

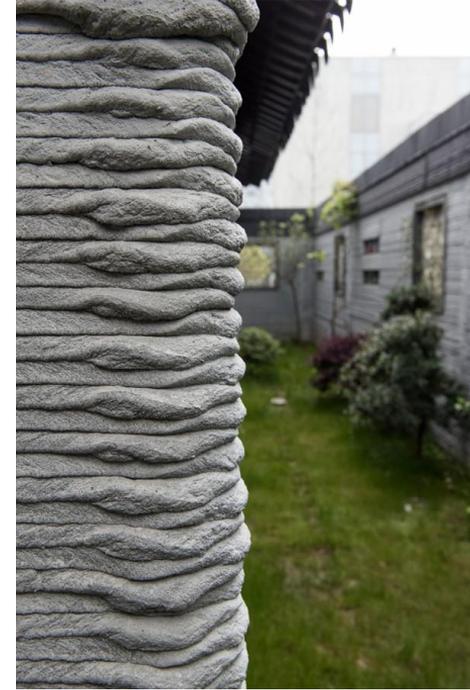
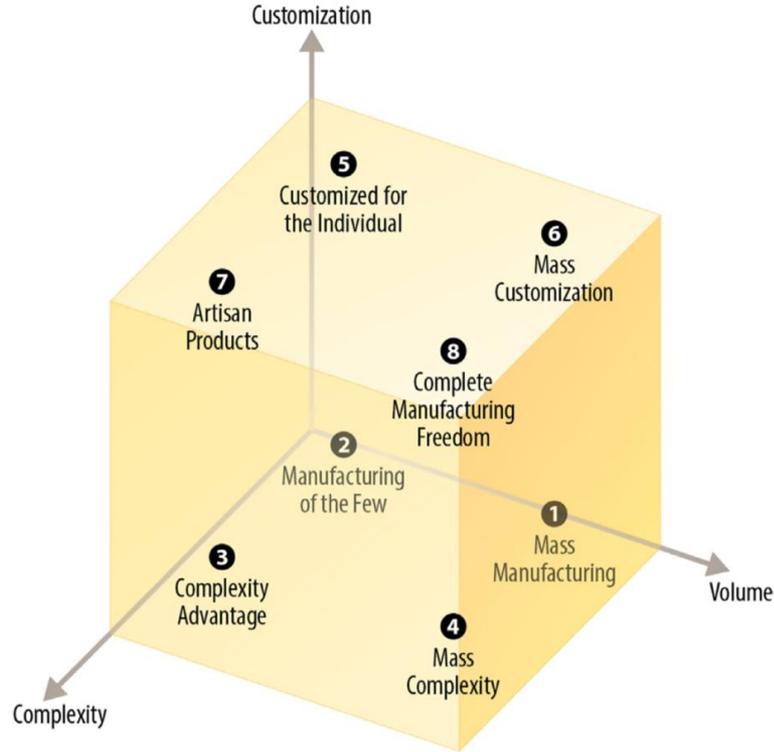
3D Printed Sand Molds – An Opportunity for Investment Casters

Bob Voigt rcv2@psu.edu



PennState
College of Engineering

The lure of 3D printed shapes extends beyond the realities of specified engineered components



Pathways for complex metal parts



www.jgrouprobotics.com

- Investment casting
 - conventional patterns
 - 3D printed patterns
- Direct 3D metal printing
- Sand Casting
 - conventional patterns
 - 3D printed patterns
 - 3D printed molds & cores

Investment casting and printed pattern investment casting is thriving



pi-castings.co.uk



3d-laserimaging.com

Printed patterns have extended the IC portfolio



Printed Wax/Plastic Patterns for Investment Castings

Adoption Incentives

- reduced first article lead time
- reduced cost for low volume parts
- more shape complexity possible

Adoption Barriers

- rougher surfaces with some stair-stepping visible on parts
- dimensional adjustments when going from printed waxes to hard tooling

Trends

- purchased 3D printed patterns are used throughout the investment casting industry
- surface texture and dimensional tolerance improvements continue

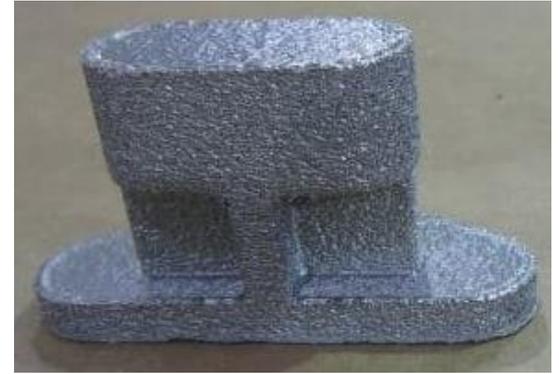
Pathways for complex metal parts



www.jgrouprobotics.com

- Investment casting
 - conventional patterns
 - 3D printed patterns
- **Direct 3D metal printing**
- Sand Casting
 - conventional patterns
 - 3D printed patterns
 - 3D printed molds & cores

Direct 3D printed metal parts – still more of a curiosity than a competitive shape-making process



Direct Printed Metal Parts

Adoption Incentives

- shape complexity
- lead time reduction

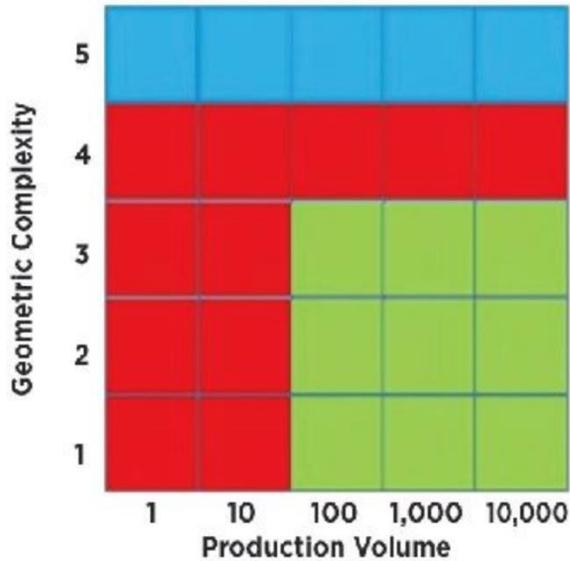
Adoption Barriers

- limited part sizes; long build times
- severe stair-stepping; poor tolerances
- secondary processing necessary
- limited alloy choices

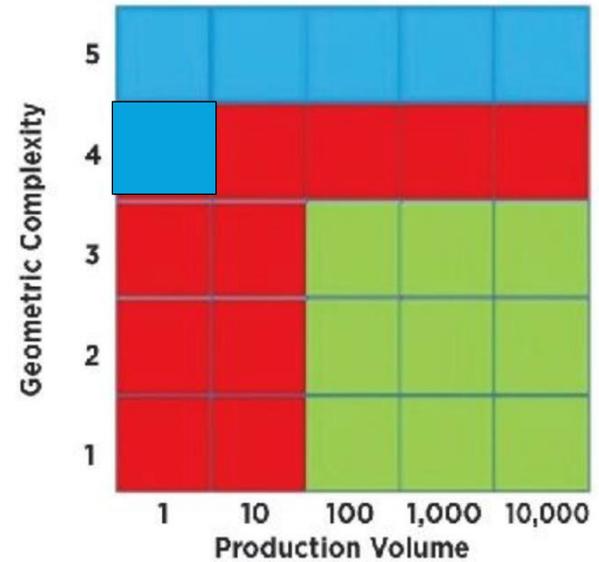
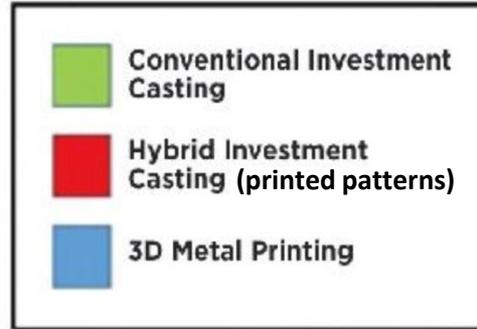
Trends

- continuing development efforts by the aerospace, DOD and university communities
- very limited adoption in the near term
- design restrictions; processing guidelines have not yet been established

Direct 3D printed metal components are not expected to compete with investment casting processes in the near future



current costs



25% of current costs

Pathways for complex metal parts



www.jgrouprobotics.com

- Investment casting
 - conventional patterns
 - 3D printed patterns
- Direct 3D metal printing
- Sand Casting
 - conventional patterns
 - 3D printed patterns
 - 3D printed molds & cores

Printed Plastic Patterns for Sand Casting

Adoption Incentives

- short run printed tooling can be created directly
- reduced pattern lead time

Adoption Barriers

- shape complexity is limited by cope and drag molding methods

Trends

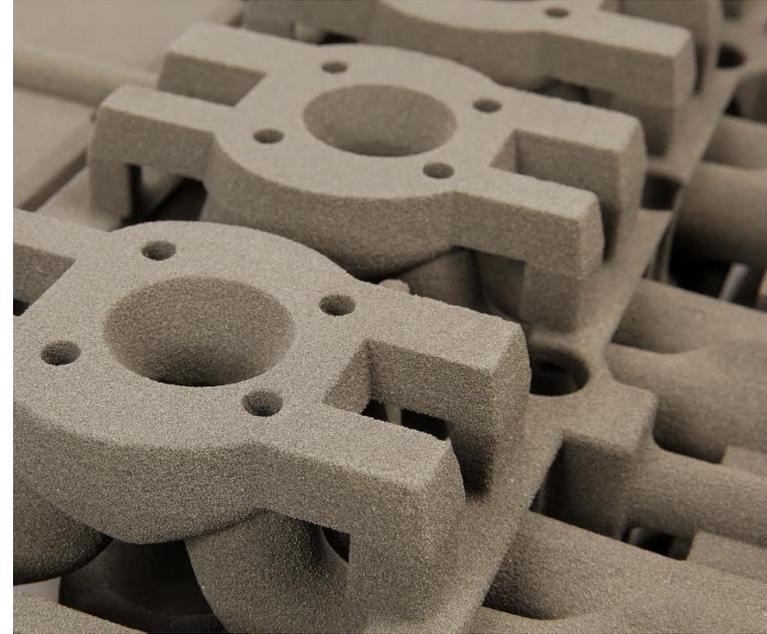
- This process has made few inroads; conventional CNC machining of conventional patterns and coreboxes is very cost competitive



3D printed sand molds/cores – an opportunity and a threat to investment casters



Large-bed printed sand machines are available to print resin-bonded sands and cores



Printed Sand Molds/Cores

Adoption Incentives

- More complex geometries can be cast
- Large shapes can be produced
- Conventional alloys
- Can be used for cores and/or molds

Adoption Barriers

- the high cost of large bed sand printing machines

Trends

- rapidly growing interest in sand and core printing for both prototypes and for complex production components. The use of printed cores in conventional sand molds is growing fastest

Vendor supply chain Who does what?

Conventional Investment Casting



Investment Casting with 3D Printed Patterns



Investment Caster pouring of 3D Printed Sand Molds



Key:

Customer/IC

Vendor

IC

Pathways for complex metal parts



www.jgrouprobotics.com

- Investment casting
 - conventional patterns
 - 3D printed patterns
- ~~Direct 3D metal printing~~
- ~~Sand Casting~~
 - ~~conventional patterns~~
 - ~~3D printed patterns~~
 - 3D printed molds & cores