Industry and Academic Collaboration Through the Master of Engineering in Concurrent Marine Design Program at the University of Michigan

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UM College of Engineering

- 11 Departments

* Aerospace Engineering
* Atmospheric, Oceanic, and Space Sciences
* Biomedical Engineering
* Chemical Engineering
* Electrical and Computer Engineering
* Industrial and Operations Engineering
* Material Science and Engineering
* Mechanical Engineering
* Naval Architecture and Marine Engineering
* Nuclear Engineering and Radiological Sciences

- 6 Interdisciplinary Professional Programs

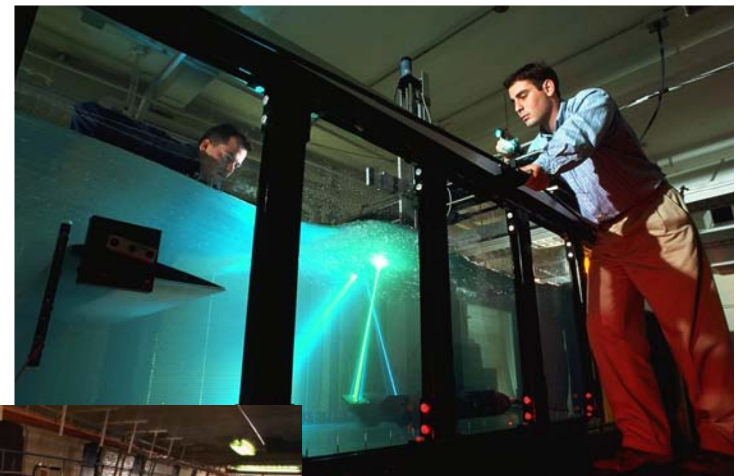
* e.g. Manufacturing

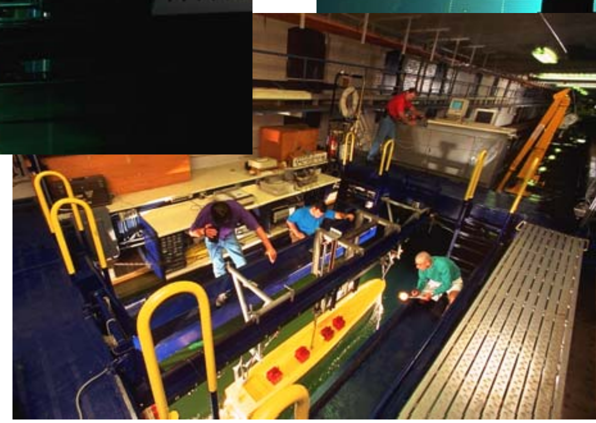
College of Engineering

- Established 1854
- Consistently Ranked Among Top UG and Grad Programs
- 4,735 Undergraduates
  * Median SAT 1,340
  * Mean HS GPA 3.9
- 2,700 Graduate Students
- 318+ Faculty
- 88 Research Faculty
- 513 Staff

Department of NA&ME

- Courses First Offered 1881, Curriculum Established 1899
- ~110 Undergraduate
- ~90 Graduate Students
- 15 Faculty (3 Joint)
- 5 Research Faculty
- 10 Staff



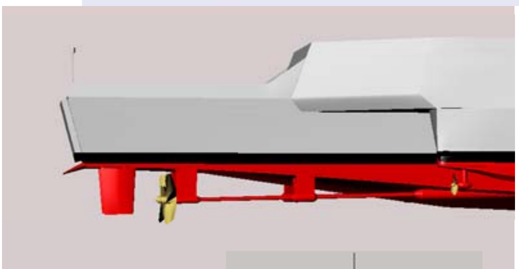


http://www.engin.umich.edu/dept/name/

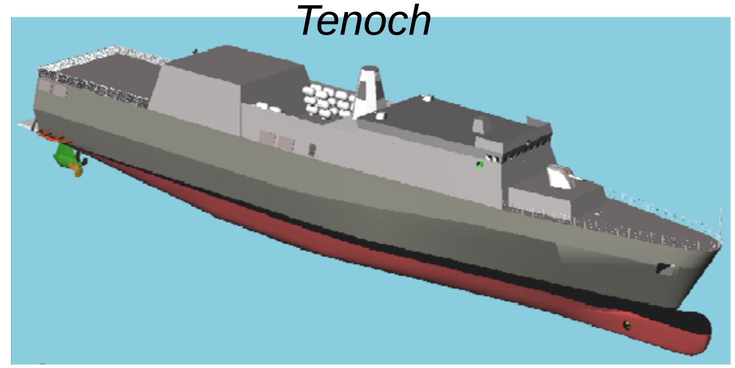
NA&ME Building and Chase Plaza
Student Welcome, September 2007

NA475 Design Examples

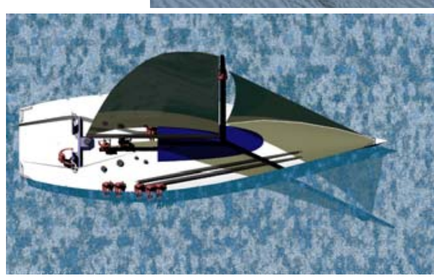
2,200 t Trimaran Offshore
Patrol Vessel/Frigate



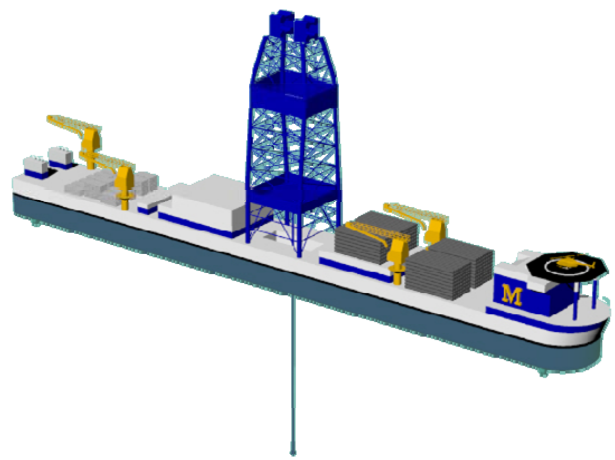
Landing Platform Dock (LPD)
Tenoch



Volvo 60 Ocean Cruiser



“Design Report Drillship Nereus”
2003 International Student
Offshore Design Competition
Winner



Origins of the Master of Engineering Degree

Requested by the College's National Advisory Committee

They wanted an alternative to the MBA path followed by many engineers

Wanted a one-year professional Masters degree with more breadth and a chance to include management

In College of Engineering (like MBA in MBS) instead of Rackham Graduate School (like M.S./M.S.E./Ph.D)

M.Eng. (Concurrent Marine Design) Mission

Focus on Marine Product Development with the goal of preparing IPPT design team leaders

Concurrent Engineering focus emphasizing the concurrent consideration and development of both product and process

Initial emphasis on students returning from industry – somewhat more professional and less academic

State Approved M.Eng. (CMD) Template

- Prerequisites – engineering B.S. degree
  – NA470 Foundations of Ship Design
  – Probability and Statistics
- Courses in naval architecture (12 credits)
- Courses in other parts of engineering (6 credits)
- Courses outside of engineering (6 credits) – business, languages, mathematics, transfer credit, etc.
- Industrial team project (6 credits)

History of Industrial Team Projects

- Originally arranged, organized, and supervised to Tom Lamb
- Most have been focused on manufacturing
- Company provides problem and pays for student incidental and travel costs
- Three visits – kickoff, midterm report, and final reports
- Some on-site work – one group at Bender
- Primarily tier two shipyards due to need to accommodate foreign students

Industrial Team Projects

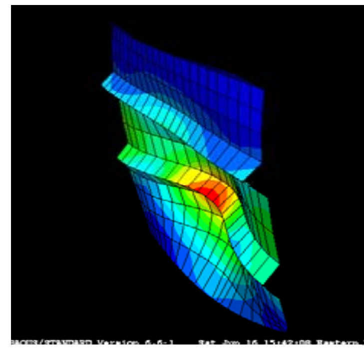
1996	Development of a Pre-installed Machinery Stern Module	Kvaerner Masa Marin
1997	A Shipbuilding Policy Developer	Bender Shipbuilding
1998	Simulation of Shipbuilding Process	Port Weller Drydock
1999	A Comparison of a U.S. and a Norwegian Small Shipbuilder	Atlantic Marine, USA, Hellesoy Yards, Norway
2000	Development of Ship Design Alternatives	TOTEM OCEAN
2001	Advances Structure Design for Laser Welding	Bender Shipbuilding
2002	Computer-Based Defect Control System and Shop Planning System	Baja Marine
2003-1	Integrated Tug/Barge Model Testing Problem Resolution	Interlake Steamship Co.
2003-2	A Depot Maintenance Plan for 47' MLBS	U.S.C.G
2004	Production Industrial Engineering Analysis and Simulation for Steel Processing Shop	Bender Shipbuilding
2005	Design and Material Selection for a Wave Energy Machine	Vortex Hydro Energy,
2007	Analysis and redesign of USCG 18' Ice Rescue Boat U.S.C.G	U.S.C.G
2008	Design of a Steel Slab Carrier for Great Lakes Service	GLMRI/Duluth PA
2009	Heartland Waterway Vessel: River Tender Replacement Project	U.S.C.G

Program Change

- In 2006 David Singer took over responsibility for the M.Eng. Program as well as the NA579 projects.
- Shifted focus of NA579 projects from strictly manufacturing and tier two southern yards to:
  - Design Oriented – new and old
  - Great Lakes community and Midwest region community
  - United States Coast Guard relevant projects
- Reason for Shift
  - The M.Eng. Course requirements are much more focused on design but the projects were manufacturing. Additionally the courses that exist in the supporting departments such as I.O.E. have moved away from traditional manufacturing.
  - The Gulf Coasts have funded shipbuilding centers and other resources, why are we supporting them? Great Lakes school should support the Great Lakes region.
  - Cost and funding changes since M.Eng. start
  - 80%-100% of our M.Eng. students are USCG officers. We should do CG related projects.
  - Selecting Great Lakes / USCG projects decreases individual participants cost via leveraging of resources.

USCG 18’ Ice Rescue Boat
Problem Statement

- Does the boat have sufficient buoyancy & stability?
- How can the structure be improved to prevent dishing & broken welds?
- Is the operational profile valid?



	LA (g)	LF (lbs)	TA (g)	TF (lbs)	VA (g)	VF (lbf)
Average	0.741	4,002.208	0.487	2,628.533	0.758	4,090.748
Median	0.594	3,209.471	0.395	2,132.957	0.583	3,146.575
Max	2.568	13,865.953	2.426	13,099.768	6.125	33,075.805
Min	0.250	1,350.146	0.250	1,350.869	0.250	1,351.285
Ext Out	4.307	23,256.997	1.839	9,928.397	4.347	23,492.776

USCG 18' Ice Rescue Boat

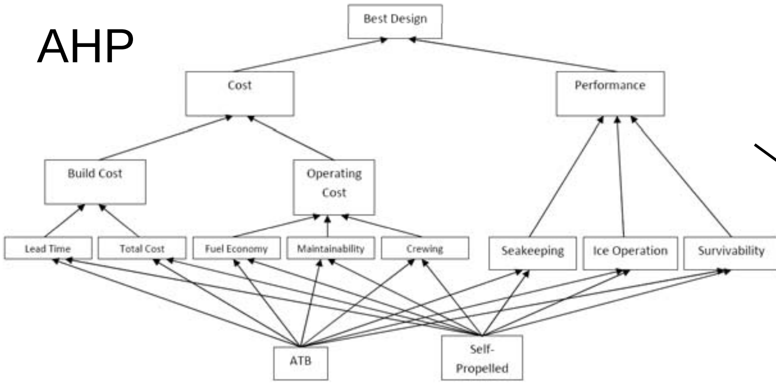
Activities completed

- Stability Analysis
- Structural Analysis
- Recommended Hull Modifications
- Operational Profile
- Safety Concerns
- General Recommendations for Ice Boat Mission

Result

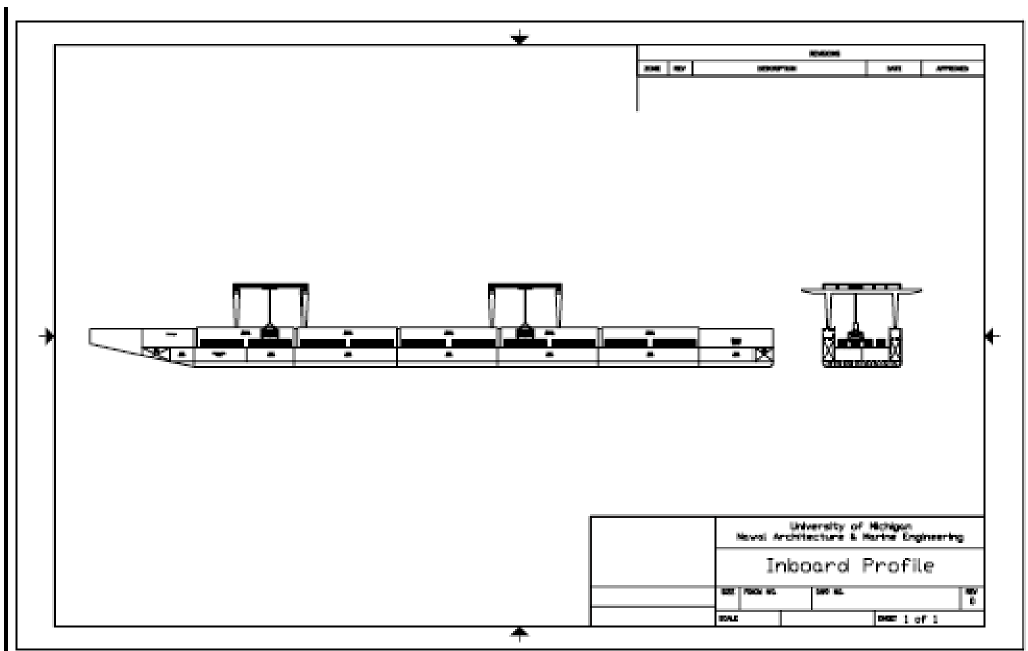
Design of a Steel Slab Carrier for Great Lakes Service

AHP



Discrete Event Simulation

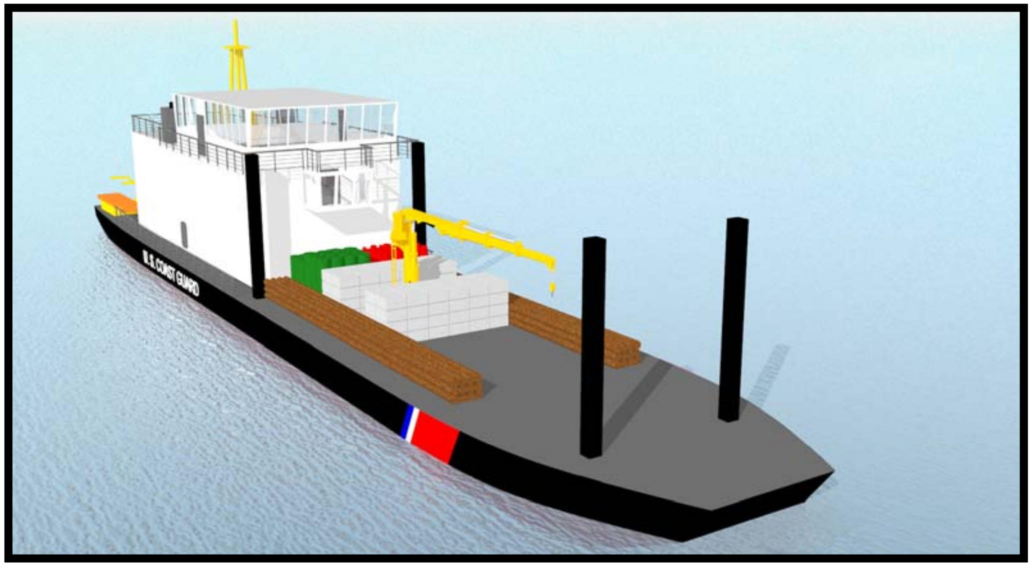
Design



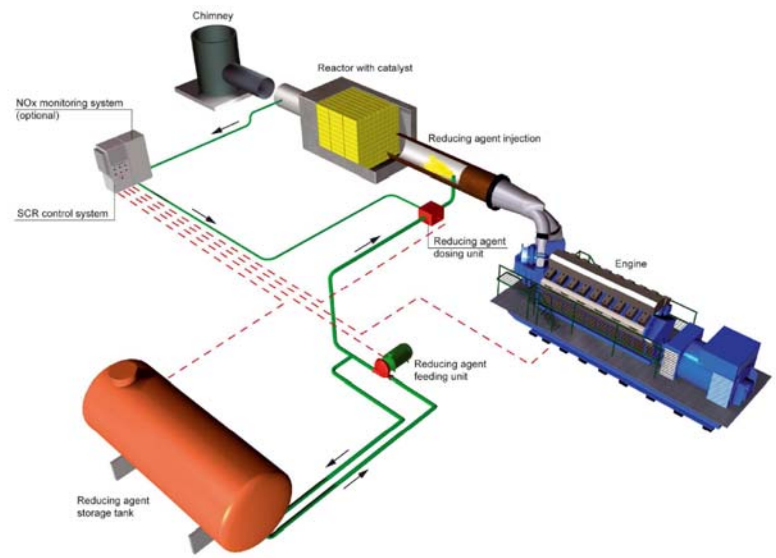
The Heartland Waterway Vessel Design Objectives

- Complete a feasibility assessment for a replacement to the existing River Tender fleet
- Do a preliminary design analysis of the ship – hull form, propulsion system, general arrangements, etc.
- Select a propulsion system and determine what emission mitigation systems will be needed to meet current and expected EPA requirements

The Heartland Waterway Vessel



Selective Catalytic Reduction



Evaluation of Integrated Electric Plants for Great Lakes Self-Unloaders

- 2009-2010 GLMRI funded project
- Proposal was a direct response to the request received from the GLMRI office to consider an investigation of the use of electric drive in future Great Lakes vessels.
- The goal of this research is to investigate the feasibility and potential advantages of using Integrated Electric Plants in future Great Lakes self-unloaders. This will consider arrangements, effects on cargo capacity at constant draft, fuel usage and environmental emissions over all operating modes, maintenance requirements, manning, and overall ship economics.

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Electric Drive Option

- "electric drive should be considered for any application where the ship spends much of its time at loitering speeds, when high ship power requirements exist, or where special mission power requirements dictate its use" and "all modern electric drive installations are of the integrated type with the same generators used to provide both propulsion and ship service power" (Stewart 2009)
- Great Lakes self-unloaders are characterized by:
  - Small relative power requirement due to their low speed,
  - Represent extreme case of a varying speed profile
  - Large lateral thruster
  - Self-unloading and deballasting loads that are relative large fractions of the propulsion power required.
  - Spend about 1/3 of their time at reduced speed or in port

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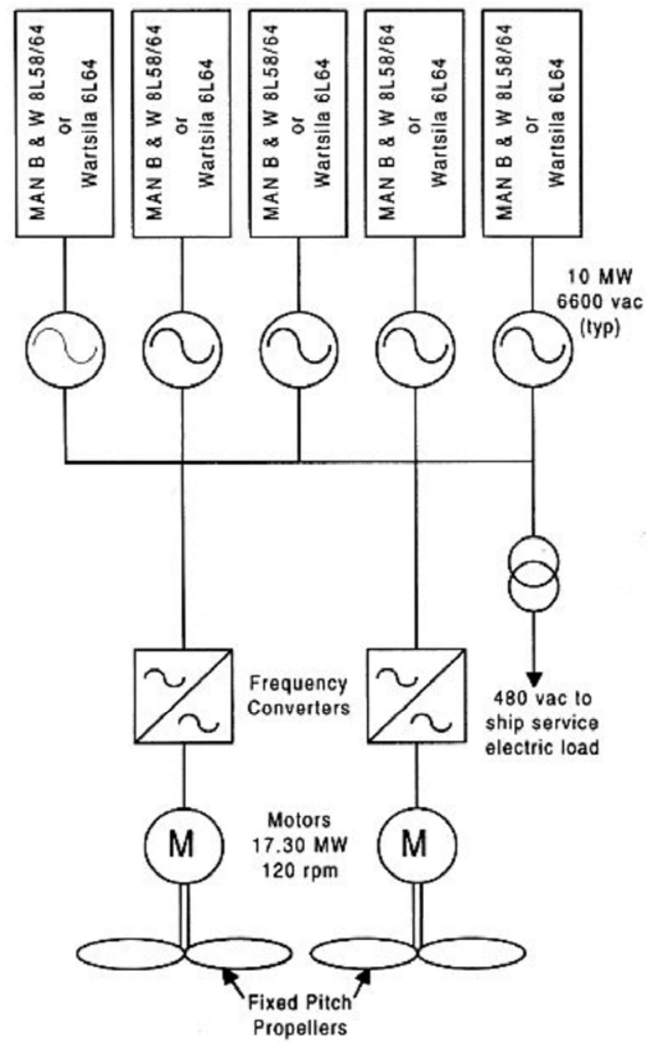
Typical Bulker Power Profile

mode of operation	percent propulsion power	percent auxiliary power	hours per round trip	percent round trip time
loading	0.0%	80.0%	6.0	4.4%
maneuvering	30.0%	70.0%	7.0	5.2%
reduced speed	50.0%	45.0%	8.0	5.9%
open lake	85.0%	45.0%	103.0	76.3%
locking	10.0%	45.0%	1.0	0.7%
unloading	0.0%	90.0%	10.0	7.4%
total			135.0	100.0%



Notes

- Concept allows for optimal loading of generator engines for various operating modes and increased flexibility for maintenance operations.
- Lowest overall annual fuel and lube oil consumption costs of the three conventional drive systems studied (Alternatives "A", "B", & "C")
- Low height of engines permits reduction in engine room height, allowing addition of drive through (port & starboard) at second deck level (not possible with slow speed diesels).
- Better suited to high propulsion maneuvering demands than slow speed diesel plant.
- Permits use of fixed pitch vs. controllable, reversible pitch propeller.
- No mechanical connection between diesel engines and propellers resulting in flexibility in machinery room arrangement.
- All main diesel engines are of same model, resulting in simplified spares compared to slow speed diesel plant.
- High level of redundancy for propulsion and ships service electrical power demands.
- No gearbox required.
- Approximately 8 percent electrical power conversion loss in propulsion train.
- Supports bow thruster without additional generator capacity.

Specific Fuel Consumption at Full Load*:
128 g/mBHP-h

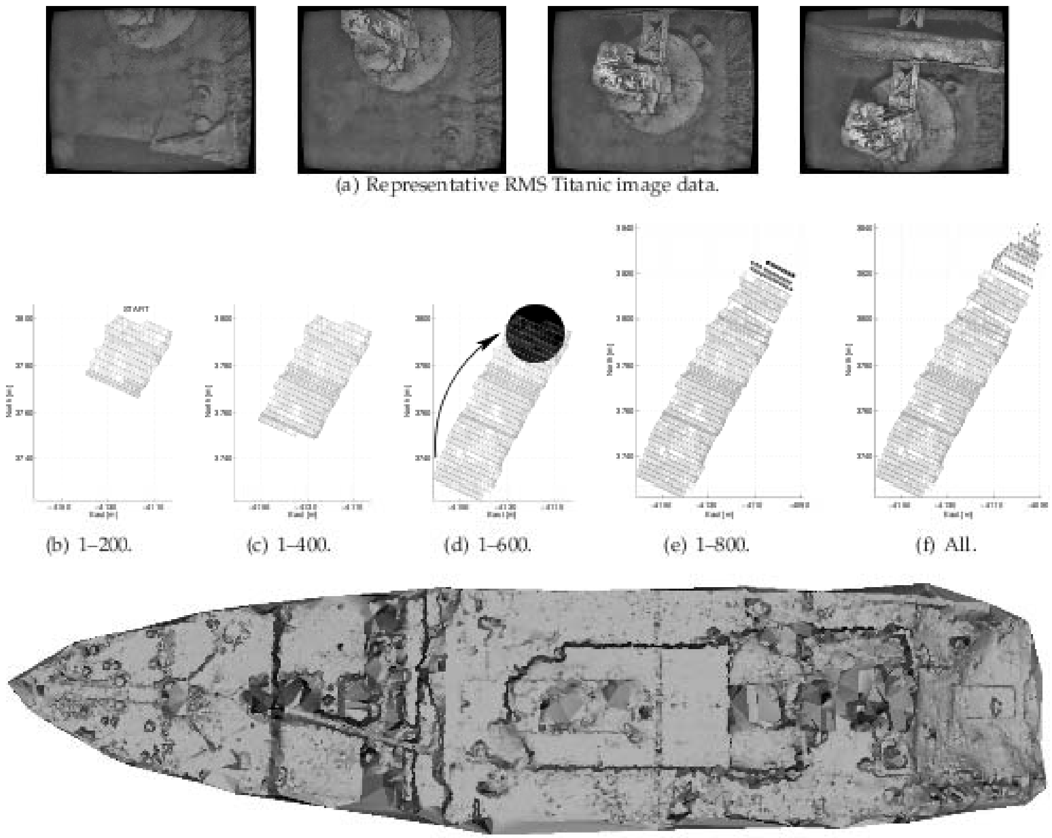
*Based on MDO fuel, no attached pumps & excluding 3 percent manufacturer's margin.

Integrated Electric Plant Studied for the Orca Class Ro/Ro's

Project Tasks

- **Task 1.** Develop a typical conventional plant and Integrated Electric Plant for two notional of Great Lakes self-unloaders assuming a 1000' iron ore carrier and a 660-700' coal/limestone carrier.
- **Task 2.** Investigate the cargo capacity and construction benefits of more flexible arrangements with an Integrated Electric Plant.
- **Task 3.** Gather input data and perform life-cycle cost comparison of the two alternatives.
- **Task 4.** Conduct air emissions comparison

- Questions?



(a) Representative RMS Titanic image data.

(b) 1–200. (c) 1–400. (d) 1–600. (e) 1–800. (f) All.

(g) Plan view of the Delaunay triangulated surface.