# ICAM Castings & Forgings

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# Castings & Forgings (C&F) Strategic Situation

*Functional View: Critical to Defense Capabilities*

**Casting and forging are fundamental** components of manufacturing; without adequate domestic capacity DoD cannot sustain its current force or modernize critical platforms, systems, and weapons, including:

- All surface and subsurface naval vessels
- All aircraft and space systems,
- Ground combat and transportation systems
- Missiles, rockets, bombs, ammunition

**As Ukraine has demonstrated**, modern warfare consumes massive quantities of C&F items. Existing C&F issues in shipbuilding, armored systems, artillery, aircraft complicated by *surge (industrial mobilization) requirements:*

- Artillery projectiles and tubes
- Anti-tank weapons, rockets, bombs, missiles, ammunition
- Jet and turbine engine parts due to accelerated flight mission tempo


*To shore up our foundation for deterring aggression and campaign through challenges, the Department will urgently build enduring advantages across the defense ecosystem*

*…As we reinforce our defense industrial base and make supply chains more robust, the Department will work across communities so that our U.S. defense ecosystem can deliver warfighters sustainment at scale.*

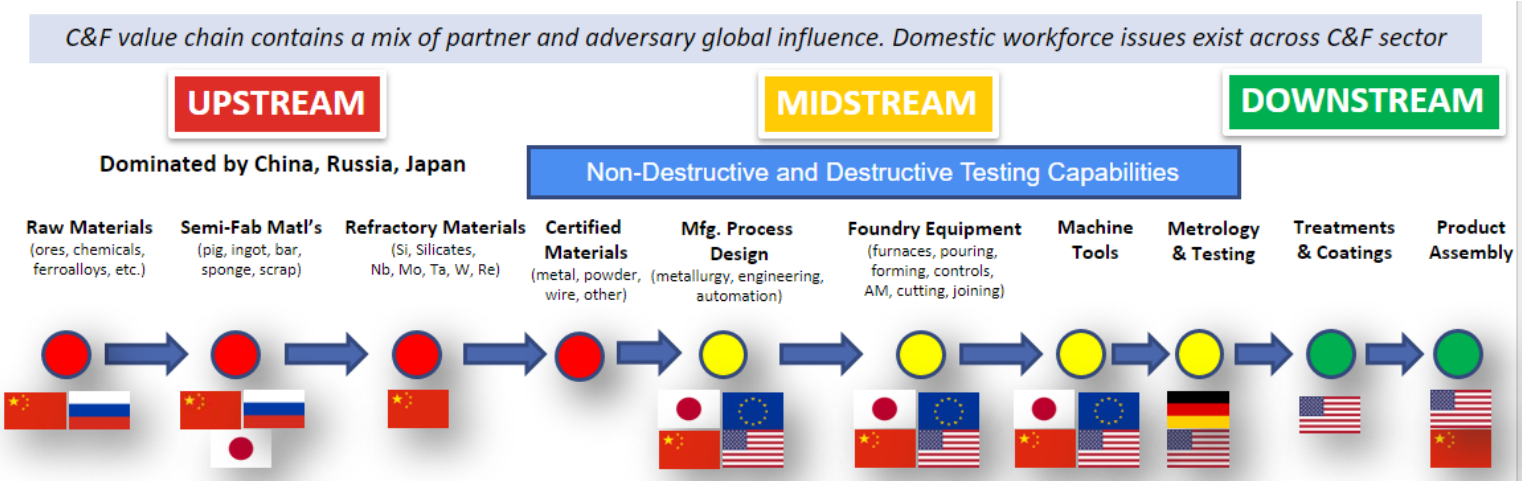
*- National Defense Strategy*





**To be ready, DoD must act now to position itself to replenish and robust its stocks of cast & forged items for future near- and long-term fights … and we must do so quickly**

# Focus Area Quick-Look
*Castings & Forgings (C&F)*




- Strategic Context: C&F parts are critical to all DoD systems and weapons
- Key Sector Challenges/Issues: Foreign competitors dominate value chain, domestic workforce is shrinking, U.S.G. and DoD policies limit global competitiveness
- DoD Supply Chain Equities:
  - C&F parts in key systems are high importance/low-volume, need specialized materials
  - C&F products are essential components of machine tools used to make other products
  - Forgings are in 20% of the products in the U.S. GDP

– Major Actions:
  - Develop DoD C&F Investment Strategy: In formal coordination
  - Invest in the C&F industrial base to modernize/expand capacity: Investing ~ $2B FYDP
  - Expand partnerships among U.S.G., industry, international bodies: Efforts beginning

# C&F Investment Strategy

- **Mission:** Strengthen the competitive posture of the U.S. Defense Industrial Base (DIB) in the era of great powers and global competition
- **Vision:** A modern industrial base that fortifies traditional DIB capabilities and forges emerging sectors to respond at will to national security requirements

## Priorities:

- Prepare the defense industrial workforce – Promote, elevate, and accelerate industrial talent pipelines
- Ready the modern DIB – Advance and sustain traditional defense manufacturing sectors
- Prepare for the future – Identify, attract, and cultivate emerging defense sectors
- Assess and shape the risk – Mitigate supply chain vulnerabilities within the global DIB
- Build and strengthen partnerships – across the global DIB

### C&F provide unique manufacturing attributes…

- **Scalability** Ability to mass produce
- **Predictability** Consistent output and quality
- **Performance** Strong, complex designs

### …But require investment to keep up with change

- New manufacturing processes and equipment are available that improve cost, performance, quality
- Digital innovations to fully realize potential of workforce and equipment
- Major advances metrology have enabled higher quality, cost effectiveness, and predictability

**Timelines for industrial response must be shorter than in the past. Only way to get there is to take advantage of these innovations**

# IACMI Workforce Objective

**Create a network of regionalized training programs based on national standards and serve important ecosystems for strengthening the industrial manufacturing supply chain, promoting clean energy, and strengthening national security.**

## Framework for Systematic Implementation Process

- **Identify** regional opportunities
- **Qualify** for delivery and success
- **Prioritize** for implementation
- **Execute** with local ownership
- **Connect** via national network to assess and maintain
- **Regionalized** to facilitate ownership and sustainability by local ecosystem

## Key Elements

- Best practices
- National credentials
- Customization to regional needs
- Industry-based qualifications
- AR/VR simulations to economize introductory programming
- Emphasis on hands-on learning experiences

# IACMI Workforce Programs

**Educating generation of students capable of taking a solutions-based approach to common, everyday problems**

ACE AMERICA'S CUTTING EDGE

**Flexible Schedule:** Online 6-hour and hands-on 32-hour CNC machining training (stand-alone camp or embedded into a course)
**Comprehensive Curriculum:** Individual courses cover CNC machining, metrology, composites, and cybersecurity

**Inclusive:** High school+ interested in starting or advancing in the machine tool industry

**Pioneering Program:** Developed by University of Tennessee professor and machine dynamics expert, Dr. Tony Schmitz

**Results Driven:** Since 2020, 9,000 individuals online in all 50 states and in-person CNC machining training to 1,100+ students

METAL

**Metallurgy Fundamentals:** Solid Metallurgical principles, processes, and their real-world applications in defense and manufacturing

**Hands-on Learning:** Students engage in practical, project-based learning experiences that mirror real world challenges

**Diverse Pathways:** Trades programs, certification, degree programs, apprenticeships, internships, bootcamps, workshops, STEM, learners at various stages

**Industry-led Expertise:** Developed in collaboration with industry and multiple armed services, METAL's curriculum is designed to ensure students are equipped with the skills demanded by employers

**Effective:** Since February 2024, METAL has already reached 800+ students

INNOCRATE By IACMI

**Experiment Driven:** Manufacturing & science technologies in a fun, hands-on, experiment-driven way

**Manufacturing Focused:** Curriculum from composites and CNC machining to casting and forging

**Developmentally Appropriate:** STEM activity kits meet students on their level, divided by grades K-2, 3-5, 6-8, 9-12

**Comprehensive:** Kits include teacher guide, experiment materials, student workbooks, and instructional videos

**Designed with Expertise**: Developed by educators at the University of Tennessee and aligned with state educational standards

**Results Driven:** Since its launch in January 2023, InnoCrate has already reached more than 2,000 students

SkillCrafters™ BY IACMI

**Composites Focus:** Classroom curriculum challenges students to research advanced composite materials, processes, and impact to our world today

**Inspiring Innovation:** Students tasked to think like a business and solve a real-world problem with a manufactured composites product

**Turnkey System:** Teacher guides, instructional videos, student supplies provided for middle and high schoolers

**Expertise:** Developed in collaboration with MUSA manufacturing institutes, including the expertise of Dr. Uday Vaidya

**Effective:** Since 2022, 1,400+ students served

# METAL

## Expose → Inspire → Educate → Employ


**Tennessee METAL Workshops**

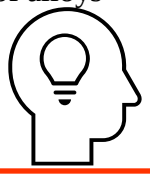
- 400+ students annually
- Melting tin into a variety of shapes using sand casting


**Pennsylvania STEAM Event**

- 1400 attendees exposed to casting in 5 hours
- Melting tin into a variety of trinkets

**In-Person Bootcamp Curriculum**

- Casting processes e.g., lost foam, sand
- Basics of modeling with SolidCast
- Pouring Aluminum and Bronze into mugs and medallions
- Post Processing machining, grinding, band saw
- Tensile strength
- Metallurgy basics
- Gray cast iron vs ductile
- Types of alloys



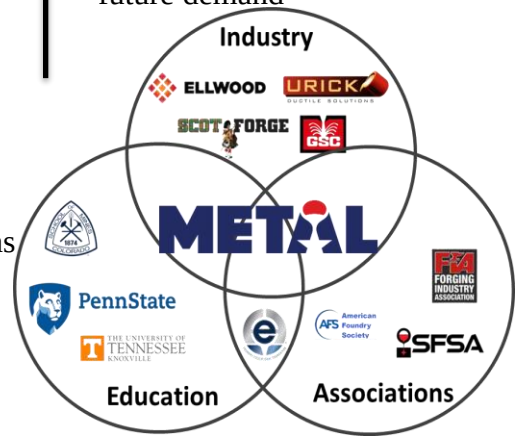



**Education pathways**

- Level 2 and 3 bootcamps in development
- Industry 5.0, AR/VR, automation, and robotics
- Specialized training
- Advanced modeling
- Engineering degrees
- Access to existing curriculum from associations such:FIA, SFSA, AFS


**Employment Opportunity for Industry**

- Recent graduate Engineers
- Apprentices
- METAL program is building apprenticeship programs in key regions
- Hire motivated individuals post bootcamp
- Increased supply of the metal industry workforce to meet future demand



# Recent METAL Outreach Event

*College for Kids Summer 2024 Penn State Behrend*

## 7 College for Kids Sessions

- 4 Chemistry 101 Sessions (Sand Casting Activity) (6 to 8 Year Olds)
- 1 Engineering Session (Sand Casting & Additive Manufacturing Activity) (6 to 8 Year Olds)
- 2 Chemistry 201 Sessions (Sand Casting & Additive Manufacturing Activity (10 to 14 Year Olds)


# Recent METAL Outreach Event

*College for Kids Summer 2024 Penn State Behrend*

**Total Roster Numbers: 102 Students**

- 6 to 8 Year Olds: 82
- 10 to 14 Year Olds: 20

# Cast in Steel / All in Steel







## Project Objective(s)

- To engage and attract future leaders in the manufacturing industry in a fun and challenging way.

## Justification for IBAS Funding

- Workforce recruitment is a critical issue identified in the DoD in response to EO 14017 for the Casting and Forging Industry.

## Primary Stakeholders

- Casting, Forging, and Additive manufacturers
- Steel Founder Founders' Society of America (SFSA)

## Technical Target

- Steel component production industry

## Rationale for Project

- Skilled labor shortage is one of the most significant challenges facing the manufacturing industry. The Cast In Steel competition has been proven to be the most effective way to outreach to the next generation workforce, upon which this project is building..

## Anticipated Impact

- Securing a capable steel manufacturing supply chain to meet existing and planned requirements for economic and national security is critical. Enhancing the workforce's capability and availability will benefit the producing industry, their suppliers, their OEM customers and the DoD users.

## Performer(s)

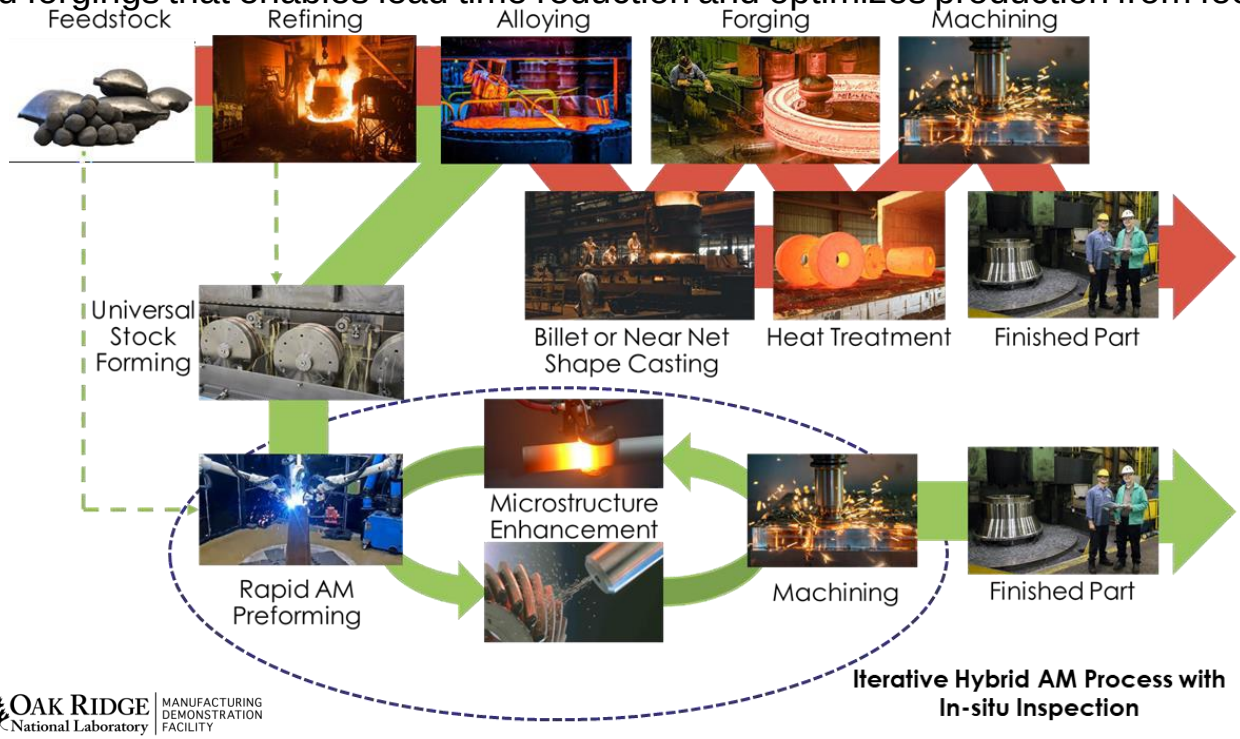
- Steel Founders' Society of America – Crystal Lake, IL
- Forging Industry Association – Independence, OH
- America Makes – Youngstown, OH

## Technical Progress to Date

- Conducted Cast In Steel competition April 2023
- Period of Performance: January 2024 – May 2028

# Advanced Manufacturing Research

Objective: Strengthen the DOD's defense industrial base by enabling new methods for replacement of castings and forgings that enables lead time reduction and optimizes production from feedstock to finished part.



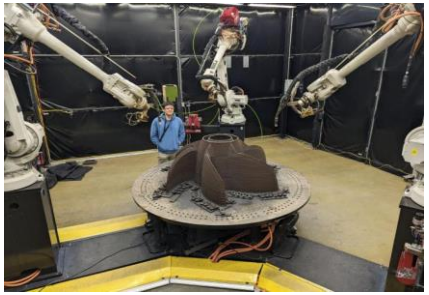

OAK RIDGE National Laboratory | MANUFACTURING DEMONSTRATION FACILITY

**Conventional Casting and Forging Production**

- Long Lead Time
- Labor Intensive
- Low Agility
- Capital Intensive
- Requires Specialized Tooling
- Requires Statistical Basis for QA

**Hybrid AM Casting and Forging Replacement**

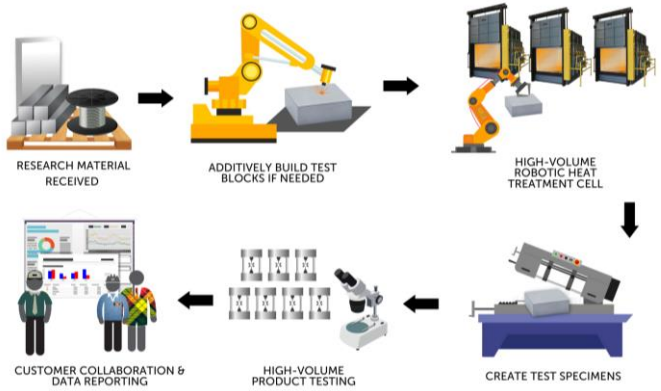
- High Agility
- Available Feedstock
- No Molds / Heavy Infrastructure
- Site Specific Material & Property Control



# Qualification & Certification Network

FUTURE ALLOY STUDY & TESTING CENTER

FAST




| | | |
|---|---|---|
| Room Temperature Tensile | Room Temperature Compression | Charpy Impact |
| Dynamic Tear | Room Temperature Fracture Toughness | Metallography |
| Elevated & Reduced Temperature Tensile / Compression | Elevated Temperature Fracture Toughness | Low / High Cycle Fatigue |
| Creep / Stress Rupture / Stress Relaxation | Chemistry | Thermal Properties |

RAMP Lab

Rapid Applied Materials and Processing Lab

**Primary & Secondary Melting**
- VCAP
- VIM
- VAR/ESR
- Air Induction
- Arc Melter

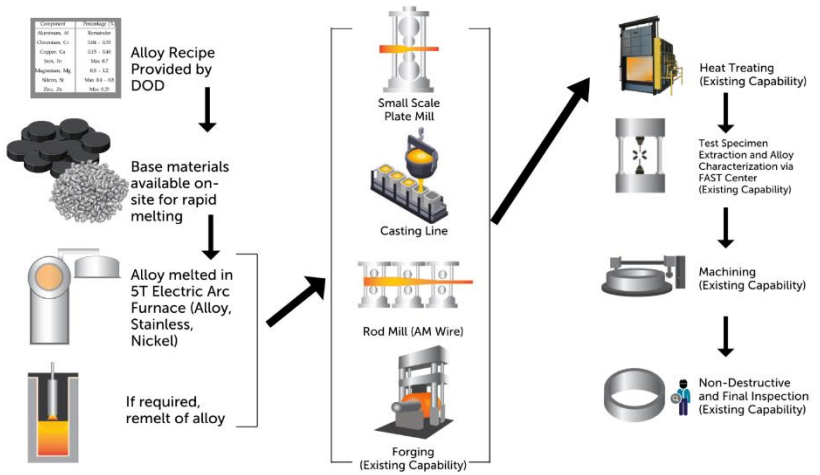
**Thermal Mechanical Processing**
- Casting
- Rolling
- Forging
- Heat Treating
- Quenching

**Rough & Finish Machining**
- Rough Cutting
- Milling & Turning
- Waterjet

**Mechanical Testing**
- Hardness
- Charpy
- Load Frame

**Analytical & Testing**
- Chemistry
- Met Lab
- Optical Microscopy

## Center for Advanced Metals and Processing



# Upcoming Proposal Calls

## Automate Trades Labor

- Transition the DoD casting and forging supply chain to industry 4.0

## Vendor Qualification Support

- Investments (in things like equipment, facility upgrades, qualification process support) to allow new suppliers to qualify to become new vendors for DoD

## Alloy and Metalworking Process Development

- Increase the speed at which metallurgical innovation, inventions, and scientific discoveries are turned into platform capabilities to match and exceed that of peer and near peer competitors through development of new advanced metallic alloy systems and associated manufacturing processes with superior properties

**RFI to be Released by COTA, RFP by NCDMM in Q4 FY24**

## Welding/AM Consumables Production (REWIRE)

- On-shoring primary melting of defense wire-based consumables

**Release Anticipated through COTA in Q4 FY24**

# Questions / Comments

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# Planned Focus Areas and Impact

- **Near-Term Focus Areas (FY23-FY24)**
  - **Strengthen foundational capabilities and correct pressing weaknesses**
    - **Metalworking infrastructure: Develop applied metals development and advanced simulation, and testing/qualification capabilities**
    - **Workforce development: Industrial skills training, government training, and labor value maximization through automation**
    - **Upstream Supply Chain Security: Reshore Ti production, modernize material certification capabilities, and produce specific AM consumables**
    - **Strategy Development: Support Defense CFMTWG Working Group operations, monitor and refine investment strategy over time**

- **Mid-Term Focus Areas (FY25-FY29)**
  - **Continue existing efforts to generate planned value over time**
  - **Accelerate and expand capabilities with special focus on INDOPACOM needs**

- **Far-Term Focus Areas (FY30+)**
  - **Fill emerging gaps identified by planned work and data analytics efforts**
  - **Leverage new capabilities/technologies based on R&E studies**