



A Division of Renaissance Services Inc.

# Successful Application of 3D-Printed Ceramics

**Dan Z. Sokol**  
Managing Partner  
Renaissance Services



**C-130**



**KC-135**



**F-15**



**B-52**



**F-22**



**F-16**



**A-10**



**B-1**

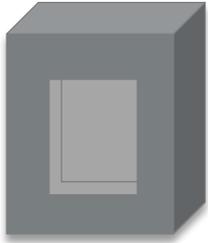
Small quantities of castings needed for replacement parts to keep planes flying

- B-52 Gearbox Housing
- B-52 Fuel Pump Housing
- E-3 Gimbal Housing
- F-15 Gun Drive Housing
- A-10 Pressure Regulator
- F-16 Fuel Oil Cooler Housing
- F-16 Torque Convertor
- KC-135 APU Air Inlet Guide

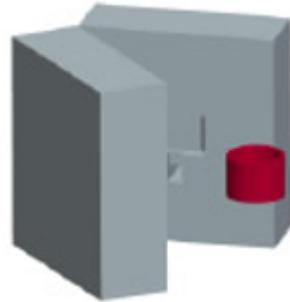


# Traditional Investment Casting Flow

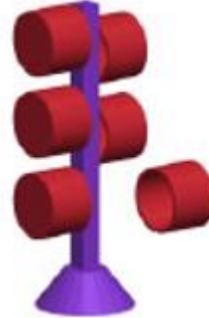
**Machining  
Pattern Die**



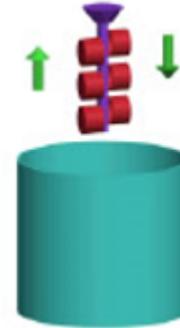
**Injecting Wax  
Patterns**



**Assembling  
Wax Mold Tree**



**Coating with  
Slurry**



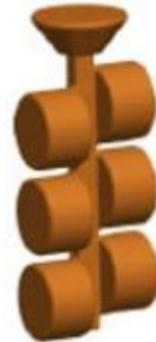
**Coating with  
Ceramic**



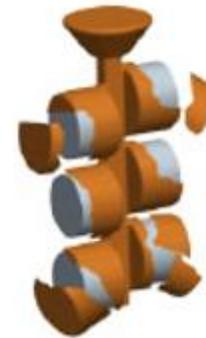
**Melting Out  
Wax**



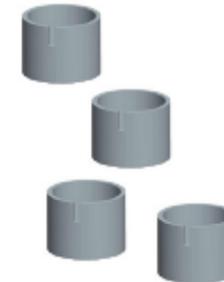
**Firing Ceramic  
Mold Tree**



**Pouring Metal  
Into Mold Tree**



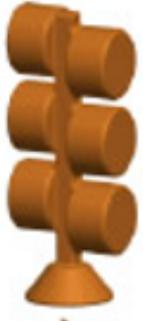
**Removing  
Ceramic Mold**



**Cleaning the  
Castings**

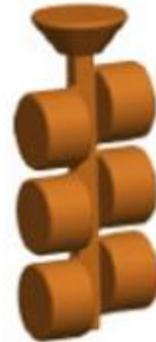
# Casting with 3D-Printed Ceramic Molds

**3D Print  
Ceramic Mold**

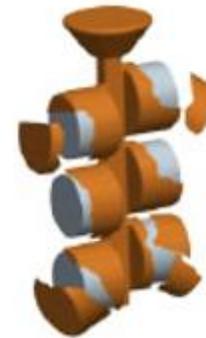


## Ceramic 3D Printing:

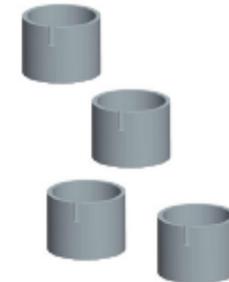
- Eliminates need for expensive hard tooling for casting process
- Reduces overall processing steps and lead time to produce castings



**Pouring Metal  
Into Mold Tree**



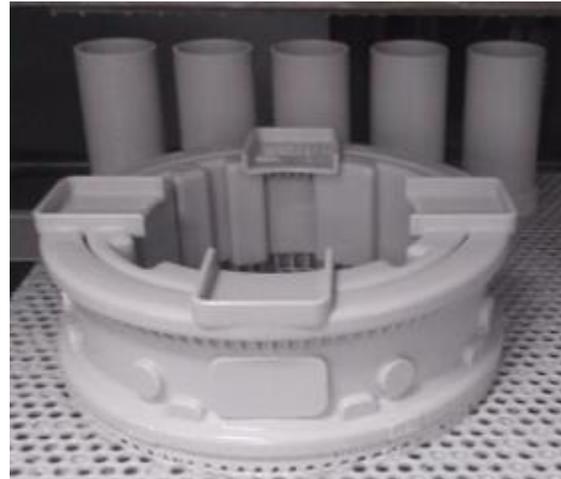
**Removing  
Ceramic Mold**



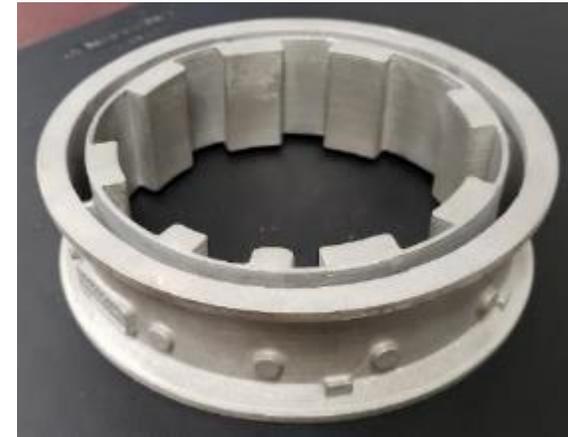
**Cleaning the  
Castings**



3D Casting Model



3D-Printed Ceramic Mold



Nickel Casting