

# Design of Value Robust Container Ship Using the Responsive System Comparison Method

Magnus Dickens (magnusdi@stud.ntnu.no)

Supervisor: Bjørn Egil Asbjørnslett (NTNU)  
Company contact: Espen Gjerde (Ship Finance International)

## Background

Traditionally the conceptual phase of ship design has focused on the technical analysis - the mapping from the design to the performance space.

Static performance models are not sufficient to perform evaluation of a design in the early stages. There are likely to be major changes in the operating context of the vessel during its lifecycle, which will greatly influence the performance and value. The quality of new vessel from the perspective of the ship owner is strongly connected to the robustness of the design. Value robustness is defined as the ability of a system to continue to deliver stakeholder value in the face of shifts in context and needs (Ross et al, 2009).

## Objectives

- Present a framework for addressing trade specific utility and value robustness for use as decision support during conceptual design of transportation vessels.
- Present an illustrative case study where the framework is demonstrated. The basis for the case study is designing for value robustness in the container shipping segment.

## Introduction

The container routes are organized as liner services, where a fleet of vessels operate on a fixed route and with predetermined schedule.

About 50% of the fleet is owned by independent ship owners. They charter vessels to the liner companies. When these ship owners invests in new tonnage they face the dilemma of ordering a vessel optimized for a given trade, or maintaining operational flexibility to be attractive for several liner companies.

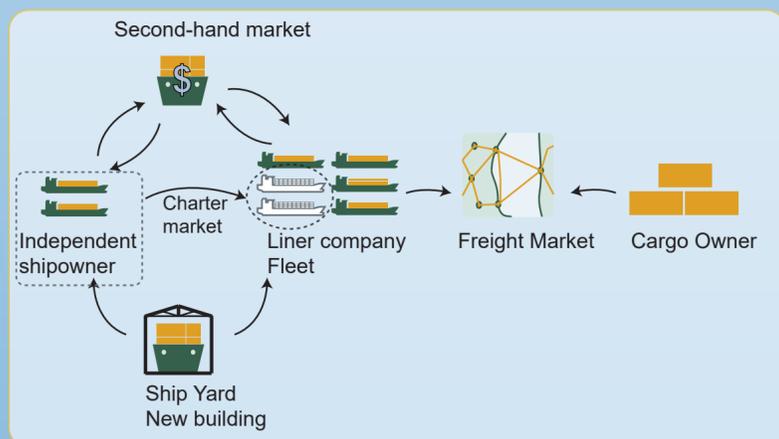


Figure 1: The market structure

## The Problem

The core of the problem can be summarized by the question: What ship should we order today that will deliver value to the shareholders throughout the lifecycle given an uncertain operational environment?

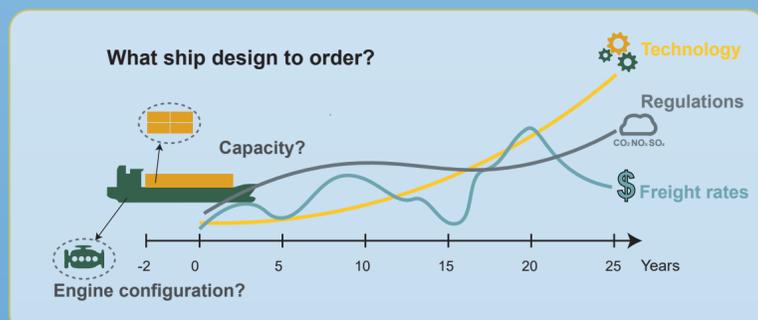


Figure 2: Illustration of the problem, adapted from Erikstad & Rehn (2015)

## Methods

The framework and illustrative case presented in this paper is based on the Responsive Systems Comparison (RSC) method.

The method is described through a seven process framework, describing the design process from definition, to concept generation, evaluation and selection.

### Seven steps of the Responsive System Comparison Method (Ross et al., 2009)

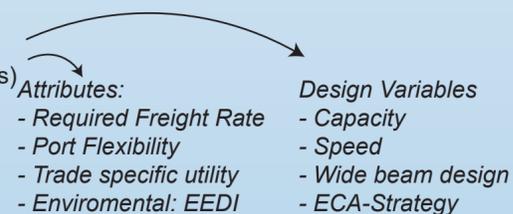
#### 1. Value-Driving Context Definition

Identify overall problem and needs statement

*The ship owner operating in the charter market seeks a design that is economically competitive on and flexible to operate in a range of trades*

#### 2. Value-Driven Design Formulation

Elicit stakeholders needs statements (attributes) and develop main concepts with associated design variables



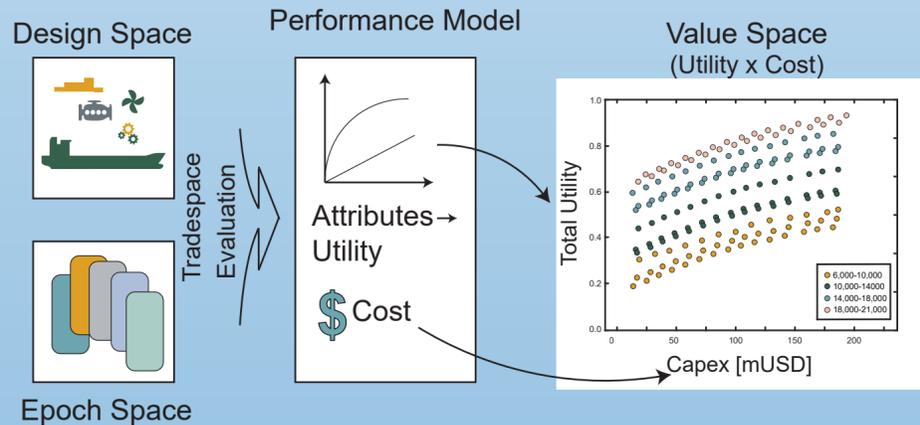
#### 3. Epoch Characterization

Parametrize the range of contextual uncertainties under consideration

**Uncertainties:**  
- Economic: GDP growth, GDP multiplier, Freight rates  
- Technology  
- Regulatory: ECA  
- Physical: Trade specific factors

#### 4. Design Tradespace Evaluation

Model how the design variables fulfill the overall value space (attributes) in response to contextual uncertainties



#### 5. Multi-Epoch Analysis

Identify value robust systems across changing context and needs

*Epoch: finite periode of time with fixed operating conditions*

#### 6. Era Construction

Develop era timelines from the set of enumerated epochs

*Era: Set of ordered epochs that make up the complete lifecycle*

#### 7. Lifecycle Path Analysis

Develop strategies for selecting value robust design- and operational decisions

## Results and Conclusion

As this is a presentation of a work in progress the process of data evaluation is still ongoing.

The goal was to investigate strategies to design for value robustness. The RSC method, with epoch-era analysis, seems like a potential strategy to achieve this.

## References

- Erikstad, S. O., & Rehn, C. F. (2015). Handling Uncertainty in marine systems design - state-of-the-art and need for research. Paper presented at the 12th International Marine Design Conference
- Ross, A. M., McManus, H. L., Rhodes, D. H., Hastings, D. E., & Long, A. (2009). Responsive systems comparison method: Dynamic insights into designing a satellite radar system. Paper presented at the AIAA SPACE 2009 Conference & Exposition, Pasadena.