# Manufacturing Focus Area

**Dr. Wolk**

*ONR Manufacturing Focus Area Lead*

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Date

# Manufacturing Focus Area

## Objective

**Provide advanced manufacturing technologies from design to sustainment utilizing a foundation of manufacturing science and technology to accelerate development and deployment**

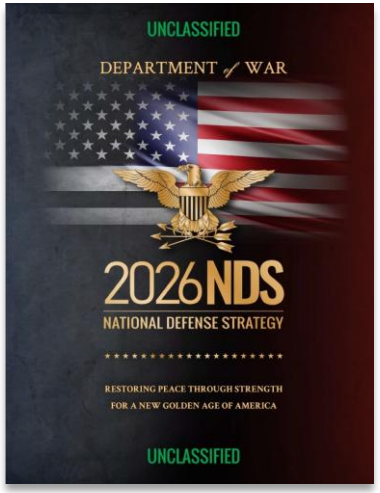


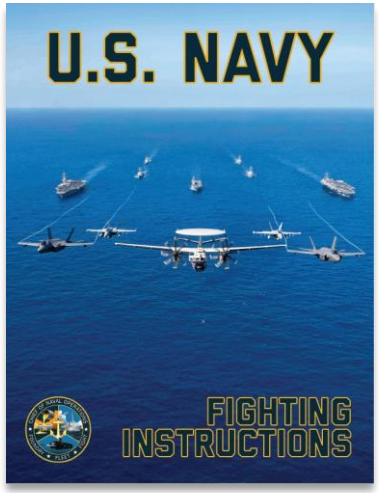
# STRATEGIC ALIGNMENT

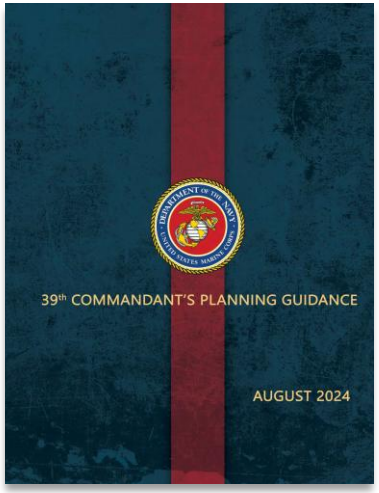
Manufacturing

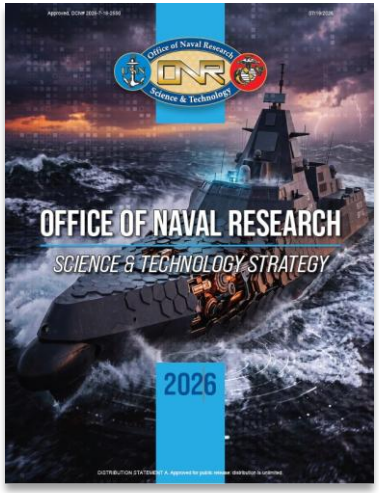
## GUIDANCE

"(Manufacturing) depend(s) on proximity between scientific research and industrial capability. Without local manufacturing capacity, the marriage of science and craft weakens. Scientists lose access to the practical problems that inspire new lines of inquiry and improve research quality, while industry loses the research ecosystem that sustains technological leadership. We need to reshore American manufacturing, not only for the sake of fruitful employment, but for the long-term health of American science itself."



# Research Area: Process & Automation

## Dr. Farren

**Research on the basic and applied science and technology for new and emerging manufacturing tools. Emphasis includes pushing the manufacturing process and automation beyond purpose-built toolsets to build intelligence into new processes and automation science. This RA focuses on adaptability and intelligent scale-up.**



**Automation**



**Non-Destructive Testing (NDT)**



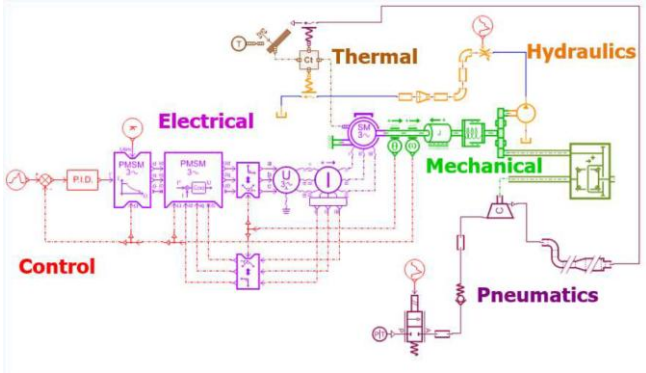


**Additive Manufacturing**

# Process & Automation RA
## S&T ROADMAP

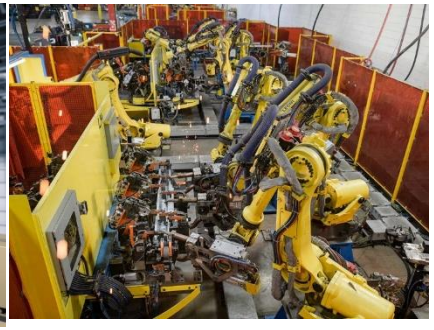


Purpose built manufacturing systems (monuments) with lengthy design/build/programming/validation cycles




Virtual commissioning/automated programming of flexible automated manufacturing systems for DoD products





- Computational/generative design/programming for manufacturing systems from original DoD product models
- Reconfigurable manufacturing systems driven by high-mix / low-volume DoD product models.

**2035 Current Program** → **2045 Technical Challenges** → **2055 End State**

# TECHNICAL CHALLENGES

Process & Automation

## Scale the Problem

- How do you increase manufacturing Resiliency?

## Flexible Manufacturing Lines

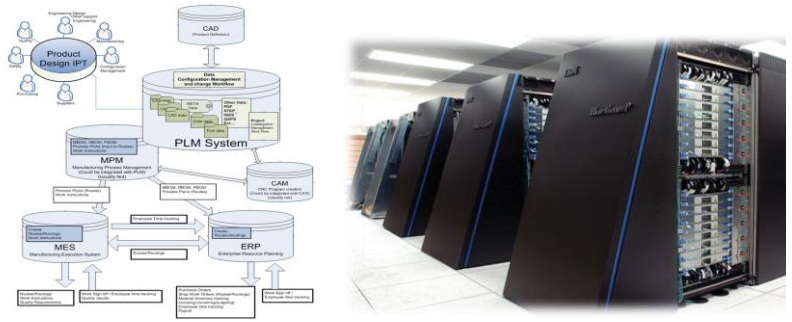
- Provide the tools that allow for sudden changes in the demand signal to be met.

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# Research Area: Digital Tools

## Dr. Fisher

**Research and development of full lifecycle digital tools from process modeling to simulation. This RA explores the cyberphysical connections of digital manufacturing and pushes beyond local toolsets. Digital tools encompass an understanding of manufacturing system health and digital records, enabling the leveraging of emerging AI/ML tools. The development of these digital tools enables a complete digital thread at local and global manufacturing and sustainment levels.**




**Data Architecture**



**Digital Twin**



**Sensor Fusion**

# Digital Tools RA

## S&T ROADMAP

### Digital Design & Virtual Prototyping



**Generative Design (AI)**
AI algorithms propose thousands of optimized designs based on constraints (cost, weight, speed).



**Twin Creation (CAD/PLM)**
Engineers build a physics-based 3D model.



**Simulation & Testing**
The twin undergoes virtual stress tests, hydrodynamic analysis, and system integration checks before any metal is cut.

**Output**
A validated, simulation-ready blueprint flows to the construction phase.

### Smart Operations & Sustainment



**Live Data Streaming (IIoT)**
Sensors on the deployed ship



**Predictive Maintenance (AI)**
AI analyzes data to predict component failures before they happen



**Operational Optimization**
The digital twin runs "what if" scenarios with live data to optimize operations

**Output (Feedback Loop)**
Operational data is fed back to designers

**Continuous Improvement**

### Digital Twin / Digital Thread

A complete, dynamic virtual replica of the ship that serves as the single source of truth. It connects every phase, integrating data from design, construction, and operations into one continuous loop.

**Output**
The physical ship is built, and "as-built" data is fed back to update the digital twin.

### Automated Construction & Assembly

**Robotic Fabrication**
Automated systems handle welding, cutting, and assembly, guided by the digital twin.



**Remote Inspection**
AI-powered cameras scan components for defects in real-time.



**Additive Manufacturing**
3D printers create complex or obsolete parts on demand.



### Foundation: Enabling Technologies

**AI & Machine Learning**
Enabling prediction, optimization, and automation.

**Cloud & Edge Computing**
Provide the power to store and process massive datasets

**Automation**
Performing precise and repetitive physical tasks

### Outcomes: Strategic Advances

**SPEED (🚀)**
Drastically reduced design and construction timelines.

**QUALITY (✅)**
Higher precision and fewer defects through automation.

**COST (💰)**
Reduced rework, waste, and expensive downtime.

**READINESS (🛡️)**
Predictive maintenance keeps ships mission-ready and extends fleet life.

# TECHNICAL CHALLENGES

Digital Tools

## Digital Tools to Physical Products

- How do you manufacture to scale from a microchip to a platform in the time frame and rate that you need it?

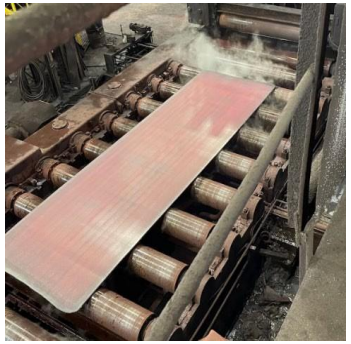
## Data Lakes

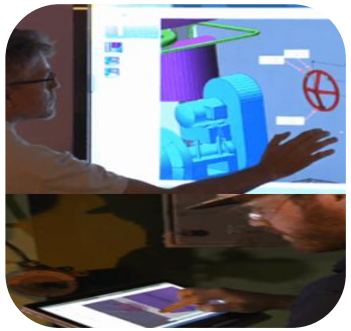
- Implementing a Digital Sandbox to collect and analyze data using AI/ML toolsets to accelerate both human and machine decision-making.

# Research Area: Integrated Manufacturing & Sustainment Technologies

## Mr. Graf

**Research and development of unique maturation challenges for scaling adoption. This RA confronts manufacturing challenges at the intersection of various other Focus Areas, with an emphasis on platform/system adoption.**





**Rapid Certification & Validation**





**Design Optimization for Manufacturability & Sustainment**



**Rapid Scale-Up**

# Integrated Manufacturing & Sustainment Technologies RA

## S&T ROADMAP

### Current State



**Rate Limiting Factors:**
An unstable demand signal and a shrinking industrial base create a fragile supply chain unable to keep pace with design improvement and digital integration. Current shipbuilding currently relies on aging infrastructure and disconnected equipment.

### Future State

**Advanced Manufacturing Processes**



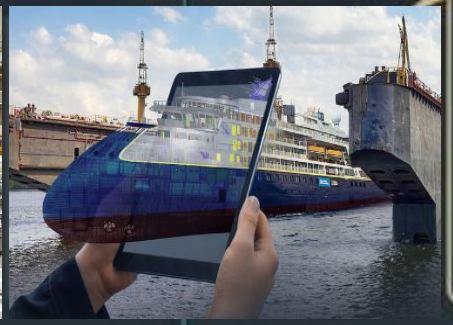
Enables rapid, on-demand production of complex, critical parts to dramatically reduce lead times. This allows for increased manufacturability with required tolerances, directly translating to faster ship construction and repair.

**Automation**



Delivers precision and consistency in critical tasks, significantly improving build quality and structural integrity. Automation augments traditional manufacturing with ease of assembly to accelerate production schedules to meet urgent operational demands.

**Remote Inspection & Maintenance**



Allows for real-time, continuous monitoring of vessel health, predicting failures before they occur. This proactive approach minimizes downtime, reduces lifecycle maintenance costs, and increases overall fleet readiness and availability.

**Digital Tools & Manufacturing Tradespace**



A complete, dynamic virtual replica of the ship, connecting every phase and integrating data from design and construction into one continuous loop to create a seamless, data-driven ecosystem.



**Fundamentally Changing Manufacturing for Responsive Wartime Readiness**

# TECHNICAL CHALLENGES

Integrated Manufacturing & Sustainment Technologies

## Integration at the Fidelity of Decision Making

- How do you make a high-fidelity lifecycle model?

## Manufacturing from LRIP to Full-Scale

- Integrating manufacturing and sustainment technologies that accelerate scale from LRIP to full rate production.

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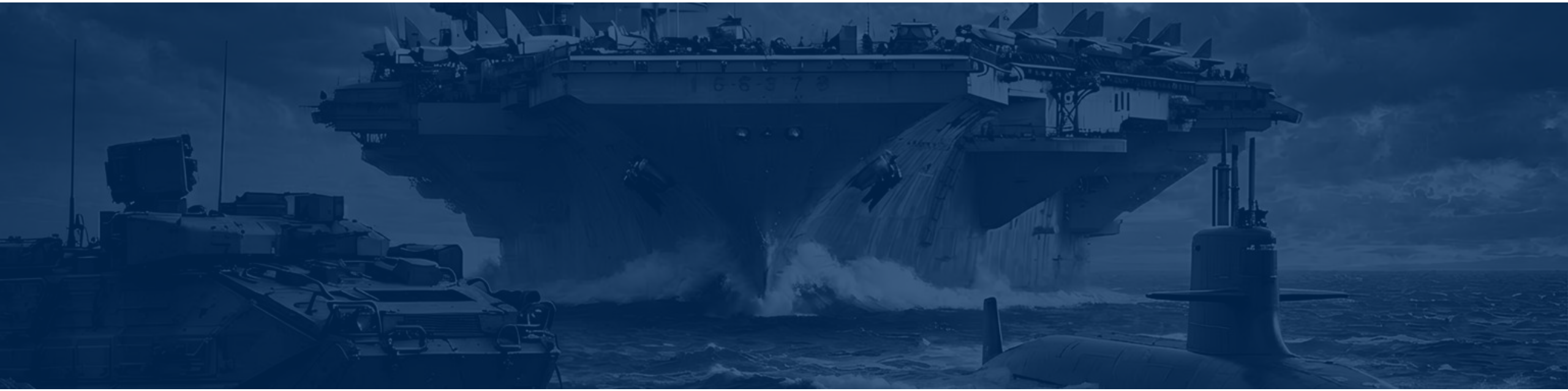
# QUESTIONS & ANSWERS

Manufacturing




**Submit Questions**

# CONTACT US




## ADDRESS

875 Randolph Street
Suite 1425
Arlington, VA 22203-1995

## WEBSITE

www.onr.navy.mil

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