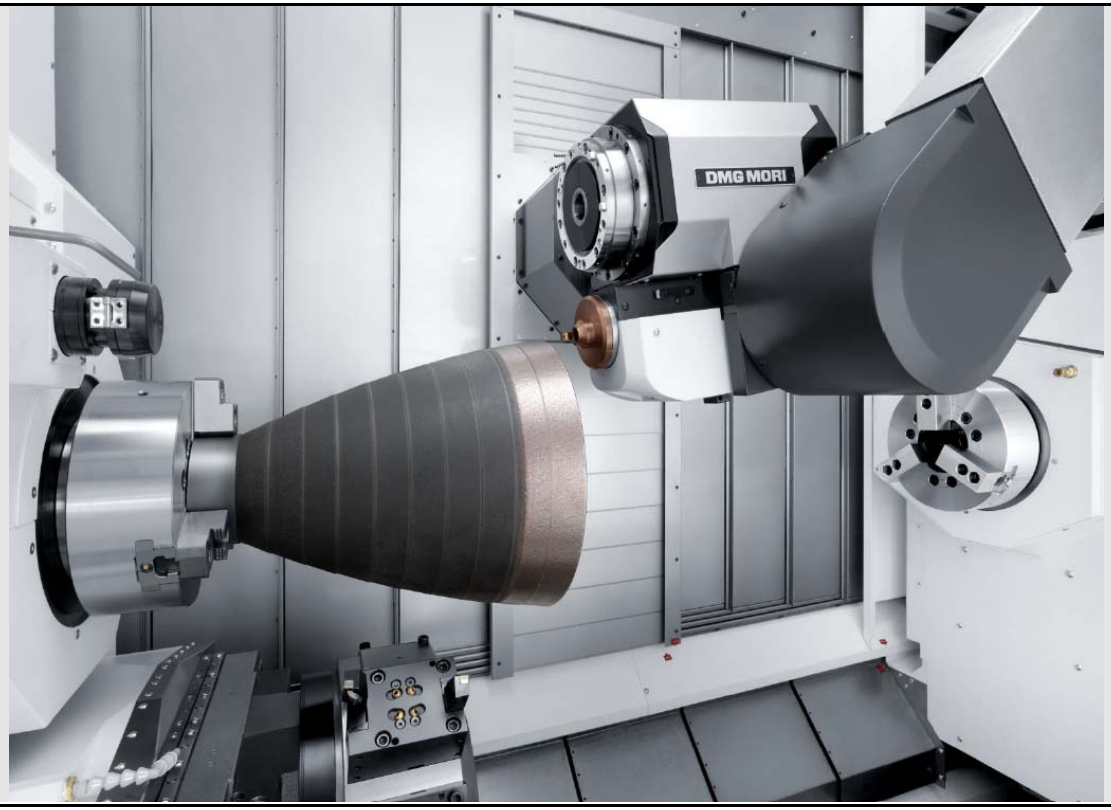
National Forum on Additive Manufacturing Education & Training

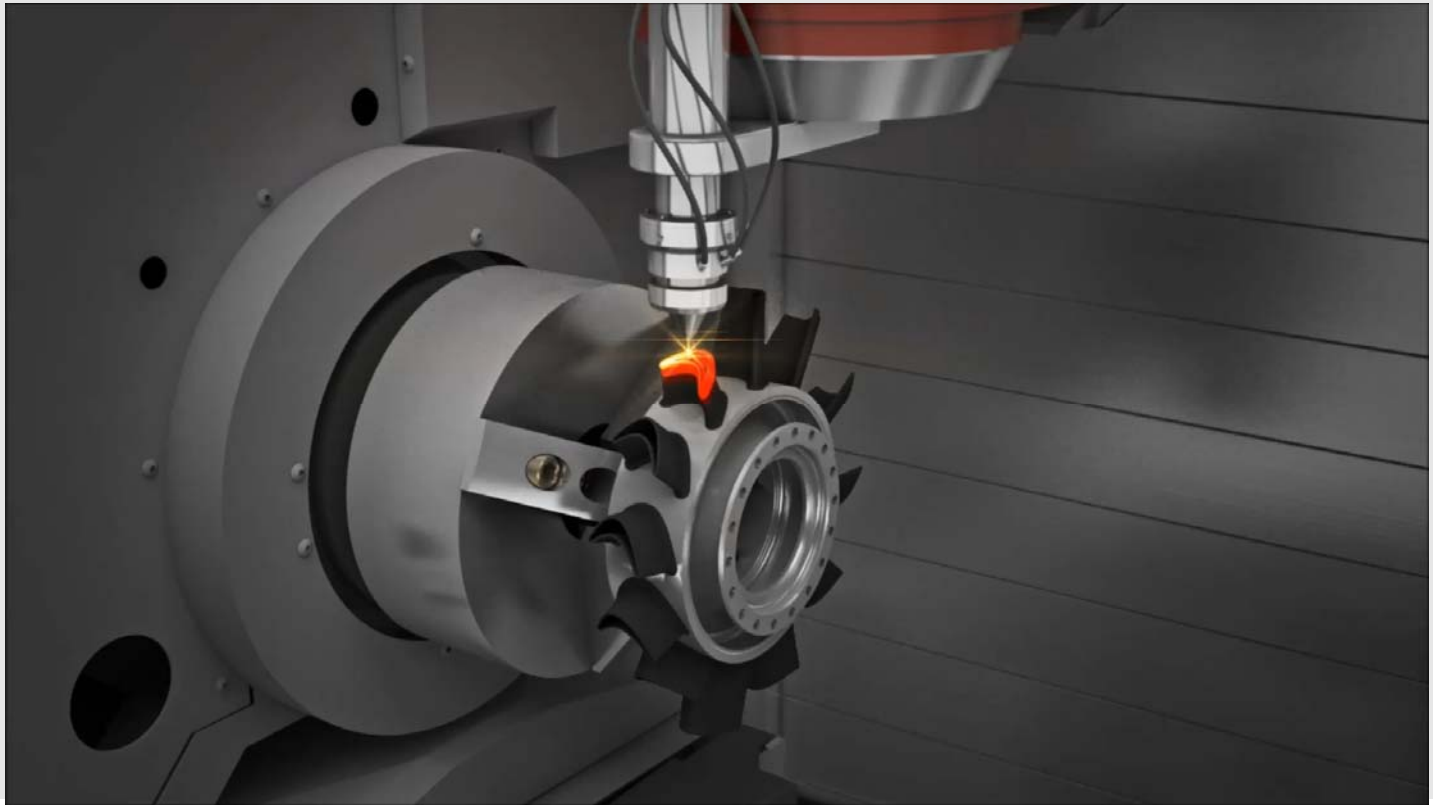


October 11 2016

Gregory Hyatt Ph.D.

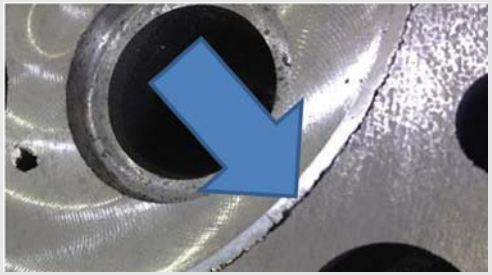
DMG MORI

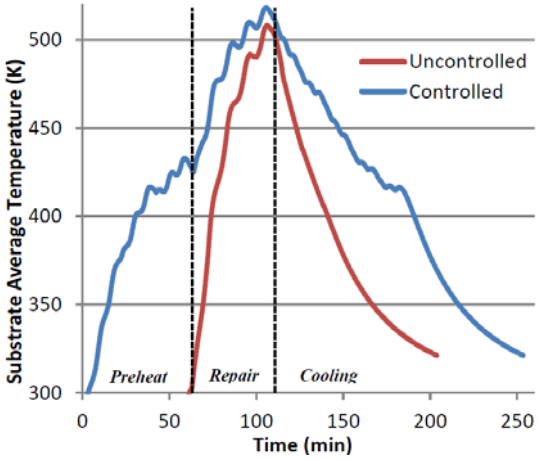
What are you doing to advance 3D printing and AM education/training?



How is your hardware/software/discipline expanding AM education/training now?

- **Collaboration with Universities**
  - **Our showroom is also a lab**
  - **Host students for the research for their thesis**





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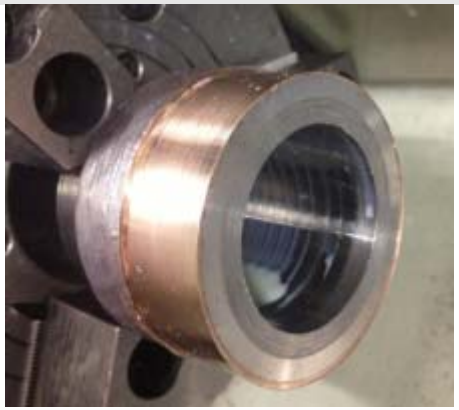
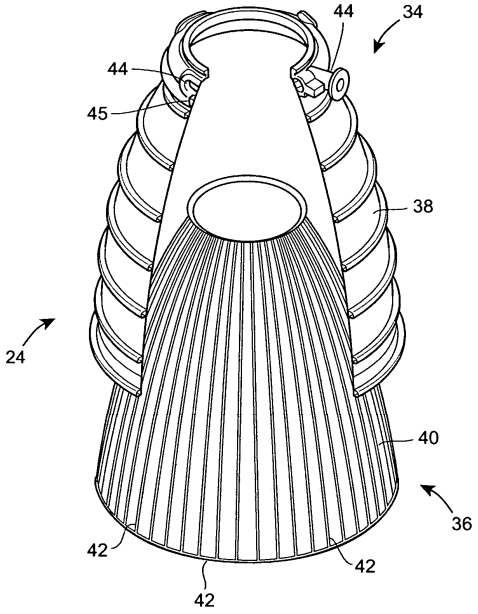
What is the biggest opportunity you see for AM education/training?

- The AM market is now clearly segrated between solutions for rapid-prototyping, and production
- Rapid Prototyping cannot benifit from any of the AM capabilities which cannot subsequently be performed by conventional production
- However if AM will be used for production we can utilize bi-metalic depositon, mid-process machining, and other unique AM capabilities
- GE‘s famous example of AM (shown) consolidates an assembly into a single component, but can only be pursued if no critical features are traped in the core making them innecesable for machining after deposition, and if all components are of the same alloy

Rapid Prototyping vrs Production

- Nozzles are typicaly a Cu billet with a milled laberenth of cooling channels sheathed in Inconel
- AM production requires a hybrid machine to mill the channels as the part is deposited from the two alloys

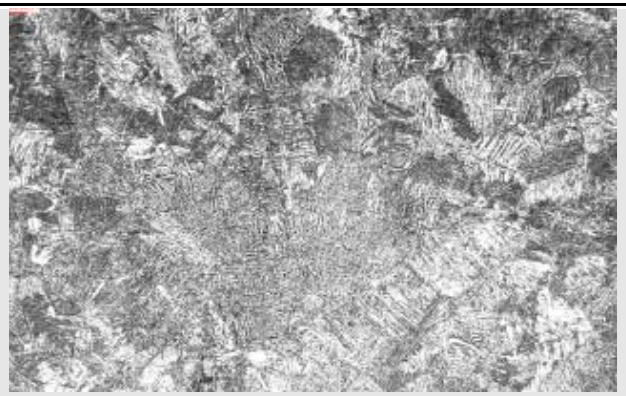


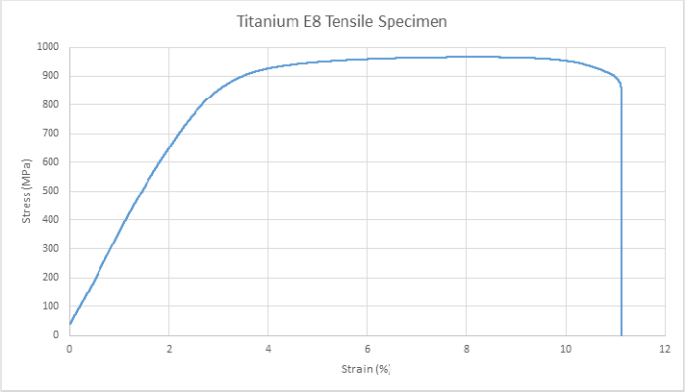


Rapid Prototyping vrs Production

- **Production applications can also deposit on existing strucutres**
- **Deposition mass can be reduced by an order of magnitude by utilizing the forged or cast substrate**
- **Cycle time for AM build is reduced by two orders of magnitude if the build rate is also 10X faster than the norm**
- **To avoid interference a 6th axis of interpolation is required to avoid interference with existing feature or fixturing (patent pending)**

Metals – Customers must develop their own parameters





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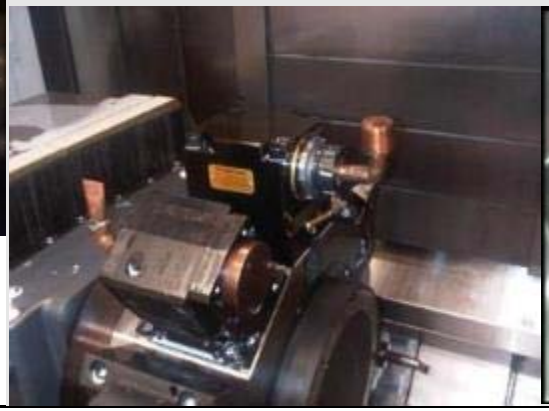
Is Precision-AM an Oxymoron?

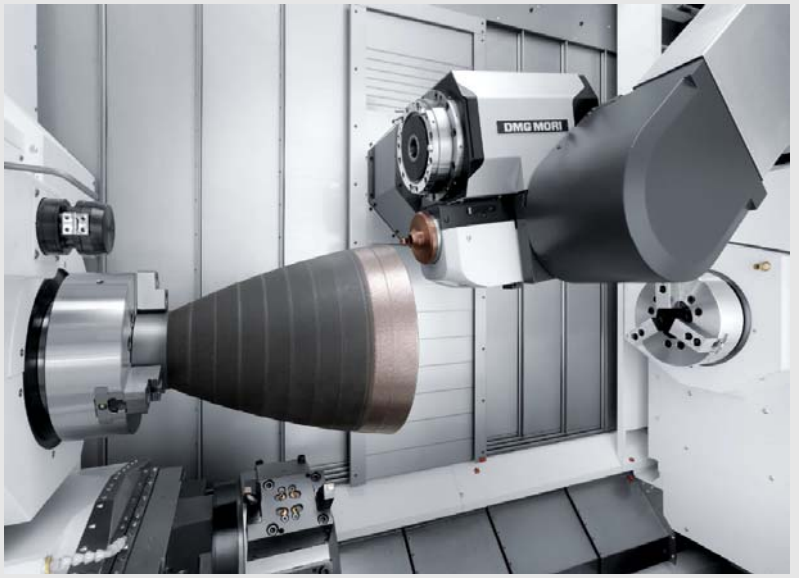
We also need the subtractive experience



In Summary

We need to hire those who:

- **Understand subtractive as well as additive**
- **Understand basic metallurgy well enough to optimize deposition parameters**
- **Understand manufacturing costing and product differentiation to understand the economic justification and value proposition of AM**
- **Are willing to get their hands dirty**



Questions?