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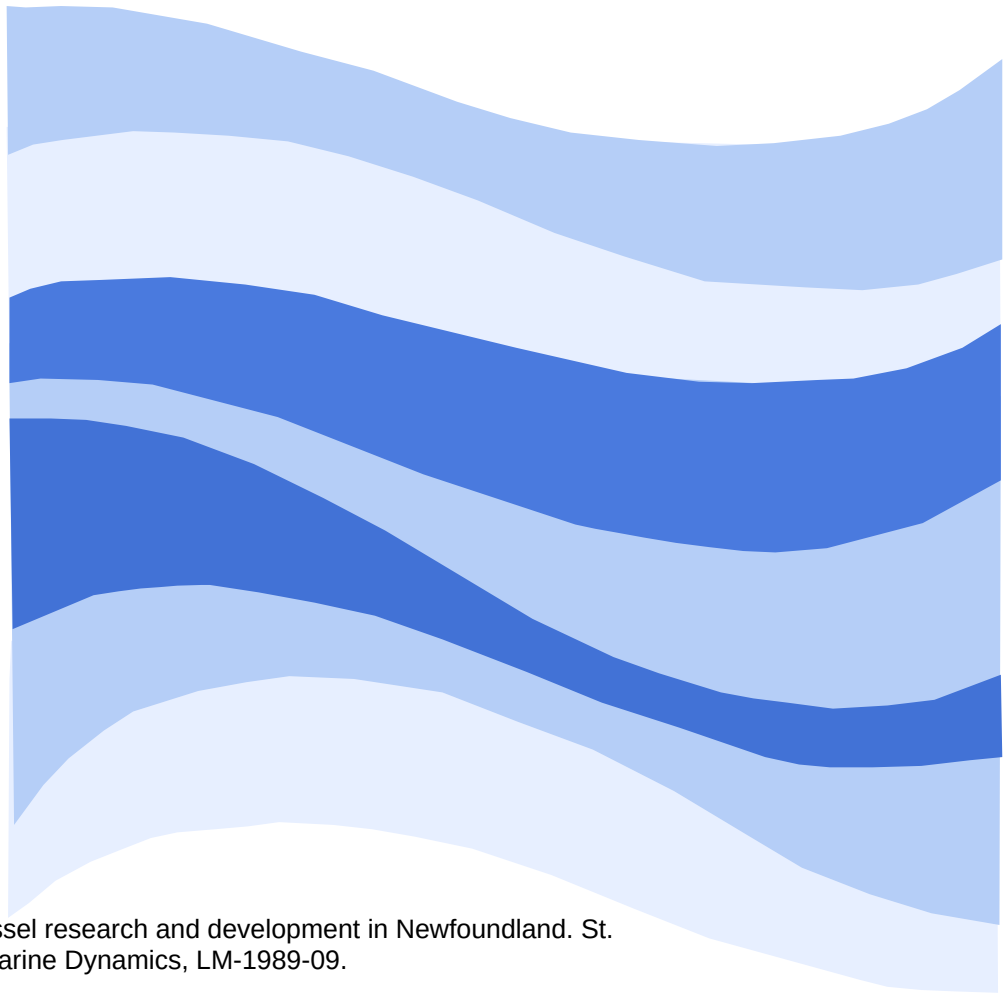
Laboratory Memorandum

LM-1989-09

Fishing vessel research and development in Newfoundland

D. Cumming

May 1989



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National Research Council Canada
Institute for Marine Dynamics

Conseil national de recherches Canada
Institut de dynamique marine

FISHING VESSEL RESEARCH AND DEVELOPMENT IN NEWFOUNDLAND

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D. Cumming

May 1989

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SUMMARY: This report consists of a formal submission related to fishing vessel research and development to the Ocean Studies Task Force; Working Group 7, Fishing Technology and Harvesting.

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FISHING VESSEL RESEARCH AND DEVELOPMENT IN NEWFOUNDLAND

1.0 INTRODUCTION

This document consists of a formal submission related to fishing vessel research and development to the Ocean Studies Task Force; Working Group 7 - Fishing Technology and Harvesting. The mandate of this group is to provide advice and comment with respect to the formulation of research projects to those Newfoundland based institutions concerned with Ocean Studies.

The logical first step is to determine what research is currently on-going in the region. Section 2 of this submission consists of a list of research projects completed within the last five years or currently being carried out by Newfoundland based institutions. Although I have tried to be thorough in compiling this list, some projects may have inadvertently been omitted.

Section 3 is concerned with describing the level of effort currently devoted to education with respect to fishing vessel design and performance in Newfoundland educational institutions.

Recommendations for future Research and Development as well as some thoughts on how the existing education system can better serve the fishing industry are included at the end of this report.

2.0 FISHING VESSEL RESEARCH SPONSORED BY NEWFOUNDLAND BASED INSTITUTIONS

2.1 Capsizing Research

The Institute for Marine Dynamics (IMD), a division of the National Research Council Canada, is presently involved in a long term research project aimed at formulating a set of stability criteria for inshore fishing vessels (References 1-3). Of primary concern is the investigation of the mechanism of capsizing in steep breaking waves. The project is co-ordinated by Dr. S. Grochowalski and is sponsored by the Ship Safety Branch, Canadian Coast Guard (CCG). An extensive model testing program has been carried out at SSPA (Sweden) and the results are

currently being analyzed to determine the major influences on vessel capsizing.

2.2 Wide Beam Fishing Vessel Study

Dr. T. Karpinnen, a visiting scientist from the Ship Laboratory, Technical Research Center of Finland, conducted a number of experiments at the IMD facility in Ottawa comparing a model of a wide beam inshore fishing vessel based on lines provided by E.F.Barnes of St. John's and a model with a smaller beam. Seakeeping, resistance and wake survey results were compared. The correlation of seakeeping data with the output from an existing motion prediction program was also carried out (References 4-7).

2.3 Time Domain Simulation

Dr. D. Bass of Memorial University of Newfoundland (MUN) is currently under contract from IMD to develop time domain simulation software to predict the motions of floating bodies in waves (Reference 8). Model test data on an inshore fishing vessel from the IMD/SSPA tests are being used to verify this software.

2.4 Ice Capable Fishing Vessels

IMD has sponsored NORDCO Ltd. of St. John's to carry out an investigation of trawler hull designs for improved performance with respect to resistance and manoeuvering in ice covered waters (References 9-12). A number of different bow designs were faired into an existing trawler hull form and tested in IMD's ice towing tank. The head sea seakeeping and resistance propulsion characteristics of the new bows were also ascertained in the IMD clear water tank.

2.5 Improvements in Fishing Vessel Energy Efficiency

It is difficult to categorize some projects as either Research and Development or technology transfer. Fishermen in the region have benefited from the efforts of many Newfoundland based organizations over the years. One recent thrust by the federal Department of Fisheries and Oceans (DFO) is a project aimed at improving the fuel efficiency of fishing vessels and is called ENER SEA (References 13,14). Sea trials have been carried out to measure fuel consumption, ship forward speed, and engine RPM. Thus a data base has been built up with the objective of improving overall fishing vessel fuel efficiency.

2.6 Roll Damping Analysis

Professors Bass and Haddara (MUN) are involved in the development of a non-linear ship roll damping analysis technique (Reference 15). Although this project is not directed specifically at fishing vessels, a series of six inshore fishing vessel models owned by IMD and built with funding provided by the CCG will be tested for the purpose of furthering this research.

2.7 Ship/Model Correlation Study

The Newfoundland and Labrador Institute of Fisheries and Marine Technology (IFMT) and IMD have embarked on a ship/model correlation study involving a single hard chine, double hard chine, and round bilge fishing vessel hull forms all with the same hull coefficients and displacement (Reference 16). Models of each hull form will be built for comparative tests and for correlation with the output from existing resistance and seakeeping prediction software. Comparison of model test results with the data from full scale trials on the existing single hard chine inshore fishing vessels M/V "Mares" and M/V "Bacalau Run" owned by the IFMT are also contemplated. This is an excellent example of the co-operative effort possible between organizations in the St. John's area and this project has generated wide-spread interest.

2.8 Ice Accretion

The IMD is presently funding ice accretion research being carried at the University of Alberta (Reference 17). Software is under development to predict the instantaneous and time average icing rates on ship superstructures. Loading due to icing is also predicted. Icing rate data from many ships including Russian fishing vessels are being used to verify the software. A few sea trials using Newfoundland based fishing vessels to measure ice accretion rates have also been carried out.

2.9 Novel Propellor Design

Dr. N. Bose (MUN) is involved in research related to the investigation of novel propellor designs with the emphasis on rotary foils. Although this research is generic in nature and not directly related to fishing vessels, the application of a successful design to fishing vessels is possible.

2.10 Paravane Evaluation

An evaluation of outrigger roll stabilizers (paravanes) on inshore fishing vessels was carried out a few years ago by the Newfoundland provincial Department of Fisheries (Reference 18).

This study included theoretical evaluations as well as crude sea trials.

3.0 EDUCATION

3.1 Newfoundland and Labrador Institute of Fisheries and Marine Technology

No courses specifically related to fishing vessel design are currently offered at the IFMT although design aspects unique to fishing vessels are included in course material. Several years ago an extensive course covering all aspects of fishing vessel/gear design was offered but has since been discontinued. An outline of this course is presented in Appendix A. Typically 25-35% of Naval Architecture students do design projects related to fishing vessels. Each student is required to carry out a minor applied research project usually associated with their design project. Very few students currently obtain permanent employment in the design and construction of fishing vessels.

3.2 Memorial University of Newfoundland

No courses specific to fishing vessel design are presently taught by MUN, however, aspects of fishing vessel design are included in general Naval Architecture courses. Approximately 10% of undergraduate students currently do design projects related to fishing vessel design. Some interest has been expressed in offering a course in fish processing/handling/grading etc. and also a course in small vessel design as an option.

A sample of undergraduate student placements is presented in Appendix B. Note the vast majority of MUN Naval Architectural Engineering graduates and work term students accept employment in the larger shipyards, consulting firms, or various government agencies.

A list of active MUN graduate students and their associated research topics is also included in Appendix B. Presently no graduate student is conducting research related specifically to fishing vessel design although there are a few projects in generic Naval Architecture. In general, existing Ocean Engineering research is biased in favour of the offshore oil industry.

4.0 TOPICS FOR FUTURE FISHING VESSEL RESEARCH

The following is a list of topics related to fishing vessel design that warrant further study:

4.1 Intact Stability

4.1.1 Ice Accretion

a) It is recommended that continued support be given for the existing research project at IMD in conjunction with the University of Alberta (Section 2.8) to develop ice accretion prediction software.

b) MUN students should be encouraged to become involved in the verification of this software on Newfoundland fishing vessels. This would involve full scale measurements of ice thickness, rate of ice buildup, and other relevant parameters.

c) Research should be carried out to isolate the critical parameters leading to the build-up of ice on fishing vessel superstructures.

d) Finally, recommendations formulated based on this research would be made leading to the reduction of the ice accretion problem.

4.1.2 Deployment of Fishing Gear

Current Canada Shipping Act (CSA) regulations require an inclining experiment to be carried out to determine the static stability of any fishing vessel for eight conditions ranging from port departure to full load. Many cases are recorded of fishing vessels that meet all the required static stability criteria yet which capsize while hauling aboard their catch. Thus research should be initiated to assess the affects on a vessel's static stability of the deployment of fishing gear and handling of cargo. Appropriate guidelines could then be appended to each stability condition.

4.1.3 Free Surface Effects of Various Commercial Marine Species

Research should be carried out to determine empirical factors related to the shifting of various commercial marine species in fishing vessel cargo spaces. Recommendations for regulations for the safe storage of fish along the lines of the current International Maritime Organization (IMO) guidelines concerning the storage of grain could be issued.

4.1.4 Simple Stability Assessment

Research aimed at developing a simple procedure such that a fisherman could quickly assess the static stability situation of his vessel should be carried out. This could include printed charts or electronic hardware designed for this purpose, such as the stability monitor presently used on offshore oil rigs.

4.2 Damage Stability/Safety

4.2.1 Stability

Research should be carried out leading to an overall improvement in fishing vessel stability to:

a) increase watertight integrity
b) increase the relatively low angle of downflooding
c) improve vessel buoyancy

4.2.2 Survival Suit

Research should be initiated in conjunction with the appropriate fishermen's unions into the design/testing/ certification of a survival suit designed specifically for fishermen.

4.3 Dynamic Stability

4.3.1 Capsizing

The existing research project at IMD related to the formulation of a set of stability criteria for inshore fishing vessels (Section 2.1) should continue.

4.3.2 Development of Seakeeping Prediction Software

Most existing seakeeping prediction computer programs were developed by military agencies for high forward speed, long slender hull forms where end effects are negligible and two-dimensional strip theory gives satisfactory results. These programs are widely available but do not predict the motions of fishing vessels well - especially at low forward speed. Thus seakeeping prediction software that takes into consideration three-dimensional effects is necessary. Support for the improvement of time domain simulation software (Section 2.3) should be continued.

Full scale seakeeping trials and model tests on typical fishing vessel hull forms would be required to provide a data base for the verification of this software.

4.3.3 Assessment of Design Criteria

Full scale sea trials are necessary to determine the limits of motion amplitude/acceleration, deck wetness etc. within which the fisherman can still work his vessel. This information would be very useful in the assessment of new fishing vessel designs.

4.3.4 Investigation of Basic Hull Parameters

This project would be an expansion of the IMD effort described in Section 2.2. Such parameters as slenderness ratio, freeboard, center of gravity etc. could be varied systematically to isolate the resulting effects on fishing vessel motions.

4.3.5 Roll Damping

Improvements in roll damping analysis techniques such as that described in Section 2.6 are to be encouraged. The assessment of various roll damping devices on Newfoundland fishing vessels also warrants investigation of:

a) single chine/double chine versus round bilge hull form
b) stabilizing sail devices
c) improved paravane designs
d) bilge keel designs that do not interfere with fishing gear
e) improved skeg design
f) anti-roll tanks have been used successfully in some countries
g assessment of pitch/roll damping due to the deployment of fishing gear.

4.3.6 Water On Deck

Research into the destabilizing effects of water on deck is justified; and requires:

a) improved techniques for measuring the water on deck in full scale and model scale.

b) recommendations for the inclusion of water on deck as a factor in the stability assessment.

c) inclusion of the dynamic effects of water on deck in seakeeping prediction software.

d) improvements in fishing vessel design to minimize the effects of water on deck.

4.4 Hydrodynamic Efficiency

4.4.1 Resistance Prediction

Research leading to improved resistance prediction software is required. Full scale trials and model tests are required to build up a data base for the verification of resistance prediction software.

4.4.2 Wake Survey

Conduct flow visualization/wake survey experiments on existing fishing vessel designs and make recommendations for the improved overall hydrodynamic efficiency of fishing vessels. This would include investigation of the flow patterns along the hull and in the vicinity of the propeller.

4.4.3 Bi-pitch Propellor

Research should be encouraged into the feasibility of using a bi-pitch propellor. This unit would be much simpler and cheaper than existing CP propellor designs. The propellor blades would have only two pitch angle positions:

a) optimum pitch angle for transit from port to the area of operation at the most economical forward speed.
b) optimum pitch angle for towing fishing gear.

The emphasis would be to develop a simple, rugged design that would be easy to maintain.

4.4.4 Bulbous Bow

Fishing vessel designers in other countries have found a bulbous bow to be a cost effective appendage. Investigation of novel resistance reducing bow designs for offshore Newfoundland fishing vessels is justified.

4.4.5 Novel Propulsors

The suitability of the novel propulsor design currently under investigation at MUN (Section 2.9) for fishing vessels should be ascertained. Comparative studies should be initiated taking into consideration the overall efficiency, propellor/ice interaction, and propellor/fishing gear interaction.

4.5 Manoeuvering

Manoeuvering is one aspect of fishing vessel design that is generally neglected yet it is important for vessels operating from small confined ports or ships that work in pairs. Most existing fishing vessels have a simple flat plate rudder fitted with little consideration for steering efficiency. Comparison of the traditional flat plate design with symmetric wing sections on existing fishing vessels should be undertaken. Also an investigation of nozzles or ducts that shroud propellers is suggested which would take into consideration the manoeuvering effectiveness and any interaction between the propellor and ice or propellor and fishing gear.

4.6 Fishing Vessels in Ice

Additional research is necessary to develop the optimum hull design for ice class vessels (Section 2.4). Areas of interest include:

a) reduction of fishing vessel resistance in ice, including reduction of sliding friction between the ice and the hull, eg. coatings, inerta 160 etc.

b) research to reduce ice induced hull damage and propellor/ice interaction

c) assessment of vessel manoeuvering characteristics in ice

4.7 Propulsion System Efficiency

Research into the improvement of the overall energy efficiency of the fishing vessel propulsion system is warranted. The DFO project described in Section 2.5 should be expanded to identify design modifications in propulsion system design leading to improved mechanical efficiency.

4.8 Fishing Vessel Construction Techniques

Research should be carried out to assess the economics/hull strength/hydrodynamic resistance and dynamic/static stability trade-offs on fishing vessels of different construction materials/techniques. There have been cases in the past of fiberglass fishing vessels fabricated with an inherent high center of gravity that gave it poor static/dynamic stability characteristics.

4.9 Novel Fishing Vessel Designs

Support for research into unorthodox fishing vessel designs such as catamarans, wind propelled fishing vessels and other novel concepts may yield interesting results. Dr. N. Bose of MUN has experience in this type of research.

5.0 RECOMMENDATIONS CONCERNING IMPROVEMENTS IN POST-SECONDARY EDUCATION

Adoption of the following recommendations should result in a post-secondary education system that better serves the fishing industry:

5.1 Newfoundland and Labrador Institute of Fisheries and Marine Technology

Recommendations for students pursuing a career in Naval Architecture or Marine Engineering:

a) An updated version of the Fishing Technology course described in Appendix A should be re-instituted. This course should be compulsory for all students!

b) The traditionally excellent relationship between the IFMT and all sectors of the fishing industry should be fully exploited. Perhaps a co-operative program could be initiated whereby all students are exposed to at least one aspect of the fishing industry. Students should spend time assisting on a fishing vessel or working in one of the many small boat yards around Newfoundland during their coop program workterms.

c) Proposals and support should be solicited from the fishing industry for relevant student projects.

In general, more students would secure employment within the fishing industry if closer links were fostered. Fishing vessel operators, designers and builders should be encouraged to take a more active role in education. Also companies like FPI, NATSEA, etc. could sponsor scholarships, workterm projects, etc. Unions could sponsor safety-related research for clothing, survival suits, deckgear, handling procedures, etc.

5.2 Memorial University of Newfoundland

5.2.1 Undergraduate Education

Recommendations for students pursuing an undergraduate degree in Naval Architecture Engineering are:

a) Closer links between MUN and the Newfoundland fishing industry would benefit everyone. Co-op students should be placed in the smaller boat yards or at sea on fishing vessels at least in the early work terms.

b) An optional course in Fishing Technology similar to the one outlined in Appendix A and taught by a qualified individual from the fishing industry should be offered.

c) Proposals and support from the fishing industry should be solicited for relevant student projects.

The modern fishing industry is a highly competitive and dynamic entity generating millions of dollars in revenue and providing thousands of jobs throughout the province. If the

Newfoundland fishery does not continually upgrade its fleet and facilities, carry out research to develop more efficient and innovative fishing technology, it will quickly fall by the wayside. The MUN Engineering graduate must play a greater role in this industry if it is to retain its vitality.

5.2.2 Fisheries Technology Program

A program in Fisheries Technology which includes fishing vessel design is offered in some countries, however, currently no university offers such a program in Canada. It would be possible to offer a Fisheries Technology program at MUN, but to be viable students would have to be attracted from other provinces. An investigation into the feasibility of such a program is warranted.

5.2.3 Post-Graduate Education

When an individual applies to MUN for entrance into Graduate Studies in Ocean Engineering, he/she submits a research proposal which is circulated to all Professors in the Department. If a Professor expresses an interest in the topic of the research proposal, and agrees to supervise the student, the student is accepted into the program (providing of course the student meets all other acceptance criteria). The shrewd applicant will thus submit a research proposal on a topic they know will interest a specific Professor. As can be seen from the list of research topics presented in Appendix B, this process appears to inhibit diversification, especially into the Fisheries Technology area.

The St. John's metropolitan area is isolated by geography and has a relatively small number of people qualified to supervise graduate research in Ocean Engineering. This is a fact of life. Thus to broaden the existing areas of research, two options should be explored:

a) A list of people qualified and willing to coordinate graduate research in Ocean Engineering along with their various areas of interest should be compiled. This would consist of both MUN Professors and other individuals in the local community deemed to have the necessary attributes and who agree to fulfill this role. These coordinators would perform two functions - ensure that the research carried out is relevant and that the high standards of Memorial University are preserved.

This option is not much different from the existing system although obviously the more research supervisors that are enlisted, the broader the range of research topics.

b) The candidate could be supervised by two people. One supervisor from outside MUN with an engineering background and

several years experience in the field of interest (ie: the fishing industry) would assess the relevance of the project and supervise the day to day research. The second supervisor would by drawn from the list in option one and would be responsible for ensuring that high standards are maintained.

Research carried out under option two would generally be applied in nature and may be restricted to Masters level students. This option would, however, serve to broaden the scope of research carried out at MUN considerably. There are several potential candidates for supervisory positions residing in the St. John's metropolitan area who would be qualified to supervise projects related to the fishing industry.

6.0 OTHER RECOMMENDATIONS

6.1 Wind/Wave/Current Data Base

A data base of wind, wave and current conditions in and around Newfoundland and Labrador should be compiled from such sources as the Marine Environmental Data Service (MEDS), U.S. Navy and the Bedford Institute of Oceanography (BIO). Efforts could be directed at securing this information for regions of interest not covered by existing data. The new IMD Ocean Engineering and Seakeeping Basin will be capable of emulating actual sea conditions described by this data base. These data would also be useful as an input to simulation/prediction software. An effort by NORDCO Ltd. to compile this data base is not yet complete.

6.2 Fishing Vessel Data Base

A data base of existing fishing vessel designs in Newfoundland and Labrador that includes basic hull definition/coefficients, propulsion system description, fishing gear description, areas of operation, length of season etc. should be prepared. This would be an invaluable source of information for researchers. The DFO "ENER SEA" data management system referred to in Section 2.5 is a good start in this direction.

6.3 Fishing Technology Committee

A permanent committee made up of representatives from the IFMT, MUN, IMD, the provincial and federal Departments of Fisheries and representatives from industry should be established with a mandate to:

a) co-ordinate research efforts which take full advantage of the co-operative agreement between the IFMT, MUN, and IMD. An

integrated approach to research is necessary to make the most efficient use of the limited Research and Development funding available. Priorities in fishing vessel research would also be established by this committee.

b) make recommendations with respect to the education of fishermen and fishing vessel builder/designers.

c) monitor and assess advances in fishing technology made here and abroad and make recommendations for the implementation of new technology in the Newfoundland fishing industry.

d) make recommendations based on the results of research to government regulatory agencies and the IMO on fishing vessel safety and design.

e) lobby government and industry for Research and Development resources.

7.0 ACKNOWLEDGMENTS

I would like to thank all those individuals who assisted me in the preparation of this submission. This included many people from the fishing industry, research community, government, as well as professors, administrators, students and former students of the educational institutions involved. Special thanks to Mr. R. Pearson (IFMT) and Mr. B. Milne (MUN) for their contributions.

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APPENDIX A

COURSE OUTLINE FOR NEWFOUNDLAND AND LABRADOR INSTITUTE OF FISHERIES AND MARINE TECHNOLOGY COURSE IN FISHING TECHNOLOGY

A. Course Outline

1. To familiarize students with deck layouts and equipment and the methods of operation in the various fisheries.

2. To instruct the students in the design and construction of fishing gear.

3. To instruct the students in the characteristics of fibres and construction of twines and ropes with comparison of breaking strengths.

B. Duration

12 weeks

C. Total time required

24 hours - 2 hours per week

D. Major Topics

1.0 General deck layouts on fishing vessels
2.0 Design features and dimensions of fishing vessels
3.0 Ancillary gear and deck machinery
4.0 Hauling and setting procedures
5.0 Design and construction of fishing gears
6.0 Characteristics of fibres
7.0 Construction of twines, ropes and wire ropes
8.0 Comparison of breaking strengths
9.0 Fishing grounds

E. Course Detail

1. General deck layouts

(1) Longliners - gill netters
(2) Side draggers
(3) Stern draggers
(4) Drum draggers
(5) Shrimp draggers
(6) Purse seiners
(7) Scallop fishing
(8) Combination fishing vessels

E. Course Detail (continued)

2. Design features and dimensions of fishing vessels

(1) Longliners - gill netters
(2) Side draggers
(3) Stern draggers
(4) Drum draggers
(5) Danish seiners - one or two boat method
(6) Purse seiners
(7) Scallop draggers
(8) Crab and lobster fishing vessels

3. Ancillary gear and deck machinery

(1) Winch used on side draggers
(2) Winches on stern draggers
(3) Split winches
(4) Cable winches
(5) Capstans
(6) Gurdies
(7) Line haulers
(8) Seine net winches & coilers
(9) Purse seine winches
(10) Power blocks for seine netters
(11) Power blocks for purse seiners
(12) Jiltson and tackle wire
(13) Dumping wires
(14) Warp tension meters

4. Hauling and setting procedures

(1) Longliners and gill netters
(2) Side draggers
(3) Stern draggers
(4) Drum draggers
(5) Danish seiners
(6) Purse seiners
(7) Scallop draggers
(8) Lobster & crab fishing vessels
(9) Pair Seining
(10) Pair Midwater
(11) Spanish Pair Trawling

5. Design and construction of fishing gear

(1) Bottom trawls
(2) Midwater trawls
(3) Seine nets
(4) Purse seines
(5) Gill nets
(6) Cod traps
(7) Long lines

E. Course Detail (continued)

5. Design and construction of fishing gear (continued)

(8) Drift nets
(9) Scallop dredges
(10) Lobster pots
(11) Crab pots

6. Characteristics of fibres

(1) Natural fibres - manilla, sisal, hemp.
(2) Synthetic fibres - nylon, polypropylene, polyethylene

7. Construction of twines, ropes and wire ropes

(1) Twines
(2) Ropes
(3) Combination ropes
(4) Wire ropes

8. Comparison of breaking strengths

(1) Breaking strength and working load of manilla and sisal ropes
(2) Breaking strength and working load of nylon, polypropylene and polyethylene
(3) Breaking strength and working loads of wire ropes

9. Fishing Grounds

(1) Location of major fishing grounds
(2) Depths of water and general bottom conditions
(3) Main species of fish caught

APPENDIX B

DISPOSITION OF MEMORIAL UNIVERSITY STUDENTS

NAVAL ARCHITECTURE STUDENTS
PLACEMENT OF STUDENTS
CLASS OF 1987

Lance Dawe:	Marystown Shipyards	(2 Work Terms)
	Fishery Products	(2 Work Terms)
David Foster:	Nfld. Marine Design	(4 Work Terms)
	Versatile Vickers	(1 Work Terms)
Boyd Howell:	Collingwood Shipyard	(1 Work Term)
	Rauma Repola - Finland	(1 Work Term)
	Gulf Canada Resources	(1 Work Term)
	Bouygues Offshore - France	(1 Work Term)
Brian Lomond:	Marystown Shipyard	(3 Work Terms)
	GVA - Sweden	(1 Work Term)
Jamie McCarthy:	A.J. Holleman	(1 Work Term)
	Petroleum Directorate	(1 Work Term)
	GVA - Sweden	(1 Work Term)
	Nortek Eng.	(2 Work Terms)
Paul Pearson:	Saint John Marine Consultants	(1 Work Term)
	Gotaverken Arendal - Sweden	(1 Work Term)
	I.M.D.	(1 Work Term)
	Melville Shipping Ltd.	(1 Work Term)
Michael Wadden:	German Marine	(1 Work Term)
	Burmeister & Wain - Denmark	(1 Work Term)
	I.M.D.	(1 Work Term)
	GVA - Sweden	(1 Work Term)

NAVAL ARCHITECTURE GRADUATES

Class of 1982
Bruce Colbourne - Graduate Studies, M.I.T., NRC/IMD
John Gillingham - Ocean Ranger Enquiry

Class of 1983
Moya Cahill - Newfoundland Ocean & Drilling, Nortek
Connie Carruthers - Seimac
Michael Fitzpatrick - Saint John Shipbuilding
Steven Lantos - Det Norske Veritas
John Maloney - German & Milne
Brian McGrath - Saint John Shipbuilding
Scott Newbury - Nordco, NRC/IMD
Antonio Ré - Nordco, NRC/IMD
Gary Savage - Nordco, NRC/IRAP
Stewart Strong - Det Norske Veritas

Class of 1984
Joao Aviero - Saint John Shipbuilding
Glen Bannister - Graduate Studies, Hamburg
Jim Butler - Nordco
Joseph Lee - Nordco
Kenneth Windsor - Conimax, NRC/IMD
Fraser Winsor - Nordco

Class of 1985
Jacqueline Kavanagh - Canada Steamship Lines
Philip Norris - Saint John Shipbuilding
Chris Ritcey - Saint John Shipbuilding
Anne Marie Ryan - Versatile Vickers
Roland Smith - Marystown Shipyards

Class of 1986
Peter Bennett - Graduate Studies
David Berger - MIL Industries
Gerald Brennan - Mobil Oil
William Carroll - Nordco
Ronald Drodge - Nordco
Dennis English - Versatile Vickers
Carl Harris - Institute for Marine Dynamics
Barbara Mackay - A.J. Holleman
Noel Murphy - Halifax Industries
Terry Toope - Graduate Studies
Gam Yeo - Husky/Bow Valley, Nortek

Class of 1987
Lance Dawe - Fishery Products International
David Foster - Newfoundland Marine Design
Boyd Howell - Bouygues Offshore
Brian Lomand - Marystown Shipyards
Jamie McCarthy - Consultants, B.C.

GRADUATE STUDENTS - OCEAN ENGINEERING DISCIPLINE

FALL, 1987

	NAME	THESIS TITLE
(Ph.D.)	Aboul Azm, A.	Ship Resistance in Broken Ice Infested Waters
(M.Eng.)	Bennett, P.J.	Angle Dependence of Rolling Damping Moment
(Ph.D.)	Choudhury, M.A.	Steady State and Dynamic Performance Study of Delta Pulse Width Modulated Inverter Fed Submersible Motor Pump
(Ph.D.)	Colbourne, D.B.	A Three Component Method of Analysing Ship Resistance in Level Continuous Ice
(M.Eng.)	Dunphy, P.M.	Hydrodynamic Loading on Floating Offshore Structures
(M.Eng.)	Goteti, R. (Thesis Submitted)	Real-Time Computer Control for a Model of a Submersible Escape Capsule
(M.Eng.)	Howell, R.K.	Ground Wave Remote Sensing of Ocean Wave Height Spectrum
(M.Eng.)	Lau, W.H.	Ice Forces on an Oscillating Cone
(Ph.D.)	Liyanapathirana, R.	Time-Frequency Analysis of Signals Relevant to Ocean Communications
(M.Eng.)	Mak, L.	Bergy Bit Impact with Semisubmersible
(M.Eng.)	Marshall, A.	Study of Ice Load Transmission Through Rubble Fields Around Caisson Retained Islands
(Ph.D.)	Marshall, M.A.	Model and Prototype Dynamic Response of an Offshore Drilling Platform Due to Wave Action
(M.Eng.)	Muste, T.G.	Impact Strength of Fibre Reinforced Concrete Slab Panels Under Cold Ocean Environment
(M.Eng.)	Nancarrow, R.D. (Thesis Submitted)	Soil Structure Interaction Under the Influence of Wave Loading

(M.Eng.)	Nwosu, D.	Fatigue Strength of Three-Dimensional Tubular Joint Subject to Random Loading
(Ph.D.)	Omar, A.	Estimation of Ice Impact Load on a Ship's Stiffened Plate Using Measured Dynamic Responses
(Ph.D.)	Parsons, B.J.	The Fracture Mechanics of Ice
(M.Eng.)	Paterson, B.	Resistance of Ships in Ice
(Ph.D.)	Prasad, K.S.R.	Finite Element Analysis of Porous Soil Response Under an Axi-Symmetric Gravity Structure
(M.Eng.)	Raisanen, P.J.	Ice Movement in the Vicinity of a Drill Ship
(Ph.D.)	Raman-Nair, W.W.	Stability of Seabed Slopes Under Wave Loading Using the Boundary Element Method
(Ph.D.)	Rzentkowski, G.L.	Flow-Induced Vibrations in Marine Riser
(Ph.D.)	Sen, D. (Thesis Submitted)	A Numerical Method for Two-Dimensional Studies of Large Amplitude Motions of Floating Bodies in Steep Waves
(M.Eng.)	Singh, S.	Dynamics of Ice-Structure-Interaction
(M.Eng.)	Song, S.	Wave and Current Interaction
(Ph.D.)	Srinivasan, N.	Damping Controlled Response of a Deep Water Tripod Tower Platform to Random Wave Excitation
(M.Eng.)	Steel, M.A.	Liquefaction Potential of Soils Related to Offshore Foundation Stability
(M.Eng.)	Stoneman, W. (Thesis Submitted)	Investigation of Remotely Operated Underwater Vehicle Motion and Computer Simulation
(M.Eng.)	Thiagarajan, K.P.	Higher-Order Wave Loading on Vertical Surface Piercing Circular Cylinders

(M.Eng.)	Toope, T.A.		Compressive Strength of Glacial Ice
(M.Eng.)	Warikoo, R.		Transverse Vibrations of Propellor Shaft
(M.Eng.)	Wilkie, B.		Heave Resonance of Wave Excited Structures
(M.Eng.)	Williams, P.G.		Crack Detection Procedures Using Acoustic and Electrical Methods
(Ph.D.)	Wishahy, M.	(Thesis Submitted)	Time-Domain Numerical Simulation of the Motion of Small Floating Bodies Drifting in Waves
(M.Eng.)	Yetman, R.	(Thesis Submitted)	Wave Attenuation by the Deltaport Floating Breakwater