AUTONOMOUS VESSELS
MAKING THE CONCEPT COMMERCIAL Viable

November 30, 2016  -  International Workboat Show
WHAT IS AUTONOMY & AUTONOMOUS TECH?

Define “Autonomous”

au-ton-o-mous /ō’tänəməs/ adjective
acting independently or having the freedom to do so

Autonomous Technology is currently SEMI-AUTONOMOUS & AUTOMATIC, but always working increasingly towards Self-Sufficiency & Independence of Control.
SEA MACHINES - INNOVATION BY MARINERS

Michael Gordon Johnson
Founder
Marine Industry Executive, Marine Engineer, Entrepreneur

Alex Lorman
Founder & CTO
Marine Technologist, Marine Salvor

Jeff Bartkowski
Sales & Marketing
Marine Sensors & Survey Systems

David Fieuw
Engineer
Electronics, Automation Control Systems

Chris Wardman
Developer
Embedded Systems & Autonomous Drones

photo courtesy of Crowley Maritime Corporation
SEA MACHINES TECHNOLOGY

Autonomous Vessel Control that enables Self-Driving & Self-Correction

NXT Autonomous System
- Remote Command
- Auto-Navigation
- Collision Avoidance
- Collaborative Following

SEA MACHINES OFFERS RETROFIT SYSTEMS TO UPGRADE EXISTING OR NEW BUILD WORKBOATS
3 years of technology development
1 year of on-water testing
PURSUING COMMERCIAL MARINE AUTONOMY
BENEFITS OF AUTONOMY & ROBOTICS

Advanced Autonomy & Robotics are valuable in situations that are categorized as the “THREE D’s”

DIRTY  DULL  DANGEROUS

Safety  Efficiency  Quality  New Operations
AUTONOMOUS TECH (IN AIR, ON LAND)

Aviation, Industrial & Road Vehicles have all adopted autonomous control systems

Autonomy makes machine operations SAFER, EASIER, and MORE EFFICIENT
A NEED FOR AUTONOMY ON WATER (SAFETY)

Major Marine Accidents Occur Daily. Over 80% of these are due to HUMAN ERROR.

MAJOR GLOBAL LOSSES IN 2015

13 AIRLINERS
53 TRAINS
1,714 LARGE BOATS & SHIPS

photo courtesy of Crowley Maritime Corporation

Autonomous Marine Technology will make marine accidents a thing of the past.
NEED FOR AUTONOMY ON WATER (EFFICIENCY)

High Revenue-Low Margin Industries MUST increase Productivity through Efficiency
MAKING MARINE OPS SMARTER & SAFER

Marine Autonomy is No Longer IF, No Longer WHEN....It’s NOW

AUTONOMOUS SYSTEMS FOR THE 20 MILLION+ VESSELS THAT PLY THE WORLD’S OCEANS, RIVERS, AND LAKES.

photo courtesy of Crowley Maritime Corporation
APPLICATION OF AUTONOMY

Autonomous Technology will benefit both MANNED & UNMANNED vessel operations

**Autonomous Unmanned Vessels**

- Low Power Persistent Station Buoys
- Low Power Mobile Data & Observation Drones
- High Power USVs or ASVs
- Large Vessel USVs

**Autonomous Support of Manned Vessels**

- Collaborative Multi-Vessel Autonomy
- Fly-by-Wire Over-watch Systems
LOW POWER APPLICATIONS

OCEAN CURRENT & ATMOSPHERIC DATA

PERSISTENT, LONG DURATION DATA

LOW POWER SURVEILLANCE

ACOUSTICS, WATER COLUMN DATA
APPLICATION OF AUTONOMY

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Primary Methods of Deploying Unmanned Autonomous Technology

Custom-Built Unmanned Autonomous Vessels

Retrofit Upgrade of Traditional Manned Vessels
Autonomous Vessel Systems are developing to work in 3 primary modes of operation, which addresses the majority of the world’s current offshore operational methods.

- **Direct Remote Command**
- **Collaborative Operations**
- **Over the Horizon Operations**
UNMANNED AUTONOMY - GEN 1 CAPABILITIES

- Waypoint Routing
- Autonomous Survey
- Collaborative Survey
- Daughter Vessel Support Towing
- Vessel Handling and Station Keeping
HIGH-POWER APPLICATIONS IN NEAR TERM

UNMANNED TOW BOATS

AUTONOMOUS SURVEY BOATS

AUTONOMOUS SEISMIC SUPPORT WORKBOATS

UNMANNED FIREBOATS
APPLICATION OF AUTONOMY

Autonomous Technology will benefit both MANNED & UNMANNED vessel operations

**Autonomous Unmanned Vessels**

- Low Power Persistent Station Buoys
- Low Power Mobile Data & Observation Drones
- High-Powered USVs or ASVs

**Large Vessel USVs**

**Autonomous Support of Manned Vessels**

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FUTURE LARGE VESSEL APPLICATIONS

UNMANNED CARGO SHIPS

UNMANNED SUPPLY VESSEL / FERRY
APPLICATION OF AUTONOMY

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Autonomous Unmanned Vessels

- Low Power Persistent Station Buoys
- Low Power Mobile Data & Observation Drones
- High-Powered USVs or ASVs
- Large Vessel USVs

Autonomous Co-Pilot for Manned Vessels

- Collaborative Multi-Vessel Autonomy
- Fly-by-Wire Over-watch Systems
AUTONOMOUS CO-PILOT APPLICATIONS

Collaborative Multi-Vessel Operations

Autonomous Over-watch Systems

photo courtesy of Crowley Maritime Corporation
MARKET SIZE

Marine Autonomy is an immature budding market on the brink of commencement.

Approximate Global Vessel Count

- Crew & Supply Boats: 4,500
- Harbor & Ocean Tugs: 7,500
- General Work Boats: 25,000
- Merchant Ships: 100,000
- Fishing Vessels: 4,000,000
- Yachts & Pleasure Boats: 15,000,000

MARKET PROJECTION

- 2016: $7.0B
- 2026: $60B
MARKET ADOPTION

While provision of increased SAFETY & OPERATIONAL QUALITY is desirable, EFFICIENCY is the key driver in major technological shifts.

Crystal Ball Projections:

- **GENERATION 1 AUTONOMY**
  - WORK BOATS < 50’ Length

- **GENERATION 2 AUTONOMY**
  - WORK BOATS & TUGS > 50’ Length

- **GENERATION 3 AUTONOMY**
  - LARGE VESSELS (SHIPS & FERRIES)
JENSEN’S HISTORY

1961 - Benjamin F Jensen opens shop
1960 - 70 PNW Fishing Fleet
1972 - First Generation NOAA Skiff
1980 - 90 Continue Fishing Vessels and Develop Tug Designs
2008 - Purchased by Crowley Maritime
JENSEN FULL SERVICE DESIGN

Design

Manage Construction

Deliver

Full Service Engineering

Construction Management

Vessel Delivery and Warranty Management

Vessel Design & New Construction

Production Engineering

Construction Management

Salvage Support

Consulting & Project Management
## AUTONOMOUS VESSEL DESIGN

### PRINCIPAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Length</td>
<td>26’ - 0” (7.9m)</td>
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<tr>
<td>Beam</td>
<td>8’-0” (2.4m)</td>
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<tr>
<td>Transit Height</td>
<td>8’6” - (2.6m)</td>
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<tr>
<td>Draft</td>
<td>4’0” - (1.22m)</td>
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<tr>
<td>Power</td>
<td>Twin 90 kw Gensets</td>
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<tr>
<td>Propulsion</td>
<td>Twin 85kw Z-Drives</td>
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<tr>
<td>Fuel</td>
<td>500 gal</td>
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V1 READY FOR LAUNCH

Base design can be customized to suite a variety of applications

• AUV Relay Station
• Security and Persistent Surveillance
• HazMat Fire Fighting
V2 - MED SPEED - MANNED/UNMANNED

PRINCIPAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Measurement</th>
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<tbody>
<tr>
<td>Length</td>
<td>32'6&quot; (9.9m)</td>
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<tr>
<td>Beam</td>
<td>12’-0” (3.7m)</td>
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<tr>
<td>Draft</td>
<td>4’6” (1.3m)</td>
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<tr>
<td>Power</td>
<td>Twin 156 kw Gensets</td>
</tr>
<tr>
<td>Propulsion</td>
<td>Twin 150 kw Z-Drives</td>
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<tr>
<td>Fuel</td>
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CHALLENGES & COMMON CONCERNS

Is the technology ready?

What about Collision Avoidance, Rules of the Road, COLREGS?

Concerns about Regulations and Regulators?

Will Autonomous Tech hurt marine industry jobs?
HOW DO WE MAKE USV’S VIABLE?

Autonomous system developers need ideas and applications from the Operators to target the desired technologies.

Autonomous system developers need in-water collaborations with the Work boat Community.

End users, such as Oil Majors, Wind Farm Managers, or Major Aquaculture can start specifying autonomous systems or vessels as options in RFPs.
LEADING THE NEW ERA OF AUTONOMOUS VESSEL OPERATIONS

www.sea-machines.com

For more information: Michael G. Johnson mjohnson@sea-machines.com