iSMART Network

CANADA'S INNOVATIVE SHIPBUILDING, MARINE RESEARCH AND TRAINING NETWORK

Strategy Workshop

University of British Columbia, Jul 6th 2016

NOBLE ASSOCIATES INC.
Marine, Offshore and Arctic Technology Consultants

Technology Development in the Marine and Offshore Industries

Some Lessons Learned From Around the World

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Planet Earth or Planet Ocean?

~ 70% of the earth's surface is covered by water
~ 80% of the world's population lives within 200 km of the coast
~ 90% of the world's trade volume moves by sea
~ 100% of life as we know it depends on water
~1000% more water mass in the oceans than land mass above sea level

The oceans present opportunities to accommodate the ever-increasing needs of the world's population for new sources of

- Trade and Transportation
- Energy
- Food
- Living Space

Definition of Marine Technology

- Technology - The sum of the ways in which social groups provide themselves with the material objects of their civilization – the making and use of artifacts
- Marine Technology: The application of engineering and scientific knowledge, tools, and techniques to the use of the ocean environment.

Canada – A Maritime Nation

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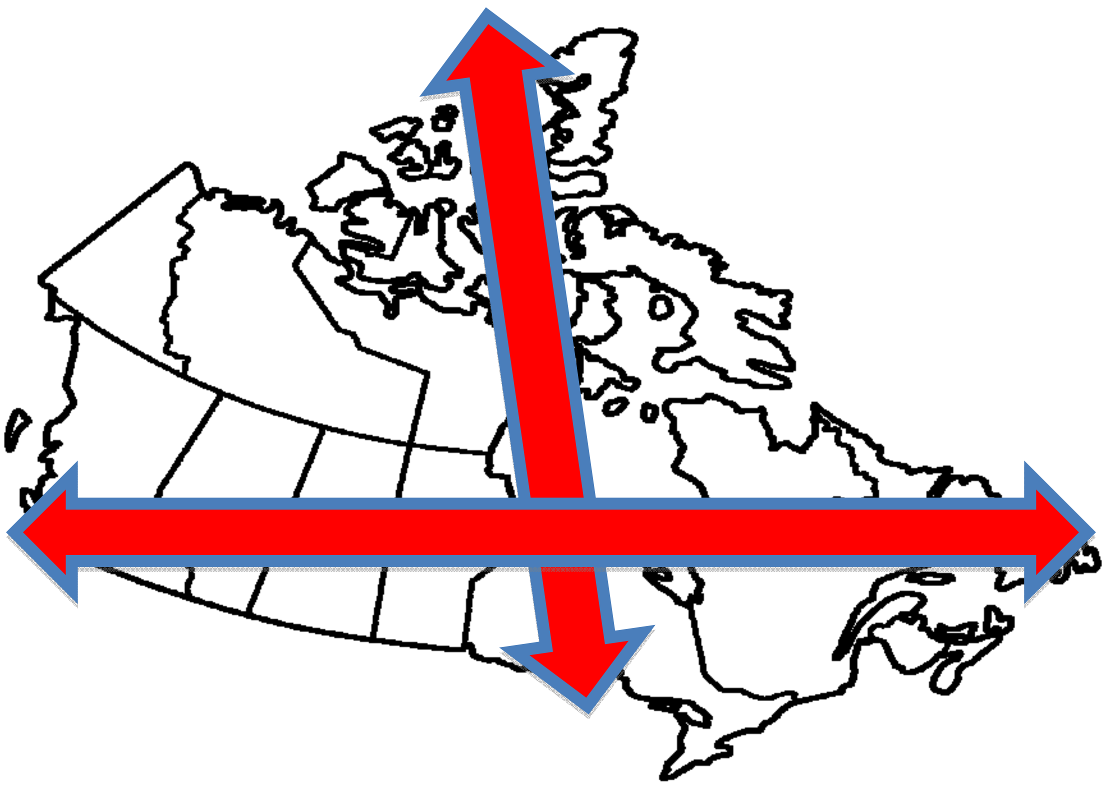
Canada – A Maritime Nation



This land is your land, this land is my land,
From Bonavista to Vancouver Island,
From the Arctic Ocean, to the Great Lake waters…….

Potential Futures for the Marine and Offshore Technology Sectors

Informed by History

"History doesn't repeat itself

- but it sometimes rhymes"

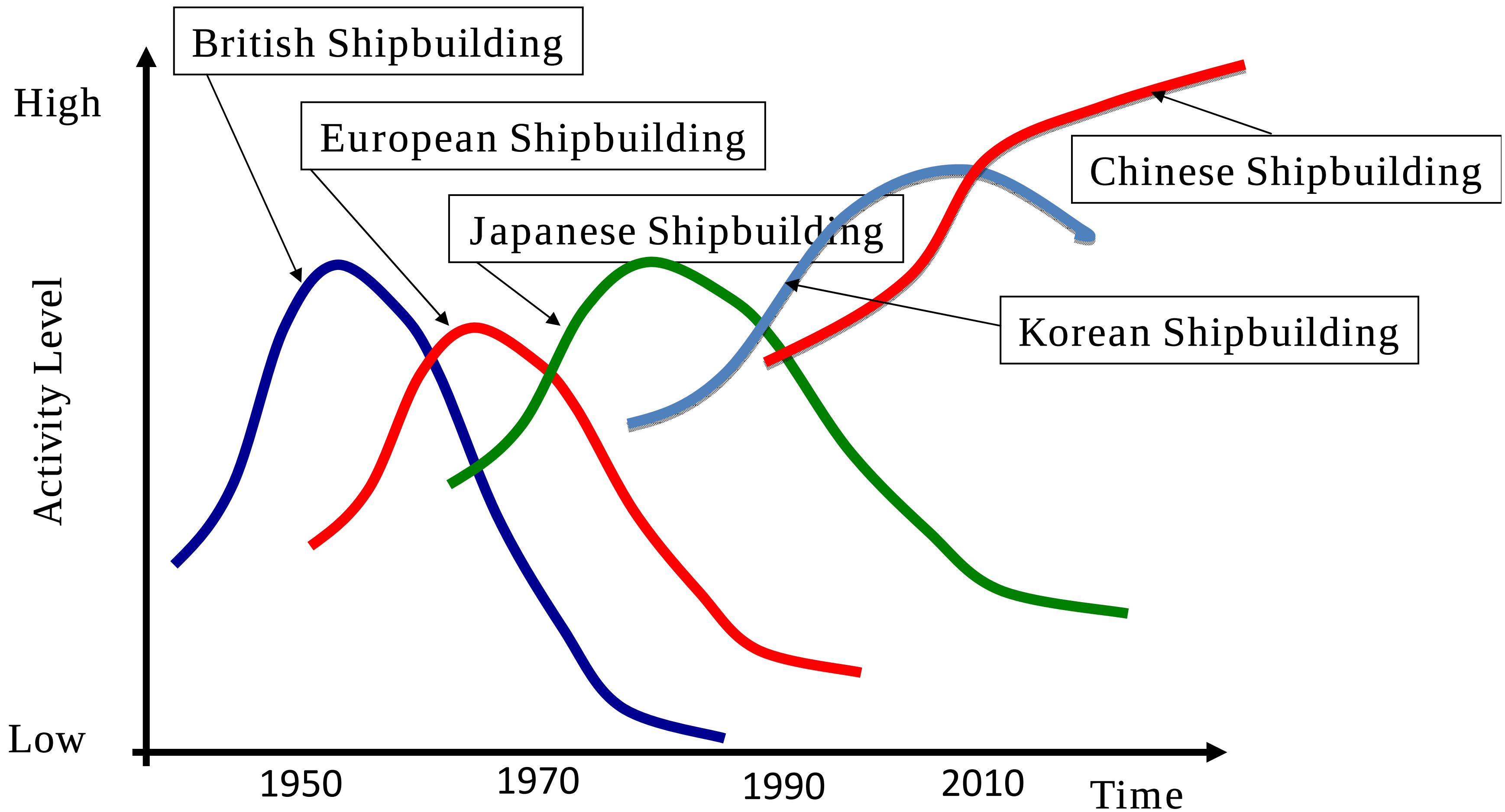
– Mark Twain, American Humorist

Premise

- Long term success in the global marine and offshore industries appears to depend on developing technology which can be separated from domestic shipbuilding.
- As will be shown on the following slides national shipbuilding is hard to sustain as countries become more affluent and we have seen a steady move of shipbuilding post WW II from UK, Europe and N. America to Japan, Korean and now to China.

World Shipbuilding

Moving from Post Industrial to Industrial and Developing Economies



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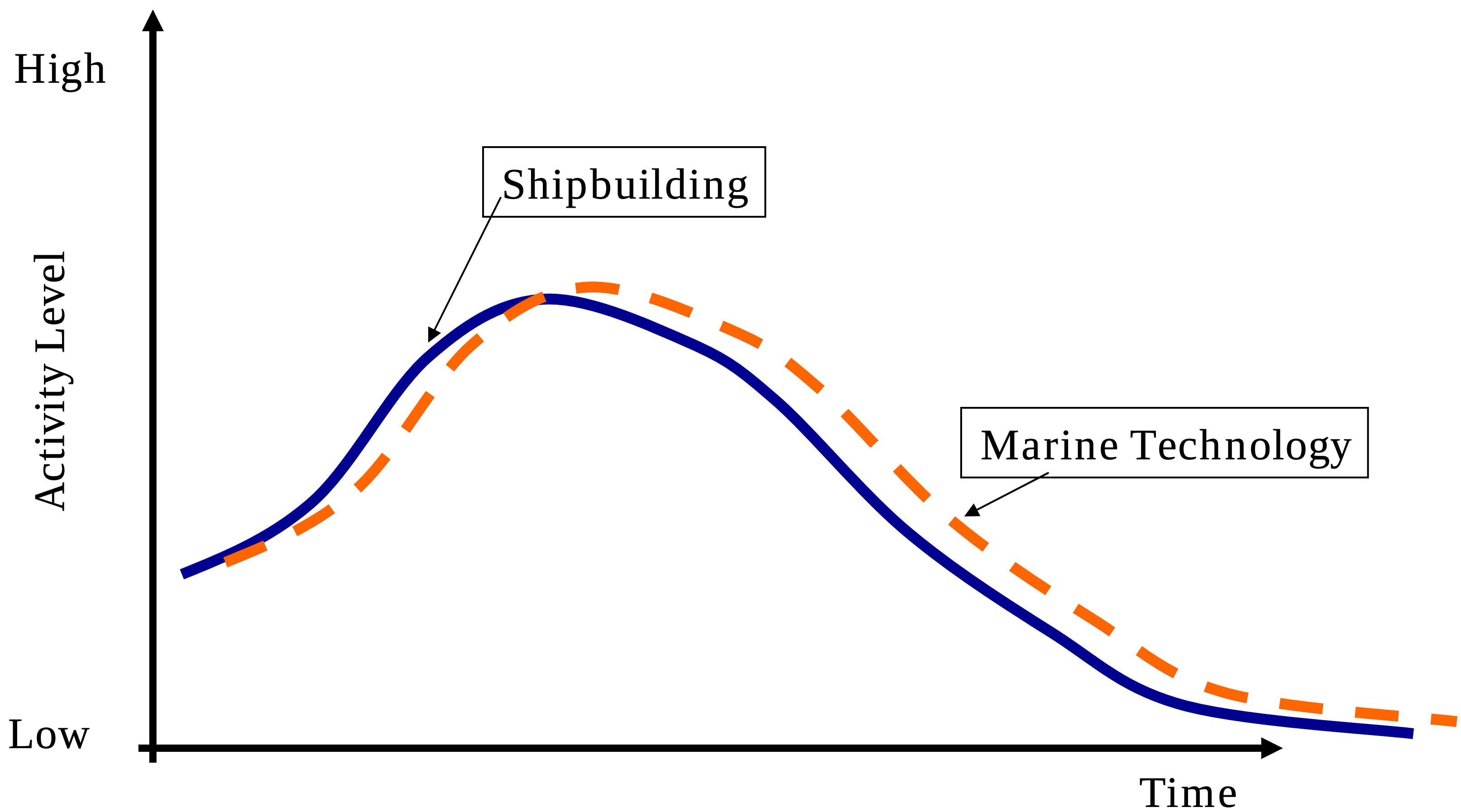
Shipbuilding & Marine Technology U.K. – U.S. Model

Marine Technology Linked to Shipbuilding



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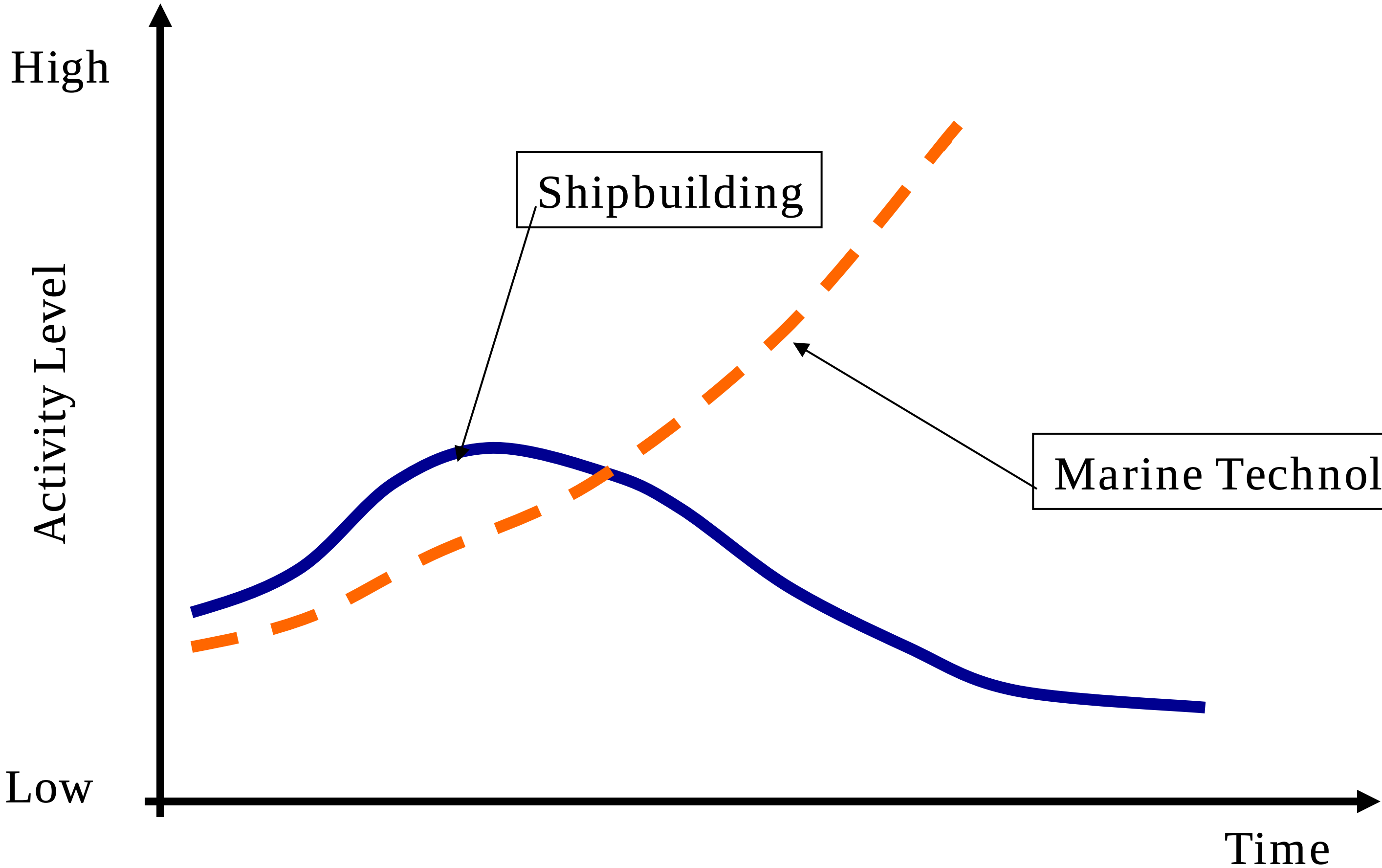
Shipbuilding & Marine Technology
Northern European Model

Successful decoupling of Marine Technology from Domestic Shipbuilding – Norway, Finland, the Netherlands etc.



Shipbuilding & Marine Technology Northern European Model

- Examples of Marine Technology decoupled from local shipbuilding
- Norway
  - Kongsberg — dynamics positioning systems
  - RR Marine — marine propulsion systems
  - DNV-GL — classification services
  - MARINTEK — marine and offshore R&D
- Finland
  - Wartsila Diesel — marine propulsion
  - ABB — marine electric propulsion
  - Aker Arctic — arctic technology
- The Netherlands
  - GustoMSC — offshore design
  - Huisman — offshore lifting, drilling and subsea
  - MARIN — marine & offshore R&D
  - Dockwise — heavy lift ship operations
  - Damen Shipyards — high performance ships

Canada's Marine & Offshore

- Examples of Canadian Marine Technology which have gained international recognition and operate independent of Canada's shipbuilding industry
  - Robert Allan Ltd - tug technology & design
  - International Submarine Engineering – underwater vehicles and robotics
  - Genoa Design International - marine production design
  - Thordon Bearings - water lubricated bearings
  - Kobelt Manufacturing - marine control systems
  - National Research Council – Arctic-ice programs





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Megatrends

- Maritime
  - The low energy ship
  - The green-fuelled ship
  - The electric ship
  - The digital ship
  - The Arctic ship
  - The autonomous ship
- Other
  - Autonomous and remote operations
  - Additive Manufacturing
  - Nanotechnology of materials
  - Offshore oil & gas activities
  - Subsea technology
  - Arctic offshore
  - Seabed mineral harvesting
  - Fishing & Mariculture
  - Marinopolis Developments
  - Renewables from the Ocean

Some International Examples of National Marine Technology Programs

US National Ship Research Program NSRP Missions

- Manage and focus national shipbuilding and ship repair research and development funding on technologies and processes that will reduce the total ownership cost of ships for the U.S. Navy, other national security customers and the commercial sector and develop and leverage best commercial and naval practices to improve the efficiency of the U.S. shipbuilding and ship repair Industry.
- Provide a collaborative framework to improve shipbuilding-related technical and business processes.

NSRP Sample Projects 2015

- Panel Projects 2015
  - Fiber Optic Testing Enhancement for Cost Reduction
  - High-Speed, High Quality Welding of Copper Nickel Pipe Joints
  - Improvement to the Supply Base Oversight Program
  - Grounding for Adhesive Outfitting
  - Improving Technical Welding Education Using Real-Time Sensory Feedback
  - Develop Long Stroke Servo Electric Hand Gun for Stud Welding
  - Qualification of Alternative Structures
  - Implementation of Robust Functional Paperless Paint
  - Cost Efficient Aluminum Welder Performance Qualification Testing
  - Preparation for the Evaluation of the Boomlift Carried Environmental Enclosure
  - Variant Reduction for Shipboard Installed Connectors
  - Develop Process for Virtual Shelf, NSRP Common Parts Catalog and NNS Parts Catalog System Data Integration
  - Deep Dive on Vane-axial Fans Intended for Naval Shipboard Use NSRP Commonality Working Group and NAVSEA
  - Digital Deadweight Survey Project
  - Advanced Mobile Test Platform to Accelerate the Installation of Electrical Harnesses and Support Sustainment of Electrical Systems in Ships
  - Improved Methods for Bonding and Grounding
  - Thermal Spray Coating of 5xxx Aluminum
  - Risk Management Ventilation Project
  - Paradigm for Optical Networks in Ships: Flexible Communications Infrastructure

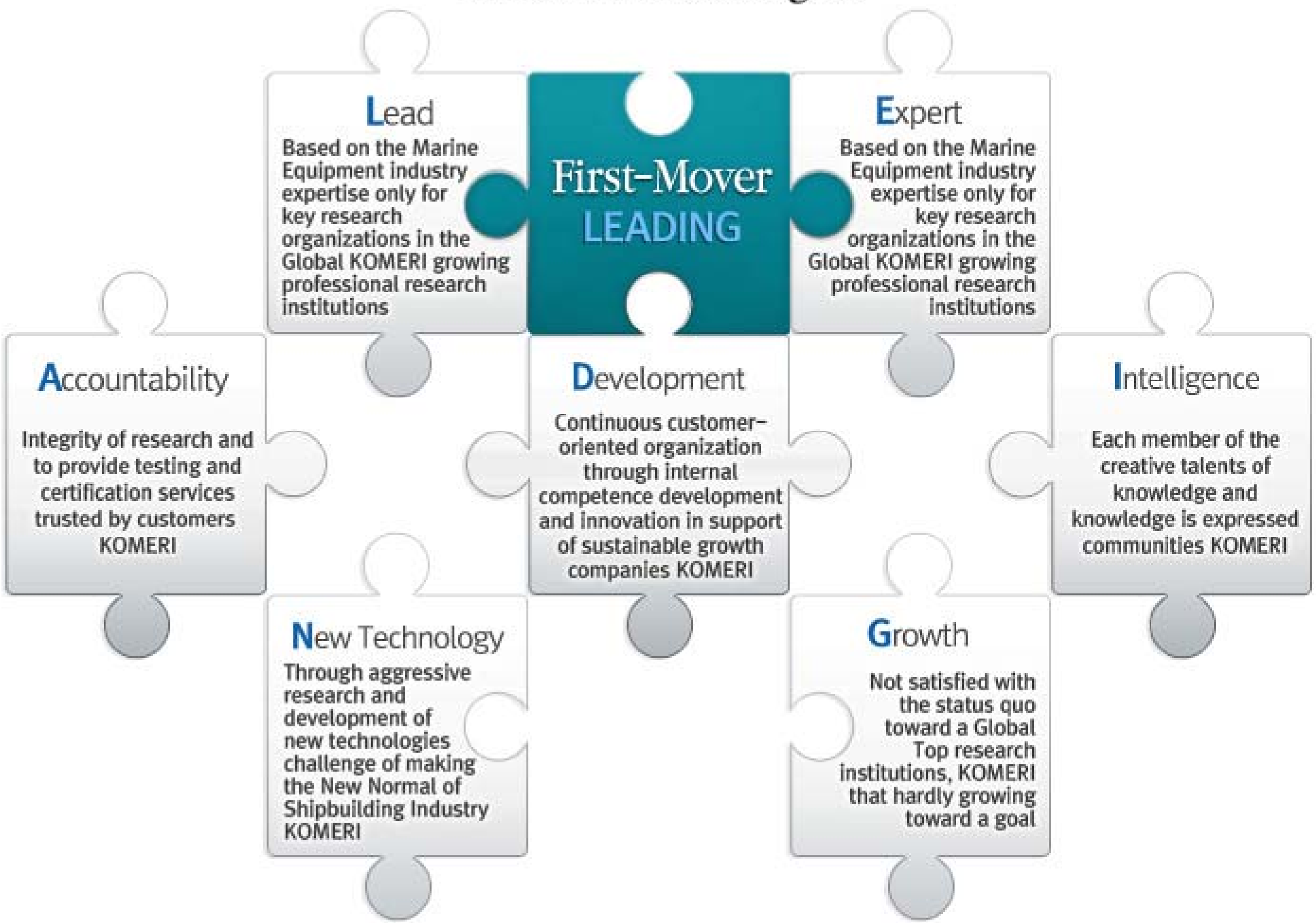
Examples of NSRP Projects

- **Research Announcement 14-01**
  - Development of HiDep Welding Processes and Butt and T-fillet Joints
  - Mitigation of Stress Corrosion, Cracking, Cavitation Erosion and Forming Complex Shapes
  - Reduction of Total Ownership Costs (R-TOC) through Application of Design for Maintenance
  - 3 Views to 3D
  - Standardization of Watertight Closures
- **Research Announcement 13-01**
  - LifeCycle Integrated Data Environment
  - Laser Peening of Ship Structures to Reduce Production Costs
  - Learning and Development Innovation
  - spARky Reducing Wiring Costs using 3D Model and Augmented Reality
  - Computer Aided Robotics Welding (CAR-W)

KOMERI 2020 LEADING

Shipbuilding industry to lead the future technology and trust First-Mover

As a First-Mover of the Shipbuilding Industry KOMERI the proactive leader in future technologies



Japan Maritime R&D
National Maritime Research Institute

Current Goals

Contribution to the development of international regulations and standards on safety and environmental protection

Promotion of Collaborative Research with External Organizations

Recent IP Developed

•Hope Light : Hull Optimization Program
•Flow analysis system for hull form design
•The Computation Program for Wave Loads
•Shell plate expansion patent and shell plate expansion program

Norway Maritime R&D

Norway Research Council - Innovation Programme for Maritime Activities and Offshore Operations (MAROFF)

•Open-ended Support for events for dissemination of research results

•Open-ended Pre-projects

•MAROFF 2016

•Planned Up to NOK 35 million available for research in the maritime sector - Knowledge-building Projects for Industry

•Planned Up to NOK 75 million available for research in the maritime sector – Innovation Projects for the Industrial Sector

•Planned NOK 10 million for Innovation Projects for the Industrial Sector targeted towards the supplier industry to the fishing fleet

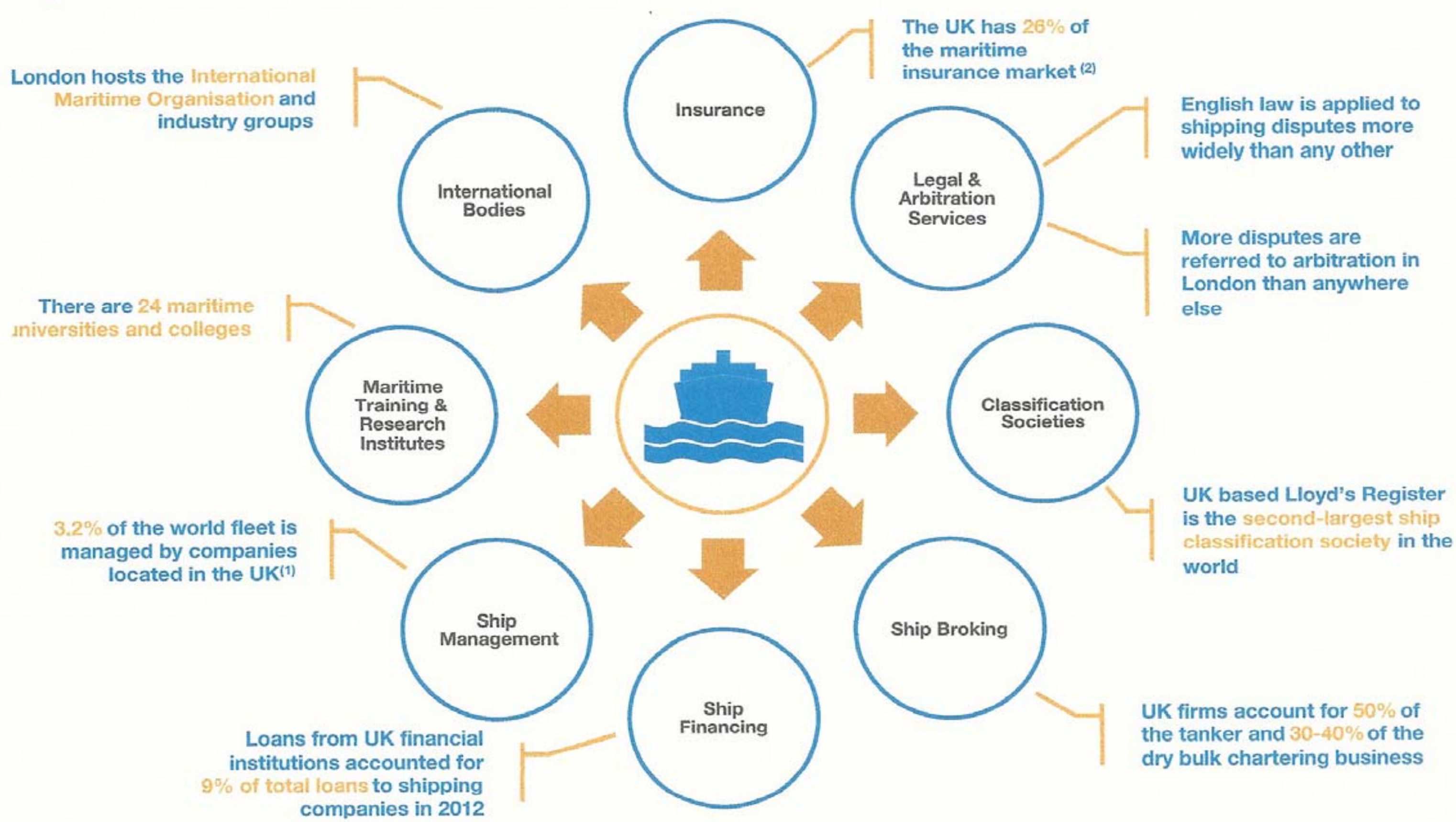
•Planned NOK 35 million for innovation projects on aquaculture technology

UK Maritime R&D

- Department of Transportation.

- Maritime Growth Study: keeping the UK competitive in a global market
  - Sept 2015

UK Network of Maritime Businesses

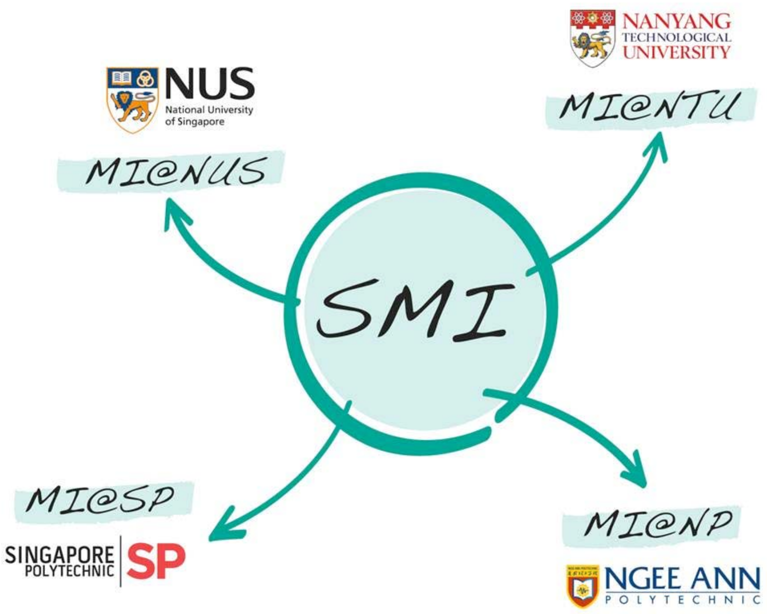


Source: Maritime Business Services (TheCityUK, September 2013)[23] except (1) Shipping Fleet Statistics 2014 (DfT) and (2) International competitiveness of the UK maritime sector (Oxera, May 2015)[24]

Singapore Marine & Offshore Industry

- *Research & Development*

- Singapore Maritime Institute
  - Joint effort
    - MPA
    - A*STAR
    - EDB
  - Fund and administer R&D initiatives
  - Partners with local Institutes of Higher Learning
    - MI @ ***
    - Singapore Polytechnic
    - Temasek Polytechnic



Singapore Maritime Institute

Mission Making a Difference through world-class R&D, Training & Education, and Thought Leadership in Policy Formulation

Vision A Thriving Maritime Industry Driven by Knowledge and Innovation

Values Impact-Driven, Forward Thinking, Team, Integrity

Singapore Marine & Offshore Industry

An example of a new joint research initiatives:

Keppel-NUS Corporate Laboratory jointly funded for 5 years with total of SGD 75 million

–*Areas of study*

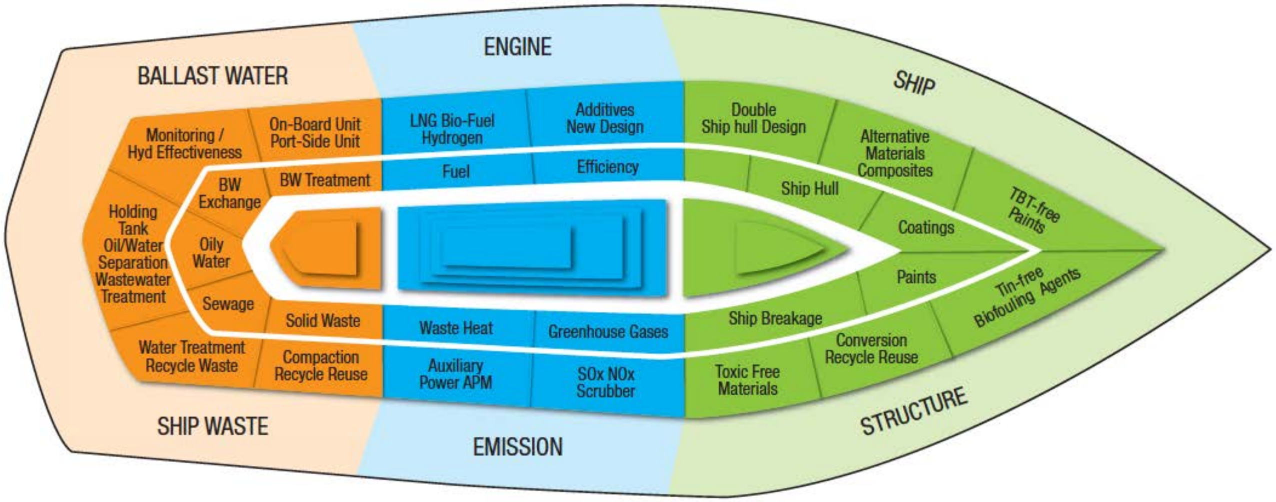
- *Shipyard Automation*
- *Deep-water offshore drilling and production*
- *Deep sea mineral harvesting and mining*
- *Arctic Technology*

Sembcorp Marine, IHPC, University of Glasgow

–*New public private collaboration aims to develop more efficient and eco-friendly ships*

Singapore Marine & Offshore Industry

- There are a number of research institutes that include a marine and/or offshore component
- An example is the Energy Research Institute @ NTU
- Among the research areas are:
  - Wind & Marine Renewables
  - Maritime Energy



Some Canadian Examples of Marine Technology Programs

NRC Canada

- Aerospace
- Aquatic and crop resource development
- Automotive and surface transportation
- Construction
- Energy, mining and environment
- Human health therapeutics
- Information and communications technologies
- Measurement science and standards
- Medical devices
- NRC Herzberg Astronomy and Astrophysics
- Ocean, coastal and river engineering
- Security and disruptive technologies

Ocean, Coastal and River Engineering

- NRC OCRE assists industry and other government departments to develop solutions to engineering challenges within ocean, coastal and river environments with a particular focus on harsh and extreme conditions. We will assist you in providing technology and solutions for the following market segments:
- **Arctic**
- Ensuring sustainable, low impact development of the North while increasing the quality of life for Northerners
- **Marine Infrastructure, Energy and Water Resources**
- Improving marine infrastructure, manage water resources and solve complex water issues through marine renewable energy technologies
- **Marine Vehicles**
- Improving their design while lowering the risks and costs associated with their operation.

C-CORE –
Arctic Development Road Map

Environmental Protection. This category includes both emergency scenarios (oil spill prevention and response) and operational considerations (emissions, pollution, noise and environmental footprint). While many important issues were identified within this category, same season well control was identified as the most critical issue.

Ice Management. This category includes detection, monitoring and physical ice management issues. The most critical need identified by industry was in the management of ice to support emergency response. Emphasis was placed on the need for ice management field trials to demonstrate the effectiveness of ice management for different operating conditions, such as detecting and towing multi-year and glacial ice embedded in first-year pack ice.

Ice Mechanics and Loading. This category includes issues related to improving understanding and modeling of ice loads and associated mechanics for different ice-structure interaction scenarios (e.g. ridge loads on sloping structures). The top priority indentified for this category is the collection of full-scale ice load data for large interaction areas (10-100 m2). Understanding and modeling pack ice pressures and its effects was also identified as a high priority.

Station-keeping in Ice. This category includes issues related to maintaining station during operations in ice using either mooring or dynamic positioning systems. Station-keeping during emergency response was identified as the limiting case used for design. Consequently, the primary R&D issue identified was the need for improved ice load models (and full-scale data) for floating platforms to guide the design of station-keeping systems. The development of mooring systems that allow for reliable, routine operational disconnection under heavy ice loads was also an identified priority.

C-CORE
Arctic Development Road Map

Environmental Characterization. This category includes issues related to technology and data used in the characterization of ice and metocean conditions, as well as bathymetric, geotechnical, geophysical and other geospatial information. The top priority issue identified in this category was the need for improved technology to allow for rapid, accurate measurement of environmental data both for design and real-time operations.

Offshore Safety and Escape, Evacuation, and Rescue. This category includes issues related to the safety of personnel both in terms of operational safety and during emergency response scenarios. The main priorities identified in this category include the improvement of evacuation craft release, retrieval and personnel transfer methods, as well as improving simulation and training technology used for offshore personnel.

Dredging and Trenching. This category includes technology used to conduct and support dredging/trenching operations. The top priority issues in this category include the need for R&D to reduce the cost of operations, reduce the required burial depth or produce better trenches for arctic pipelines. The development of improved technologies for shallow water dredging/trenching operations was also identified as a priority.

Simulation and Training. This category includes issues related to the development and use of simulation-based tools to evaluate the effectiveness of operational processes, and to assist in the training of personnel. The two main priority areas identified for application of simulation and training technology are in training personnel for escape, evacuation and rescue scenarios, and also for training personnel for oil spill response scenarios.

Hydrocarbon Export Technologies. This category includes different issues associated with delivering produced hydrocarbons to market. The main long-term issue identified in this category was the exploitation of stranded natural gas reserves. Floating liquefied natural gas technology was identified as an export technology of high priority due to its potential applicability in Arctic regions.

Arctic Drilling. This category includes issues related to the drilling and completion of wells in Arctic regions. The top priority issues identified for this category were finding ways to reduce the extremely high cost of drilling in the Arctic and extending the drilling season to enable year-round drilling.

Canadian Academy of Engineering

ENGINEERING IN CANADA’S NORTHERN OCEANS – RESEARCH AND STRATEGIES FOR DEVELOPMENT

A Report for the Canadian Academy of Engineering
by
K. Croasdale, R. Frederking, I. Jordaan and P. Noble

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Report Recommendations

1. Education

Improved access to educational facilities in engineering and technology by northerners is seen as a priority, and we advocate the commencement of instruction in engineering and technology at CHARS linked to expertise in other Universities in Canada, for example Memorial University. The concept could be similar to the Ny-Ålesund research facility in Svalbard which is managed by the Norwegian government.

2. Arctic LNG—Clean Green Fuel for the North

The Arctic has an abundant supply of natural gas both in the Beaufort Sea region and in the Arctic Archipelago. Arctic communities and activities need fuel. It is proposed to develop an Arctic LNG Public-Private partnership to supply LNG both for fuelling government Arctic operations and supplying local community needs would provide clean green fuel Arctic fuel which would, for example, allow year round icebreaker operations

3. Mobile Arctic Engineering Research Platform

In this concept an iceworthy ship would be developed to be the engineering experiment itself, rather than a platform for science laboratories.

Ice transit experiments, hull and propeller loads, study of towing of arrays in ice, ice management strategy development, experiments to develop support of sub-sea developments in ice are possible functions, with Nanisivik as a possible northern base.

Report Recommendations

4. Canadian Arctic Railway along the McKenzie Valley from Hay River to Inuvik

A Canadian Arctic Railway would provide a two-way system which could be used to deliver materiel for northern construction as well as fuel and other essentials for local communities presently serviced by summer barge traffic on the McKenzie River. The system could bring Arctic oil to southern markets, and the rail road would provide a strong logistics link to the western arctic which would improve infrastructure; reinforce Canadian Arctic Sovereignty. Further, the system would allow for development of other natural resources such as mining and forest product, along its route. Possibly fuelled by LNG.

5. International Arctic Ocean-Space Engineering Experimental Station (IAOSEES)

A permanent base is proposed on Hans Island, which is currently disputed territory in the Kennedy Channel between Canada and Denmark. The IAOSEES (pronounced *Eye-Oh-Seas*) would be jointly managed by Canada and Denmark as a shared facility available to members of the Arctic Council. There is a need for large scale experimentation to further advance Arctic marine & offshore engineering.

6. Northern Involvement

It is recognized that traditional knowledge plays a role in engineering for Northern Oceans and that there is benefit from close relationships between engineers and Northern residents through organizations such as the Centre for the North, CFN, which provides a forum for research and dialogue on Northern and Aboriginal issues.

INSTITUTE FOR OCEAN RESEARCH ENTERPRISE - IORE

- *The genesis for a collaborative marine research institution was sparked at a Global Ocean Forum in Halifax in March 2009. Following two years of consultation with our founding partners, The Halifax Marine Research Institute (HMRI) was formed, with a formal launch held in June 2011 as part of Dalhousie Oceans Week. Since its inception, HMRI has undergone a name change to better define itself as a vehicle for creating sustainable economic activity from ocean research in Atlantic Canada. In January 2014, HMRI changed its name to the Institute for Ocean Research Enterprise (IORE).*

THE CHALLENGES, NEEDS AND OPPORTUNITIES FOR STRATEGIC WORKFORCE DEVELOPMENT IN THE GREATER MARINE INDUSTRY Oct 2015

In-scope

- Shipbuilding and ship repair (DND and Commercial contracts)
- In-service support General Manufacturing/Fabrication
- Suppliers for shipbuilding and ship repair
- Marine technology sector
- Marine-related R&D
- Marine Defense
- Fleet Maintenance Facilities

Out of scope

- Aqua-culture
- Fisheries
- Recreational boat building
- Logistics and transportation related to in-scope projects
- Marine transportation industry (i.e. operations of marine transportation)
- Defense Industry generally
- Oil & Gas

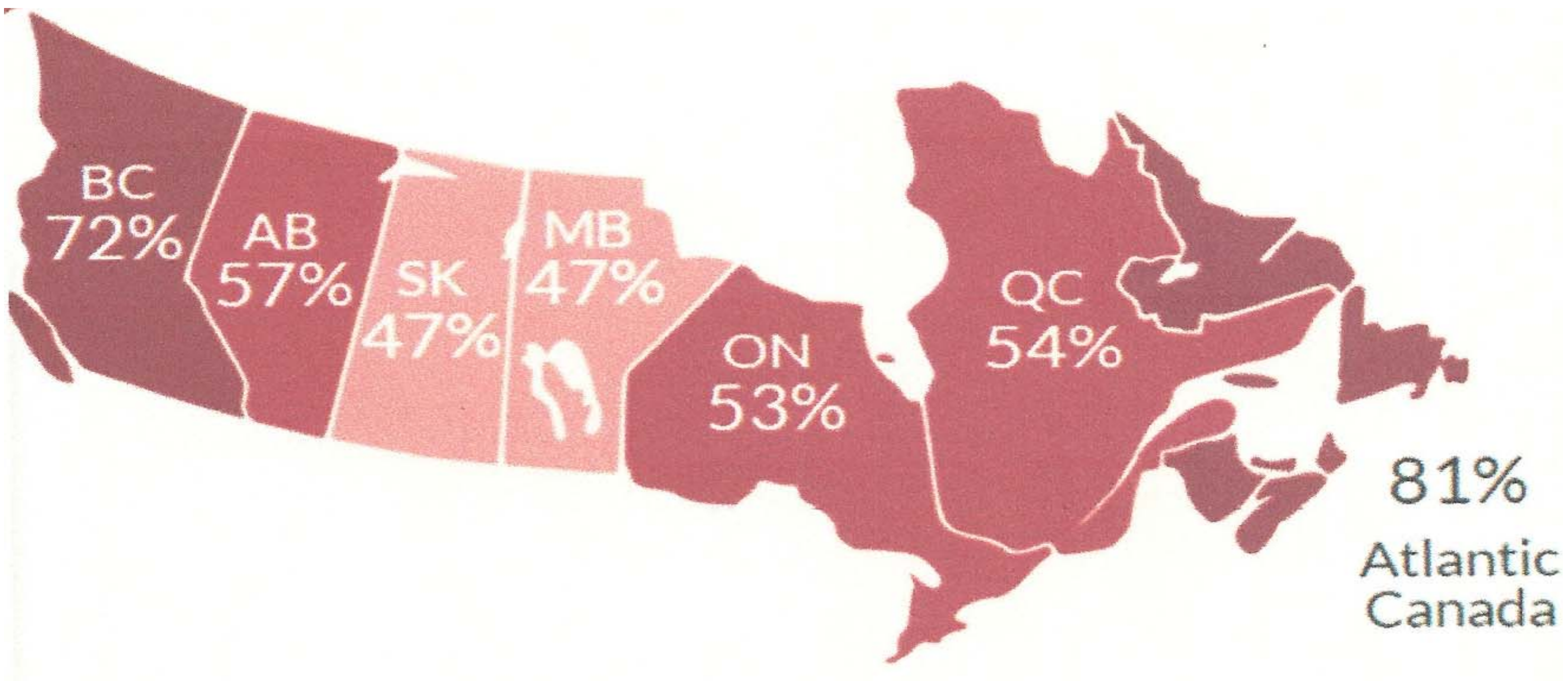
Clear Seas - Centre for Responsible Marine Shipping

- Clear Seas is an independent, not-for-profit organization that provides impartial and evidence-based research about marine shipping in Canada, including risks, mitigation measures and best practices. Clear Seas' vision for safe and sustainable shipping encompasses environmental, social and economic impacts of the shipping industry.

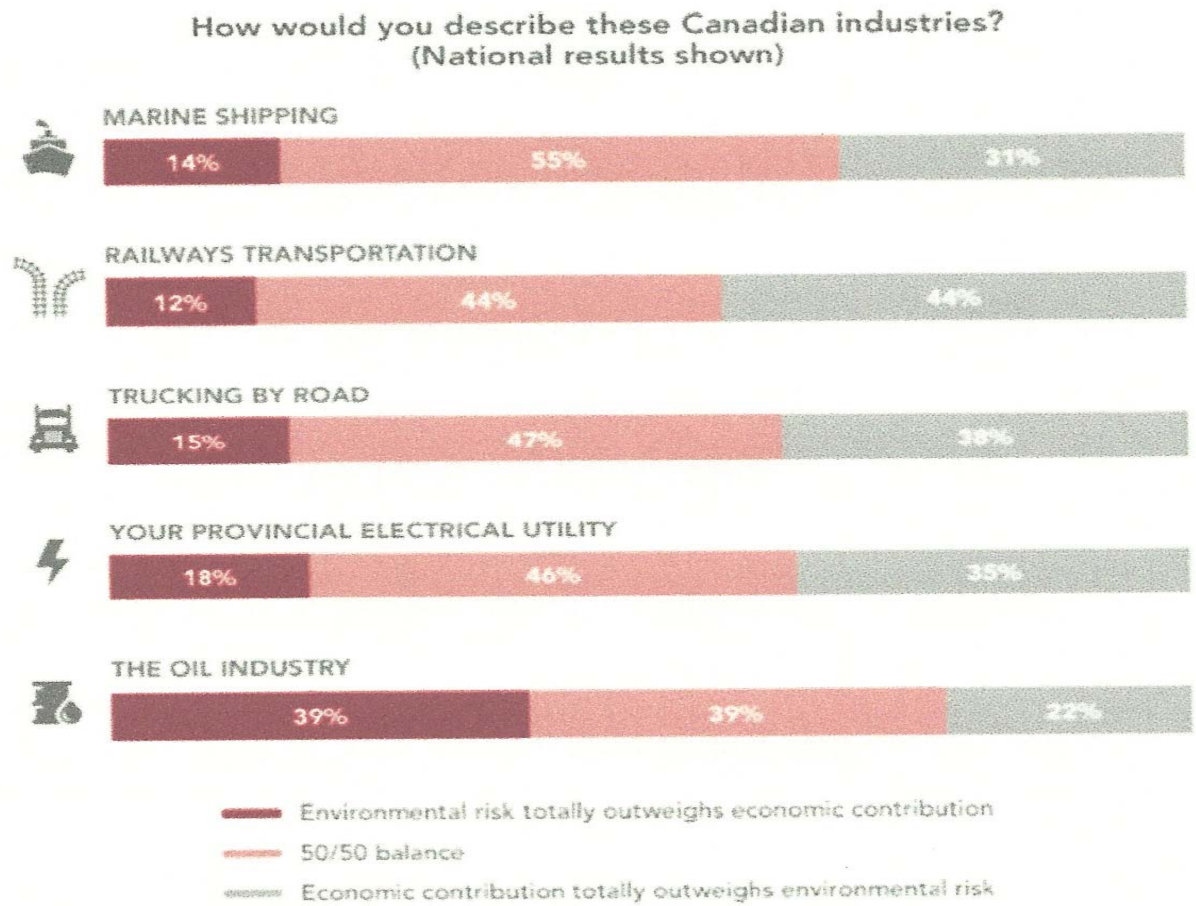
Clear Seas Research

- The social, environmental, and economic value and impacts of marine shipping in Canada
- Current knowledge of risks in marine shipping in Canada as well as how risk is assessed and how risk information is used in decision making
- Best practices for safe loading, unloading, and handling of bulk commodities at marine terminals
- Risks associated with any specific marine traffic routes
- Risk of marine spills in Canadian waters, mitigation measures currently in place, what constitutes an appropriate response, who is liable and how compensation occurs, etc.
- Current practices involving oil and liquid natural gas (LNG) shipping and spill prevention, preparedness, response, and recovery in Canada and worldwide
- Reducing usage conflicts in the marine environment through Marine Spatial Planning
- Examining research results and gaps, interpreting and translating results of relevant research that has been done, and recommending research to be done with respect to safe and sustainable marine shipping operations in Canada

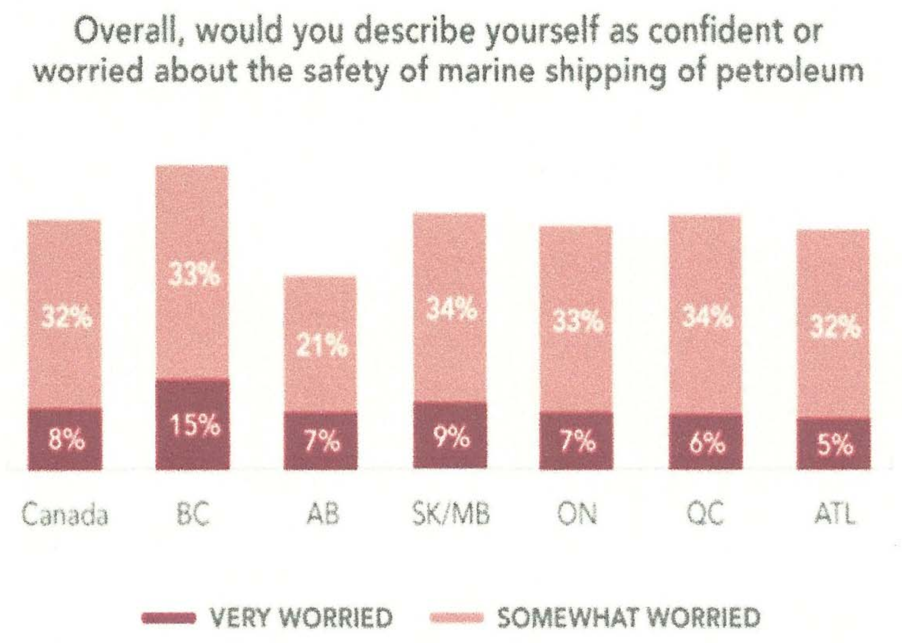
Percentage who personally identify with Canada being a maritime or sea-faring nation

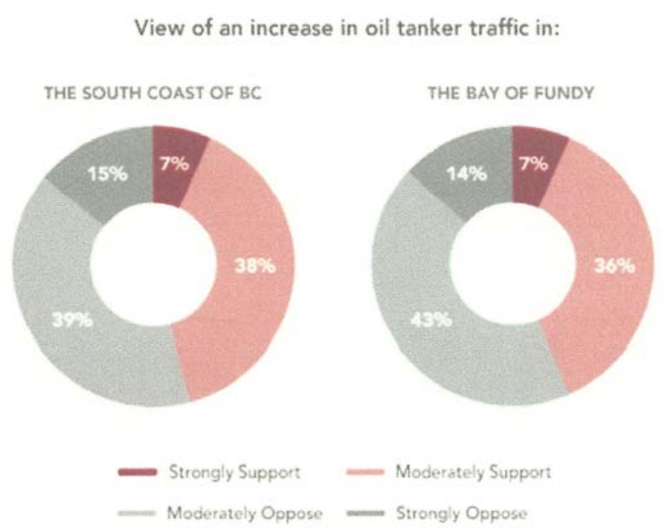


How would you describe these Canadian Industries?



Opinions on Oil Transport by Sea



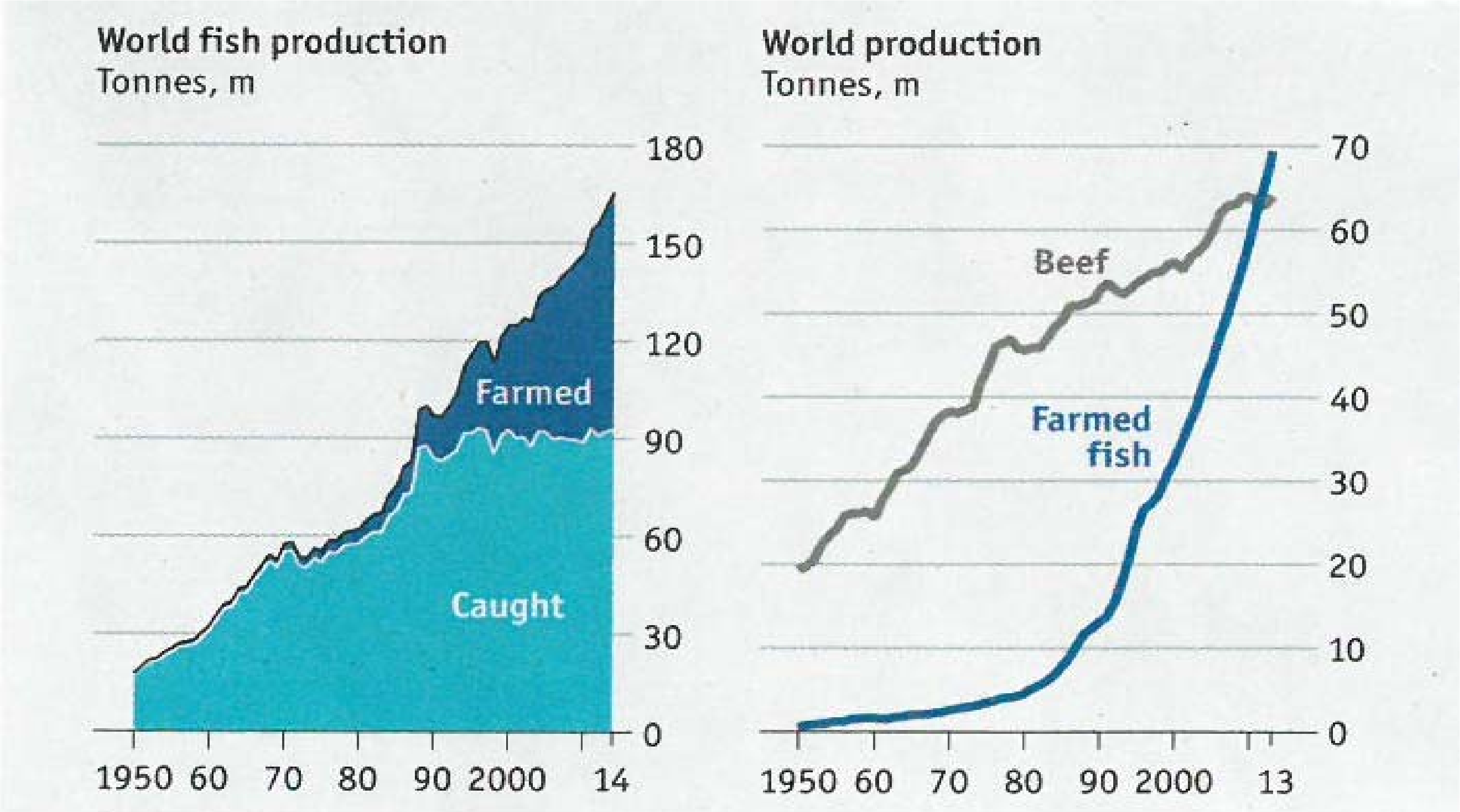


Council of Canadian Academies

- CCA studies are conducted by eminent academics and industry professional with relevant expertise and are intended to inform policy and political decision makers
- Some current relevant studies:
  - Commercial Marine Shipping Accidents: Understanding the Risks in Canada
  - Some Assembly Required: STEM Skills and Canada's Economic Productivity: The Expert Panel on STEM Skills for the Future
  - The Social and Economic Value of Commercial Marine Shipping in Canada

Let's not Forget the Fishing Industry

"You shall hae a fishy in a little dishy when the boat comes hame"



Source: FAO

Value of Canada's Fishing Industry

Gross Value of Outputs ($'000)

Commercial sea and freshwater fisheries landings	$2,840,915
Aquaculture production	$733,370
Seafood product preparation & packaging revenues	$4,333,696
Total	**$7.9 billion**

The Need for a Network and Potential Research & Development Topics

Need for a Network

- The preceding slides, which are far from comprehensive, show that in Canada we have a number of diverse groups working on engineering development and maritime research for Canada’s oceans and inland waters.
- There is little or no coordination between these groups
- There may be conflict between projects competing for limited funding

ArcticNet

- **ARCTICNET** is a Network of Centres of Excellence of Canada that brings together scientists and managers in the natural, human health and social sciences with their partners from Inuit organizations, northern communities, federal and provincial agencies and the private sector.
- The objective of ArcticNet is to study the impacts of climate change and modernization in the coastal Canadian Arctic.
- Over 150 ArcticNet researchers and 1000 graduate students, postdoctoral fellows, research associates, technicians and other specialists from 34 Canadian universities, and 20 federal and provincial agencies and departments collaborate with more than 150 partner organizations in 14 countries.

Potential Hurdles

Scientific Research

- Traditional thinking (at least as promoted by central governments and conveyed by the media) seems to be that new technological developments emerge from scientific research performed by universities and large government or industry research laboratories.
- While these institutions can do valuable work, there is little evidence to support this premise as there appears to be only a loose coupling between scientific research and technology development.

Design & Invention versus Science

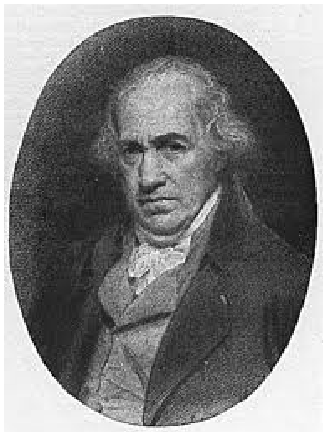
- ***"Design & Invention*** *cause things to come into existence from ideas; they* ***make the world conform to thought****;*

- *whereas* ***Science****, by deriving ideas from observation and analysis;* ***makes thought conform to existence****."*

  - Carl Mitcham, Philosopher, Prof of Liberal Arts and International Studies, Colorado School of Mines

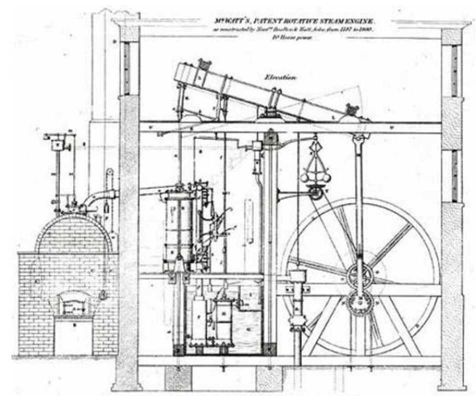
- Or more succinctly
- *Science* ***discovers****, while engineering* ***creates***

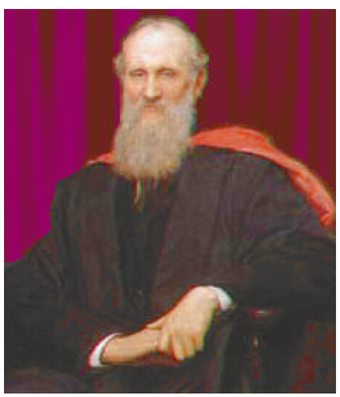
Focus on Technology Development
Scientific Research will Follow



James Watt 1736-1819

Watt Steam Engine - 1775





William Thompson,
Baron Kelvin of Largs 1824-1907

Kelvin's articulation of
the Second Law of Thermodynamics - 1851

"No process is possible in which the sole result is the absorption of heat from a reservoir and its complete conversion into work."

Intellectual Property Rights

- IP rights can be a show stopper in attempted cooperation between industry and universities.
- Background IP retained by original partners, but fore-ground may be shared or may be claimed by only one partner (this is happening more often with universities even when they are paid for the R&D by an industry partner).

Education and Training
- the key to future success

Higher Education – circa 1740

"In the University of Oxford, the greater part of the public professors have, for these many years, given up altogether even the pretence of teaching."

"The discipline of colleges and universities is in general contrived, not for the benefit of the students, but for the interest, or more properly speaking, for the ease of the masters."

- Adam Smith – *Wealth of Nations* Book V Chapter II 1776

EDUCATING MARITIME ENGINEERS FOR A GLOBALISED INDUSTRY - BRIDGING THE GAP BETWEEN INDUSTRY AND UNIVERSITIES

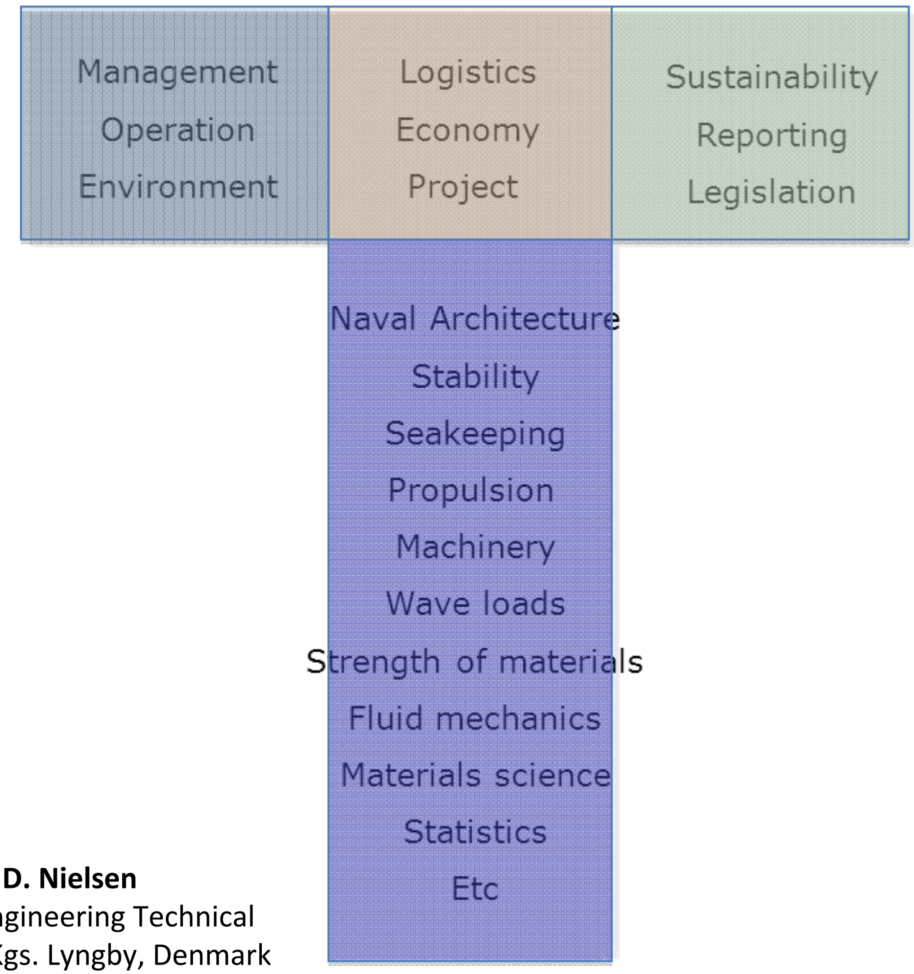
Operations

- Operation management.
- Operation optimization.
- Operation economy.
- Performance management and performance monitoring.
- Operation of ships and offshore structures.
- Environmental management.
- Environmental reporting.
- Understanding of national and international environmental legislation.
- Sustainability and life cycle analysis.
- Creativity, innovation and change management.

Competences for projects

- Naval architecture.
- Stability, seakeeping and propulsion.
- Structural assessment of ships and marine structures.
- Fluid mechanics, hydrodynamics and CFD.
- Wave loads.
- Thermal energy systems, machinery and combustion engines.
- Combustion processes, combustion chemistry and air emissions.
- Material science (metals and composite materials).
- Statistics.
- Electric control and automation systems.
- Alternative marine fuels, particularly the use of liquefied natural gas.
- Understanding of complex machinery systems.
- Acoustics and vibrations.

Proposed “Tee” Shaped Education



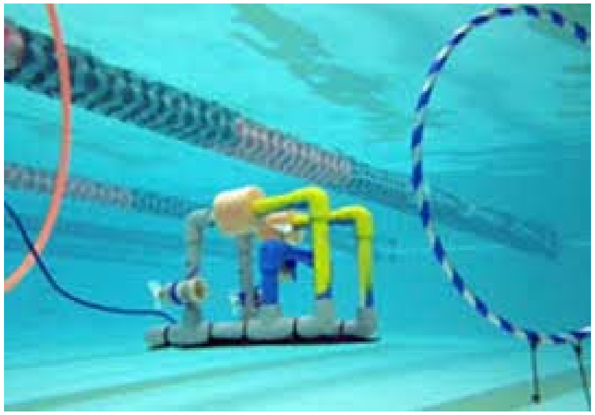
Ingrid M.V. Andersen 7 Ulrik D. Nielsen
Department of Mechanical Engineering Technical University of Denmark 2800 Kgs. Lyngby, Denmark
Proceedings of the ASME 2012 International Mechanical Engineering Congress & Exposition

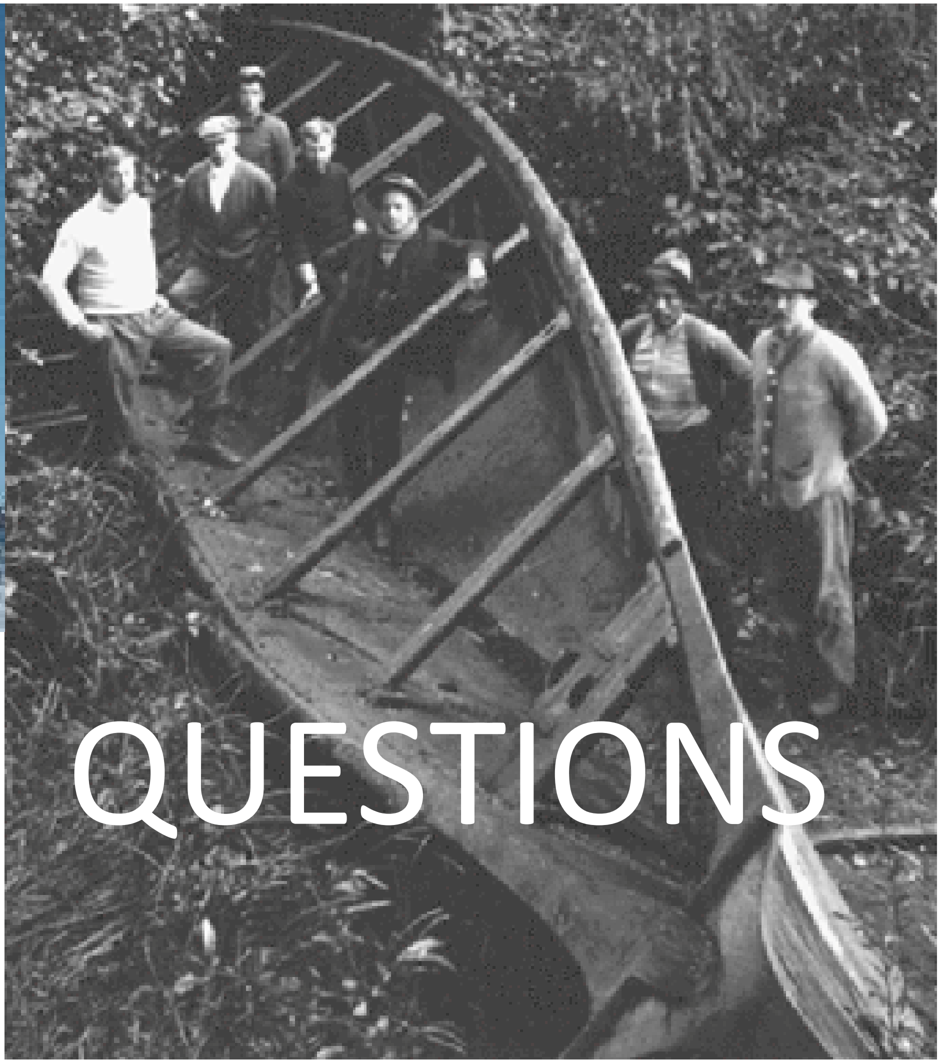
Potential Through-Career Education

- Commercial and strategic understanding of the drivers of decisions in the maritime business.
- Environmental aspects in relation to ship and offshore operations.
- Project management and economy.
- Inter-cultural communication and understanding.
- Negotiation techniques.
- Sales and sales processes.
- Updated knowledge about new technologies and their use.

The Importance of Early Education Outreach K-12 Ocean STEM

- Examples:
  - Norway - NTNU - Havromstechnologi published 2011
  - Singapore – Shipyard Soap Opera
  - US – SeaPerch Program
  - SNAME – STEM program support





QUESTIONS

CENTURIES OF SHIPBUILDING IN CANADA

NOBLE ASSOCIATES INC.

Marine, Offshore and Arctic Technology Consultants