



# COLLABORATION THAT WORKS

## *NAVAIR & NAVSEA FLEET CASTING PROJECT*

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# AGENDA

- Project overview
- Team Members
- NAVAIR part and benefits
- NAVSEA part and benefits
- University of Northern Iowa

# FLEET CASTING PROJECT

The intent of this project is to implement a dual technical solution to greatly reduce the cost and lead-time facing commercial foundries:

- Solidification Analysis tools will be used to evaluate mold design candidates with the ultimate goal of predicting mold flaws numerically before producing molds. The intent of the analysis is to greatly reduce the number of mold design iterations.
- Additive Manufacturing technology in form of “sand printing equipment” will be used to produce physical sand molds directly from digital CAD data. This technical innovation completely eliminates the need to produce costly and complex patterns.

As a testbed within this project, a number of complex Navy castings will be used for development purposes. The project development will employ new solidification and additive processes to the testbed applications - from initial design to final casting development. The castings represent a similar level of complexity and alloys used by commercial industries. Knowledge and lessons learned for these testbed applications will be directly applicable to commercial casting applications

# TEAM MEMBERS

Naval Undersea Warfare Center, Keyport, WA

Naval Air Systems Command, Patuxent River, MD

University of Northern Iowa, Metal Casting Center & Additive  
Manufacturing Center

Wellman Dynamics, Creston, IA

# NAVAIR

## Overview of Part Selection

- Sand cast parts were reviewed across various interested programs
- Types of components that were considered for the AMCAST program included gearbox housings, engine brackets, fittings, etc.
- The value proposition was assessed for each potential part including: current fleet needs, part availability, part criticality, manufacturing lead time, cost, manufacturability risk and feasibility for additive manufacture of sand molds, etc.

## Potential Benefits

- Significantly reduced lead time, improved speed to the fleet
- Improved casting yields
- Reduced manufacturing costs and life cycle costs
- Ease of re-manufacture of legacy castings
- Potential for improved part performance, durability, reduced weight...

# NUWC KEYPORT

## Overview of Part Selection

- Evaluated several NAVSEA auxiliary ship system sand casting parts with obsolescence and problematic production issues
- Selected challenging Ni-Al-Bz casting with low yield at OEM
- Achieved business case and value proposition requirements (similar to NAVAIR component)

## Potential Benefits

- Casting candidate allows for optimization of the rigging & mold design for higher yield
  - The proposed gating systems is only achievable with complexity gained from sand printing
  - Reduced turbulence in molds will improve part quality
  - Pressure-control gating has promise for future platform Ni-Al-Bz casting designs
- Demonstrate rapid casting design verification with process
- Demonstrate digital “paternless” TDP for future procurements
- Demonstrate no special qualification to stakeholders
- Demonstrate reduction of lifecycle costs (increasing yield performance)



Jerry Thiel  
Director  
University of Northern Iowa  
Metal Casting Center  
Additive Manufacturing Center

# UNI Materials Characterization laboratory on Campus

- Over 8000 square feet comprised of five laboratories;
  - Hot Metal Lab with capability to melt 500 lbs of ferrous based materials and 300 lbs of non-ferrous metals
  - Chemically and bentonite bonded sand molding capabilities





# UNI Materials Characterization

## laboratory on Campus

- Chemical, physical and mechanical testing capabilities for metals, ceramics and minerals
- Research & Development and performance testing for foundry consumable materials
- EPA mold gas emission testing for foundry materials
- Process simulation thermo-physical dataset development for foundry aggregates

# UNI Additive Manufacturing laboratory



- Over 8000 square feet of laboratory space outside the university campus
- S-Max sand printer
  - 1m x 1.8m x .7m work space
    - Have produced molds in excess of 13,000lbs
  - More molding material selection capability than any other printer of this type.



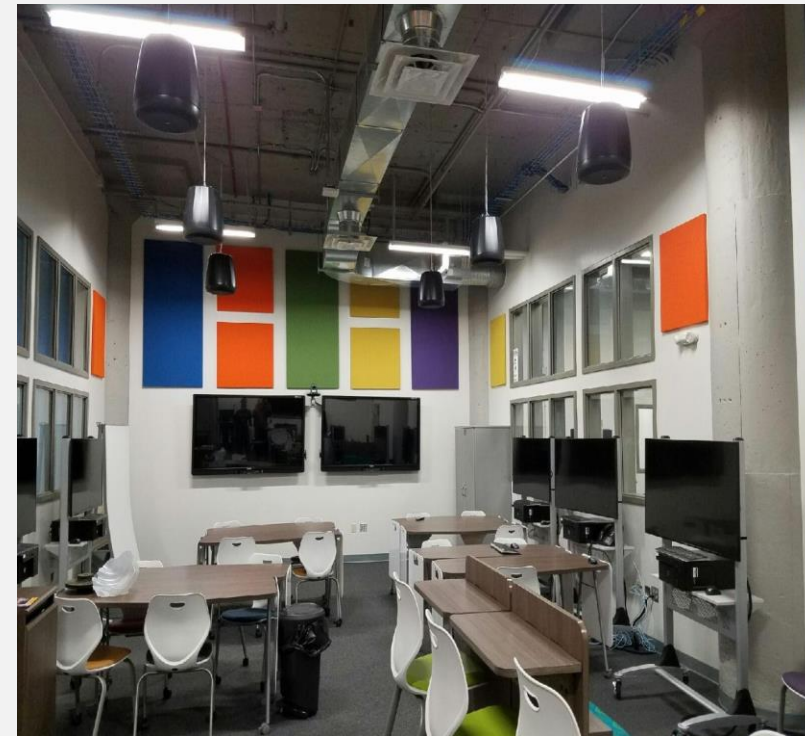
- 3DSystems ProX 300 Direct Metal Laser Melting printer – currently printing 17-4PH stainless steel
- 3DPlatforms 1m X 1m X .5m FDM plastic printer for foundry tooling and fixtures
- VoxelJet VX200 research sand printer for aggregate and resin development research
- Zcorp foundry aggregate 3D printer



- CAD - ProE , Creo, SolidWorks, Autodesk Inventor
- FEA – Topologic Optimization, COMSOL, solidThinking (Altair)
- Laser Scanning and Reverse Engineering, ROMER, PolyWorks, GeoMagics Design X



- 25 seat Additive Manufacturing Design laboratory
  - Casting process modeling, MAGMA simulation software, Flow 3D simulation software
  - High Speed synchronous network connection for web based interactive audio/video conferences up to 100 participants



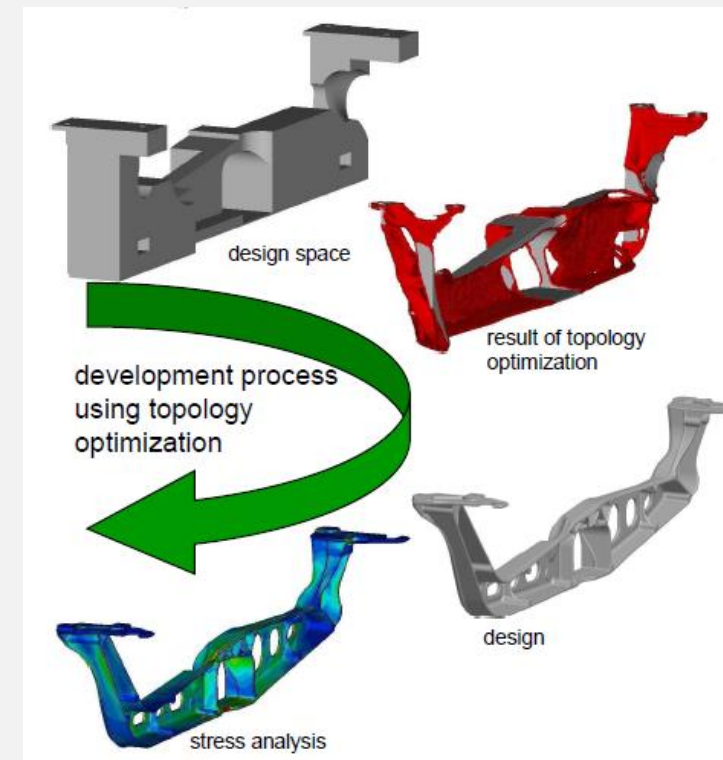
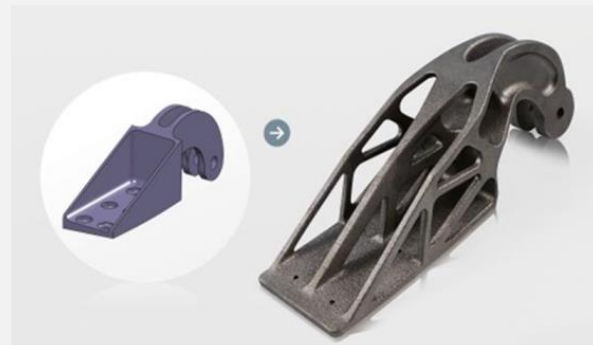
- America Makes – Accelerated Adoption of Additive Manufacturing for Metal Casting
- America Makes – Development of High Speed Sand Printing for Production Applications
- AFRL/UDRI - Maturation of Advanced Manufacturing for Low Cost Sustainment
- RDECOM- Proof-of-Concept of In-Theater Casting of Long Lead Time DoD Components Utilizing Desert Sand Printed Casting Molds
- Rockwell Collins – Rapid Production of Cast Metal Components for Airbus A330, nose gearbox, electro-mechanical chassis
- Oak Ridge National Labs - Development of Digital Castings with High Surface Finish and Resolution
- Eck Industries – Mold Development for Fuel System Casting for F35 Joint Strike Fighter
- AMRDEC – Topological optimized mold design for electronics chassis in cast aluminum
- Space X – Rocket Engine Compressor Castings

- Part design verification
  - Casting process selection
  - Geometry Creation if necessary by reverse engineering



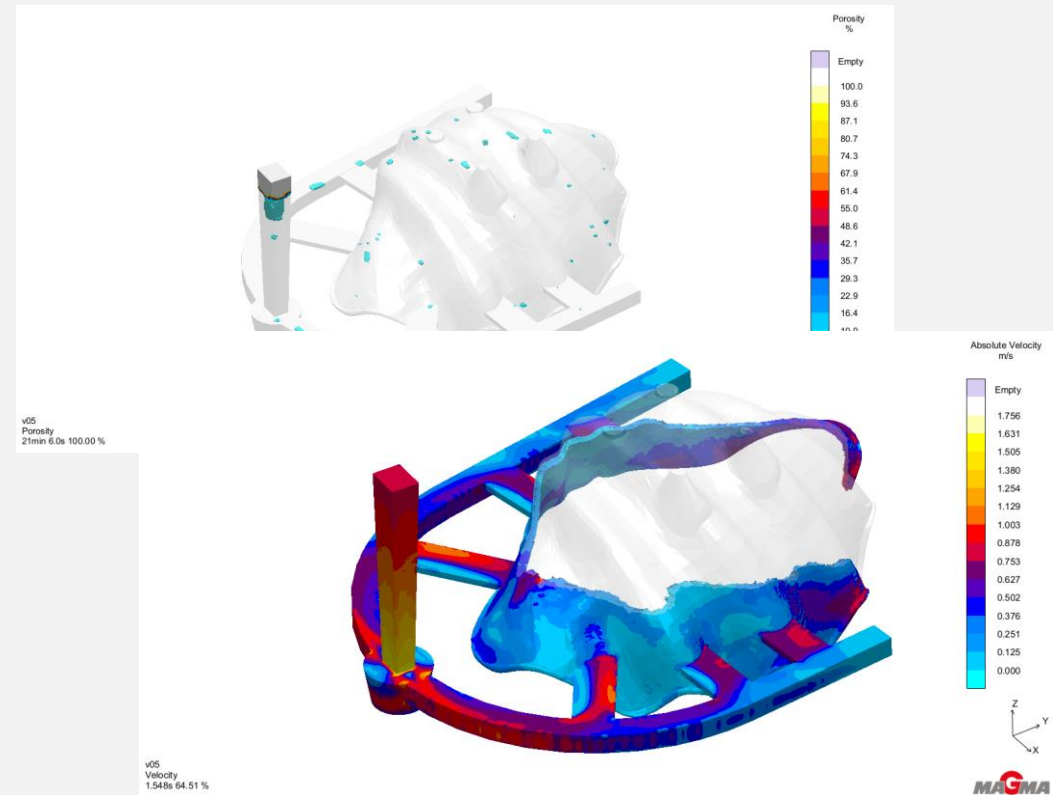


- Weight Reduction
- Strength Improvement
- Manufacturability
- Quality Improvements

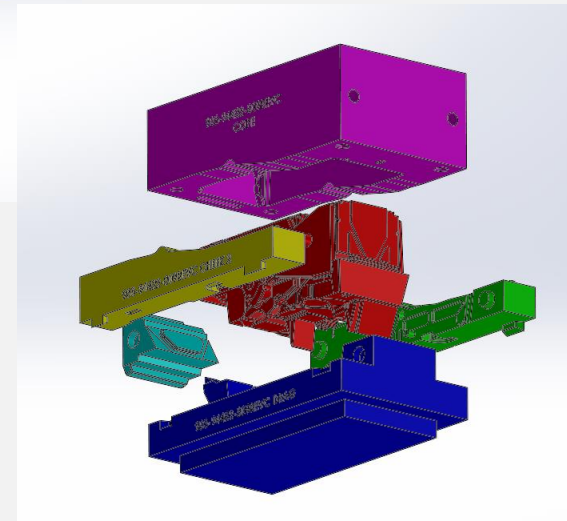
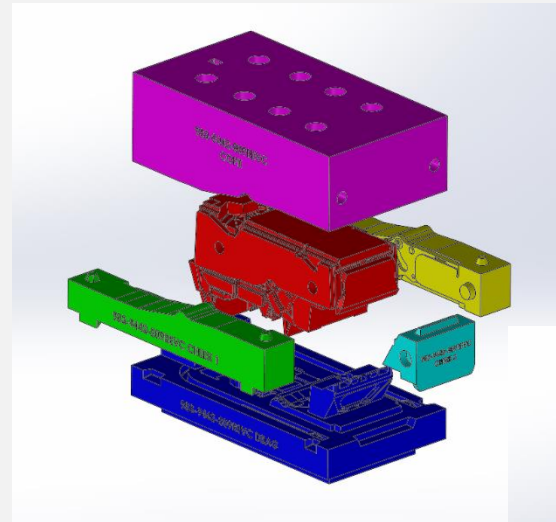


# Process Simulation and Defect Prediction

- MAGMA Foundry Simulation software
- Custom Applied Programming Interface (API)



- Feeding system is integrated
- Individual parts are marked for identification
- Assembly instructions are developed



- UNI Contact

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