Ulstein Ship Design Professorship – 1st Year Report

Henrique M. Gaspar
Associate Professor

Gaveprofessorater Ulstein
1st Year (2013/2014)
Three Fundamental Branches

Teaching
- classes, MSc supervision
- international students
- extra-curricular activities

Research
- cooperation within HIALS
- maritime knowledge hub
- and international institutions

Industry
- strong cooperation with Ulstein group
- and related companies in the region

Henrique M. Gaspar / Gaveprofessorater Ulstein – 1st Year (2013/2014)
Agenda

- **Teaching**
  - Ship Design (fall & spring, w/ Arne Jan)
  - Strength Calculations (fall w/ Arne Jan)
  - Short Courses (Matlab, Research Methods)
  - Best Practice Systems Engineering (from Fall 2014)
  - Bachelor and Master's Supervision (HIALS, NTNU, UFSC)
  - International Cooperation (USP, UFSC, MIT, UCL)

- **Industry (Ulstein Group)**
  - EMIS
  - Ulstein Internal Projects (Parametric Design, Multi-objective methods, Custom and Standard design)

- **Research**
  - Ship Design Lab
  - NTNU/MIT/USP/UFSC Research
  - Internship Supervision
  - Project Proposals (BIP, SFI)
  - Scientific Papers (Journal/Conferences)

- **Future Tasks**
Time Breakdown

11.4% Industry
25% Teaching
13.6% Research

9.1% Strength Calculations
6.8% Ship Design
4.6% EMIS
4.55% Ulstein Projects
2.3% Short Courses
2.2% International
2.2% Industry
2.2% Research
13.6% Teaching
29.5% Research
6.8% Teaching
6.8% Industry
15.9% Teaching
45.5% Teaching
9.1% Teaching
9.1% Teaching
11.4% Industry
25% Teaching
13.6% Research

29.5% Research
6.8% Teaching
6.8% Industry
15.9% Teaching
45.5% Teaching
9.1% Teaching
9.1% Teaching
11.4% Industry
25% Teaching
13.6% Research

Henrique M. Gaspar / Gaveprofessorater Ulstein – 1st Year (2013/2014)
Teaching

**Ship Design**

With Arne Jan and Øyvind Kamsvåg)
Fall & Spring Ship Design course (2nd year, Bachelor)

**Strength Calculations**

With Arne Jan Paul Stephen Kleppe
Fall Product and Ship Design course (2nd year, Bachelor)

**Short Courses**

With Karl Henning and Vilmar Æsøy
(Matlab, NCE Seminar, Design Methods, Science w/o borders)
Teaching

45.5% of time spent on this task

Teaching

Supervision
- Bachelor HIALS (2 students)
- Bachelor UFSC (1 student)
- Master NTNU (co-supervision, 1 student)
- PhD advice NTNU/HIALS (informal)

International
- UFSC and USP (Brazil) cooperation (students, quota scheme, etc)
- UFPE (Brazil) agreement in progress
- CIAGA/CIABA partnership (paused)

 Henrique M. Gaspar / Gaveprofessorater Ulstein – 1st Year (2013/2014)
Teaching

Travel Salesman Problem Exercise

Exercise:
- a) For the coordinates presented below, develop a code to find all possible paths, plus the minimum path – distance and path.
- b) Adding E = (40,30), F = (80,70), G = (80,30), H = (90,30), I = (20,30), what is the minimum path? What is the minimum distance?
- c) Present your code and a plot of the cities. Explain your code.

Coordinates of each city: A = (0,0), B = (100,100), C = (0,80), D = (50,50)
Create all paths: ABCD, ABCD?, ABDC, ABDC?, ACDB, ACDB?, ADDB, ADDB?, ADDB?
Check every path: Min: [ABC, D, B, A, C, A, B, D, C, D, B, A, C, A, B]
Select smaller distance: Min: [ABC, D, B, A, C, A, B, D, C, D, B, A, C, A, B]

3D Beam Example

1) Consider a rectangular prismatic barge, where; breadth = B, length = L, depth = D = 4.0 x 1.0 x 0.5, center of gravity, G_z = 0.5L, floating in a fluid, F = 253 kN.
2) Calculate the transverse and longitudinal metacentric height (GM_x and GM_y) in function of the breadth (B).
3) Using the expression calculated in 1), find GM_x and GM_y, for B = 30m.
4) Consider a prismatic barge from example 1, for B = 30m:
   a) Calculate the empty volume (V_barro) = breadth x depth x length = 0.125 m^3.
   b) Calculate the displacement (D) = GM x F/9.81 = 9.81 x 0.5 x 0.5 x 0.5 x 0.5 = 0.565 m^3.
   c) Calculate the draft (T) = GM x F/9.81 = 9.81 x 0.5 x 0.5 x 0.5 x 0.5 = 0.565 m^3.
   d) Calculate the length (L) = GM x F/9.81 = 9.81 x 0.5 x 0.5 x 0.5 x 0.5 = 0.565 m^3.
   e) Calculate the length (L) = GM x F/9.81 = 9.81 x 0.5 x 0.5 x 0.5 x 0.5 = 0.565 m^3.
   f) Calculate the length (L) = GM x F/9.81 = 9.81 x 0.5 x 0.5 x 0.5 x 0.5 = 0.565 m^3.

Damaged Stability

- Method of lost buoyancy
- Method of added weight

Grounding

- Ship Design for a certain draft
- Shallow waters areas
- Unpredictable changes in tide
- Human Error
- Structural damage
- Critical draft
- Instability and capsizing

http://www.youtube.com/watch?v=d5hOcABC1dQ
http://www.youtube.com/watch?v=6A3kJV3X0xA
http://www.youtube.com/watch?v=KPF9WtZ4r7U

Henrique M. Gaspar / Gaveprofessorater Ulstein – 1st Year (2013/2014)
Research

Proposals

- BIP (w/ Ulstein, 3yr project, 5MNOK)
- SFI (multi-partnership project)
- Pre-projects sketch

In progress:
- 6 Conference papers (IMDC/SOBENA)
- 2 Journal Papers
- Diverse reports

Publications

- ÆMIS - Effective Ship Design, Engineering and Fabrication: - Facilitation of beyond state of the art modular and standardized ship design, engineering and fabrication approaches, HM Gaspar, Brett, PO, Hildre, HP – BIP project application (2013)
- New vessel design approaches and the gradual obsolescence of the current designers’ software application toolbox, HM Gaspar HIALS Research Seminar (2014)
- Data-Driven Documents (D3) applied to Conceptual Ship Design Knowledge, HM Gaspar, PO Brett, A Ebrahimm, A Keane, COMPIT 2014 (UK)
- Data-Driven Documents (D3) applied to Conceptual Ship Design Knowledge – Online Examples , HM Gaspar, HIALS (2014)
- Parametric Ship Design A Simple Application in HTML + Javascript, HM Gaspar, HIALS (2014)
- Lifecycle Model for LNG fueled Ships Operating in the Arctic via Epoch-Era Analysis, HM Gaspar, HIALS (2014)
- Epoch-Era Analysis using Blue Ship Invest case as Example - A Simple Application in HTML + Javascript, HM Gaspar, Ulstein Internal Report
Research

Internships
- 2 bachelor levels (Brazil)
- 1 Master level (France/Brazil)
- Co-supervision (w/Ulstein)

Ship Design Lab
- Initial tasks
- Infrastructure
  - (w/ Karl Henning and Vilmar Æsøy)

Seminars
- Research Seminars AMO/AIR
Research – OMAE 2014

OMAE2014-23914

CHALLENGES FOR USING LNG FUELED SHIPS FOR ARCTIC ROUTES

Henrique M. Gaspar
Aalesund University College
Aalesund, Norway

Søren Ehlers
Norwegian University of Science and Technology
Alesund University College
Trondheim/Aalesund, Norway

Vilmar Alsvik
Aalesund University College
Aalesund, Norway

Sandra Eriseg
Norwegian University of Science and Technology
Trondheim, Norway

Oceane Ballard
DNV GL
Havik, Norway

Hans Petter Hildre
Alesund University College
Aalesund, Norway

ABSTRACT

The utilization of the Northern Sea Route by commercial ships is an official fact. Since 2009 the number of international cargo vessels using the passage has been increasing, and a considerable rise in these numbers is expected if the route establishes itself as reliable. The route saves vessels approximately two weeks’ time in summer over a route via the Suez channel, but the increased shipping volumes, regarding environmental impact, safety, and operability on the route.

This paper investigates the current challenges of using LNG fueled ships for arctic transport routes. A panacea of the recent conditions and predictions for the arctic environment regarding ice concentration and seasonal route availability is presented. The current development of LNG as a commercial fuel is discussed based on this arctic panorama, approaching key topics such as infrastructure, economic viability, propulsion requirements, and environmental impact. Special attention is given to the performance of LNG propulsion systems under arctic conditions, focusing on powering and air emissions.

We conclude the paper by proposing the implementation of a lifecycle model to predict economical and environmental performance indicators when simulating a fleet of LNG fueled ships operating under many possible future ice conditions scenarios.

INTRODUCTION – THE ARCTIC AND LNG FUELED SHIPS

The Russian Federation opened up the Northern Sea Route (NSR) for foreign traffic in 2009 and thereby a new transport route connecting Europe to Asia. By July of 2013 the administrators of the NSR had granted permission to 284 ships to sail this year (Mile, 2013). Moreover, some activity also occurred on the Northeast Passage, with the ice-strengthened bulk carrier Nordica running through the route from Vancouver to Finland. Figure 1 provides an overview of the routes in the arctic (OMAHAUS, 2013). The implications of the diminishing Arctic icecap for maritime transport are unclear. On the one hand, a possible opening of the Northern or Trans-Arctic Sea route represents about 50% reduction of the sailing distance for several trading routes. These vessels that can exploit this opportunity are likely to improve their competitive position significantly. On the other hand, the operational challenges in these waters, and the corresponding risks and uncertainties involved, are considered very severe. This includes political factors (Russian territorial waters), environmental concerns (possible oil spills and air pollution), operational conditions (harsh environment, distance to nearest land base, rescue time etc.), ice navigation (possibility of drifting ice), contractual and insurance issues (increased probability of delays) and the length of the season that is sufficiently ice free. As a result, arctic transit is not even considered by most shipowners. However, DNV (2010) suggests 480 container transit voyages across the Arctic Sea in 2010, primarily using the NSR. Arctic areas are also very important for marine biomass production, and highly sensitive to environmental impacts. Therefore, emissions to sea and air must be kept to a minimum, and care must be taken when activities expand into these areas. Direct oil spill and air emissions such as sulphur (SOx), nitric oxides (NOx) and particulate matter (PMx) are the result of burning residual fuels such as heavy fuel oil. As a consequence, heavy fuel oil is banned in the Antarctic and coastal waters of Switzerland. In this context, LNG is now introduced as a very clean alternative fuel.
Data-Driven Documents (D3) applied to Conceptual Ship Design Knowledge

Henrique M. Gaspar, Aalesund University College, Faculty of Maritime Technology and Operations, hgas@hais.no
Per Olaf Brett, Ulstein International AS, per.olaf.brett@ulstein.com
Ali Ebrahim, Ulstein International AS, ali.brahim@ulstein.com
André Kanes, Ulstein International AS, andre.kanes@ulstein.com

Abstract
This paper focuses on data-driven documents (D3) examples applied to the conceptual ship design process, especially in how to effectively and quickly filter and present complex input, multilevel and multifaceted interactions, associating into design knowledge. The traditional ship breakdown structure, with costs and subsystems elements, is encapsulated via analogous representations, such as tree layout, force layout, pack layout, sunburst layout, and Sankey diagrams. Large dependency matrices are represented via interactive chord diagrams (dependency wheel and hierarchical edge bundling). A parametric design web application is used as example, to tie in a single structure knowledge representation. An overall discussion is presented, focusing on how this approach improves the expressiveness of data and interactions in an industrial ship design context, allowing the designer to better interact with a conceptual ship design dataset, as well as facilitating the presentation of the expectations of stakeholders involved.

1. Knowledge in Conceptual Ship Design

A good functional design description requires gathering conceptual ship design knowledge, that is, an efficient exploration of existing and related information. Even as the freedom to change the primary variables of the design decreases as a design progresses through phases, the engineer’s knowledge of the problem and how the design could be adapted to the situation increases (Erlstad 1996; Brett 2012). In other words, as one goes to a more detailed part of the process, the decisions narrow toward a certain set of solutions. Ontologically, to make a decision means giving up other options, thus decreasing the freedom to modify the design parameters in future stages of the process. The idea of conflict between design knowledge and freedom to change is presented in Figure 1a.

The objective of every design method during the conceptual phase is thus to create knowledge as early as possible, without compromising much of the freedom, as observed in the lighter line from Figure 1a. In other words, a designer would like to have as much flexibility as possible to improve vessel parameters while acquiring fast knowledge about her decisions, hopefully decreasing risk and uncertainty (OMNOX, 2008).

Figure 1 - Trade-off between freedom to change a design and the knowledge acquired during the process (a) and basic design process (b), based on Erlstad (1996).

In addition, designers must seek elucidation of the requirements proposed by Andrews (2003, 2011). The author contrasts fixed and straightforward approaches to a pre-established list of requirements,
Research – Ship Design Lab

- Develop applied research in design and behavior performance of ships for complex offshore maritime design and operations
- Contribute to establish a strong research group at AMO
- Apply for projects and funding from research council and industrial partners
- To involve competent and motivated colleagues (researchers, students, visitors) to take part in the activities
- Balance between teaching, research and industrial collaboration
Industry

Ulstein Internal Projects
- Design Best Practice
- Systems Engineering
- Industrial Approach

EMIS
- BIP Project
- Applied research
Research + Industry – EMIS BIP

activities in the value chain
- conceptualisation
- design
- construction
- manufacturing systems equipment and components
- assembly
- commissioning and testing
- deliverable
- operation
- scrapping

required design modelling/analysis
- 3D
  - low
- 2D
  - high
  - medium
  - ?

activities man-hours
- offshore support vessel: 300 000 - 500 000 man-hours in upstream value chain until delivery

? redesign and re-construction hours after delivering
3 Main Objectives:

1. Develop a cost-effective **framework for design and engineering of Offshore Vessels** based on a modularized and standardized approach, through the whole value-chain, from the conceptual design of the vessel until scrapping.

2. Develop a system theory based prototype design tool able to concurrently **integrate the framework with the current module work** at the value-chain.

3. **Test and implement** the framework within the value chain elements.
Henrique M. Gaspar / Gaveprofessorater Ulstein – 1st Year (2013/2014)

**2 research lines: Framework and 3D Modular System Integration**

**UDD FRAMEWORK TASKS JUNE 2ND**

- Study on an multi-stakeholder/multi-platform framework needs and functionalities, which integrate the multi-levels of the ship design value chain (Ulstein Design Dashboard - UDD)
- Sketch of a prototype version of the framework, integrating designers and clients approaching conjointly a conceptual design
- Integrate basic parametric equations for a fast first approach design in the framework
- Study on the level of detail required to jump from fast to customized design in the framework
- Sketch methodology for integrating the framework with Ulstein tools from 2015
- Summary of the pros and cons of the approach

**AUGUST 5TH UPDATE**

- UDD Presentation July 8th [1]
- Functionalities presented in [1]: Waiting feedback for requirements from Øyvind Kamsvåg, Per Ivar Roald and Stein Frode Haugen. Prototypes activities starting in August.
- Meeting with Ali & Per Olaf during August. Implementation Framework starting from August.
- Study requiring feedback from other tasks, probably starting around October/November
- Study requiring feedback from other tasks, probably starting around October/November
- Study requiring feedback from other tasks, probably starting around December

**CAD/CAE SOFTWARE TASKS**

- Study on using NX as tool for rapid ship design prototype: first phase - conceptual design
- Tutorial on how to draw a simple hull in Siemens NX (conceptual design)
- Tutorial on how to parameterize a simple hull in Siemens NX
- Study on which calculations are provided “out of the box” for Stability and Structural analysis
- Study on the level of detail required to jump from conceptual to basic design in Ulstein case
- Proposal for methodology to merge CAD/CAE with the UDD framework from 2015
- Summary of the pros and cons of the approach (bottlenecks)

**AUGUST 5TH UPDATE**

- Short example during April’s workshop [2] and another case during Allan’s internship [4]
- A more robust case connecting MaxSurf and/or Napa should be done during September/October
- Sketch from Allan’s internship [4]
- A more robust case using MaxSurf and/or Napa should be done during September/October
- Sketch from Allan’s internship [4]
- A more robust case using MaxSurf and/or Napa should be done during September/October
- Requiring NX server implementation, probably starting around October/November
- Requiring NX server implementation and Ulstein design team feedback from the prototype, probably starting around October/November
- Study requiring feedback from other tasks, probably starting around November/December
- Study requiring feedback from other tasks, probably starting around November/December
Ulstein Internal Projects

Internal projects on Ship Design and Modular Integration (confidential)
Future Tasks

- **Teaching**
  - Improve current courses
  - Intensify International Cooperation (USP, UFSC, MIT, UCL)

- **Industry (Ulstein Group)**
  - EMIS 2+ years
  - Ulstein Internal Projects

- **Research**
  - Ship Design Lab Starting
  - Integration with other Labs
  - NTNU/MIT/USP/UFSC Research
  - Integrate Science without Border Students with Projects