# Survey of Surface Preparation and Coatings Automation Panel Briefing

Final Project Presentation – March 25, 2021

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# Survey of Surface Preparation and Coatings Automation

PROJECT TECHNICAL REPRESENTATIVE

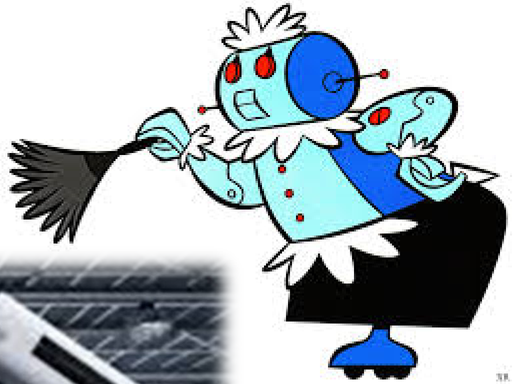
- Arcino Quiero, Jr., HII-NNS

INDUSTRY INVOLVEMENT

- BAE Systems JSR – Stephen Cogswell
- GD-BIW – Robert Cloutier
- HII-Ingalls Shipbuilding – Conlan Hsu

NAVY INVOLVEMENT

- None (officially)



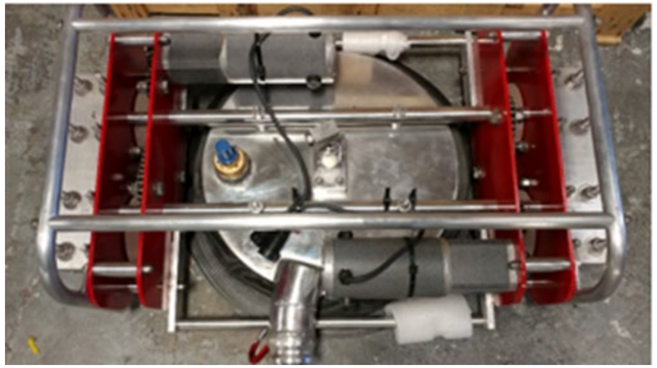
# Survey of Surface Preparation and Coatings Automation

SCOPE

- Establish the current state of surface preparation and coatings automation in shipyards
- Identify the current state of the art in two areas:
  - Surface preparation and painting automation in other industries
  - Use of robotics and automation in shipbuilding (all trades)
- Perform a gap analysis to identify paths forward for automating surface preparation and coating activities in shipbuilding
- Identify promising technologies for shipyard demonstration on production scale and lay out a path forward for NSRP, perhaps through an RA project

# Major Activities

- Workshop
  - Fall Panel Meeting (SEP2019)
- Field Visits
  - Allstream UHP Stingray Robotic Hydroblasting System
  - JH Fletcher/ARS Cobra Robotic Grit Blaster (2 locations)
  - Titan Robotics
  - PPG automotive applications lab
  - Manufacturing USA – Advanced Robotics for Manufacturing (ARM)
  - Boston Dynamics (virtual)
- Industry Outreach and Research

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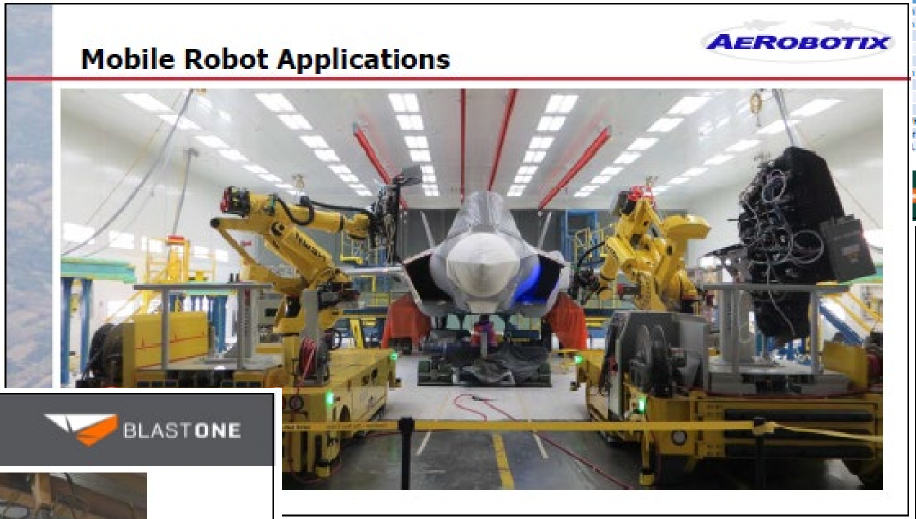
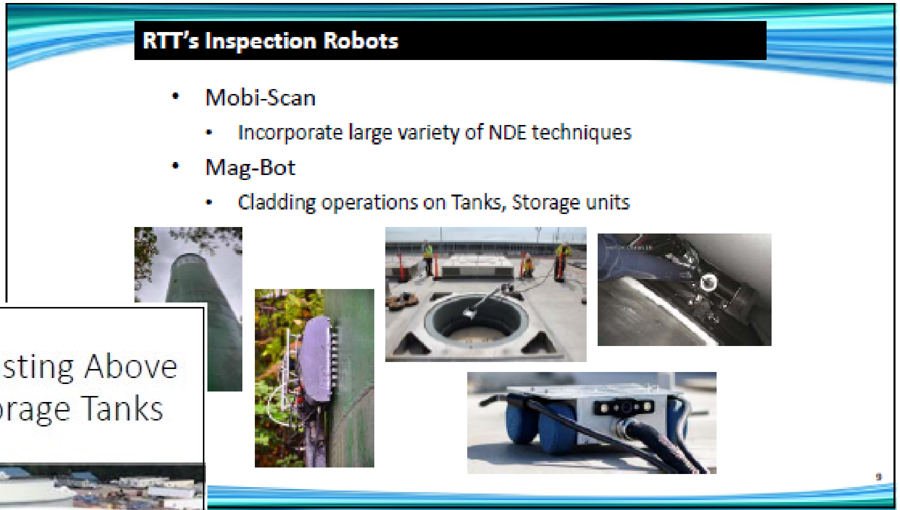
ADVANCED ROBOTICS
FOR MANUFACTURING

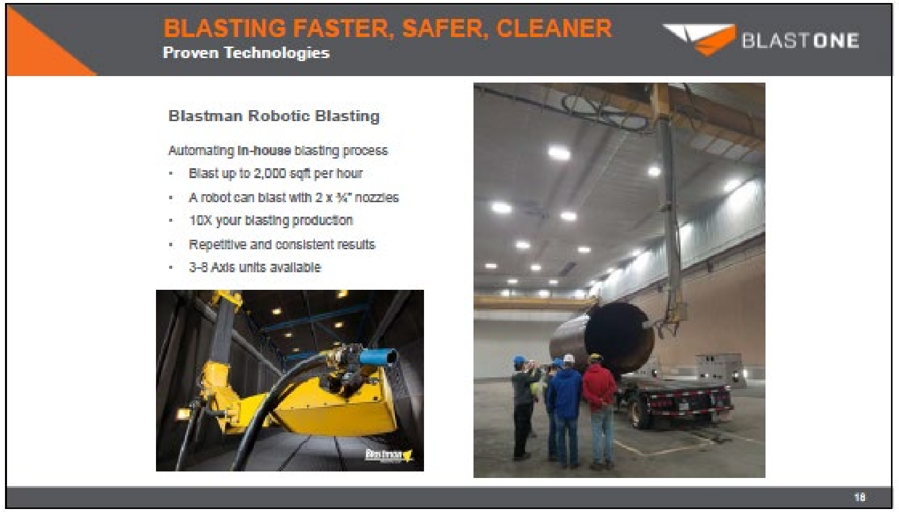
Manufacturing USA®

# Workshop

- Brainstorming Session
- Panel Discussion
- Q & A

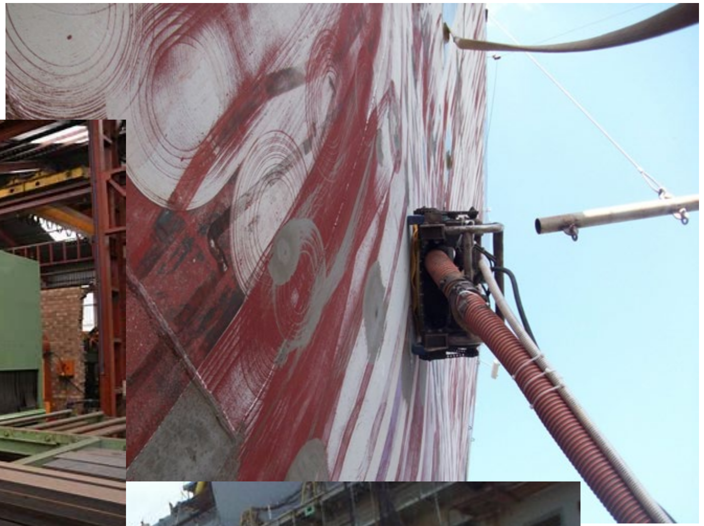




# State of SPC Automation

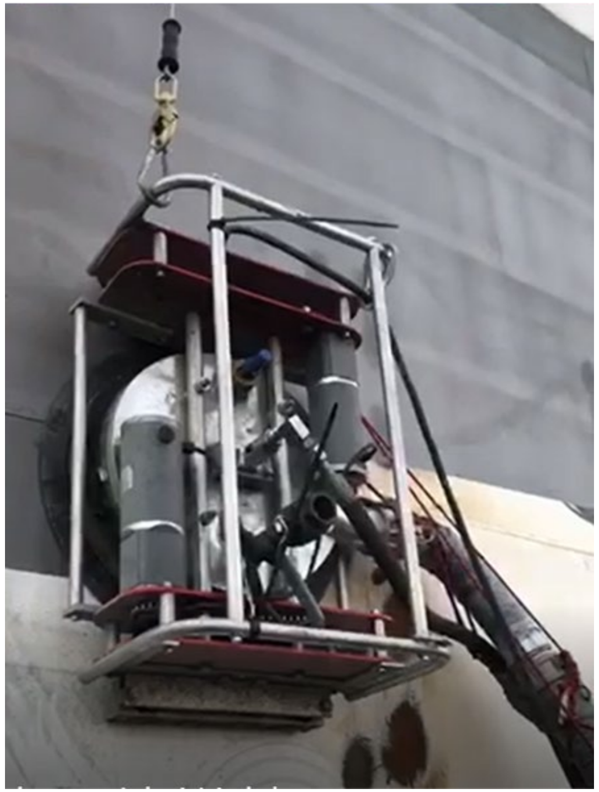
- Attached solutions being implemented and optimized on flat surfaces (e.g., hulls and decks)
- Rail/gantry solutions being implemented and optimized in early stages of production (production lines and shop applications); concepts being developed for use in late stage construction
- Crawling systems are being developed for various industry uses; their use in late stage construction would be transformative for the industry




# Shipyard Demonstration Allstream UHP Stingray Robotic Hydroblasting System

- Demonstrated improved productivity vs current system

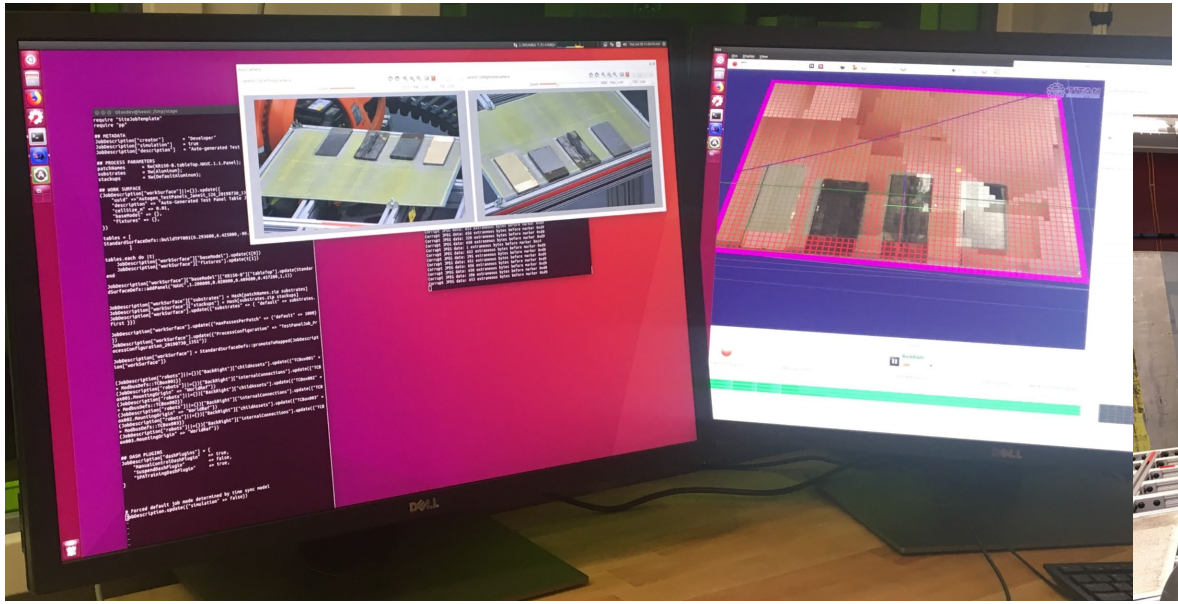


# Shipyard Demonstrations
# JH Fletcher/ARS Cobra Robotic Grit Blaster

- First exterior hull demonstration generated “lessons learned”
- Second exterior hull demonstration (different yard/contractor) was quite successful
  - Good production rate
  - Reduced impact on other activities

# Other Industry Solutions
# Titan Robotics

- Obstacle avoidance system
- Geometrical challenges for mobility system in drydock



# Other Industry Solutions
# Boston Dynamics

- No existing edge detection/avoidance
- Connectivity limitations
- Payload limitations

# Other Industry Solutions Apellix

- Drone Technology
- Visual Inspection
- DFT and Wall Thickness
- Washing and paint application capability in development

# Other Industry Solutions
# Blast One

- Abrasive Blasting
  - VertiDrive Crawler
  - Blastman robotic system

# Key Observations

- Current Uses
  - Simple surface preparation and coatings tasks applied to flat surfaces, simple shapes and small parts
  - The most prominent robotic activity in shipyards is generally confined to early stages of construction
  - Other industries having the advantage of simpler shapes or well-suited production lines
- Developmental
  - Expanded sensing and mobility, allowing for increased autonomy and obstacle negotiation

# Gap Analysis

- Common to Many Industries
  - Cost
  - Culture
  - Commitment of management
  - Supporting Infrastructure (e.g., IT systems, workforce)
  - Undeveloped business cases
- Shipyard Unique
  - Inconsistent and complex design
  - Interaction between ship design and manufacturing technology
  - Integrated nature of multiple activities at each stage of construction

# Robotic Design Factors

**Mobolity system design**

- Wheeled
- Tracked
- Double frame
- Rail
- Fixed

**Adhesion system design**

- Magnetism
- Suction Force
- Mechanical
- Chemical

**Degree of autonomy**

- Remote
- Semi-Autonomous
- Autonomous

**Programmability**

- Single
- Multiple
- Repeatable

# SPC Activity Design Factors

| Activity | Grit/Hydro Blasting | Vacuuming | Painting | Inspecting |
|---|---|---|---|---|
| Payload/ End Effector | Blast nozzle, grit/ water supply hose (1-2 inches), grit/water in hose | Suction hose | Spray gun nozzle, paint, hose, IR sensor, solenoid valve | Camera, sensors (e.g., thickness, color or roughness gages) |
| Forces | Weight of hose and blast arm (if there is one), resist force of grit/water coming out of nozzle (80-120 psi/4000-10000 psi), weight of robot (for climbing), magnetic force (for climbing) | Vacuum force (-5 to -8 psig), weight of robot (if climbing), magnetic force (if climbing) | Spray gun, weight of paint arm, weight of robot (for climbing), magnetic force (for climbing), weight of paint/hose | Weight of robot (for climbing), magnetic force (for climbing), weight of camera arm/sensors |
| Environ-ment | Dusty, sparks, dark, tight spaces, weather, toxic waste (paint, oxides), possibly no large, flat surfaces (issues for vacuum blasting) | Dusty, tight spaces | Complicated geometry, toxic or flammable vapors, tight spaces, weather | Dark, tight spaces, moving camera arm around obstructions, sensor access to surfaces, possible dusty or explosive environment |
| Sensors | Accelerometer, gyroscope, proximity sensors | Accelerometer, gyroscope, proximity sensors | Accelerometer, gyroscope, proximity sensors | Accelerometer, gyroscope, proximity sensors |
| Ingress Rating | IP-64 | IP-54 | IP-54; intrinsically safe (explosion) | IP-54 |
| Extra Systems Needed | Compressor, collection tube (if collecting waste), power for compressor | Return tube, filtration system for hazardous waste or liquids, power for vacuum motor, collection containers | Compressor, power for compressor, QC system (monitor plaint application rate or thickness) | None |

# Industry Path Forward

- Incrementally automate existing, stand-alone processes
  - Prep and paint lines for plates and small parts
  - Robotics for large, flat areas
  - Automated QA and QC processes
- Re-visit proven technologies when shipyard processes are being re-engineered
  - Drop-in solutions are unlikely to fit existing processes
- High Investment, High Payoff Ideas
  - Automation of Tank Preservation
  - Ship designs that are more conducive to automation (e.g., repetitive or robot-accessible designs)
  - Automation-friendly materials (e.g., coating materials which can be applied using electrostatic equipment)

# Thank You to our Commercial Resources!

- Advanced Recycling Systems
- Advanced Robotics for Manufacturing (ARM)
- Aerobotix
- AllStream Services and Rental
- Apellix Aerial Robotic Systems
- Blast One International
- Boston Dynamics
- Boston Engineering
- Champion Painting
- Chariot Robotics
- Clemco Industries Corporation
- Confined Space Robotics
- Equipois
- FANUC America
- J.H. Fletcher
- Near Earth Autonomy
- Park Derochie, Inc.
- PPG Allison Park Coatings Innovation Center
- Robotic Technologies of Tennessee
- Titan Robotics
- Wolf Robotics

# Questions?

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