
CTMA

COMMERCIAL TECHNOLOGIES FOR MAINTENANCE ACTIVITIES

# READINESS AT BEST COST

## AM FOR FLEET CASTING SUSTAINMENT

20 YEARS

*20 years of transforming maintenance and sustainment*

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Additive Manufacturing Lead

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Metal Casting & AM Center
Director

# PROBLEM STATEMENT

- Supply Chain Development
  - There's a growing need to compress the metal castings acquisition cycle
- Foundry Industry
  - The United States faces a foundry engineering/experience shortage
- Military Readiness
  - DoD depots & shipyards require faster, more reliable alternatives to rebuild weapons platforms and respond to OPTEMPO
- DoD is slow to adopt sand printing and advanced casting tools on a broad scale
  - 3D-Printed sand molds allow

# TECHNICAL APPROACH

- Printed Sand Molds
  - Evaluate the performance and benefits of using additively manufactured sand molds to produce high-quality, complex castings
- Solidification Analysis Tools
  - Evaluate the performance of solidification analysis in predicting casting quality
- Demonstrate Process on NAVSEA and NAVAIR Castings
  - Verify the quality & dimensional accuracy; compare to traditional methods
- Develop a 3-day training workshop for DoD Participants
  - Expand the DoD corporate knowledge base

# TECHNICAL APPROACH – APPLICATIONS

## SSBN/SSGN Ohio-Class Submarine

- Torpedo Tube Bracket
- 4” Seawater Ball Valve Body

## H-53E Helicopter

- Nose Gearbox Cover

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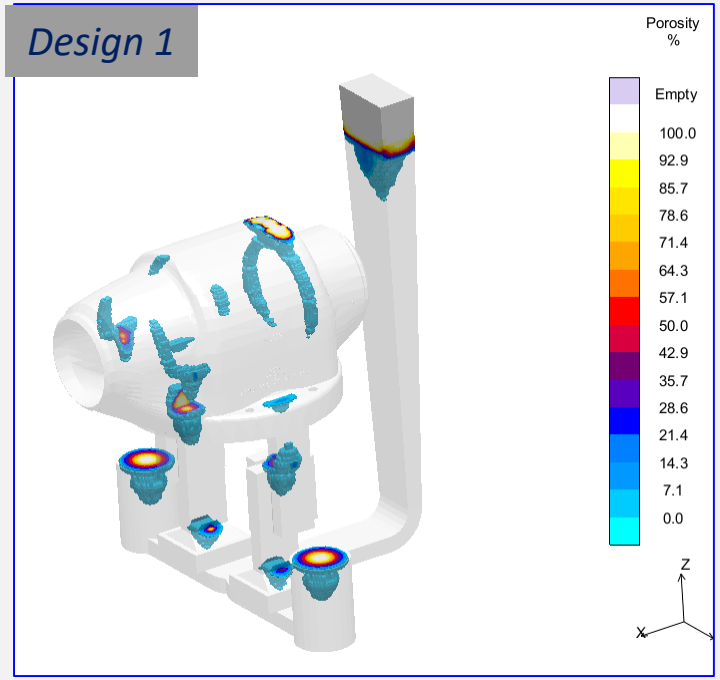
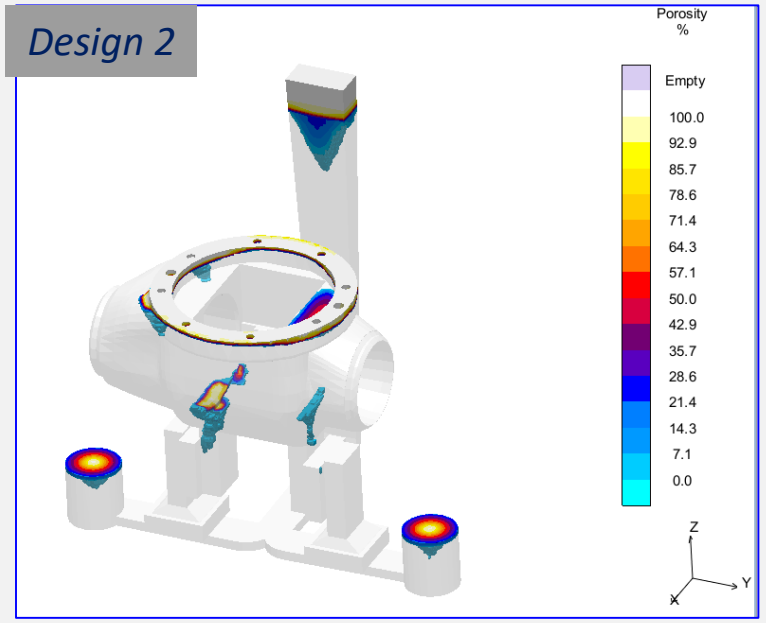
# TECHNICAL APPROACH – 4” BALL VALVE

**Solidification Analysis:**
Orientation & Gating Design Evaluation

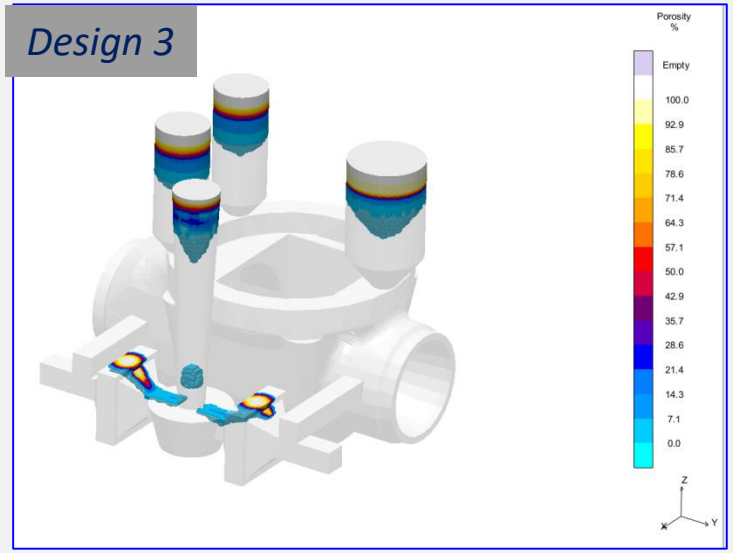
*Design 1*




*Design 2*




*Design 3*

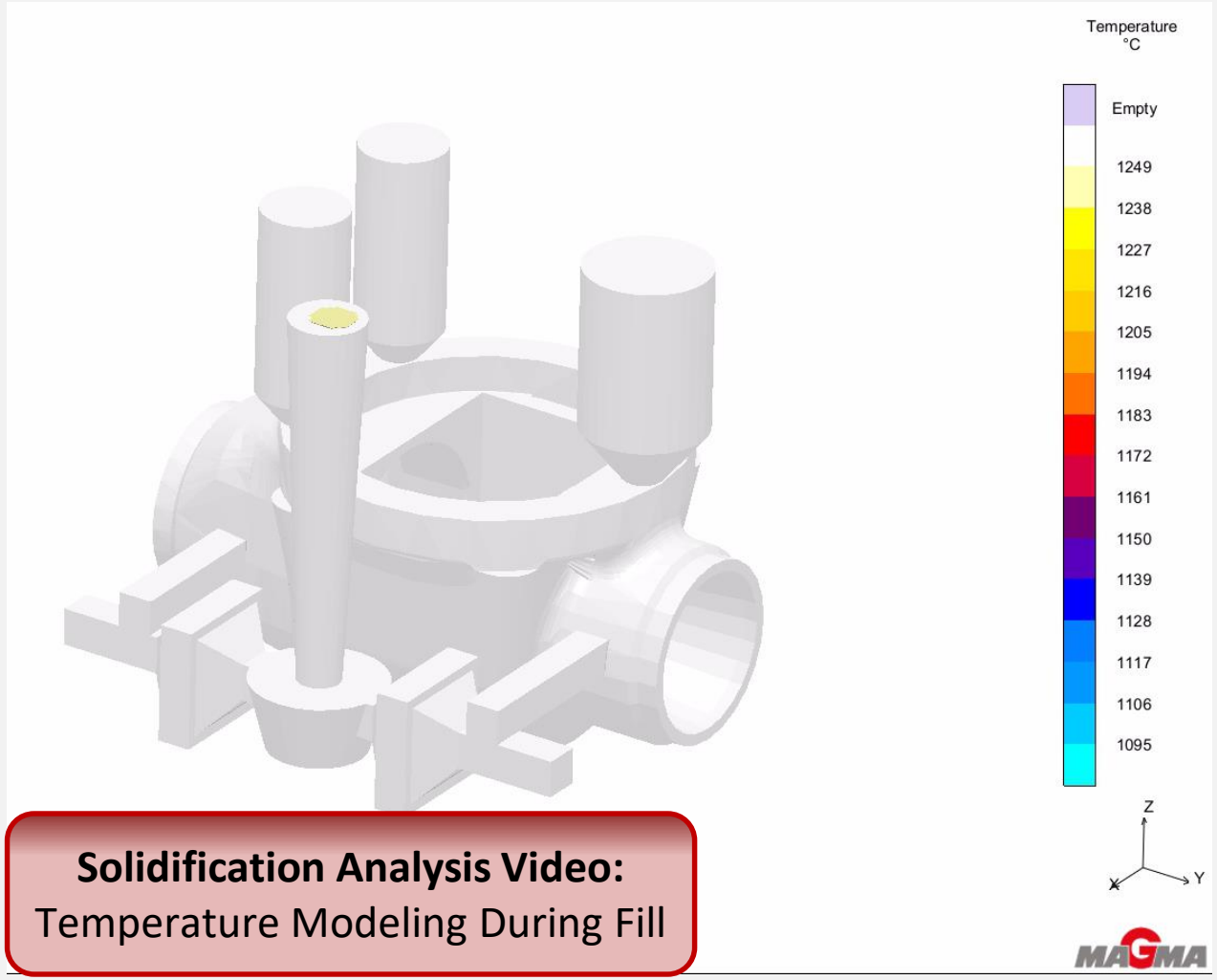



Material: Cu-Ni (MIL-C-20159)

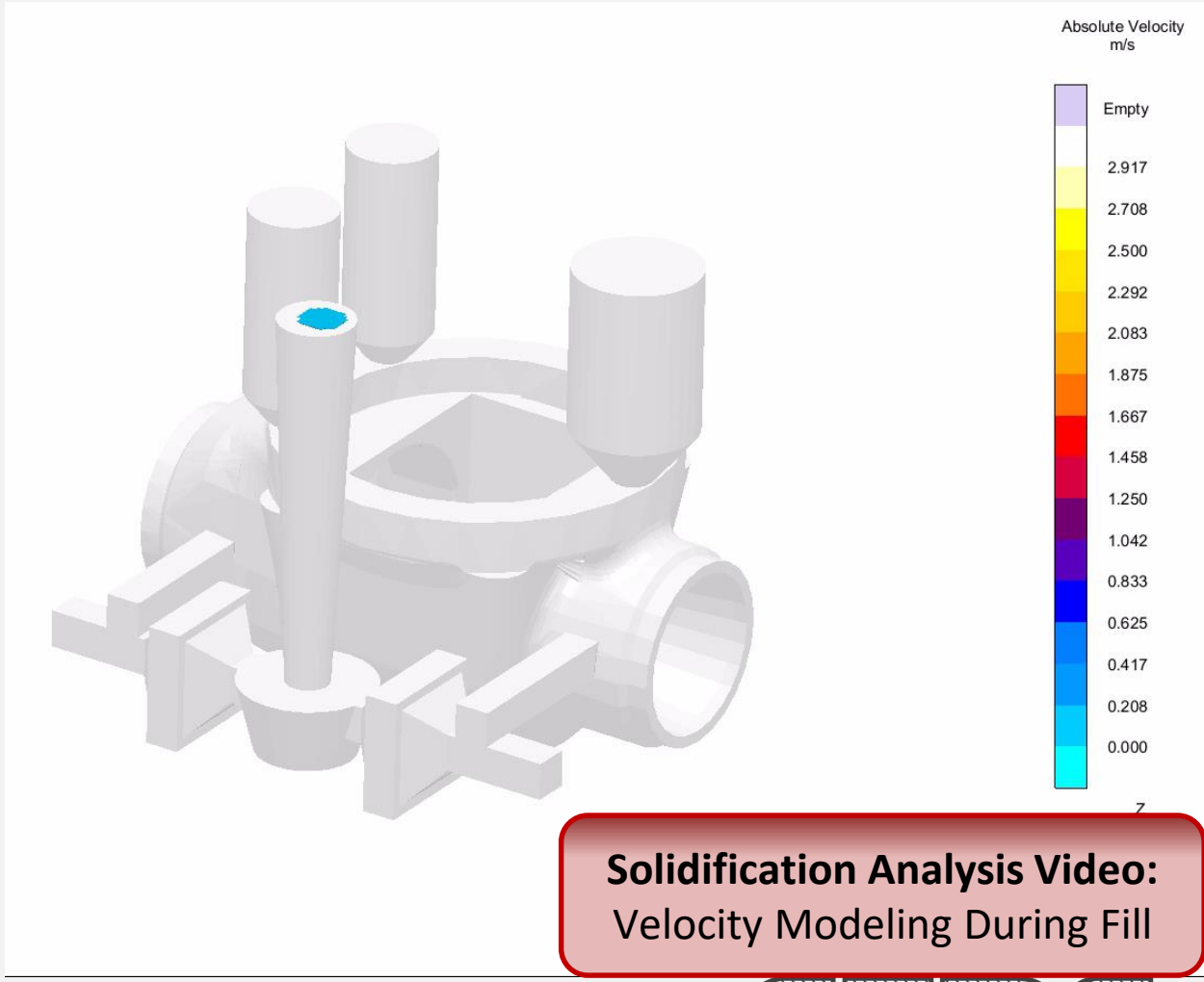
Photo credit: University of Northern Iowa Metal Casting Center

Rapidly simulate multiple rigging design strategies

# TECHNICAL APPROACH – 4” BALL VALVE




**Solidification Analysis Video:**
Temperature Modeling During Fill




**Solidification Analysis Video:**
Velocity Modeling During Fill

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Video credit: University of Northern Iowa Metal Casting Center

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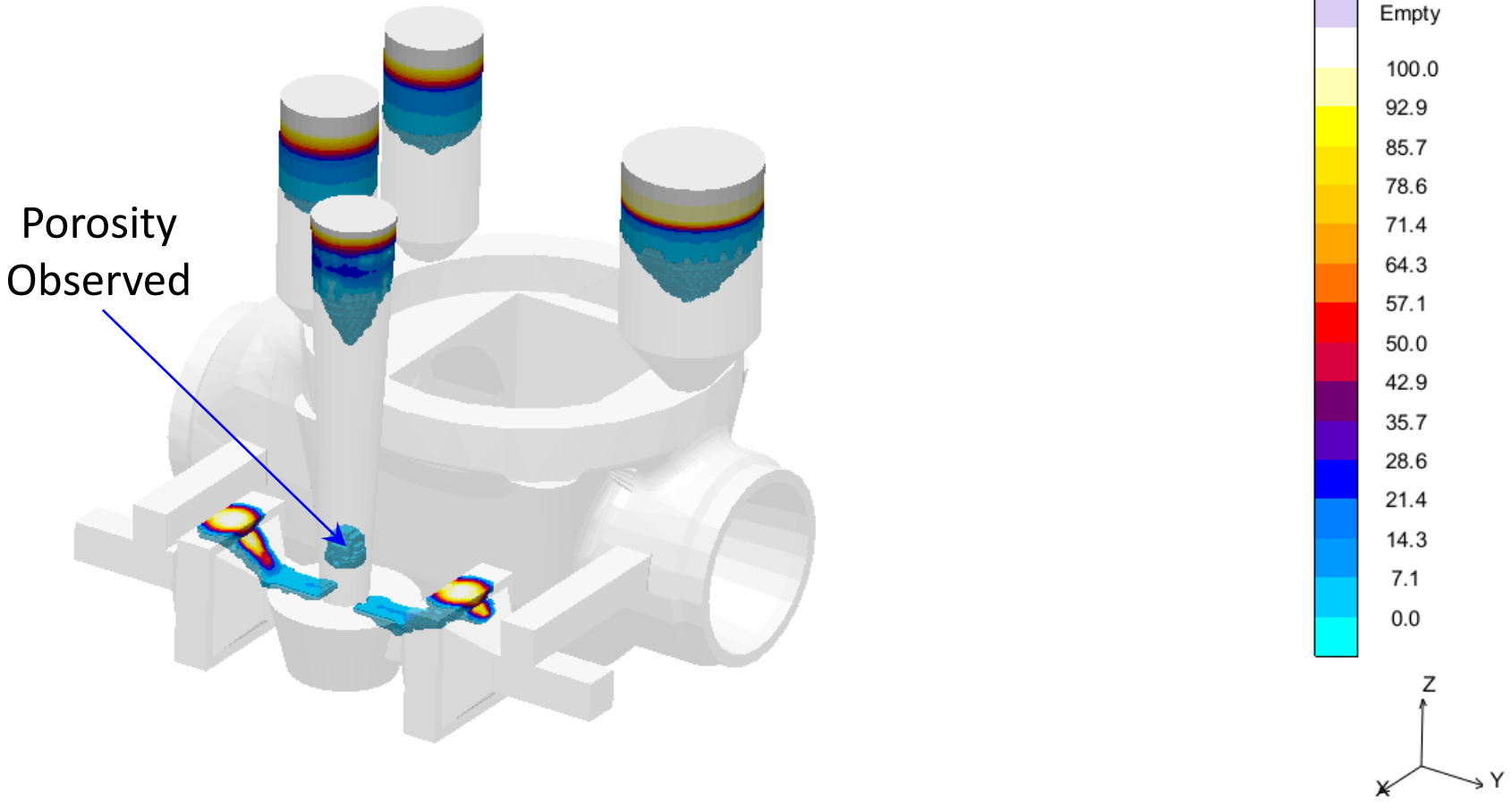
# TECHNICAL APPROACH – 4” BALL VALVE

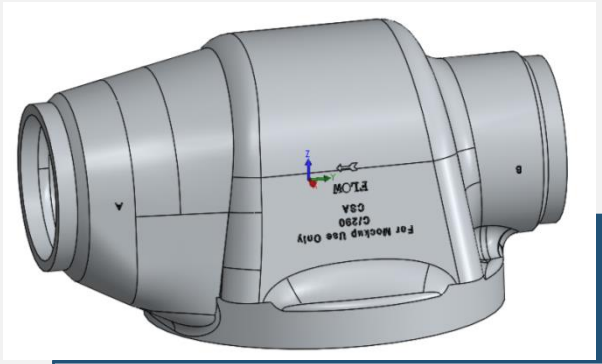
Solidification Analysis:
Porosity Analysis




- Identify defects before pour
- Modify rigging & mold designs and simulate
- Compare physical results to enhance alloy data sets

Photo credit: University of Northern Iowa Metal Casting Center

# OVERALL BENEFITS



## 4” Ball Valve - Value Proposition

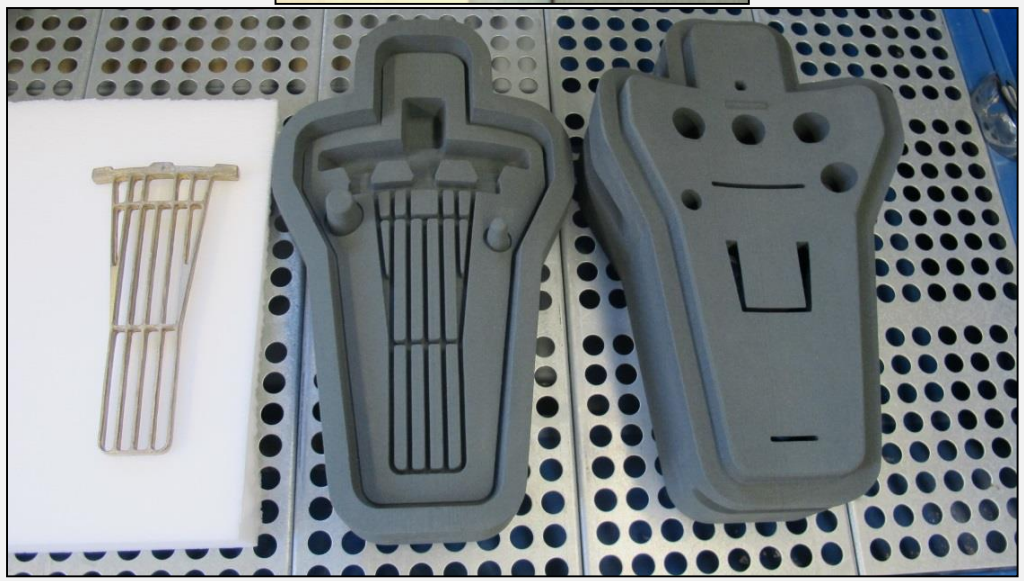
| | Current Approach (Procure Entire Valve Assy) | AM Approach (New Valve Body) |
|---|---|---|
| Replacement Option Lead Time | 12-18 Months | 3-4 Months |
| Replacement Option Cost | $130K (buy entire valve assembly) | $37K (buy finished valve body) |
| Repair Option Cost | $15K - $50K/EA (weld repair) + impact to schedule costs* | $0* |
| Repair Reliability | Low yield weld repair; Higher corrosion rates | High; new casting |

Supply System Availability: Not available; Valve assembly long-lead item

Demand: Numerous valves per OHIO CLASS submarines; 1-2 needed per availability

*Cost if Valve Body Not Available: If not achievable during shipyard maintenance availability, add cost of temporary departure and any actions to prevent further erosion/corrosion of valve body near area of wall reduction. Higher Risk of erosion/corrosion on weld-repaired valve bodies.

# OVERALL BENEFITS



- Reduce *Trial-and-Error* Casting Production
- Reduce Poor Casting Quality
- Identify Casting Failures Rapidly; Minimize Rework
- Increase Versatility of Casting Processes
- Increase High Mix / Low Quantity Speed-to-Fleet
- Reduce Inventory Costs &
- Reduce Reactionary Planning and Waste
- Demonstrate Digital Portability of Process

NAVSEA WARFARE CENTERS KEYPORT

NAVAL AIR SYSTEMS COMMAND

University of Northern Iowa

NCMS NATIONAL CENTER FOR MANUFACTURING SCIENCES

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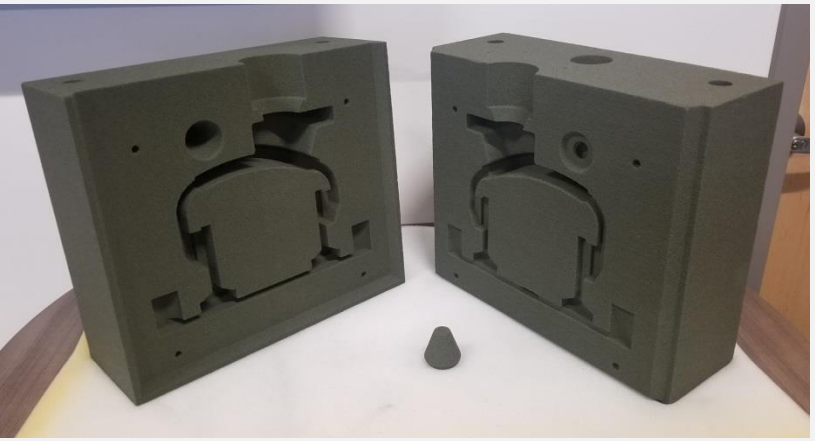
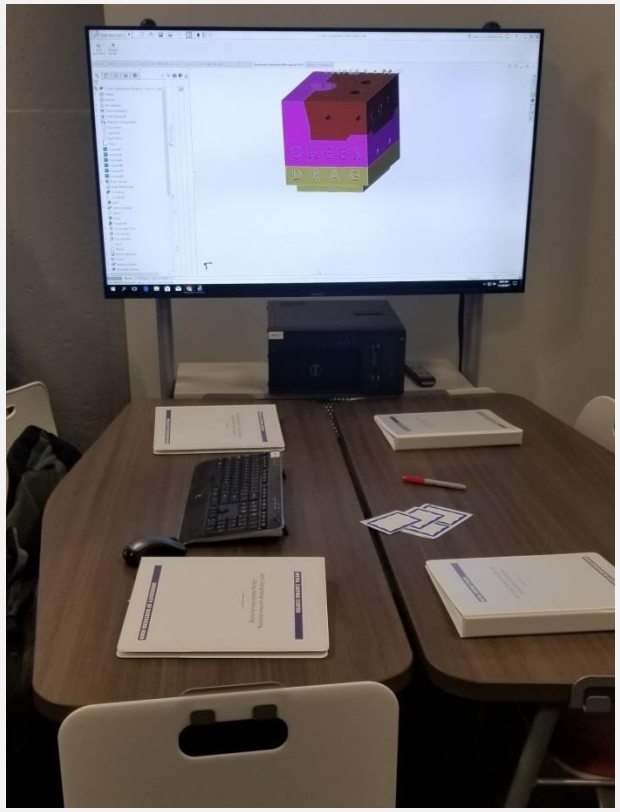
# UNI METAL CASTING COURSE OBJECTIVES



- Fundamentals of sand casting
- Sand printing design & applications
  - Mold design optimization
  - Printable sands for Naval alloys
  - Rigging design concepts
  - Solidification analysis
- Sand printing business case
  - Digital data package; portability
  - Speed & higher yield potential
- Investment casting with AM
- Hybrid tooling
  - FDM patterns, robotically milled molds
- Tours:  UNI and Rock Island Arsenal

*Navy hardware examples used throughout the course*

# TECHNOLOGY GAPS REMAIN

## Additional Casting Alloys Found in Navy Systems

- Ni-Al-Bz, HY Steels, Titanium

## Expanding Sand Types and Binder Resins

- Chromite, Zircon, Silica blends

## Chemical Compatibility with Casting Alloys

- Example:  Sulphur from Furan binders can embrittlement & welding issues

## Expeditionary Sand Casting

- Investigate feasibility of a portable “foundry-in-a-box”

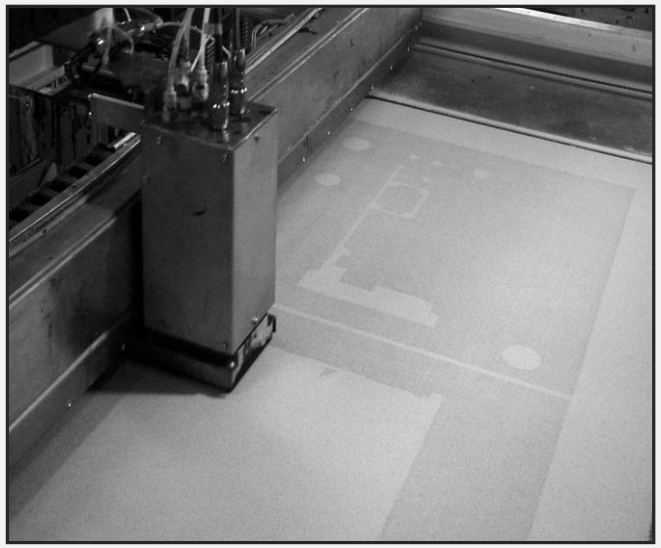
## Technical Data Package (TDP) Requirements

# WHERE DO WE GO NEXT?

1) Grow the DoD's castings corporate knowledge and skillsets
2) Establish a functional DoD casting material readiness chain
   - Dynamically identify application candidates in supply chain
   - Establish foundry & services contracts
   - Consider new acquisition model leveraging 'digital portability'
   - Coordinate new capability investments; establish R&D / production partnerships
3) Educate and communicate with industry
   - Lead industry towards a different business model
4) Integrate
   - Digital/Portable Data Transfer
   - Standard Technical Data Package

# SPECIAL THANKS


- *Defense Innovation & Sustainment Group (DISG)*
- *NAVSEA 05T Additive Manufacturing Program Office*
- *NAVAIR Additive Manufacturing IPT*
- *University of Northern Iowa Metal Casting Center team*
- *Puget Sound Naval Shipyard*
- *NUWC Keyport Additive Manufacturing Team*
- *National Center for Manufacturing Sciences (NCMS)*

# THANK YOU


**NUWC KEYPORT**

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