



CANADIAN NETWORK FOR INNOVATIVE SHIPBUILDING, MARINE RESEARCH AND TRAINING | RÉSEAU CANADIEN POUR L'INNOVATION DANS LA CONSTRUCTION NAVALE, LA RECHERCHE MARINE ET LA FORMATION

Assessment of Capability in Canada in Autonomous Ships

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Workshop on
Autonomous Surface Ships

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1

Overview

- Challenges and opportunities
- Operations most suited to autonomy
- Autonomous ships in Canada
- Assessment of capability in Canada

2

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Challenges & Opportunities

- *Workforce shortages*

- According to BIMCO/ICS worldwide shortfall is:
 - 16,500 officers currently
 - 147,500 by 2025
- Ocean Policy Research Foundation anticipates increasing shortages:
 - 364,000 seafarers shortfall by 2050
- Similar challenges evident in Canada
- Reluctance to be “away from home” appears to be main reason for lack of interest in seagoing careers



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Source: Canadian Shipper , November 2019

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Challenges & Opportunities

- *Economic*

- Short-sea shipping can potentially help reduce volumes of cargo carried by road
 - Facilitated by autonomous ships especially if also supplemented by the use of autonomous systems in other parts of the supply chain
 - In general marine transport more efficient than road transport
- Autonomous ships offers the possibility of greater efficiencies
 - Reduced, or no requirement, for accommodation

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Source: Canadian Shipper , November 2019

4

Challenges & Opportunities

- Safety

- Safety can be improved by removing/reducing the human element
 - Dangerous work
 - Dirty unpleasant conditions

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Source: Canadian Shipper , November 2019

5

Operations Most Suited to Autonomy

- General

Feasible roles for complete unmanned operations today.

Hydrographic Survey Launches
 Small open ocean data gathering platforms
 Acoustic positioning / communications vessels in Oil and Gas operations
 Oil spill response / boom boats
 Weapons training targets
 MCM vessels (sweep, hunt, dispose)
 ASW Barrier vessels
 Small, dedicated ISR platforms

'Middle Ground' roles that are suitable for lean or reduced manning through the application of remote or autonomous technologies.

Warships
 ROV ships
 Deepwater survey vessels
 Standby tug roles
 Short sea freight
 Short sea / inland water ferries
 Offshore supply vessels

Vessels / roles likely to have a high level of human involvement onboard for the foreseeable future.

Large open sea RORO passenger ferries
 Cruise Ships
 Fishing vessels
 Note to reader: what else do you think will remain largely unchanged for a long time, with the same or more crew count?

Source: <https://www.bmt.org/insights/unmanned-marine-systems>

6

Operations Most Suited to Autonomy

- General

- Focus in Europe
 - Short-sea shipping
 - Ferries
- Some projects in Asia interested in transocean shipping, but appear to have a longer timescale

I don't expect we will be allowed to sail around with 400-metre-long container ships weighing 200,000 tonnes without any human beings on board
 - **Søren Skou, Chief executive Maersk**

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Operations Most Suited to Autonomy

- General

- DTU Report "A pre-analysis on autonomous ships", 2016 (?)
 - Small/minor island ferries
 - Tugs
 - Barges
 - Supply/service vessels for drilling platforms, wind turbines, etc.
 - Autonomous surface vessel for servicing underwater and drone units for offshore inspection

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Operations Most Suited to Autonomy

- Canada: A Couple of Views

- Certain pilot operations in the Great Lakes

Mark Fisher, President and CEO of the Council of the Great Lakes Region, a non-profit agency in Ottawa

(Source: <https://www.cbc.ca/news/canada/windsor/autonomous-ships-great-lakes-detroit-river-michigan-1.4411320>)

- *“The electric, LNG or hydrogen-fueled autonomous ships of the future will happen; there is no doubt about this ...”*

Tom Paterson, Senior VP Ship Owning, Arctic And Projects, Fednav

(Source: <https://gbreports.com/interview/tom-paterson>)



9

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Operations Most Suited to Autonomy

- Canada (based on BMT table – Unmanned)

Vessel Type	Examples for Canada
Hydrographic Survey Launches	Already happening 
Small open ocean data gathering platforms	Aquaculture, general data gathering
Acoustic positioning / communications vessels in Oil and Gas operations	Grand Banks operations
Oil spill response / boom boats	Demonstration projects (USA) 
Weapons training targets	Military
MCM vessels (sweep, hunt, dispose)	Military
ASW Barrier vessels	Military
Small, dedicated ISR platforms	Military

10

 Discussed elsewhere in presentation

10

Operations Most Suited to Autonomy

- Canada (based on BMT table – Lean or reduced manning)

Vessel Type	Examples for Canada
Warships	Military
ROV ships	Grand banks
Deepwater survey vessels	Grand Banks operations
Standby tug roles	Ports
Short sea freight	Great Lakes/St. Lawrence Seaway ★
Short sea / inland water ferries	Great Lakes/St. Lawrence Seaway etc.
Offshore supply vessels	Grand Banks operations

11

★ Discussed elsewhere in presentation

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Operations Most Suited to Autonomy

- Canada: Speculative

- Arctic
 - Supply
 - SAR?
 - Transport of ore
- Arctic-related concept from Russia
 - Rosatom planning project to operate unmanned cargo ships in a convoy
 - Convey will be led by manned nuclear icebreaker



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Source: The Barents Observer, April 5, 2018

12

Autonomous Ships in Canada

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What's Happening in Canada

- Algoma testing autonomous shipping technologies
 - Algoma Central Corporation
 - Owns and operates fleet of dry and liquid bulk carriers
 - Largest fleet in the Great Lakes – St. Lawrence Waterway



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What's Happening in Canada

- Algoma testing autonomous shipping technologies
 - Installed AutoMate software on at least one ship
 - Developed by Buffalo Automation, a US-based startup
 - System relies on sensors and cameras to allow ship to operate semi-autonomously
 - Algorithms and sensors used to interpret weather and other conditions
 - Automatically adjusts speed to meet a scheduled time

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What's Happening in Canada

- CSL operates a diversified fleet of dry bulk cargo handling vessels
- Sister companies operate in the US, Australia, Europe and Asia



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What's Happening in Canada

- CSL's Great Lakes fleet will be outfitted with CSL-developed digital infrastructure known as O2 that will enable "connected vessels".
- CSL trialing Wärtsilä's Lock Entry System
 - Designed to ease the approach and entrance of vessels into waterway locks
 - Uses GNSS to accurately measure a ship's location as it enters a lock
 - Controls the vessel's lateral position and heading
 - Accuracy +/- 1 cm
 - Allows operator to focus on controlling the speed of the vessel during entry.



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What's Happening in Canada

- Hydrographic survey vessels

- The Canadian Coast Guard operates survey vessels on behalf of the Canadian Hydrographic Service(CHS)
- A vessel has been converted to act as test platform for unmanned survey work
- A 26ft survey launch has been converted to allow surveys with the vessel in an unmanned state



Source: <https://www.asvglobal.com/asv-global-delivers-autonomous-system-canadian-hydrographic-service/>

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What's Happening in Canada

- System installed is the ASView Control System
- ASView seamlessly interfaces with the launch's existing engine, steering and navigation systems to enable autonomous operation
- The launch is connected to a remote station via a suite of IP radios enabling real-time monitoring of the survey acquisition data and vessel parameters.
- The launch is equipped with an advanced collision avoidance system using radar and AIS to ensure its safe operation.

19

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What's Happening in Canada

- Situational awareness is provided by five onboard cameras with audio feedback
- ASView monitors the launch's onboard sensors including depth, engine and battery health status
- System alerts remote station of any potential hazards



C-Worker 8 is a multi-role work class ASV

Source: <https://www.asvglobal.com/product/c-worker-8/>

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What's Happening in Canada

- Hydrographic survey vessels

- SeaRobotics Corporation has supplied four 2.5m autonomous unmanned surface vehicles (USVs) to CHS
- These are complete hydrographic systems including multibeam echo sounders, support sensors, cast winches, deployment carts and road trailers
- The USV will be used to improve bathymetric, hydrographic and nautical data throughout Canada for waterways, estuaries and coastal bathymetric surveys



Source: <https://www.searobotics.com/news/searobotics-delivers-two-autonomous-hydrographic-survey-vehicles-to-the-canadian-hydrographic-service/>

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What's Happening in Canada

- RALamander 1600 – firefighting vessel

- Robert Allan Ltd, Vancouver, BC
- Developed the RAmora series of unmanned tugs
- RALamander 1600
 - Rapid response vessel for close-in firefighting
 - 16m long – high speed and high capacity
- Robert Allan and Kongsberg Maritime collaborate on new remotely-operated fireboat design



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What's Happening in Canada

- *Regulatory*

- Canada Government Agencies Active at IMO
 - Canada leading the legal review committee at IMO
 - A Transport Canada maritime lawyer is leading committee at IMO on the regulatory scoping exercise

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Assessment of Capability in Canada

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Assessment of Capability

- Canada has a track record in autonomous systems:
 - Land-based systems
 - Underwater remotely operated vehicles
 - Etc.
- Less so in the case of surface marine autonomous systems
 - A few outstanding examples ...
 - ... but not many

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Land-based autonomous vehicles

- *Canada has critical mass*

- Canada is the 4th largest exporter of cars in the world
- According to KPMG's Autonomous Vehicles Readiness Index Canada ranks 7th
- The Waterloo-Toronto Innovation Corridor
 - Research universities
 - Technology companies
 - Stratford is home to Autonomous Vehicle Innovation Network



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Land-based autonomous vehicles

- *Collaboration with other countries*

- Government supporting Canadian organizations collaborate with those in other countries
- Recent example – Canada/Korea cooperation
 - Canadian companies well-positioned to partner with equivalent Korean entities to, for example,;
 - Validation of the suitability of Canadian technology to the Korean or other markets
 - Adaptation of Canadian technology to meet Korean or other market characteristics;
 - Joint development of new products or services by combining Canadian and Korean technology
 - Canada will sponsor and facilitate contact between Canadian and Korean entities

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Marine Companies

- *Actual experience or potential to contribute to autonomous ship projects*

- While experience in engineering and building autonomous ships in Canada is limited many companies have the latent expertise
- Several such companies are identified in the sample tables that follow
- These will be further populated in the coming weeks
- Tables are presented in the following categories:

<ul style="list-style-type: none"> ▪ Comprehensive Relevant Products and/or Services ▪ Ship design ▪ Underwater autonomous, remotely operated vehicles & robotics ▪ Communications 	<ul style="list-style-type: none"> ▪ Navigation systems ▪ Sensor technology ▪ Cybersecurity ▪ Propulsion systems ▪ Fire safety systems
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Companies

- Comprehensive Relevant Products and/or Services

Name	HQ (in Canada)	Scope of services
ABB	Switzerland (Saint Laurent, QC)	Advanced power and automation technology
BAE Systems	UK (Ottawa, ON)	Systems integrator
Kongsberg	Norway	Comprehensive provider of autonomous ship technical services
L3 Harris	USA (Ottawa, ON)	Defense contractor and information technology services
Lockheed Martin	USA (Ottawa, ON)	Systems integrator
Thales	France (Ottawa, ON)	Systems integrator

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continued ...

29

Companies

- Comprehensive skills & services

Name	HQ (in Canada)	Scope of services
Wärtsilä	Finland (Richmond, BC)	Wide range of marine products including propulsion power, bridge control and navigation systems
Maya HTT	Montréal, PQ	Consulting, software development

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Companies

- Ship design companies (1)

Name	HQ (in Canada)	Scope of services
BMT Fleetech	UK (Kanata, ON)	Ship design, specializing in naval vessel + wide range of related services from sister companies
VARD Inc.	Norway (Vancouver, BC)	Ship design, specializing in government vessels+ wide range of related services from sister companies
Robert Allan Ltd.	Vancouver, BC	Ship design, specializing in tugs and other small vessels
Fleetway	Halifax, NS	Engineering, technical, logistics and management services
Genoa Design International	Mount Pearl, NL	Production lofting, detail design and 3D modeling services to shipbuilding and offshore industries

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Companies

- Ship design companies (2)

Name	HQ (in Canada)	Scope of services
Navtech	Québec	Naval architecture, marine engineering, brokerage and marine surveys
Concept Navale	Québec	Naval architects and marine engineers
3GA Marine	Victoria, BC	Naval architects and marine engineers

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Companies

- Underwater autonomous, remotely operated vehicles & robotics

Name	HQ (in Canada)	Scope of services
ISE	Port Coquitlam, BC	Design and integration of autonomous and remotely operated robotic vehicles and terrestrial robotics
Cellula Robotics	Burnaby, BC	Turnkey design and production of subsea robotic systems.
MarineNav	Panmure Island, PEI	Underwater Remotely Operated Vehicles (ROVs)
GeoSpectrum Technologies	Dartmouth, NS	Manufacturer of underwater acoustics primarily for navy applications
GRI Simulations	St. John's, NL	Simulators for ROV applications

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Companies

- Underwater autonomous, remotely operated vehicles & robotics (2)

Name	HQ (in Canada)	Scope of services
Clear Path Robotics	Kitchener, ON	Robotics

Company Mission: Automate the world's dullest, dirtiest, and deadliest jobs

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Companies

- Communications

Name	HQ (in Canada)	Scope of services
MetOcean Telematics	Dartmouth, NS	Iridium satellite hardware and airtime plans. Sister company, MetOcean systems undertake design and production of meteorological and oceanographic technology
Sky Hawk Telematics	St. John's, NL	Internet-based GPS tracking and monitoring solutions
Nova Communications	Dartmouth, NS	Motorola two-way radio dealer and communications systems integrator
MDA	Richmond, BC	Advanced systems in surveillance, intelligence solutions, defence and maritime systems, robotics, satellite antennas, and communication subsystems

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Companies

- Navigation systems

Name	HQ (in Canada)	Scope of services
OSI Maritime Systems	Burnaby, BC	Integrated navigation and tactical solutions (naval)
NavSim Technology	St. John's, NL	Software and hardware R&D firm focused on electronic navigation solutions for both land and marine applications
CNS Systems Canada	Sweden (St. John's, NL)	System solutions for communication, navigation and surveillance of traffic, both marine and aviation

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Companies

- Sensor technology (1)

Name	HQ (in Canada)	Scope of services
Kraken Robotics	Mount Pearl, NL	Design and development of advanced sensors for Unmanned Underwater Vehicles
Think Sensor Research	Burnaby, BC	Underwater and above water marine sensor systems
PanGeo Subsea	St. John's, NL	High resolution 3D acoustic imaging solutions
CartNav Solutions	Halifax, NS	Mission system software that enhances situational awareness and improves mission effectiveness in airborne, land-based, and maritime platforms.
WhiteCap Scientific	St. John's, NL	

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Companies

- Sensor technology (2)

Name	HQ (in Canada)	Scope of services
RBR Limited	Ottawa, ON	Oceanographic sensors, loggers & associated hardware
Rutter Inc.	St. John's, NL	Specialist signal processing technologies for radar systems for marine security, safety and environmental monitoring
SubC Imaging	Clareville, NL	Technology for ROV inspection tasks
MTE Instruments	Rimouski, QC	Design and manufacture of oceanographic equipment such recorders, buoys etc.
M2Ocean	Rimouski, QC	Autonomous bathymetric data acquisition system

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Companies

- *Cybersecurity*

Name	HQ (in Canada)	Scope of services

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Companies

- *Propulsion systems*

Name	HQ (in Canada)	Scope of services
Aspin Kemp & Associates	PEI	Hybrid propulsion systems
Ballard Power Systems	Burnaby, BC	Fuel cells
Gastops	Ottawa, ON	Propulsion systems engineering, remote monitoring & condition assessment

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Companies

- Fire safety systems

Name	HQ (in Canada)	Scope of services

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Concluding Remarks

- Ship operations in Canada that lend themselves to autonomous operation are emerging – are there others?
- Examples of engineering and operations in Canadian of autonomous vessels summarized
- Well established Canadian expertise in certain sectors, for example
 - Land vehicles
 - Underwater and remotely operated vehicles
- Several companies identified with expertise that could, in principle, be adapted for application to surface autonomous ships
 - Work continues in identifying others

42

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