



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

Progress Report 4 on Development of CISMART

**Workshop on**  
**Key Research Themes**



January 14, 2019

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## Acknowledgements

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Members of the workshop organizing committee are Dr. Wei Qiu (Chair), Prof. Jon Mikkelsen, Dr. Neil Pegg, Brian McShane, Dan McGreer, Tabitha Takeda, Fraser Winsor and Dr. Roger Basu.

The preliminary report was prepared by Dr. Roger Basu who serves as a consultant of Memorial University and assists in the development of the CISMART National Network.

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## Highlights

- The report describes the recent activity towards implementing the national network CISMART (Canadian network for **I**nnovative **S**hipbuilding, **M**arine **R**esearch and **T**raining). The report summarizes the findings from the one-day workshop held at the Four Points by Sheraton Halifax, Nova Scotia on November 27, 2018.
- The Halifax Workshop was the fourth workshop and built upon the outcomes from the first three workshops held at the University of British Columbia (UBC) in Vancouver on July 6, 2016, at Memorial University (MUN) in St. John's on September 26, 2016, and at Sheraton Ottawa Hotel in Ottawa on July 11, 2017.
- The focus of the Halifax Workshop was on marine technology-research themes that are the main elements of CISMART's research program which has been developing over the last few years. The primary objectives of the Workshop was to report of progress made with pilot projects and to seek input for future projects.
- The morning session of the Workshop was devoted to several presentations including ones on autonomous ships, technological challenges faced by the Royal Canadian Navy and opportunities for ship time made available by the Canadian Coast Guard. The morning session concluded with reports on the progress made in three CISMART pilot projects.
- The afternoon session included presentations on topics that potentially provided the basis of projects for CISMART to consider for the future. The subjects covered by these presentations were general research ideas, underwater ship noise topics, and on IDEaS, a relatively new program from DND to encourage defence-oriented innovative research.
- The day concluded with a breakout session where groups considered the material presented during the Workshop with a view to develop future project ideas for CISMART to pursue.
- The information gathered was useful in understanding the priorities of stakeholders in marine technology research which is an essential input into CISMART's future growth.
- A post-Workshop meeting was held by the Interim Board to formalize the input from the Workshop and the initial tasks for the next steps.

## 1 Introduction

Steady progress has been made in the development of the Canadian network for Innovative Shipbuilding, Marine Research and Training (CISMART) through a series of workshops and the initiation of a number of pilot projects. Three workshops have been held as follows:

1 <sup>st</sup> Workshop	July 6, 2016	University of British Columbia, Vancouver, BC
2 <sup>nd</sup> Workshop	September 26, 2016	Memorial University, St. John's, NL
3 <sup>rd</sup> Workshop	July 11, 2018	Sheraton Ottawa Hotel, Ottawa, ON

All the workshops were designed to promote the concept of CISMART and to engage Canada's marine industry and marine-related elements of the government and academia. However, the focus of each workshop varied. The first workshop was designed to introduce the concept of CISMART and to understand the needs of Canadian industry, government and academia. The second workshop sought the input from delegates in regard to the organization of CISMART and also to prioritize the tasks that it should engage in. The third workshop concentrated on the education and training mandate of CISMART and canvassed the views of participants to design education and training projects that CISMART could develop and potentially deliver, or arrange to deliver. In all cases the ultimate objective is to promote Canadian marine technology through research, education and training. Reports<sup>1</sup> describing the proceedings of the three workshops are available at [cismart.ca](http://cismart.ca).

The subject of this report is the outcomes of the fourth workshop held in Halifax on November 27, 2018. This workshop was focused on current and future projects. Reports on existing pilot projects were provided. Invited presentations were made, which were designed to stimulate ideas from the participants for future projects. The next section, Section 2, presents an overview of the Halifax Workshop and outlines the remainder of the report.

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<sup>1</sup> Progress Report - Development of the National Network for Innovative Shipbuilding, Marine Research and Training - iSMART, September 8, 2016.

Progress Report 2 - Development of the Canadian Network for Innovative Shipbuilding, Marine Research and Training - CISMART, January 2017.

Progress Report 3 - Development of the Canadian Network for Innovative Shipbuilding, Marine Research and Training: Workshop on Marine Education and Training - Findings and Recommendations - CISMART, January 2017.

## 2 Overview of the Halifax Workshop

The agenda for the Halifax Workshop is presented in Appendix A.

The overall objectives of the one-day workshop were to:

- To present progress on three ongoing pilot projects which are in different stages of execution
- To identify opportunities and ideas for future projects through presentations and brainstorming sessions.

As with the previous workshops, the participants, broadly representing the Canadian marine community, were from industry, academia and government. This workshop preceded a joint workshop hosted and organized by CISMaRT and Transport Canada on **Ship Noise Mitigation Technologies for a Quieter Ocean** on November 28 and 29, 2018.

The day-long CISMaRT workshop comprised several presentations and a breakout session. Three presentations provided an update on the progress of the three pilot projects. The other presentations were given by government and industry representatives, which were designed to encourage discussions on potential future projects for CISMaRT to pursue. The presentations are summarized in Section 3.

A structured brainstorming session was held. This was accomplished by forming seven breakout teams from the participants with each team having a mix of backgrounds. Each team was asked to consider the same set of questions and report back to the workshop. The results of breakout session are described in Section 4. The report concludes with a summary in Section 5.

### 2.1 Workshop Participants

Those who registered for the workshop are listed in Appendix B and 59 participants were drawn from industry, government and academia. The approximate breakdown of the organizations represented by the participants are as follows:

Academia	11
Classification society	4
Consulting	16
Government	22
Manufacturing	3
Operators	3

The great majority of the attendees were naval architects and engineers. Note that the majority of participants from government agencies had technical backgrounds, including many from government laboratories and research agencies.

The participants were divided into seven teams for the breakout brainstorming session. The composition of the teams is given in Appendix C.

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### 3 Halifax Workshop Presentations

The morning session was opened by Wei Qiu, Chair of CISMART's Interim Board, stating that the objective of the workshop was to develop collaborative projects under the key R&D themes of SMART, GREEN, SAFE and IMPLEMENT. An overview and updates were provided on the progress made by CISMART. The mission of the network was described together with steps taken towards making CISMART fully operational. Current activities in terms of workshops, pilot projects and exploratory efforts to fund CISMART activities were summarized. Among other activities planned for the future are to develop more collaborative projects, pilot online short courses and to continue efforts to seek funding.

This was followed by an overview of the planned activities of the day. Also briefly introduced was the workshop to be held on November 28 and 29 on Ship Noise Mitigation Technologies.

Three presentations summarized the progress made in three pilot projects which are in various stages of execution. In addition, seven invited presentations were made. These presentations were given by leading figures from industry and government. All the presentations are outlined below.

As noted earlier the primary purpose of these presentations was to stimulate discussions about what new projects should be pursued by CISMART.

#### 3.1 Pilot Project Presentations

##### **Pilot Project 1: Operational Capabilities of Low- and Non-Ice Class Vessels in Ice-Infested Water**

John MacKay of DRDC – Atlantic Research Centre outlined the challenges for navigating ships with low or no ice class (intentionally or unintentionally) in ice-infested waters, and described the project designed to improve the understanding of the issues and develop tools to allow assessments of structural strength. The project is a collaborative effort of a team comprised of Memorial University, DRDC – Atlantic Research Centre, VARD Marine and ABS. The project which started in September 2018 is due to conclude in September 2022. Among the goals of the projects are the development of software tools and new ice-load monitoring techniques. In addition, a number of specialist studies in support of the overall objectives of the project are being conducted. An experimental program is planned in which exact “copies” of a grillages from a destroyer will be tested for ice impact loads. As part of this work, improved models of material behaviour up to fracture will be developed. The project administration has been set up and some key staff have been hired to start the project.

##### **Pilot Project 2: Development of Best CFD Modeling Practices for Problems Important to Marine Industry**

This pilot project was described by Dan McGreer of VARD Marine. The objective of the project is to develop and validate best practices in undertaking CFD analyses for marine applications.



It was noted that there is a shortage of engineering analysts with a background in CFD analysis and hence the quality of analyses is variable often relying on “trial and error” approaches. This collaborative project has eight partners – Memorial, DRDC – Atlantic Research Centre, VARD Marine, University of New Brunswick, Robert Allan Ltd., ABS, Lloyds Register and NRC-OCRE, and is supported with funding and in-kind contributions. The first set of problems to be investigated concern the prediction of the propeller effective wake and manoeuvring coefficients using RANS solvers. Some of the first results are emerging from the project on propeller wake and comparisons with experimental results on wake fields for the KCS containership are being undertaken. In regard to manoeuvring coefficients, the plan also includes the comparison of CFD-derived values with experimental results.

### **Pilot Project 3: Effect of Manufacturing Tolerances on Propeller Performance**

The presentation was made by Bodo Gospodnetic of Dominis Engineering. Considering the greatest contribution to underwater noise from large ships is from the propeller, the quality of propeller manufacturing should be an aspect of focus. In the presentation, the typical propeller manufacturing process was outlined and the requirements of ISO 484/1 were introduced. The guiding principle of propeller manufacturing adopted by Dominis was summarized with a focus on the accuracy typically achieved in their facility. The accuracy was demonstrated in terms of very low statistical variation in key propeller parameters. The manufacturing process involved a single setup, in which the CNC machining (unattended) is used to achieve the final form, i.e., finished form, without involving hand grinding. In addition the general relationship between various propeller parameters and noise levels was indicated. Preliminary investigations indicate that very small manufacturing defects can have a significant effect on flow characteristics. The research program will systematically study these effects focusing on characterizing the degradation, in terms of cavitation, that occurs as a result of compromised propeller geometry. Both CFD simulations and experimental work are planned. The partners in this project are Dominis Engineering, DRDC – Atlantic Research Centre and Memorial University. The final report will be used to provide advice to ship owners and as input to ISO.

## **3.2 Invited Presentations**

Invited presentations were designed to educate the audience on the challenges faced by various sectors of Canada’s marine infrastructure, make the audience aware of certain government funding programs, and generally stimulate discussions about potential projects for CISMART to pursue. Short summaries of the talks are provided as follows:

### **Technological Challenges Faced by the Royal Canadian Navy Now and in the Future**

The presentation by Capt(N) Jacques P. Olivier of DND provided a comprehensive description of technological areas that present the most challenges to the Royal Canadian Navy (RCN). An overview of the design and maintenance of navy ships was provided. Among the most

severe challenges is the problem of corrosion and fatigue in ship structures and systems. The presentation outlined the alliances that RCN has formed with classification Societies, navies of allies and commercial organizations to develop best practices in dealing with these challenges. It was noted that the Canadian Patrol Frigates are now 30 years old and plans for them to remain in service until the late 2030s. The presentation included discussions of systems to manage information related to the maintenance of structure. Systems security is also an important aspect, and the systems installed to manage this threat were described.

### **Autonomous Ships and Uncrewed Workboats**

Vince den Hertog of Robert Allan Ltd. (RAL) described some of the innovative work that the company has been involved in with respect to autonomous ships. After a short introduction to RAL, the presentation provided some general remarks on autonomous ships and related development work being done elsewhere, primarily Europe. The presentation identified the main hurdles that face the widespread use of such ships – regulatory and legal issues, technology, economics and business case, and acceptance by society and industry. A key message was that autonomous ships are mission-driven and that there has to be a demand to avoid becoming a “concept looking for a market”. The presentation goes on to describe the work that RAL has done in the area, including a remotely operated fireboat, ship-handling tug and some concept development work. Current and future technology needs computational resources for R&D (mainly CFD), access to simulator facilities, and opportunities for uncrewed vessel technology demonstrations.

### **Opportunities for Ship Time on CCG Ships**

The Canadian Coast Guard (CCG) has generously offered CISMART ship time for appropriate projects requiring the ship as a platform. Tarachand Satsangi of CCG started by listing CCG assets ranging from search-and-rescue lifeboats up to heavy icebreakers. The CCG commitment to CISMART is 35 days of sail time per year for the next five years; this is believed to represent a \$1M per year value. The use of ship time in CISMART project is to be opportunistic since normal ship operations cannot be altered, and the projects should preferably be non-commercial research. It should be recognized that planned ship operations may be interrupted by unforeseen demands such as SAR calls. CCG is seeking a list of planned projects from CISMART annually.

### **Introduction to the Innovation for Defence Excellence and Security Program (IDEaS)**

Eric Fournier introduced the IDEaS program and described its main features. Canada’s Defence Policy 2017 noted that “Innovative technology, knowledge, problem solving are critical for Canada and its allies to mitigate new threats, ...”. The IDEaS program is one program developed to respond to this challenge. The presentation outlined some of the technology areas that are important to meeting the challenge. “Innovation” is central to the

program and hence the presentation explained how the program is to be implemented with the ultimate goal of enhancing Canada's defence capability and also its allies. Among the mechanisms to be employed under IDEaS are competitive projects, innovation networks and contests. The program is fully web-based including managing proposals. The eligibility of organizations to receive funding support was summarized. The program is funded for 20 years with a budget of \$1.6B. The program is open to individuals, businesses, academia, and not-for-profits among others.

### **BMT Research Ideas**

Some general thoughts on applied research and some specific ideas were presented by Charles Nisbet of BMT Canada Ltd. The general observation was made that much good research has been done but not necessarily taken to later stages. Among the reasons are the cautious nature of the industry, the results not being mature, and sometimes the marine community is simply unaware of the research. The presentation outlined ways in which the present situation can be improved. A number of specific technology areas were identified where the approaches outlined may be applied, including material selection for cold weather application, production practices to ensure fatigue resistance, application of composite materials, hybrid structural advances, power generation, storage, distribution and consumption, conventional and next generation propulsion configurations, and marine support systems, component and product development.

### **Real World Application of Noise Control**

Mark Oakes of Alion Science and Technology Corporation described in good detail the types of noise control measures that have been applied towards navy, research and survey ships. The main considerations in developing a ship design with the desired low noise characteristics were described and a flow chart describing the process was shown. Each potential noise source, such as the propeller, main engines and generators, was introduced together with key features related to noise generation and mitigation. Also outlined were acoustic modeling methodologies. The latter half of the presentation was devoted to noise mitigation methods for each of the noise making systems. These included damping treatments, such as coatings, tiles and isolation mounting systems, and good practice for supporting pipes and hoses to minimize noise transmission. Techniques for quieting propulsion motors were also outlined.

### **Industry Collaboration Opportunities with HydroComp's "Design for Sustainability Tool" Initiative**

A presentation was made by Don MacPherson of HydroComp, Inc. describing a system dubbed "Design for Sustainability", which includes a suite of analysis and design systems to address sustainability-related design issues such as reducing fuel consumption, emissions

and noise control. This requires an approach that incorporates both incremental and disruptive technologies. As an example, NavCad was mentioned as an excellent tool to handle conventional systems, but is less suited to dealing with disruptive technologies. The current emphasis is on introducing new URN capabilities to the suite of tools that comprise “Design for Sustainability” system as well as those to address consumption and emission issues. One current initiative in this regard is the collaboration between HydroComp and a UK university on developing tools focusing on propeller performance. The importance of data in calibrating and refining various models was noted and in this regard industry could play a key role through involvement in making full-scale noise measurements available.

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## 4 Breakout Session

This section reports on the proceedings of a breakout session towards the end of the workshop. Participants were divided into seven groups and were asked to consider the same set of questions in the brainstorming sessions. Results of the brainstorming sessions were presented to the workshop by each group. This was accompanied by a general discussion prompted by the presentations.

The questions for the breakout brainstorming sessions are presented in Appendix D. Each group recorded their answers and a summary of these deliberations is provided as follows. In addition, the comments made during the general discussion are also summarized.

### 4.1 Brainstorming Session Comments

This section contains a summary of findings during the breakout brainstorming sessions. The findings are organized under each of the questions. Note that questions are shown in *italics*. The answers provided by the breakout groups varied. Some did directly address the question at hand, but some responses included many general comments, which are not always directly related to the question. Both are reproduced below. In certain cases, it was difficult to interpret the written responses recorded during the breakout brainstorming sessions. Where it was possible, the response was paraphrased. In cases where this was not possible, it is indicated with a question mark in brackets (?).

Some of the responses are presented in **bold**, which indicates this response, or a similar response, was made by more than one team, and in some cases essentially the same observation was made by three or four of the breakout groups.

#### 4.1.1 Current Pilot Projects

*The three pilot projects currently underway were reviewed earlier. Can any of the projects be usefully expanded in terms of scope, or otherwise extended? If so, please outline additional aspects that can be addressed.*

##### **Pilot Project 1: Operational Capabilities of Low- and Non-Ice Class Vessels in Ice-Infested Water**

Comments/suggestions made for this project are as follows:

- a. **The project could be expanded to include commercial vessels. This suggestion was made by several breakout groups.**
- b. The project could be expanded beyond ice-structure interaction issues. For example, issues, such as winterization, the application of the Polar Code and risk assessment, could be considered.

- c. Use Memorial's large pendulum apparatus to examine response of typical side-shell structure with ice without relative motion.
- d. Expand the project to include real time application (live feedback to operators) that help decision making in operations. Then evaluate the effectiveness of the decisions using collected ship data.
- e. Consider routeing and how it will impact fleet/ship design requirements because of operating in weaker ice. (?)
- f. Ability to model the entire system will help.
- g. A less prescriptive method is needed for meeting Ice Class

### **Pilot Project 2: Development of Best CFD Modeling Practices for Problems Important to Marine Industry**

Comments/suggestions made for this project are:

- a. **Full-scale trials data could be used to validate CFD predictions**
- b. Would like to see more partners involved.
- c. Establish a Canadian database (post data, and share new data).
- d. Establish standard courses/training to communicate best practices – could develop certification course for users.
- e. Establish a baseline from which to gauge improvements to published best practices, i.e., continuous improvement.
- f. Suggest including manoeuvring and resistance as case studies, perhaps including a real world scenario.
- g. Related subjects of interest include rudder and propeller blade vortex induced vibration.
- h. Sloshing impact could also be investigated similar to the SLOSHEL JIP administered by MARIN.

### **Pilot Project 3: Effect of Manufacturing Tolerances on Propeller Performance**

Comments/suggestions made for this project are listed as follows:

- a. Project seems to focus on a single parameter.
- b. **CFD analysis is encouraged examining various parameters and their influence on performance. This can be used to focus on parameters that show the most potential.**
- c. Validation studies to compare the CFD results with measured data, including full-scale test results. It is noted that the latter would be very difficult.
- d. Investigate the use of 3D printing for propeller hub and blade to improve manufacturing quality.
- e. The project could contribute CFD best practices as applied to propeller analysis.

- f. Reduced-order models/panel methods could be used.
- g. Full-scale validation using CCG Vessel. Note that Transport Canada has data Signus (NRC) before and after cleaning of hull and propeller. BC Ferries – four vessels have been tested.
- h. A closer look at uncertainties is suggested – uncertainty management, quantifying uncertainties and uncertainties in measurements. This would be of value for standards and certification in relation to noise and cavitation measurements.
- i. One extension could be to start with a “perfect” propeller and make changes to parameters and use factorial design matrix methods to examine several parameters at the same time.
- j. Other factors that could be investigated include the effect of tolerances on erosion due to cavitation and marine fouling (?). A related comment concerned the consideration of age effects, cavitation erosion and marine growth as they affect performance.
- k. Can the impact of tighter tolerances on noise generation be quantified or documented? This has possibly already been done on navy propellers.
- l. The potential for cost savings should be examined.
- m. This project has the potential for sharing in data.
- n. Propeller optimization – efficiency versus noise from cavitation is an issue that could be investigated.
- o. Smart active propellers

#### 4.1.2 Projects Requiring Ship Time

*The Canadian Coast Guard has kindly made ship time available to CISMaRT for meaningful projects under conditions outline earlier. Can you think of projects that fall into one of the themes mentioned above that would benefit from field work requiring ship time? Please list two or more projects perhaps supported by an explanatory sentence or two:*

- a. Expose naval architects to ship operations – good learning opportunity.
- b. **Noise measurements on icebreakers including effect on crews.** This was mentioned by two breakout groups.
- c. Send a CCG vessel through a sound range and collect data.
- d. Standardized data collection methodology should be applied to projects using ship time.
- e. Collect all experiments – use common data acquisition equipment/organization.
- f. Onboard noise measurements.
- g. Air wake measurement on helideck – full-scale measurement.
- h. Field data on vessel icing.
- i. Target No. 1 should be underwater noise.
- j. If a twin screw ship is available, measure noise and vibration in single screw mode and twin screw mode .
- k. Small vessel access – SAR – use for validating CFD – hindcasting.

- l. **Measured CCG ship behaviour during operations could be compared with CFD predictions for validation purposes.** Similar comments were made by several groups.
- m. Full-scale validation of ship motion predictions.
- n. Is it possible to trial a Dominis propeller on a CCG ship?
- o. Investigate the installation of passive monitoring systems during docking periods to minimize disruption. Use systems to test new observation technologies.
- p. Temperature recording data in the Arctic. Measure external wet and dry bulb temperatures, and water temperature. Compare with actual design requirements for steel temperatures.

#### 4.1.3 Projects on Video-based Training Courses

*In the opening presentation an example of video-based training was introduced. CISMART is considering delivering short training courses using this vehicle. In your view how effective could this form of short course delivery potentially be? What types of subject matter could be delivered? Please give examples.*

The following subjects were considered suitable for video-based training:

- a. Best practices in FEA
- b. Best practices in CFD
- c. Polar Code – use of Polaris
- d. Effective communication skills
- e. Underwater noise – mammal response, prediction and modelling, construction opportunities, political/regulatory questions
- f. Survey related training courses
- g. Human factors issues
- h. Hazards of particular operations such as towboat passing a line to the bow of a large freight ship

Other comments made include:

- a. Producing professional video-based training courses is very time consuming.
- b. It is suggested each session is limited to 20 minutes.
- c. Should be interactive, and have assignments for students. Answers for the latter should be shown on website or be addressed by the instructor.
- d. Would the videos be publicly shared?
- e. Need a human archive interface (?)
- f. Apparently class societies provide something similar.
- g. Interactive webinars might be more effective.
- h. Could the courses be used to support applications to attain professional engineer's status?



- i. Establishing the best way to deliver such course should be a project itself
- j. General requirements for lecturers.
- k. Lecturer and material should match audience.
- l. Lecturer needs to have an energetic voice.
- m. Lecture should be supported with “lots of pictures”.
- n. Hire experts rather than “try it out”.
- o. Courses should be adequately funded – properly designed and consistent. Poorly executed course can “kill your brand”.
- p. It should be possible to have the videos as the basis for Professional Development Hours
- q. Video courses could be advertised through Professional Engineers societies.

#### 4.1.4 Other Potential Projects

*Please identify potential projects for CISMaRT to consider in the near term (1-2 years) and medium term (3 – 5 years). These should be considered in the four themes shown in the graphic on the first page. Examples of typical technologies under each category are shown in the graphic.*

*Several presentations were given this morning and this afternoon addressing a wide range of challenges and opportunities. It is hoped that these acted as a catalyst for ideas on potential projects for CISMaRT to pursue. The breakout groups are asked to identify potential projects. A table is attached which can be used to capture project ideas developed by each breakout group.*

Suggested potential projects are listed in the table below. More general comments follow after the table.

<b>Project Title</b>	<b>Possible Collaborators</b>	<b>Benefits of Project/Comments/Questions</b>
Autonomous Ships		Collision avoidance, especially marine life Autonomous vessel operation in ice What is the “energy field” from the ship and how does it affect marine life?
Polar Vessels Environmental and Winterization	Fednav, CCG, Transport Canada	Feasibility of various environmental and winterization technologies
Hybrid Propulsion LNG / Batteries to Reduce GHG	University of Victoria, RAL	Implement UVic model to a wide variety of ship types
Simulation Framework Plug-in Software Modules to Create Simulation Modules	DRDC, UVic	Simulation environment to combine simulation models; digital twin
Unmanned Vehicles Monitoring (Drones for the Arctic)	Transport Canada	Mammal distribution; environmental compliance monitoring; harsh conditions
Baseline for Environmental Conditions, i.e. Noise Pollution Levels, Mammal Distribution	Transport Canada	
Propeller Leading Edge measurement		
Red Lights and VHF Communication	Coastguard, Garmin, Raytheon, Universities	1 year project
Underwater Noise and Efficiency Relationship	Jasco, Ocean Sonics, Vancouver Port, RightShip + Class Societies	1-2 year project
Self-Monitoring of Noise: Sensors for Vessels	NRC	1-4 year project

/continued on next page...

<b>Project Title</b>	<b>Possible Collaborators</b>	<b>Benefits of Project/Comments/Questions</b>
Passive Control Methods based on Coatings and Surface Modifications		
Active/Smart Propeller Design for Cavitation Noise Suppression		
Smart Propeller Design via Active Monitoring		
Uncertainty Quantification of Marine Acoustics in Complex Environments		
Real-Time Data-Driven Analysis of Marine Environments		
Marine Biology		
Digital Twins/Smart Ships		
Data Standardization for Design and In-Service Assessment		
Alternative Fuels, Fuel Cells etc.		
Dynamic Stability		
Corrosion Prevention, Longer-Lasting Coatings, Scratch-Proof (?) Coatings		
Arctic-Friendly Waste Disposal and Handling Garbage, Sludge, Scrubber Sludge, Grey and Black Water		
Video-Based Training	MUN, Industry	Find ways to make hard parts easy. Use external party for developing platform – the hard part and most time-consuming

## 5 Summary

The key findings from the workshop are listed below together with suggestions in regard to the pilot projects currently in progress and potential future projects:

- Various presentations were given, including three presentations on the pilot projects, one on technological challenges faced by the Royal Canadian Navy, and others on autonomous ships, noise control, software systems targeted at sustainability, and some general thoughts on research relevant to CISMART themes. A presentation was given on the availability of ship time for CISMART projects and another on a DND program to support innovative research
- The presentations acted to stimulate discussions among the participants in breakout brainstorming sessions where participants were encouraged to develop ideas for projects that CISMART could pursue within the themes of SMART, SAFE, GREEN and IMPLEMENT.
- The breakout sessions yielded numerous ideas for broadening the scope of existing pilot projects. How many of these suggestions can be included depend on a number of factors, including the availability of resources, the interests of partners, etc. Nevertheless, the suggestions will be considered.
- Many ideas were forthcoming in regard to ship time kindly made available by the Canadian Coast Guard. A few project ideas were mentioned frequently. The most popular ones had to do with noise monitoring and using full-scale data to validate CFD predictions.
- Concerning the sample pilot training video, a recommendation was made to seek the professional input in the delivery of such training material. There were also many suggestions of subjects to be covered using the video format.
- A large number of project ideas were proposed by the workshop participants. The most popular ones were related to Arctic operations, aspects of underwater noise from ships, and systems for reducing emissions from ships.

## Appendix A Agenda of the Halifax Workshop

CISMART Workshop on Key Research Themes		
November 27, 2018		
Admiral's Room, Four Points by Sheraton, Halifax, Nova Scotia		
<u>Tuesday, November 27, 2018</u>		
<b>08:00 – 08:30</b>	Registration and Breakfast	
<b>08:30 – 09:15</b>	<ul style="list-style-type: none"> <li>Objectives and scope of the Workshop</li> <li>Overview of CISMART</li> <li>Progress made</li> <li>Next steps</li> </ul>	Workshop Facilitator: Roger Basu
<b>09:15 – 09:45</b>	<i>Technological Challenges Faced by the Canadian Navy Now and in the Future</i> Capt(N) Jacques P. Olivier, DND	
<b>09:45 – 10:15</b>	<i>Autonomous Ships and Uncrewed Workboats</i> Vince den Hertog, Robert Allan Ltd.	
<b>10:15 – 10:35</b>	<b>Coffee break</b>	
<b>10:35 – 11:05</b>	<i>Opportunities for ship time on CCG ships</i> Tarachand Satsangi, CCG	<ul style="list-style-type: none"> <li>CCG ship time: Ideas for use of ship time and guidelines</li> </ul>
<b>11:05 – 11:25</b>	<i>Pilot Project #1: Operational Capabilities of Low and Non-Ice Class Vessels in Ice</i> John MacKay, DRDC	<ul style="list-style-type: none"> <li>Overview and progress will be presented by a main participant of the project.</li> </ul>
<b>11:25 – 11:45</b>	<i>Pilot Projects #2: Development of Best CFD Modeling Practices for Problems Important to Marine Industry</i> Andrew Kendrick, VARD Marine	<ul style="list-style-type: none"> <li>Overview and progress will be presented by a main participant of the project.</li> </ul>
<b>11:45 – 12:05</b>	<i>Pilot Project #3: Effect of Manufacturing Tolerance on Propeller Performance</i> Bodo Gospodnetic, Dominis Engineering	<ul style="list-style-type: none"> <li>Overview and progress will be presented by a main participant of the project.</li> </ul>
<b>12:05 – 13:10</b>	<b>Lunch at Navigator Room</b>	<ul style="list-style-type: none"> <li>Group photo will be taken immediately before lunch</li> </ul>
<b>13:10 – 13:30</b>	<i>Introduction to the Innovation for Defence Excellence and Security Program (IDEaS)</i> Eric Fournier, Leader IDEaS	
<b>13:30 – 13:40</b>	<i>BMT Research Ideas</i> Charles Nisbet, BMT Canada Ltd.	
<b>13:40 – 14:00</b>	<i>Real World Application of Noise Control</i> Mark Oakes & Daniel E. Rolland, Alion Science and Technology Corporation	
<b>14:00 – 14:20</b>	<i>Industry Collaboration Opportunities with HydroComp's "Design for Sustainability Tool" Initiative</i> Don MacPherson, HydroComp, Inc.	
<b>14:20 – 14:40</b>	<b>Coffee break</b>	
<b>14:40 – 16:40</b>	Breakout sessions and general discussions  Breakout Rooms: Explorer, Admiral's, Compass	<ul style="list-style-type: none"> <li>Groups to discuss projects presented in previous session and propose projects</li> <li>Suggest modifications, if necessary, to proposed projects</li> </ul>
<b>16:40 – 17:00</b>	Closing remarks	
<b>18:00 – 19:30</b>	Reception at the Navigator Room	

## Appendix B List of Participants

First Name	Last Name	Title	Organization
Chanwoo	Bae	Engineering Manager	BC Ferries
Roger	Basu	Facilitator	Roger Basu & Associates Inc.
Eric	Baudin	Head of Test & Measurements	Bureau Veritas
David	Benoit	Captain	DND
James	Bonnell	Director, Business Development	Dominis Engineering Ltd
Anna	Bryns	Naval Architect	Bryns - Naval Architect
Scott	Carr	CEO	JASCo Applied Sciences (Canada) Ltd.
Colin	Clark	President, LR ATG	Lloyd's Register
Elena	Corin	Director of Sales	Albion Marine Solutions Ltd.
Allan	Dale	Director, Industry Partnership	UPEI - Faculty of Sustainable Design Engineering
Vince	den Hertog	Vice President, Engineering	Robert Allan Ltd.
Caroline	Denis	Manager, Environmental Programs	Canada Steamship Lines
Gordon	Deveau	Deputy Director	NSERC Atlantic Regional Office
Zuomin	Dong	Professor	University of Victoria
Pierre-Charles	Drapeau	President	InnovMarine Inc.
Patrick	Fortier-Denis	Ingenieur	Innovation Maritime

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<b>First Name</b>	<b>Last Name</b>	<b>Title</b>	<b>Organization</b>
Eric	Fournier	Role Leader IDEaS	DND
Abigail	Fyfe	Research & Development Officer	Transport Canada Innovation Centre
Bodo	Gospodnetic	President	Dominis Engineering Ltd.
Jason	Gu	Professor	Dalhousie University
Kathy	Heise	Research Associate	Coastal Ocean Research Institute
Mohammed	Islam	Senior Research Officer	National Research Council Canada
Rajeev	Jaiman	Associate Professor	University of British Columbia
Jasmin	Jelovica	Assistant Professor	University of British Columbia
Andrew	Kendrick	Vice President	Vard Marine
Rory	Macdonald	President	Lengkeek Vessel Engineering Inc.
John	MacKay	Chief Scientist/Physical Sciences (Acting)	Defence R&D Canada
Donald	MacPherson	Technical Director	HydroComp. Inc.
David	Males	Director, Sales and Marketing	InnovMarine Inc.
LCdr Shauna	Masson	Deputy Program Manager, Naval Materiel Assurance	Department of National Defence
Liz	McCrary	Marketing Communications Manager	HydroComp, Inc.

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<b>First Name</b>	<b>Last Name</b>	<b>Title</b>	<b>Organization</b>
Dan	McGreer	Principal Engineer	Vard Marine
Brian	McShane	Senior Innovation Officer	ISED Canada
David	Michelson	Co-Director, UBC Marine Systems Research Cluster	University of British Columbia
Sue	Molloy	CEO	Glas Ocean
David	Molyneux	Associate Professor/Director of OERC	Memorial University of Newfoundland
Lorenzo	Moro	Assistant Professor	Memorial University of Newfoundland
Holly	Neatby	Defence Scientist	Defence Research & Development Canada
Charlie	Nisbet	Engineering Director	BMT
Mark	Oakes	Chief Technical Officer	Alion Science and Technology
Dan	Oldford	Sr. Engineer	ABS
Capt. Jacques	Olivier	Director Naval Platform Systems	Department of National Defence - Royal Canadian Navy
John	Osler	Acting Centre Director	DRDC Atlantic Research Centre
Neil	Pegg	Program Manager, Naval Platforms	Defence Research & Development Canada
Melissa	Perera	Biologist	US Coast Guard
Greg	Peterson	Director Engineering Service	BC Ferries

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<b>First Name</b>	<b>Last Name</b>	<b>Title</b>	<b>Organization</b>
Wei	Qiu	Department Head, ONAE	Memorial University of Newfoundland
Bruce	Quinton	Deputy Head, Assistant Professor	Memorial University of Newfoundland
Braden	Rostad	Mechanical Engineer	US Coast Guard
Tarachand	Satsangi	A/Manager of Vessel Maintenance Management	Canadian Coast Guard
Dong	Seo	Research Officer	National Research Council
Mo	Shamma	Research Associate	Nova Scotia Community College
Jaideep	Sirkar	Naval Architect	US Coast Guard
Tabitha	Takeda	A/Chief Marine RD&D	Transport Canada Innovation Centre
Krista	Trounce	Project Manager - ECHO Program	Vancouver Fraser Port Authority
Karin	de Vries	Customer Solutions Engineer	Wärtsilä Canada Inc.
David	Whitehouse	Business Development and Innovation Manager	Lloyd's Register
Fraser	Winsor	Senior Research Officer	National Research Council
Jinshan	Xu	Physical Scientist	Bedford Institute of Oceanography

## Appendix C Breakout Session Teams

First Name	Last Name	First Name	Last Name
<b>GROUP 1 (at Admiral's Room)</b>		<b>GROUP 2 (at Admiral's Room)</b>	
Chanwoo	Bae	Elena	Corin
Allan	Dale	Zuomin	Dong
Vince	den Hertog	Patrick	Fortier-Denis
Gordon	Deveau	Eric	Fournier
David	Males	Dan	McGreer
Brian	McShane	David	Molyneux
Braden	Rostad	Mo	Shamma
Dong	Seo	Tabitha	Takeda
<b>GROUP 3 (at Compass Room - A)</b>		<b>GROUP 4 (at Compass Room - B)</b>	
Eric	Baudin	Jon	Mikkelsen
Caroline	Denis	Kathy	Heise
Abigail	Fyfe	Jasmin	Jelovica
Bodo	Gospodnetic	Andrew	Kendrick
Jason	Gu	Charlie	Nisbet
Sue	Molloy	Dan	Oldford
Krista	Trounce	Greg	Peterson
David	Michelson	Fraser	Winsor
<b>GROUP 5 (at Compass Room - C)</b>		<b>GROUP 6 (at Navigator Room)</b>	
James	Bonnell	Rory	Macdonald
Mohammed	Islam	Lorenzo	Moro
Capt. Jacques	Olivier	Anna	Bryns
John	Osler	John	MacKay
Jaideep	Sirkar	Neil	Pegg
Jianshan	Xu	Mark	Oakes
Liz	McCrary	Tarachand	Satsangi
<b>GROUP 7 (at Explorer Room)</b>			
David	Benoit		
Scott	Carr		
Donald	MacPherson		
LCdr Shauna	Masson		
Melissa	Perera		
Bruce	Quinton		
Karin	de Vries		

## Appendix D Breakout Session Questionnaire

### **Breakout Session on Proposed Projects (14:40 – 16:40):**

The purpose of this session is to seek input from workshop participants on initiating future projects. CISMaRT projects are typically collaborative involving as many sectors of Canada’s marine ecosystem as possible. Ultimately the work should contribute to Canada’s economy and global competitiveness.

The initiatives that CISMaRT will consider fall under the following four themes and are described in outline below:

<b>SMART TECHNOLOGIES</b>	<b>GREEN TECHNOLOGIES</b>	<b>SAFE TECHNOLOGIES</b>	<b>IMPLEMENT DEVELOPMENTS</b>
<ul style="list-style-type: none"> <li>• Autonomous Marine Vehicles</li> <li>• Communications</li> <li>• Cyber Security</li> <li>• Shipbuilding</li> <li>• Simulation</li> </ul>	<ul style="list-style-type: none"> <li>• Alternative Fuels and Propulsion Systems</li> <li>• Efficiency Improvement</li> <li>• Ocean Energy</li> <li>• Ship Emission and Noise Reduction</li> </ul>	<ul style="list-style-type: none"> <li>• Arctic Engineering</li> <li>• Harsh Environment Operations</li> <li>• Human Factors Engineering</li> <li>• Safety and Risk Engineering</li> </ul>	<ul style="list-style-type: none"> <li>• Personnel Training and Education</li> <li>• Policy Advancement in the Public Interest</li> <li>• Technology Commercialization</li> </ul>

The objectives of this breakout session are:

1. To consider if there are opportunities and value in extending scopes of the three pilot projects currently underway
2. To identify projects that require ship time for field work.
3. To comment on video-based training course introduced during the opening presentation
4. To propose future projects that have the most potential to contribute to Canada’s marine ecosystem

**Current Pilot Projects**

The three pilot projects currently underway were reviewed earlier. Can any of the projects be usefully expanded in terms of scope, or otherwise extended? If so, please outline additional aspects that can be addressed.

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**Projects Requiring Ship Time**

The Canadian Coast Guard has kindly made ship time available to CISMART for meaningful projects under conditions outline earlier. Can you think of projects that fall into one of the themes mentioned above that would benefit from field work requiring ship time? Please list two or more projects perhaps supported by an explanatory sentence or two:

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### **Projects on Video-based Training Courses**

In the opening presentation an example of video-based training was introduced. CISMART is considering delivering short training courses using this vehicle. In your view how effective could this form of short course delivery potentially be? What types of subject matter could be delivered? Please give examples.

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### **Other Potential Projects**

Please identify potential projects for CISMART to consider in the near term (1-2 years) and medium term (3 - 5 years). These should be considered in the four themes shown in the graphic on the first page. Examples of typical technologies under each category are shown in the graphic.

Several presentations were given this morning and this afternoon addressing a wide range of challenges and opportunities. It is hoped that these acted as a catalyst for ideas on potential projects for CISMART to pursue. The breakout groups are asked to identify potential projects. A table is attached which can be used to capture project ideas developed by each breakout group.

<b>No</b>	<b>Project Title</b>	<b>Possible Collaborators</b>	<b>Time Scale (yrs)</b>	<b>ROM (\$K)</b>	<b>Benefits of Project</b>

DRAFT