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

Overview of Autonomous Shipping Initiatives Worldwide

Roger I. Basu

Roger Basu & Associates Inc.
Toronto, Canada

Workshop on
Autonomous Surface Ships

Québec, PQ
27 – 28 November 2019

1

Overview `

- Selected major projects on autonomous shipping
- Test facilities
- Demonstration and concept projects
- Lessons Learned

2 Roger Basu & Associates Inc.

2

Selected Major Projects `

- Europe
  - MUNIN
  - ReVolt
  - AAWA
  - Yara Birkeland
  - SVAN
  - NFAS
  - Autoship
- Asia
  - Autonomous Ocean Transport System
  - World's Largest Ocean-going Autonomous Vessel Program

MUNIN

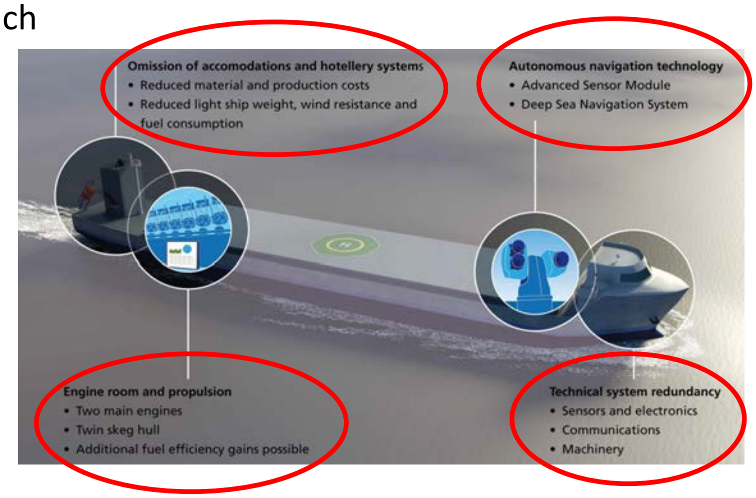
*- **M**aritime **U**nmanned **N**avigation through **I**ntelligence in **N**etworks*

- MUNIN was among the first major collaborative research projects on autonomous shipping (2012– 2015)
- Overall budget was €3.8m of which €2.9m contributed by the EU
- Remaining funds from partners:
  - Aptomar AS
  - Chalmers Technical University
  - Fraunhofer Center for Maritime Logistics
  - Hochschule Wismar
- MarineSoft - benntec Systemtechnik GmbH
- MARINTEK, Trondheim
- Marorka ehf
- University College Cork

MUNIN

*- **M**aritime **U**nmanned **N**avigation through **I**ntelligence in **N**etworks*

- Several objectives among which
  - Technology concept
  - Critical integration mechanisms
  - Verify and validate concept through test runs:
    - Scenarios
    - Critical situations
  - Impact on legislation & commercial contracts
  - Impact on European shipping competitiveness & safety
  - Identify direct benefits



Roger Basu & Associates Inc.

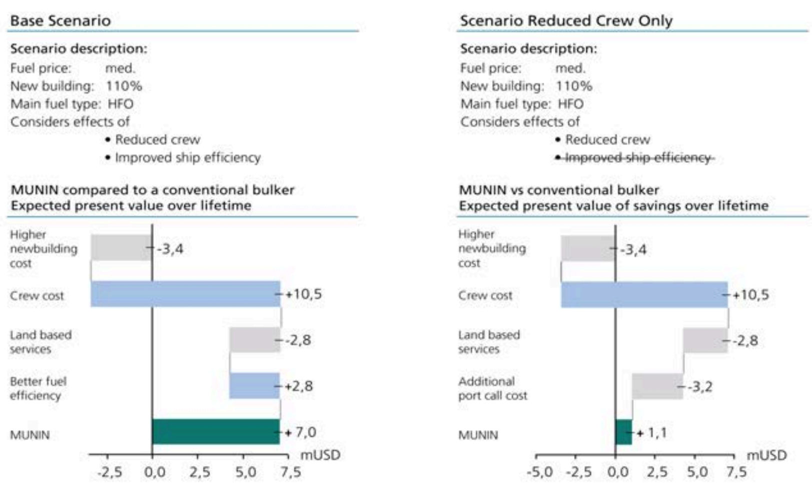
5

MUNIN

*- **M**aritime **U**nmanned **N**avigation through **I**ntelligence in **N**etworks*

- Financial study
  - Base case is a dry bulk carrier operating in intercontinental trade
  - Conventionally manned bulker

    vs
  - New-built MUNIN design with reduced crew



Roger Basu & Associates Inc.

6

MUNIN
- Some conclusions

- Conclusions are complex
  - A primary aim of MUNIN to consider the mitigating higher crew costs for "slow steaming"
- For a typical medium-sized bulk carrier
  - 30% reduction in speed ➡ 50% fuel savings BUT almost all offset by increased crew wages
- Unmanned ships likely to realize savings from various sources:
  - Advanced automatic energy management system
  - Improved routing and navigation
  - Omission of accommodation superstructure
- But there are associated higher costs
  - More reliable operator-independent technical systems
  - Redundancy in machinery and energy production
  - Alternative fuels

7 Roger Basu & Associates Inc.

7

ReVolt

- Concept study initiated by DNV GL
  - The concept was developed during the drafting of the the Norwegian Transport Plan 2014 – 2023
  - A key element of the plan is the transferring of road freight to waterways
- Project is part of a broader concept
  - Connect major cargo hubs within an autonomous and unmanned logistical chain
  - Unmanned ship propulsion powered by electric battery
  - Automated cargo handling
  - Automated shore-based charging

Source: https://www.dnvgl.com/technology-innovation/revolt/index.html

8 Roger Basu & Associates Inc.

8

ReVolt

- Supported by Transnova, a Norwegian funding agency supporting transportation research
- Key features
  - Length: 60 m
  - Speed: **6** knots
  - Range: 100 nautical miles
  - Cargo capacity - 100 x 20ft containers
  - Fully battery powered

Source: https://www.dnvgl.com/technology-innovation/revolt/index.html

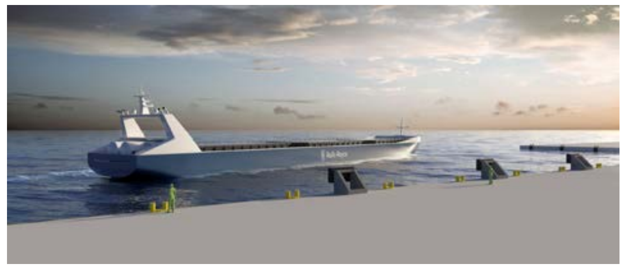
ReVolt

- A 1:20 scale model has been built to investigate control of unmanned vessels
  - Sensor technology
  - Data analytics
  - Increased bandwidth
- Advanced control systems and navigation software for controlling unmanned vessels
- Norwegian University of Science and Technology (NTNU)

Source: https://www.dnvgl.com/technology-innovation/revolt/index.html

AAWA
- *Advanced Autonomous Waterborne Applications*

- A €6.6m project funded by the Finnish Funding Agency
- Several organizations participated including universities, ship designers, equipment manufacturers, and class societies
- Multi-phase project started in 2015 and concluded in 2017
- Follow-on project SVAN



Source: Remote & Autonomous Ships, AAWA White Paper, 2016

Roger Basu & Associates Inc.

Yara Birkeland
- *World's first autonomous zero-emission containership*

- Collaboration between Yara and Kongsberg
- Yara is a leading fertilizer company
- Ship is a 120 TEU open hatch container feeder
- Ship will be built by VARD
  - Due to be delivered in 2020
  - Gradually moved from manned to autonomous operation by 2022

Length:	*80m*
Beam:	*15m*
Depth:	*12m*
Eco speed:	*6 – 7 knots*
Max speed:	*13 knots*

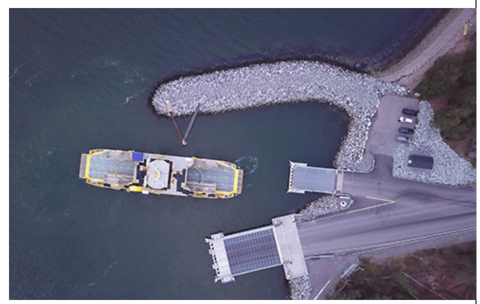
Source: https://www.yara.com/news-and-media/press-kits/yara-birkeland-press-kit/

Roger Basu & Associates Inc.

SVAN

- *Safer Vessel with Autonomous Navigation*

- Using as a basis the results from the AAWA project Rolls-Royce and Finferries agreed to collaborate on a new research project in May 2018
- The collaboration culminated in a successful demonstration of the world's first autonomous ferry in the archipelago south of the city of Turku, Finland
- The ferry *Falco* travelled between Parainen and Nauvo in autonomous mode
- Rolls-Royce Autodocking system was also demonstrated



Falco – a 53.8 metre double-ended car ferry

Source: https://www.rolls-royce.com/media/press-releases/2018/03-12-2018-rr-and-finferries-demonstrate-worlds-first-fully-autonomous-ferry.aspx

NFAS

- ***N**orwegian **F**orum for **A**utonomous **S**hips*

- NFAS is an interest group for those interested in autonomous ships
- Initiative to set up the forum was taken in Norway by two marine government agencies, an industry federation and MARINTEK, the Norwegian Marine Technology Research Institute
- NFAS is promotes cooperation between interested parties:
  - Conferences
  - Newsletters
  - Courses
  - Etc.
- While membership is primarily Norwegian there are foreign members which is a recognition progress requires cooperation internationally

AUTOSHIP
- Autonomous Shipping Initiative for European Waters

- Major EU Project
  - Total budget €27.7m; €20.1m will be funded by the EU Horizon 2020 program
  - Started May 2019 and due to conclude in November 2022
  - Project will build
    - Two remote & autonomous vessels
    - Shore control and operation infrastructure
  - Focus in on short sea shipping and inland waters
  - Operational area of interest is Baltic Corridor to a major EU seaport and the hinterland

AUTOSHIP
- Autonomous Shipping Initiative for European Waters

Partners:

- Ciaotech
- Bureau Veritas
- Blue Line Logistics
- Kongsberg
- Sintef Ocean
- De Vlaamse Waterweg
- Upm-Kymmene
- Rolls-Royce (acquired by Kongsberg in April 2019)
- University of Strathclyde

> *"The high ambition is to deliver the technology on the market in 5 years boosting ocean and intercontinental unmanned shipping. It is an ambition with a solid base in the involved value-chain and in the financial and commercial commitment"*
>
> - European Commission

Projects in Asia
- *Autonomous Ocean Transport System*

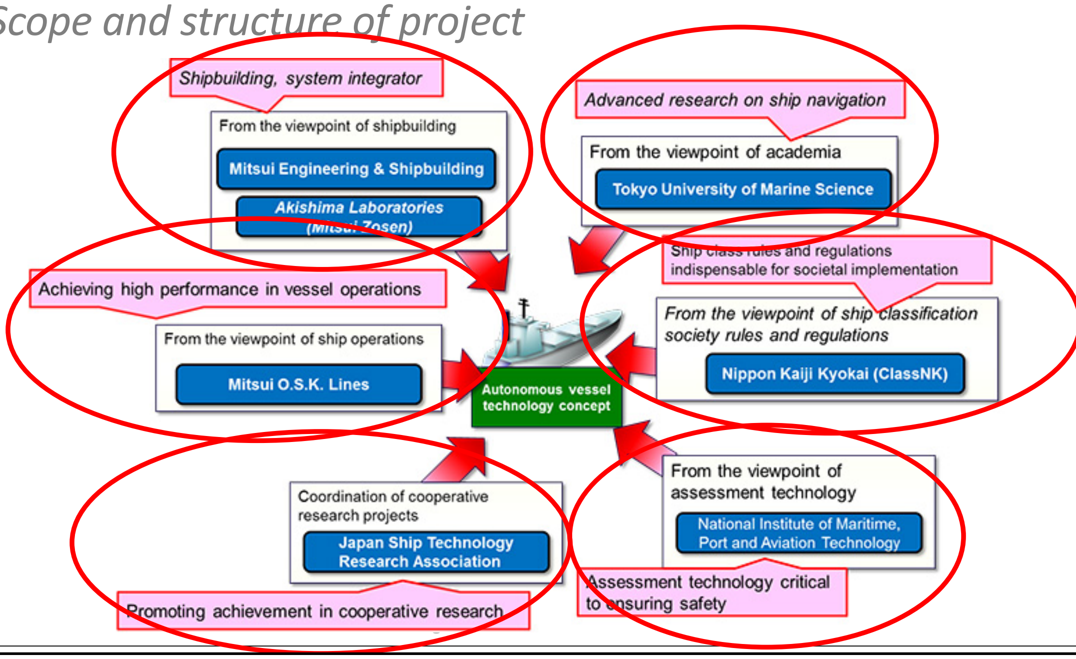
- Mitsui O.S.K. Lines & Mitsui Engineering & Shipbuilding developing a technological concept for Autonomous Ocean Transport System
- Partners also include
  - National Institute of Maritime
  - Port and Aviation Technology
  - Tokyo University of Marine Science and Technology
  - Nippon Kaiji Kyokai (ClassNK)
  - Japan Ship Technology Research Association
  - Akishima Laboratories (Mitsui Zosen) Inc.
- Project announced May 2017
- Goal is to bring *"… autonomous vessels into service by 2025"*

17

Roger Basu & Associates Inc.

17

Autonomous Ocean Transport System
- *Scope and structure of project*



18

18

Projects in Asia

- World's Largest Ocean-Going Autonomous Vessel Programme

- The Maritime and Port Authority of Singapore (MPA) has set up the new Maritime Innovation Lab (MIL) which will work on a variety of projects
- One such project announced April 2019 is a collaborative effort with
  - ST Engineering
  - Mitsui
  - Smart City Solutions
  - Lloyd's Register
- Focus is the deployment of autonomous navigational technology to an ocean-going vessel for commercial operations

19

19

Other Projects

- Unmanned Cargo Ship Development Alliance, China
  - Based in Shanghai
  - Started June 2017
  - Several partners: class societies, shipyards, equipment manufacturers & designers
  - Objective: Design and build China's first unmanned cargo vessel by October 2021
- ShippingLab, Denmark
  - Started March 2019
  - Thirty partners including Ballard Europe
  - Objective: Design and build Denmark's first autonomous, environmentally friendly ship

20

20

Test Facilities

Roger Basu & Associates Inc.

Demonstration Projects
- Wansham Marine Test Field

- Test establishment dedicated to development of China's unmanned ship industry
  - Opened December 2018
- Joint venture of
  - China Classification Society
  - Wuhan University of Technology
  - Oceanalpha – a Zhuhai-based company focused on unmanned surface vessel development
    - Unmanned cargo ship design

Source: www.chinadaily.com.cn/a/201802/14/WS5a8372f8a3106e7dcc13c9ca.html

Roger Basu & Associates Inc.

MARS

- Maritime Autonomy Research Site

- Set up by the Smart Ships Coalition of the Great Lakes
- Broad coalition of about 26 entities
  - Academic, state and federal agencies
  - Private and non-profit industries
  - International organizations
- Test site will be used for testing autonomy of small vessels
  - L < 10 meters (initially)
  - Most likely vessel types - research and survey

SMART SHIPS COALITION OF THE GREAT LAKES-ST. LAWRENCE

23

23

MARS

- Smart Ships Coalition of the Great Lakes Members

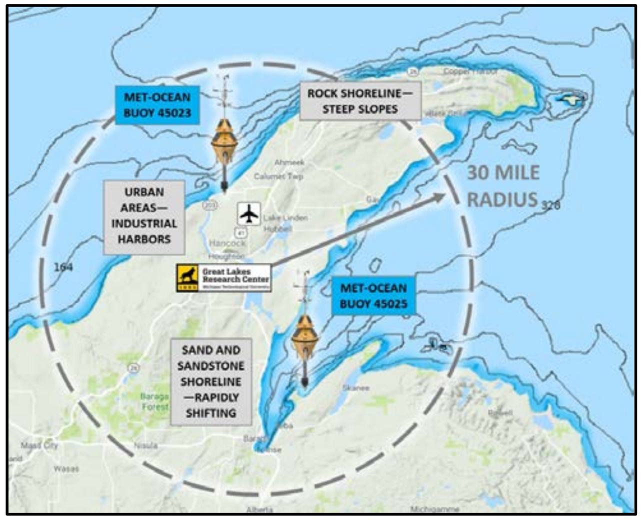
- Buffalo Automation
- Fincantieri – Marinette Marine
- GMATEK, Inc.
- Grand Valley State University – Robert B. Annis Water Resources Institute
- Great Lakes Research Center – Michigan Technological University
- Great Lakes-St. Lawrence Governors and Premiers
- **Memorial University**
- Mercury
- Michigan Office of the Great Lakes
- Michigan State University
- Moran Iron Works
- Netsco
- NOAA - Great Lakes Environmental Research Laboratory (GLERL)
- Northern Michigan University
- Northwestern Michigan College
- ProNav
- Schottel
- Sea Grant Michigan
- Sea Robotics
- Seaview Systems
- The Interlake Steamship Company
- **Transport Canada**
- United States Geological Survey
- University of Wisconsin, Superior – Transport & Logistics Research Center
- Wärtsilä
- Western Norway University of Applied Sciences

24

24

MARS

- Maritime Autonomy Research Site



Keweenaw Peninsula, Lake Superior

25

Roger Basu & Associates Inc.

25

Demonstration & Concept Projects

26

Roger Basu & Associates Inc.

26

Demonstration & Concept Projects

- Maxlimer

- The 36’ unmanned vessel launched in 2017 sailed from UK to Belgium in May 2019
- Designed and built by SEA-KIT International, based in SE England, a provider of high-tech solutions to the maritime and research industries
- Vessel is due to cross the Atlantic in first half of 2020

Source: http://www.sea-kit.com/mother-ship/

27 Roger Basu & Associates Inc.

27

Demonstration & Concept Projects

- Mayflower Autonomous Ship Project

- The project commemorates the crossing of the *Mayflower* in 1620
- Unmanned, fully-autonomous ship to sail from Plymouth, England to Plymouth, MA in Sep 2020
- Global consortium of partners:

Source: www.multivu.com/players/English/8247554-ibm-promare-mayflower-autonomous-ship-project/

IBM PROMARE UNIVERSITY OF PLYMOUTH

28 Roger Basu & Associates Inc.

28

Demonstration & Concept Projects
- Autonomous Spill Recovery Vessel

- Autonomous spill response vessel
- Unmanned vessel for performing oil spill recovery in ports
- Sea Machine Robotics employed remote control systems
- Vessels built by collaboration between Vigor and Kvichak Marine Industries
- Trials organized by MARAD and held in Portland harbor in Maine, USA

29

Roger Basu & Associates Inc.

29

Demonstration & Concept Projects
- Autonomous Spill Recovery Vessel

Key features:

- Remote autonomous control from an onshore location.
- Electronic navigational chart-based mission planning.
- Autonomous waypoint tracking.
- Autonomous grid line tracking.
- Collaborative autonomy for multi-vessel operations.
- Wireless, remote payload control to deploy onboard boom, skimmer belt and other response equipment.

30

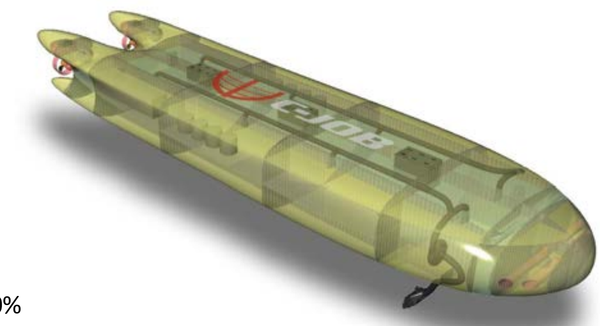
Roger Basu & Associates Inc.

30

Demonstration & Concept Projects

- Autonomous Underwater Maintenance Dredger (AUMD)

- C-Job Naval Architects, The Netherlands
- Concept design for a maintenance dredger.
- Claims include:
  - 55% less propulsion power
  - Reduced demand on dredge pump power by 80%



Source: https://c-job.com/aumd/

Demonstration & Concept Projects

- Autonomous Underwater Maintenance Dredger (AUMD)

	Units	AUMD	Reference vessel
Length over all	[m]	80	113
Breadth	[m]	20	18
Draught	[m]	8.5	7.2
Dredging depth	[m]	35	30
Displacement	[t]	10316	+/- 11900
Transit speed	[kn]	11	11
Propulsion power	[kW]	2x 575	2x 1100
Dredge pump power	[kW]	2x 175	2x 675
Total installed power	[kW]	1600 [a]	3550 [b]

Concluding Remarks

- Much of the development work in autonomous ships is occurring in Europe
  - Short-sea shipping
  - Ferries
  - Specialist vessels
- There is interest in Asia in autonomous ships
  - Focus more on ocean-going ships
  - Projects are longer term