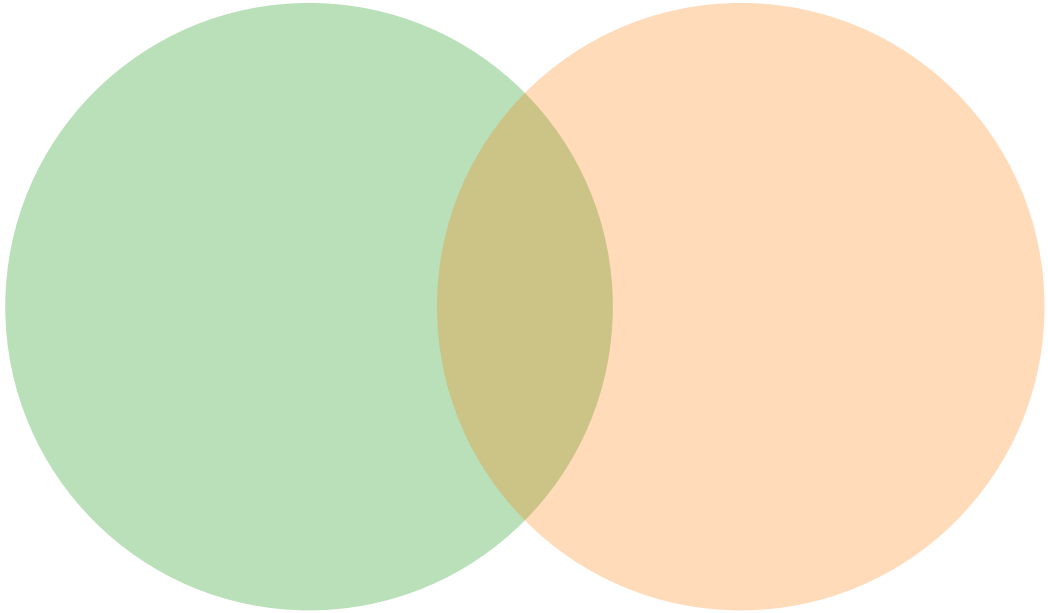
New vessel design approaches and the gradual obsolescence of the current designers' software application toolbox



Henrique M. Gaspar
Associate Professor
Ship Design and Operations Lab

March 2014

Agenda

- Approaches AND Obsolescence
- What we call as "new ship design approaches"?
- The idea of obsolescence in current maritime engineering software
- A trending for the future: dealing with a large amount of information
- Initial Activities

Based on PhD Trial Lecture given at NTNU, 15 Nov. 2013

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- **Approaches AND Obsolescence**
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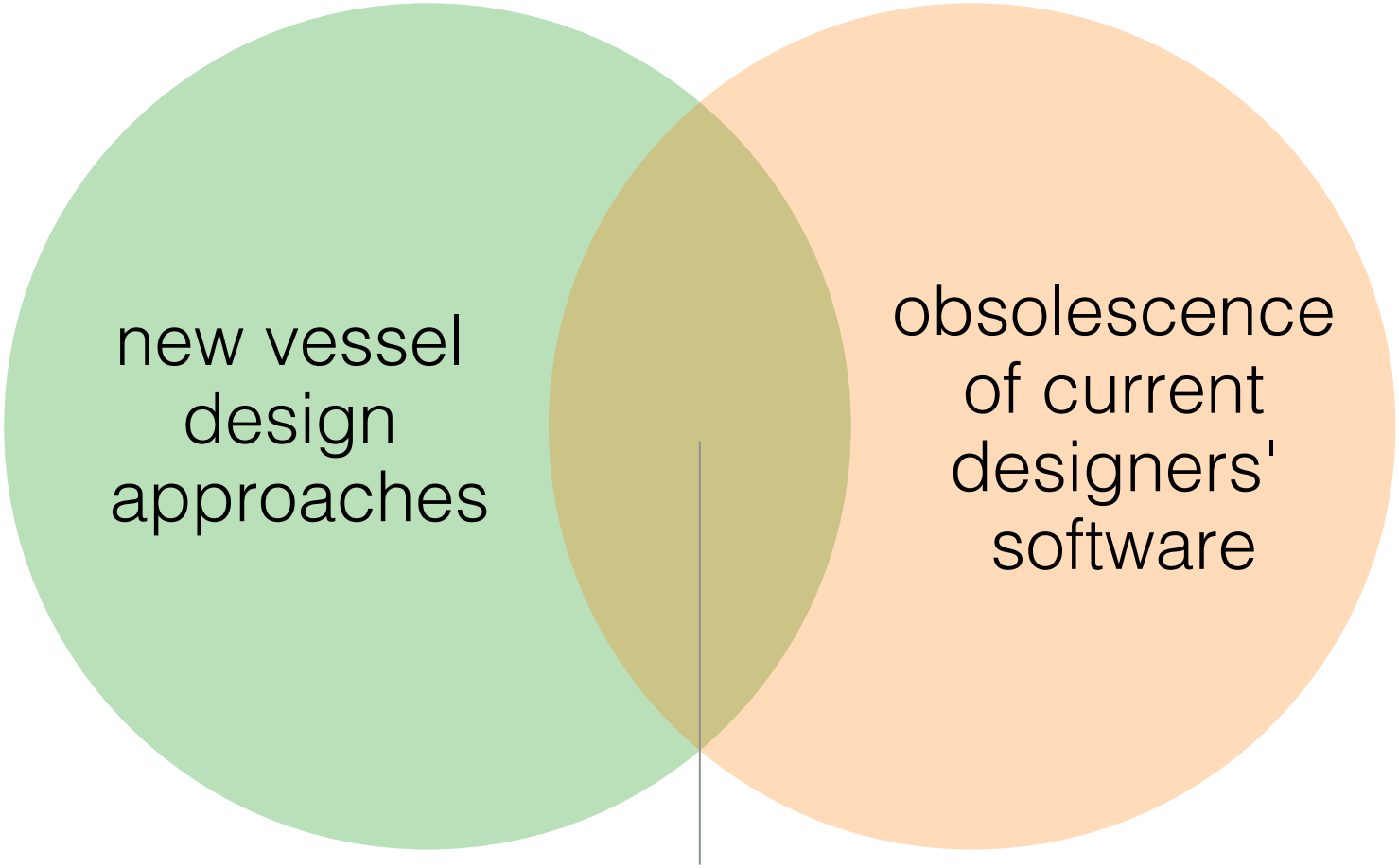
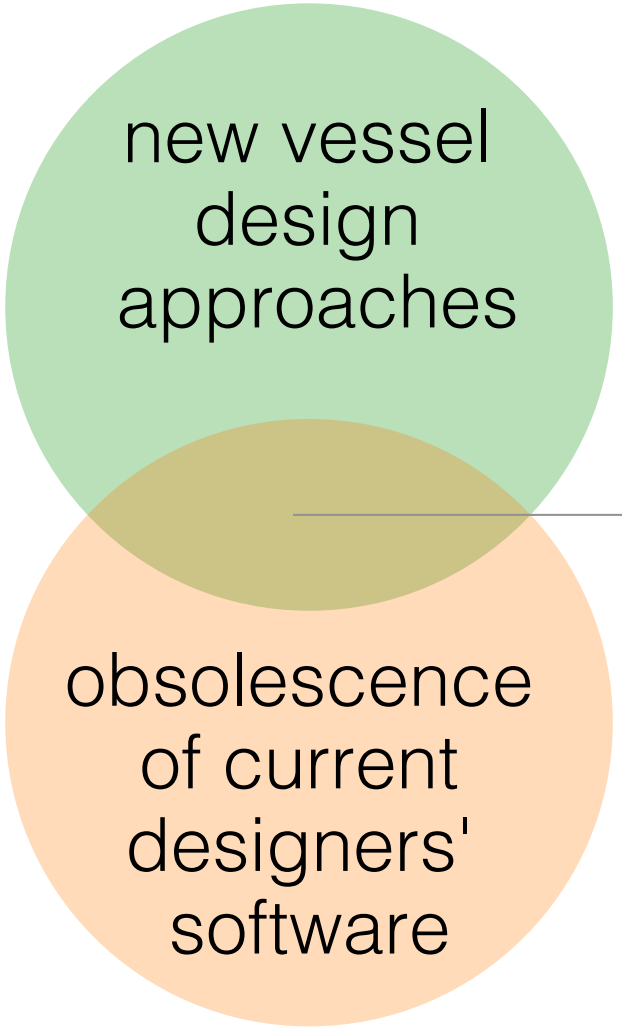
The meaning of "AND"



We should talk about the intersection of the two subjects

What lies at the intersection...



- What are considered traditional and new design approaches?
- What kind of software can designers use?
- What is considered "new approach" for a ship design software?
- What we mean by obsolete?
- What tools designers would like to have available?
- How to deal "smartly" with a large amount of information?

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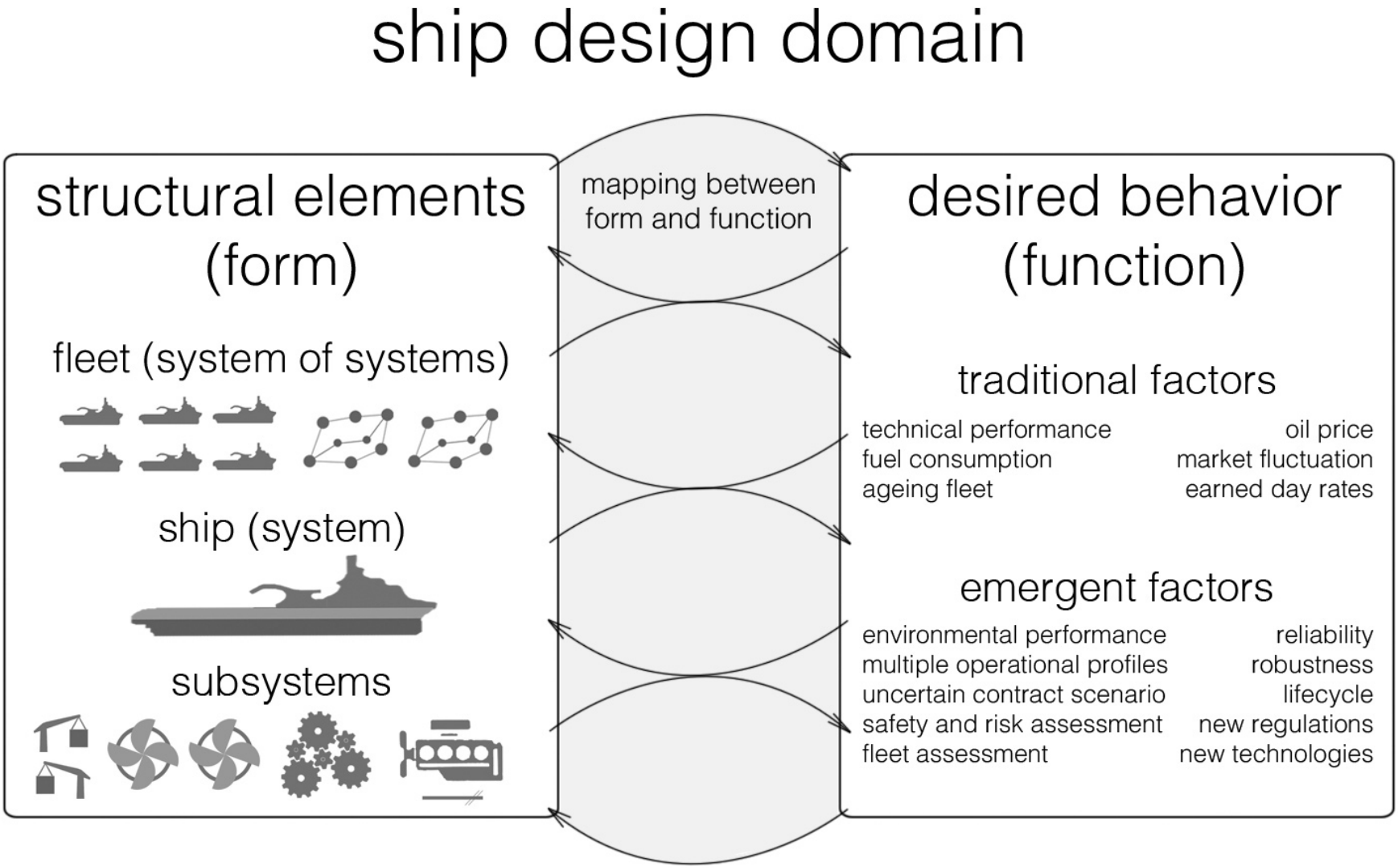
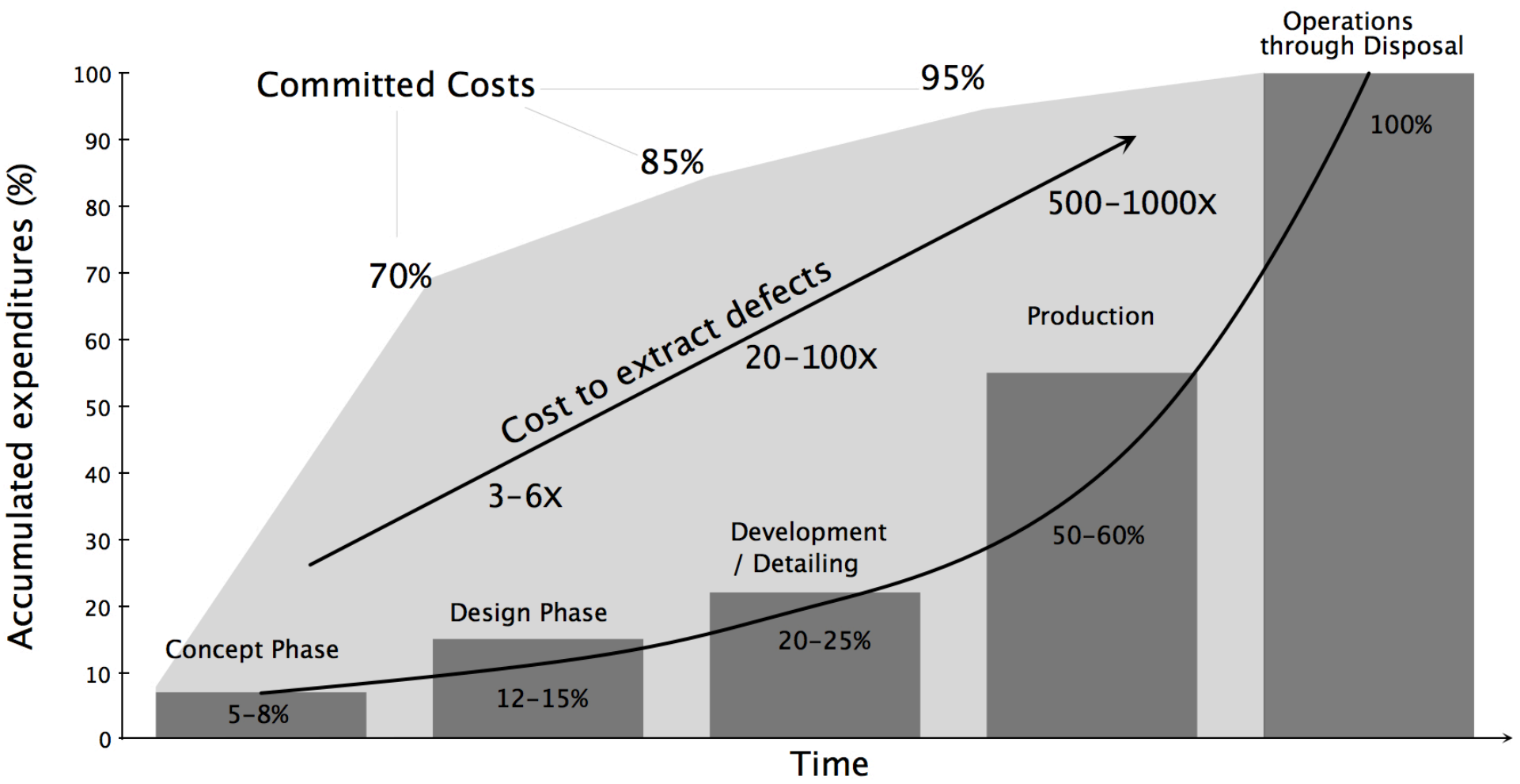
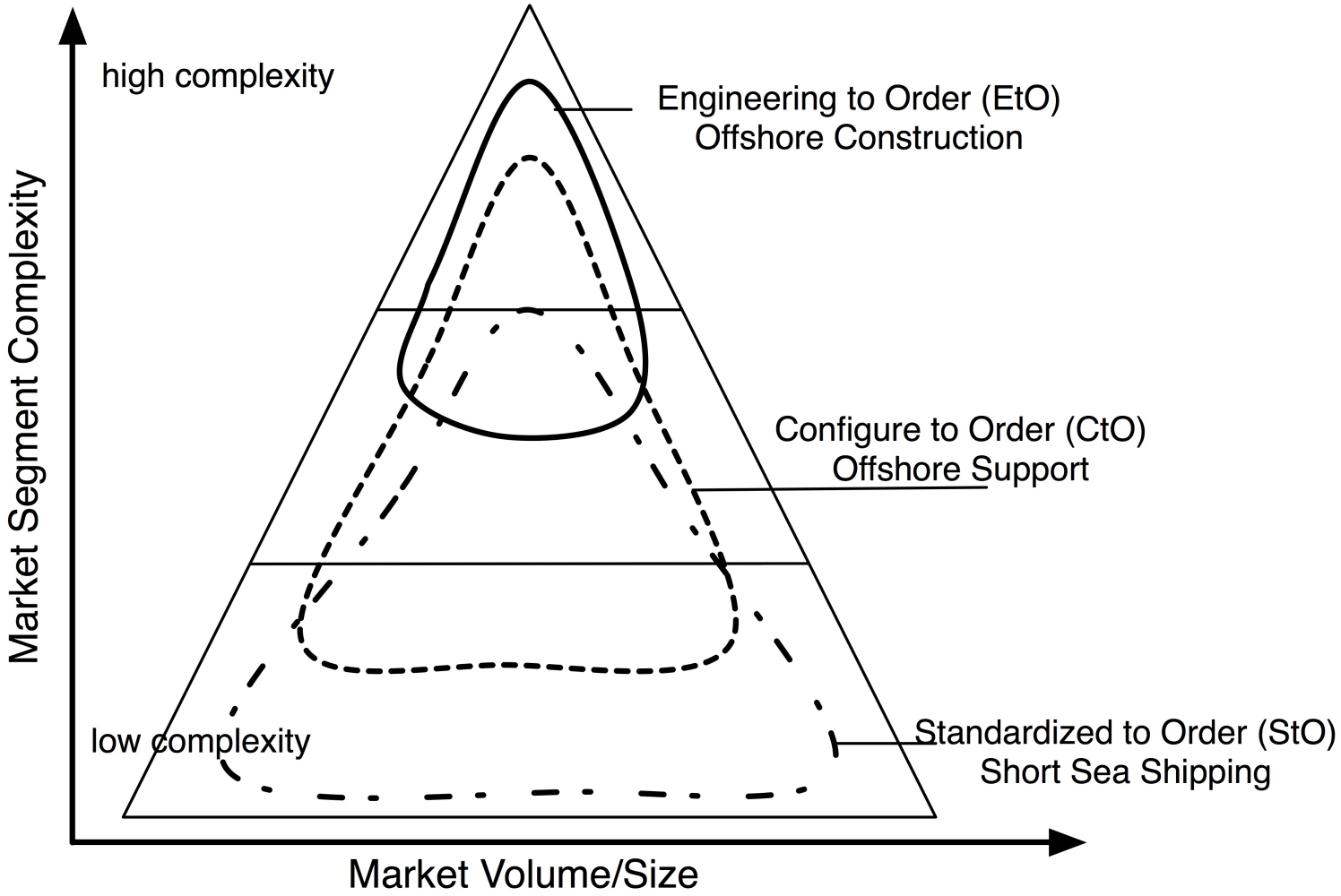
Mapping


ship design domain
structural elements (form)
fleet (system of systems)
ship (system)
subsystems
mapping between form and function
desired behavior (function)
traditional factors
technical performance
fuel consumption
ageing fleet
oil price
market fluctuation
earned day rates
emergent factors
environmental performance
multiple operational profiles
uncertain contract scenario
safety and risk assessment
fleet assessment
reliability
robustness
lifecycle
new regulations
new technologies

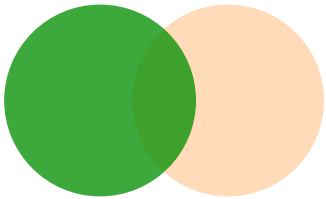
Expenditures & Defects



Complexity for Each Segment

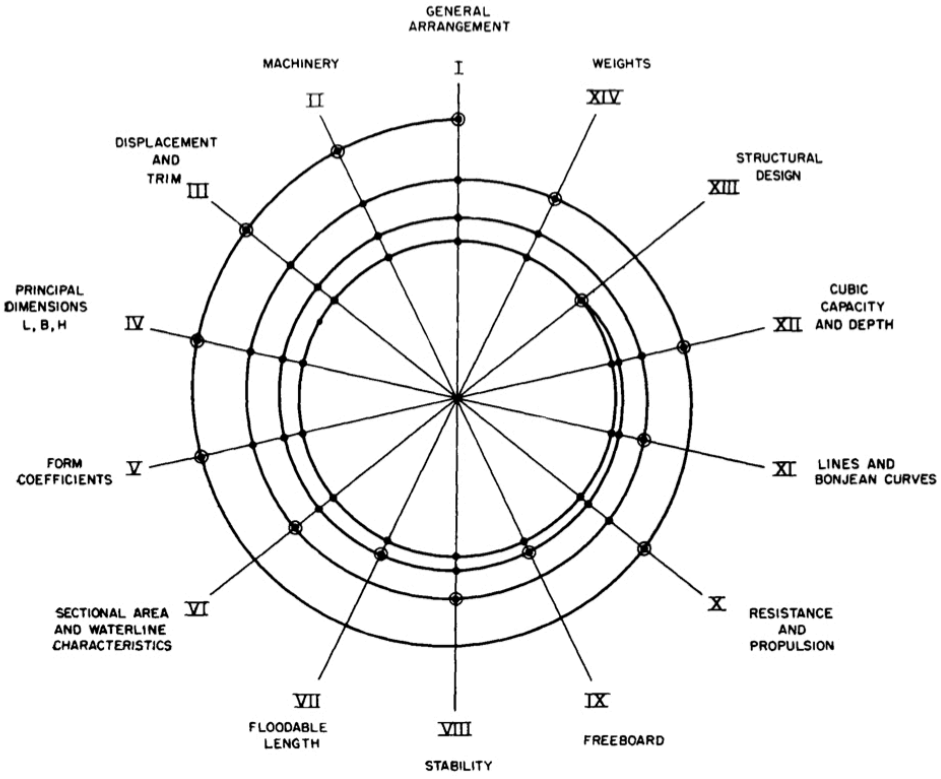


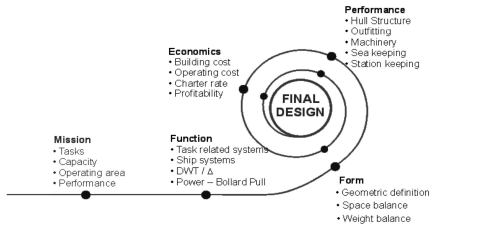
7 Characteristics

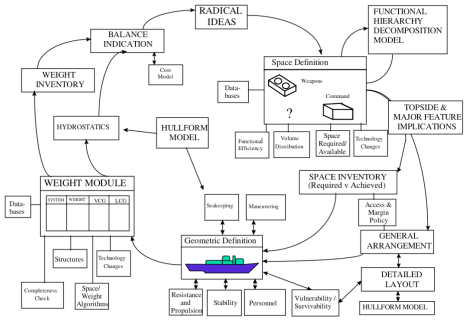


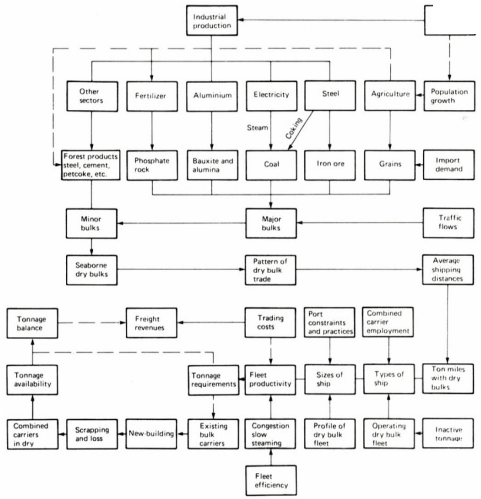
- Highly-integrated structure, operating in the boundary between two fluids
- Multi-dimensional, partly non-monetary performance evaluation
- High cost of error
- Shallow knowledge structure
- Strong domain tradition
- Strict time and resource constraints on the design process
- Predominantly ‘one-of-a-kind’ and ‘engineering-to-order’ solutions

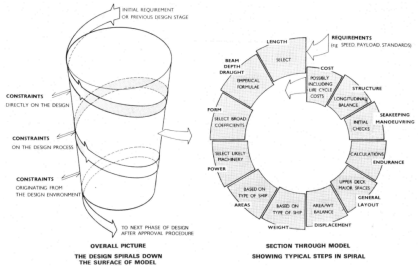
Ship design approaches

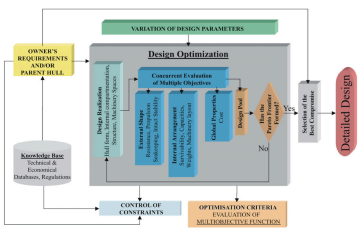


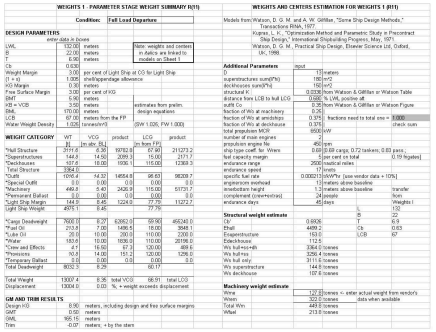




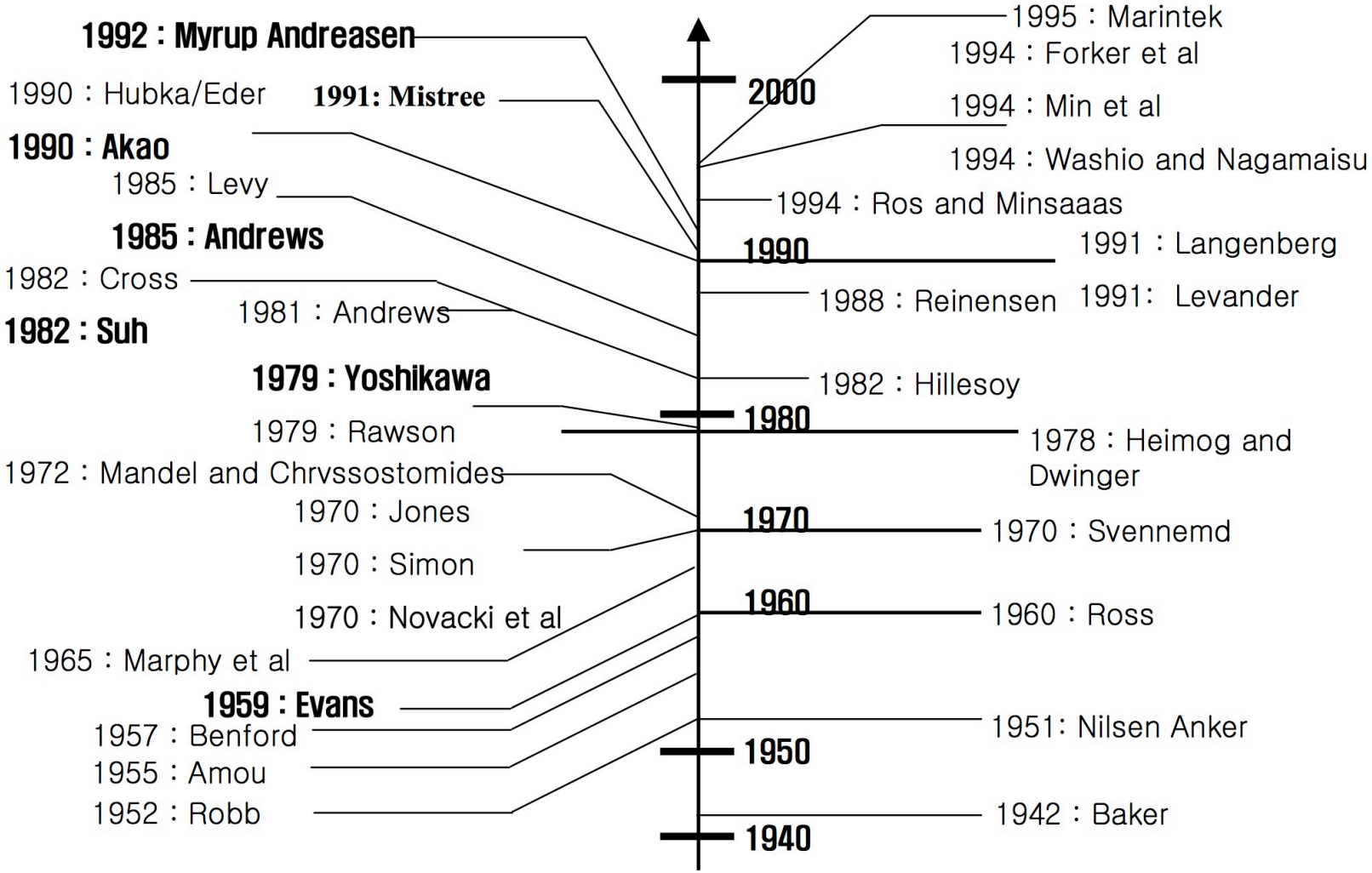




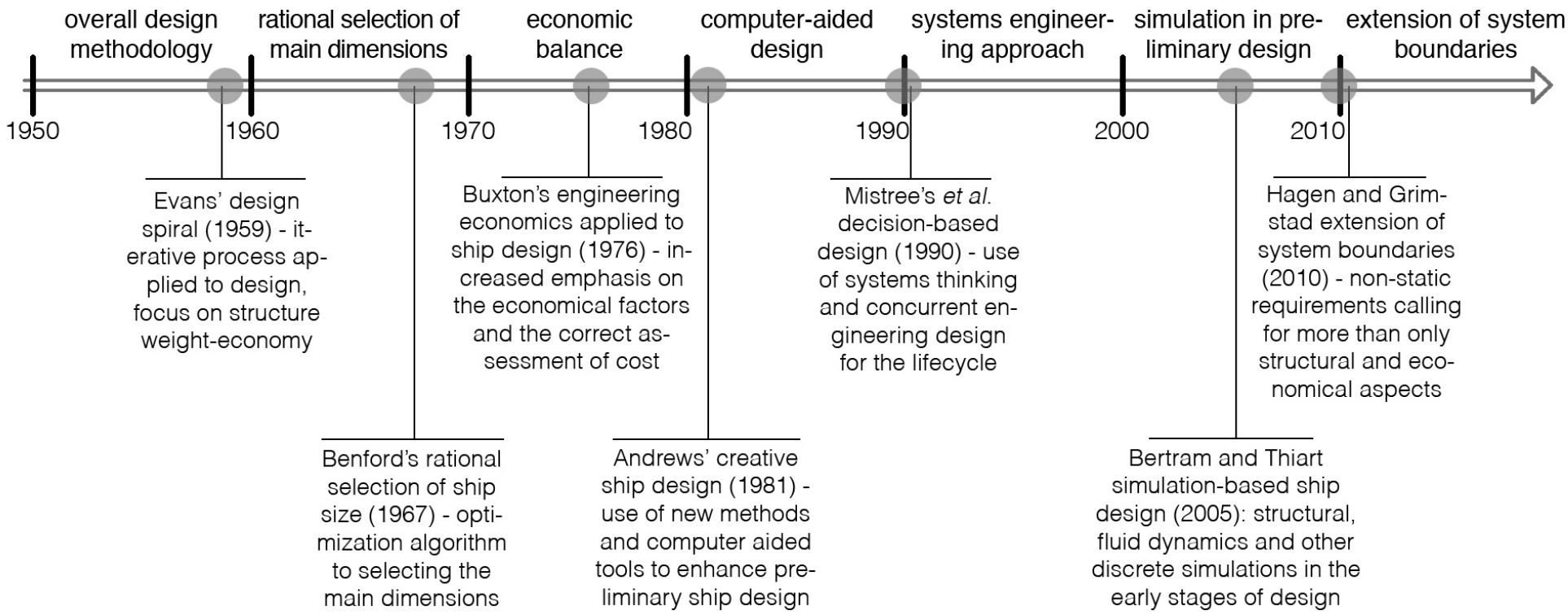




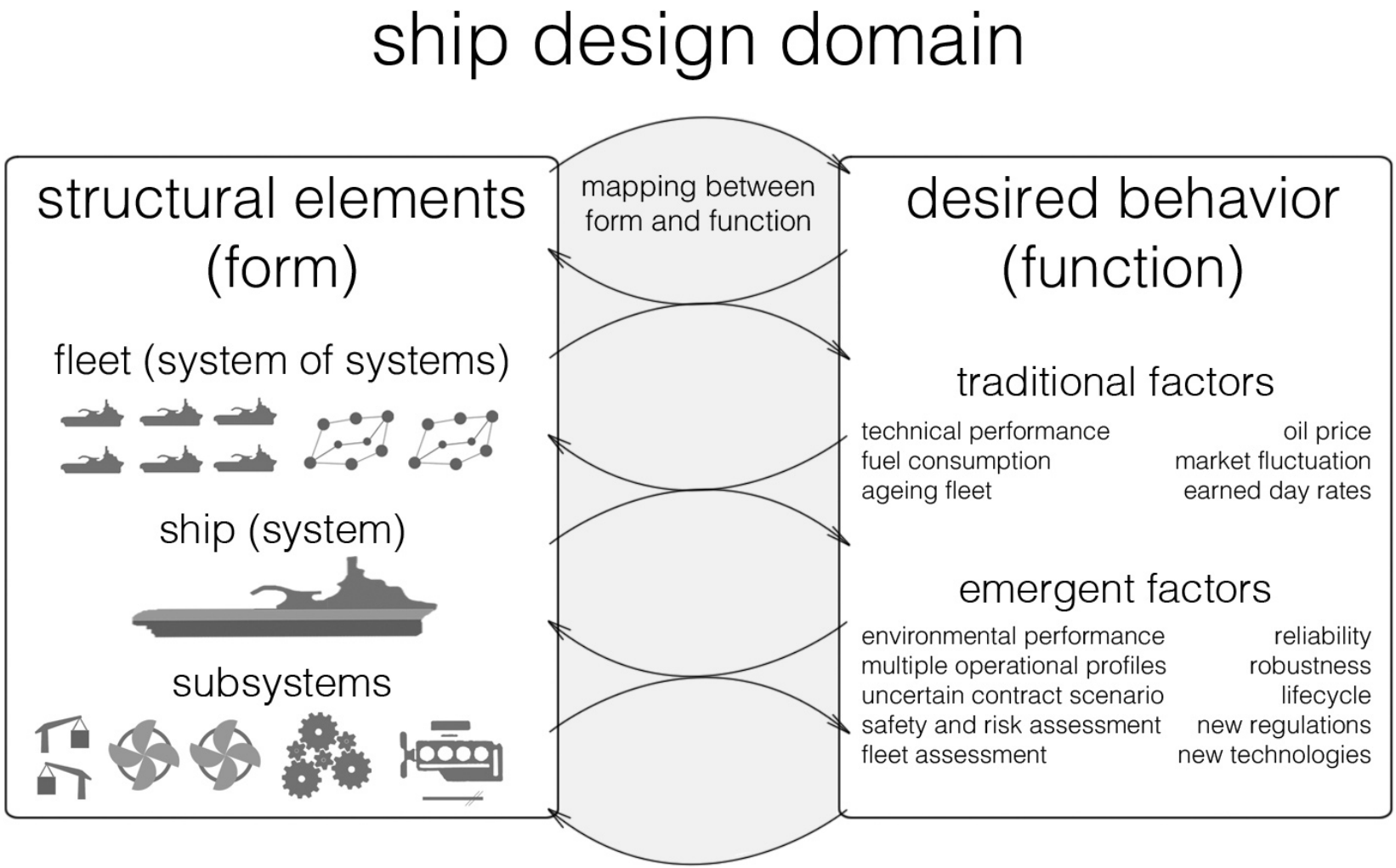
Traditional and new design approaches?



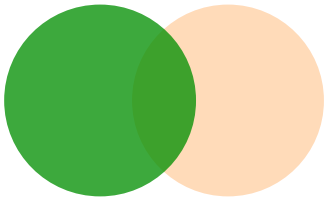
Traditional and new design approaches?



Traditional and Emergent



Incorporating emergent factors



A decade ago, a shipowner would sit with the client and discuss hull and propulsion. Today, the meetings are steered by factors such as safety, fuel consumption, capability, and reliability, necessitating documenting this kind of information as precisely as possible.

Gäel, 2013

Incorporating emergent factors

- There is no consensus by the market or academia how it should be done
- Knowledge on the abstract nature of these factors
- Shift from purely technical to knowledge-oriented factors
- Gut-feeling
- Conception of value including not only immediate economic return
- Hard to document these requirements and expectations

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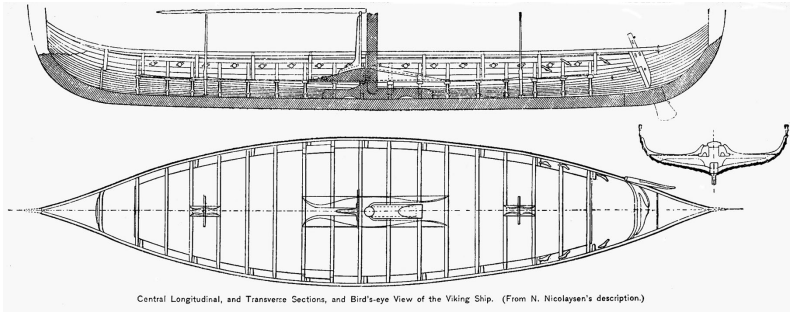
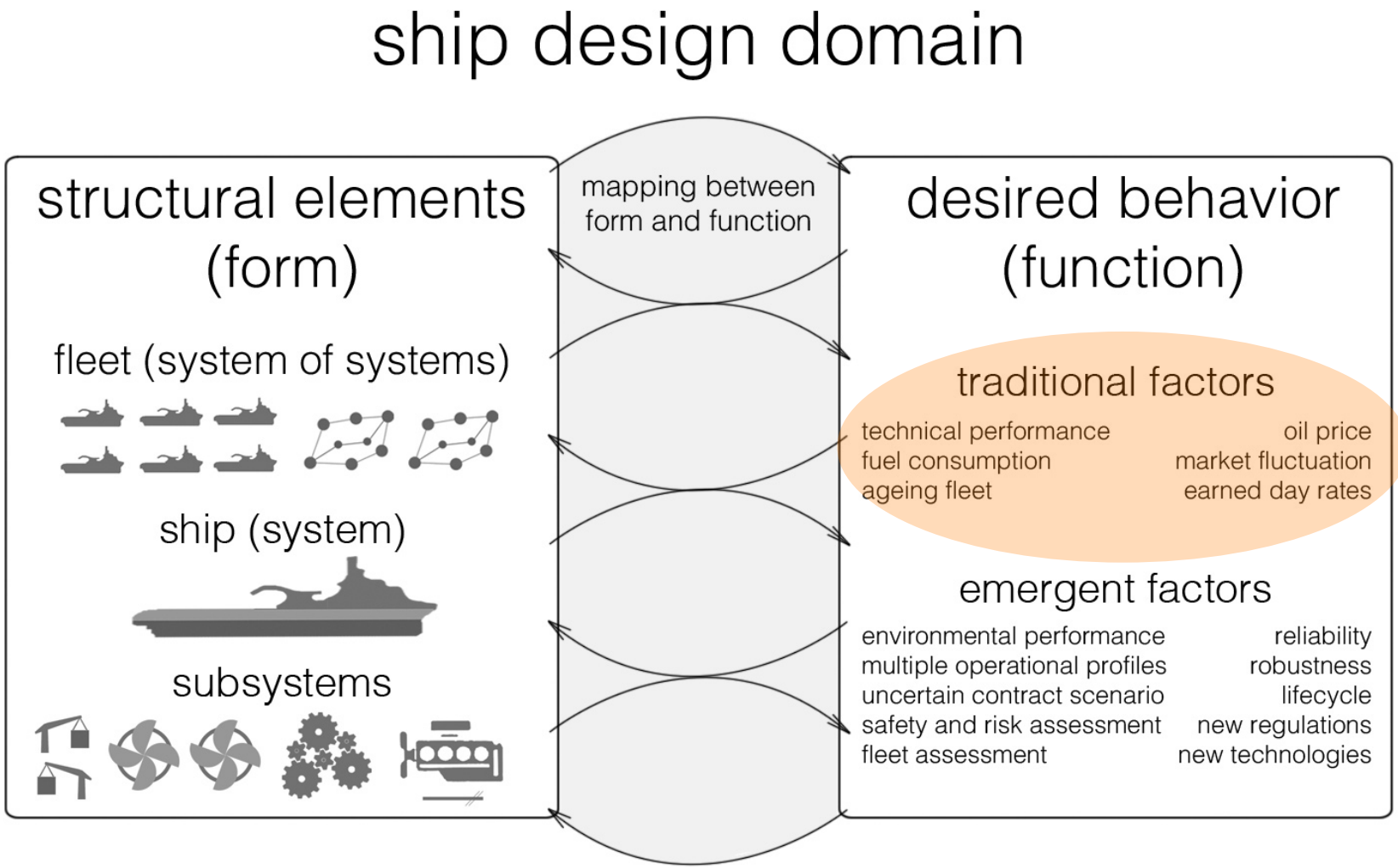
Becoming Obsolete

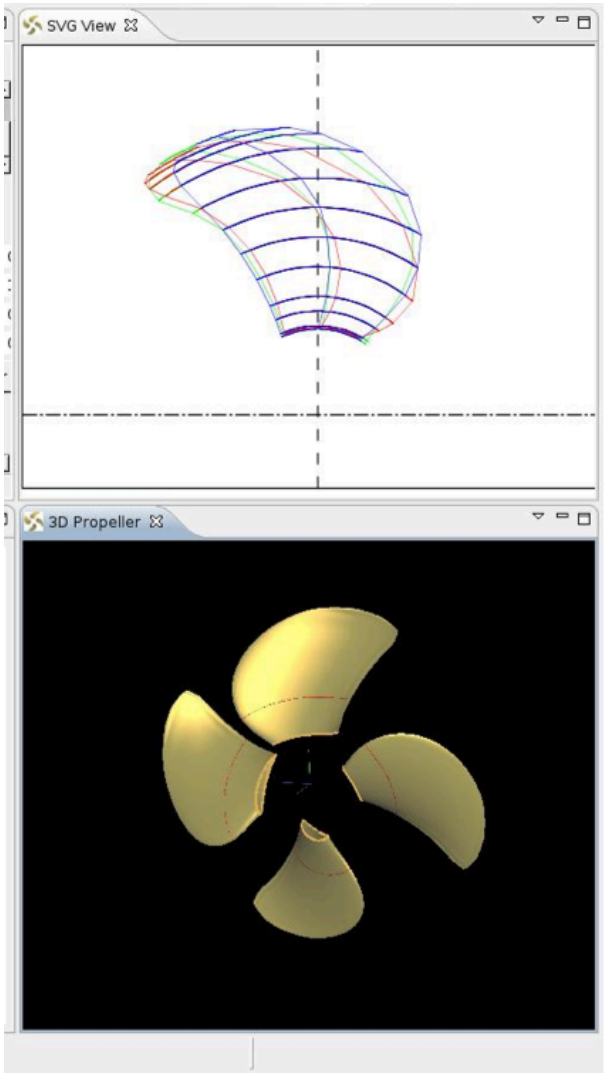
- Obsolescence: the process of becoming **obsolete**
  - No longer useful
  - Discarded
  - Out of date
  - Synonymous: antiquated, old, ancient
- Approach: In what sense the current toolbox is obsolete? What is the shift in the consensus of a "useful toolbox"?



Current Toolbox



Hull & Propeller Optimization



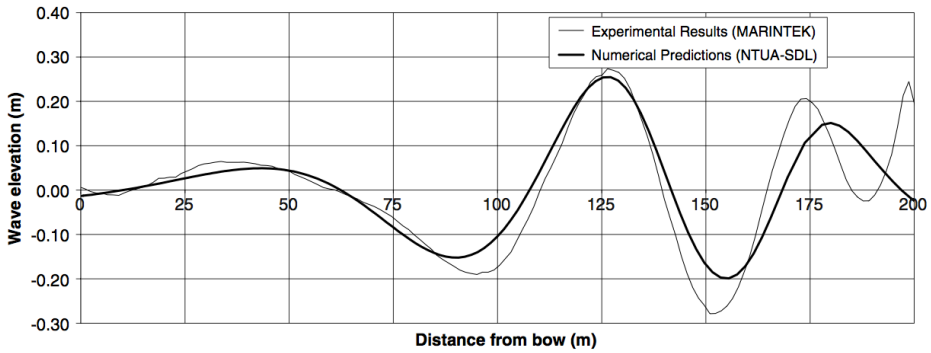


Fig. 7. High-speed catamaran, comparison of measured vs. predicted wave cuts at 0.845*L* off CL and 15 m water depth.

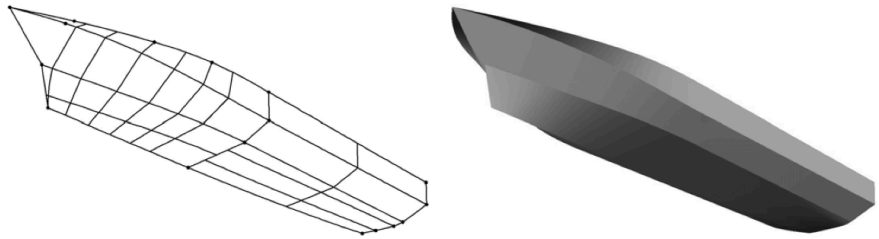


Fig. 8. Grid definition and resulting hull form for monohull vessel.

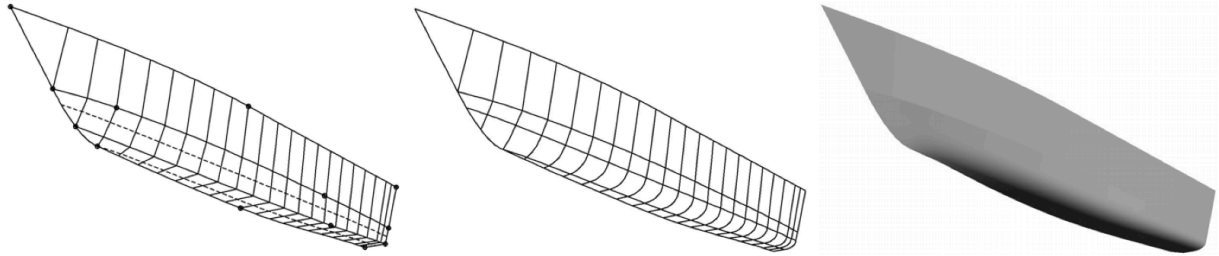


Fig. 9. Grid definition and resulting hull form for catamaran vessel.

Structural Analysis

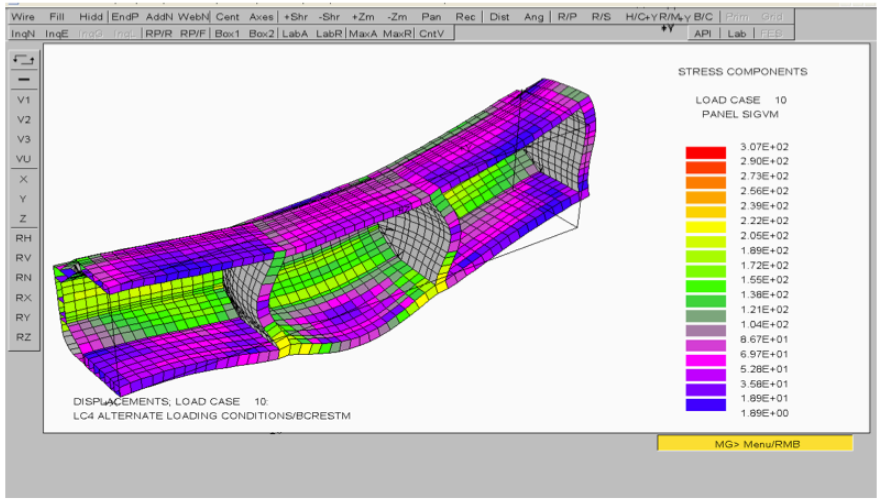


Fig.6: VERISTAR Hull - Structural results on the coarse mesh

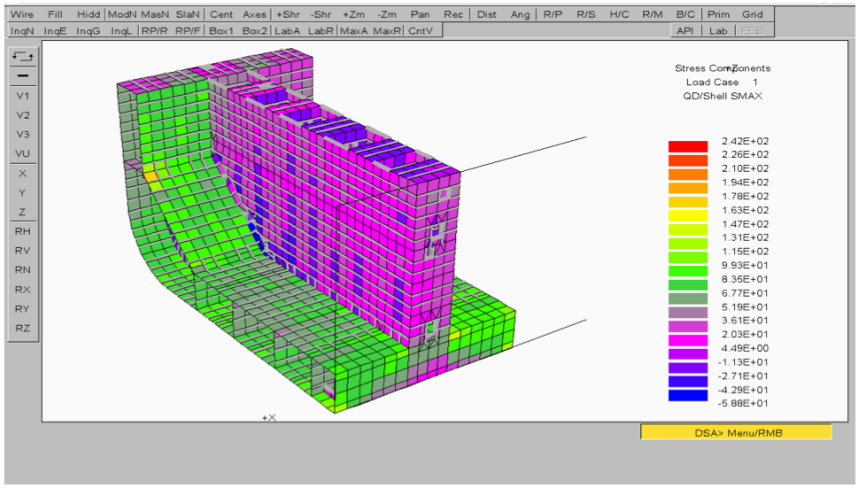
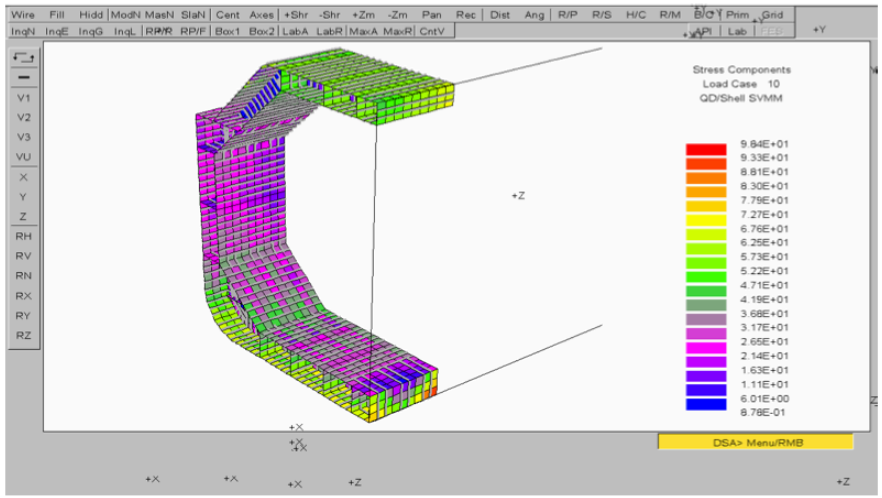
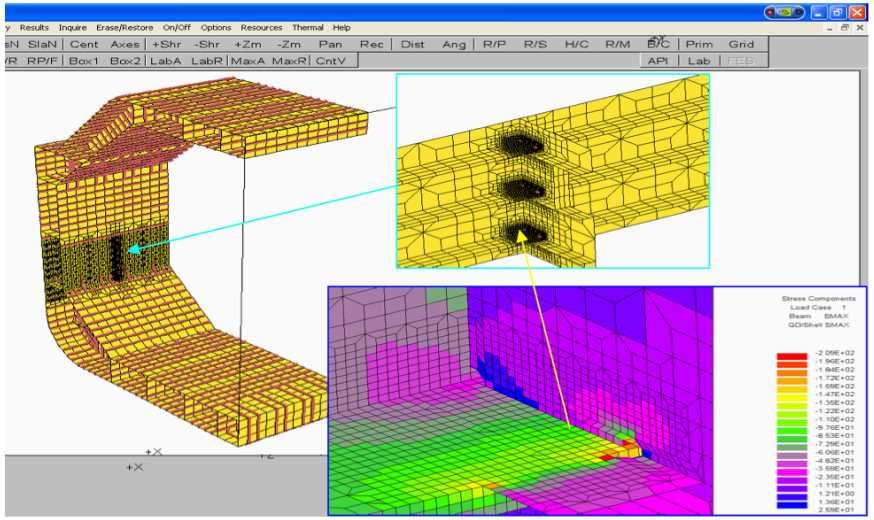
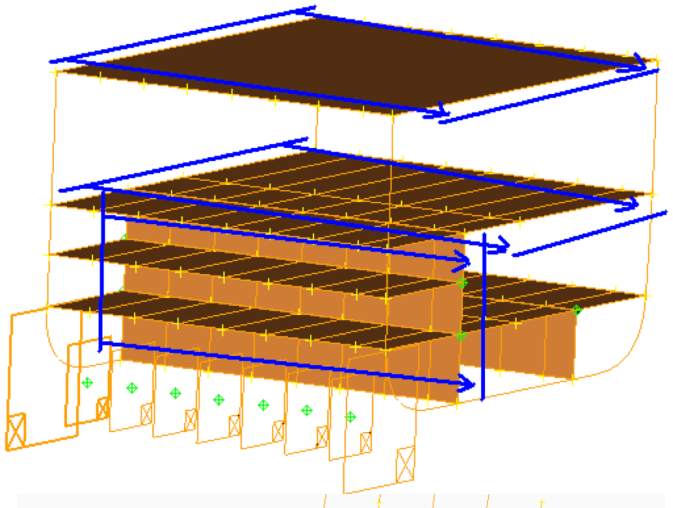


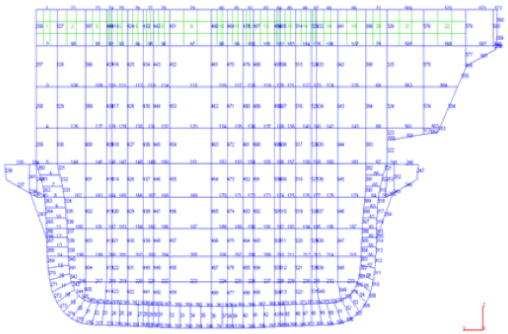
Fig.8: VERISTAR Hull - Structural results on the fine mesh, cofferdam foot

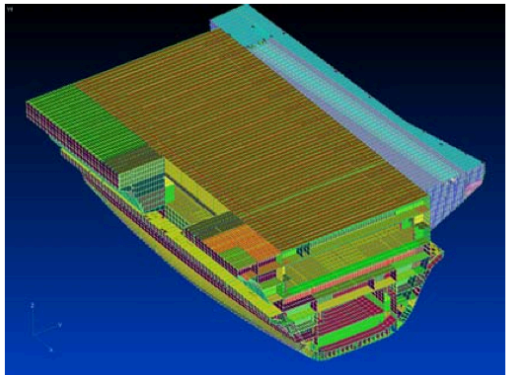


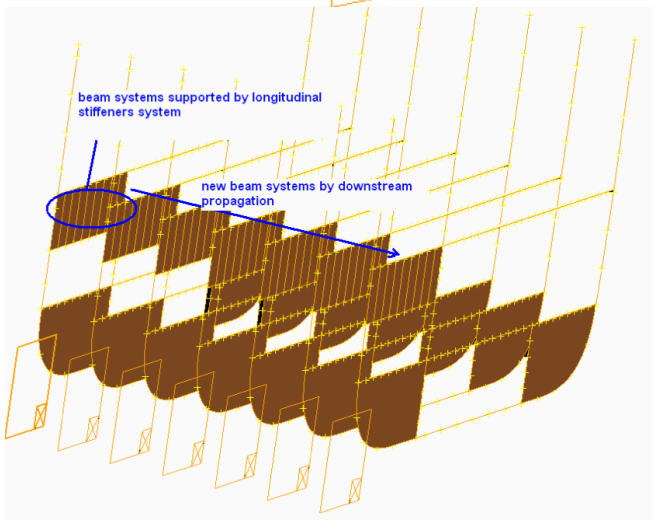


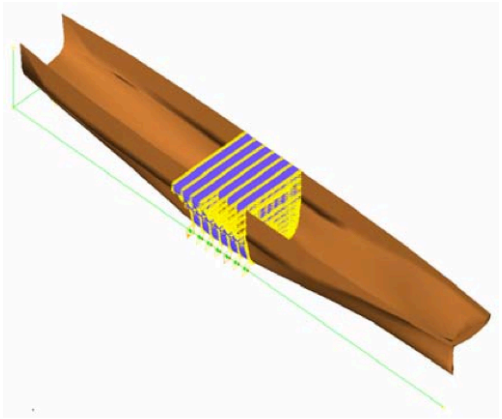
Modules & Blocks

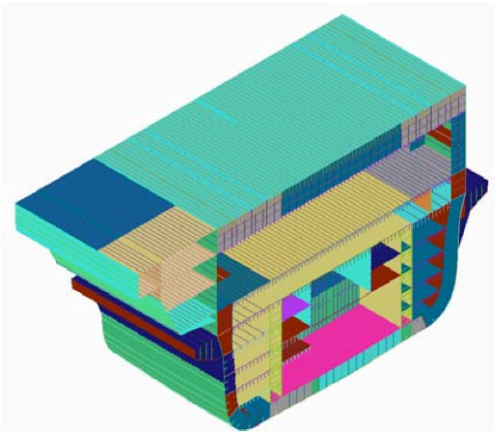






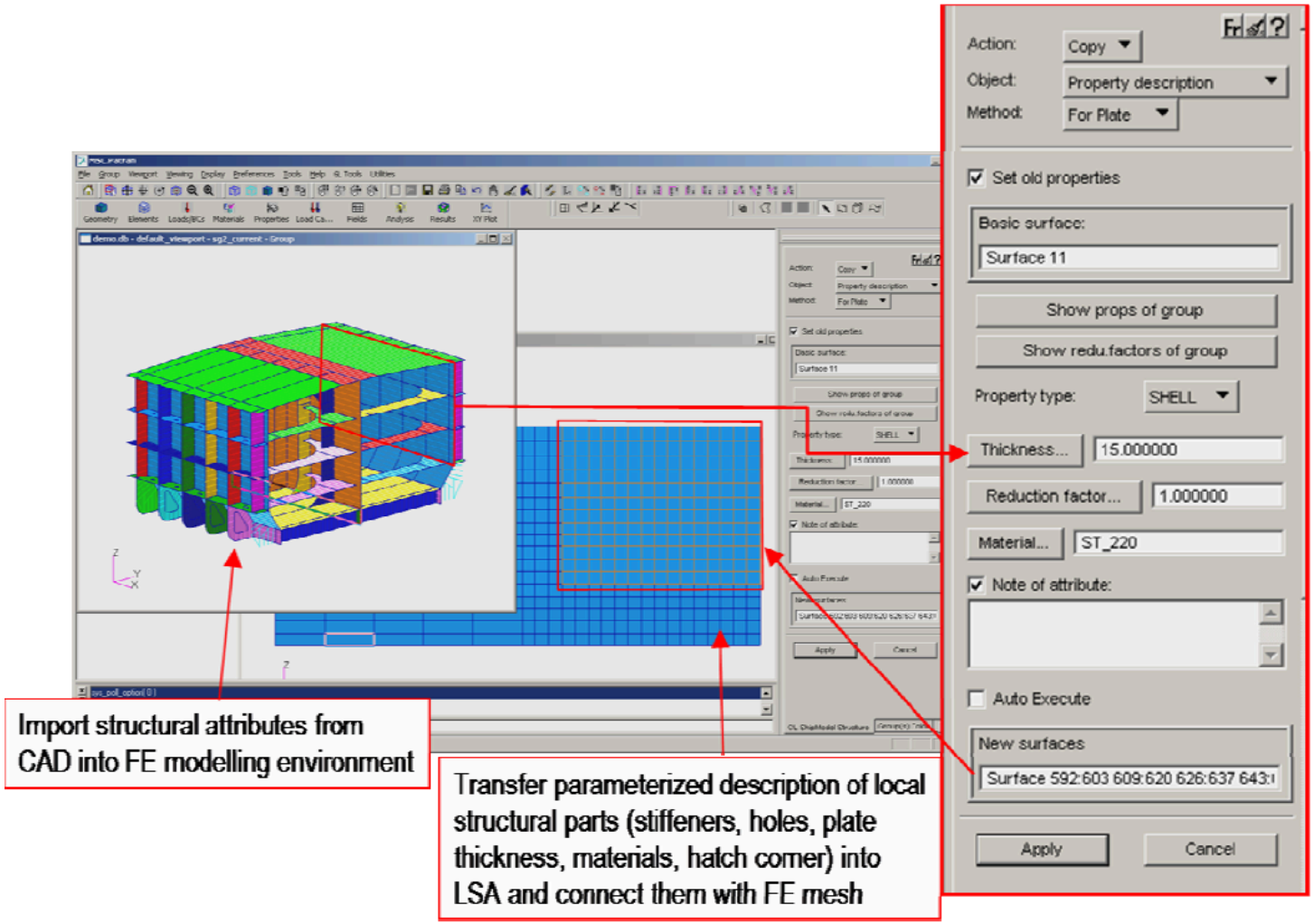






Integration

e.g.: AVEVA, CATIA, NX



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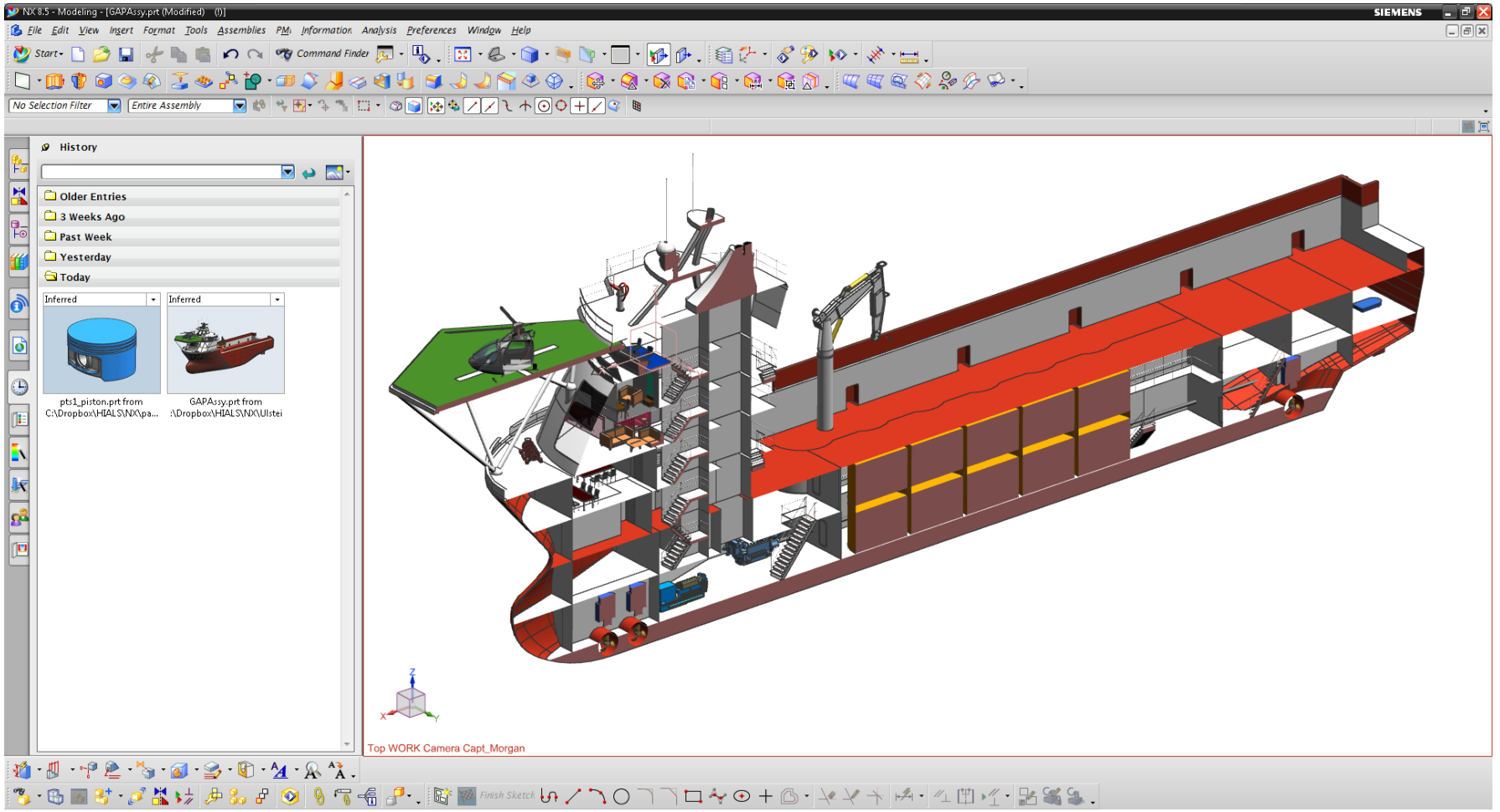
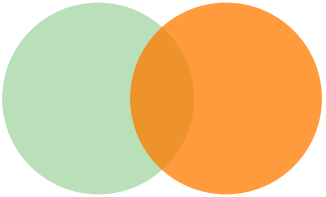


We have the parts



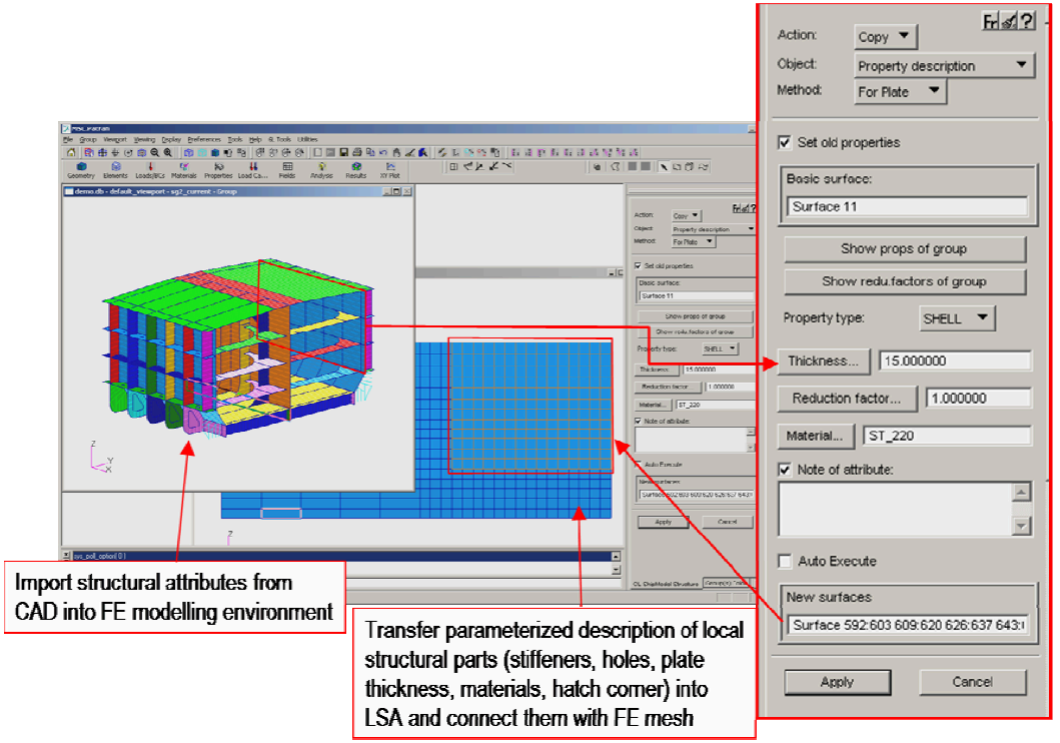
Hull Modeling
Operations Simulator
Space Allocation
Evacuation
Classification - Rule Based
Flooding simulation
Ship Design and Simulation
Configuration Based Design
Seakeeping
Stability
Powering
Propulsion
Machinery Configuration
...

- Several "standalone" tools
- How obsolete?
- Useful to solve part of a problem

- Conferences:
  - COMPIT
  - ICCAS
  - IMDC

Challenges

- Gap between prototype and trustable/maintained tool
- Integration with current modus operandi
- Integration with other software
- Accessible to every phase and every player of the process
- Very specific segment
- Large investment to small number of potential buyers

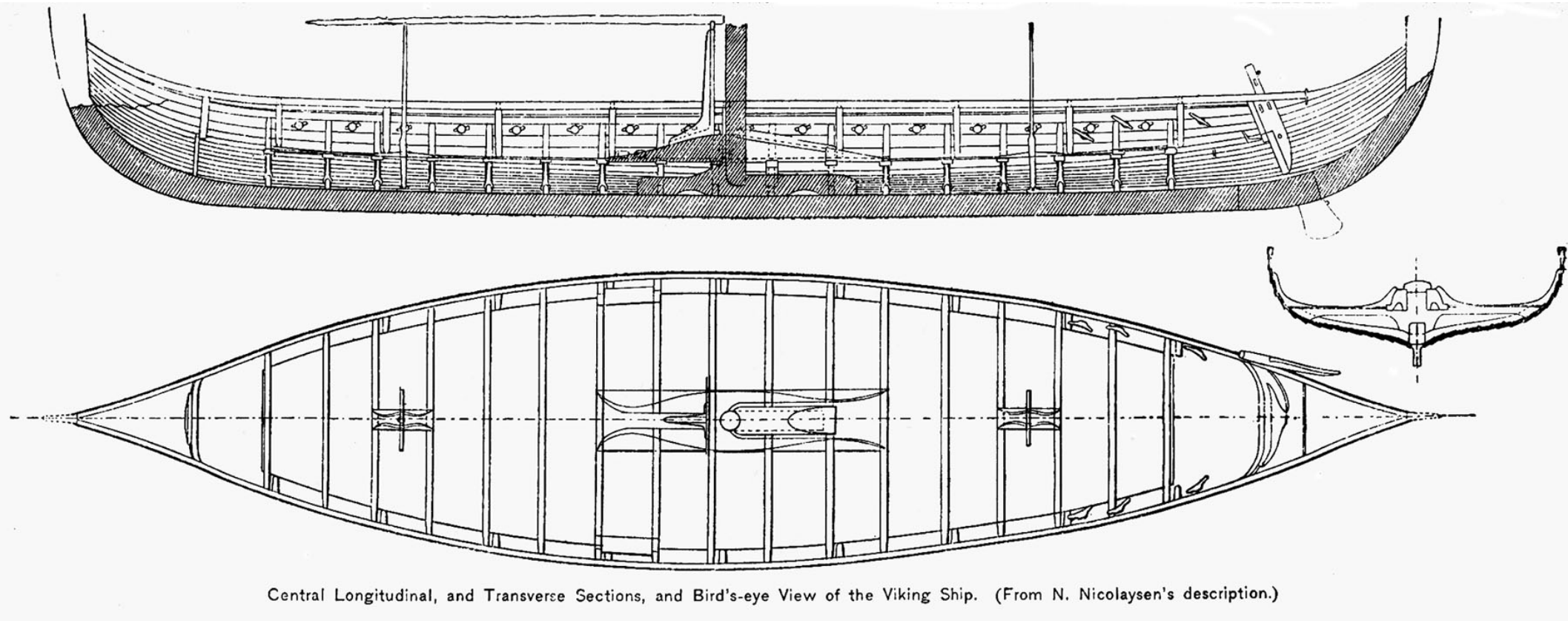


Lack of Integration

Hull Modeling
Operations Simulator
Space Allocation
Evacuation
Classification - Rule Based
Flooding simulation
Ship Design and Simulation
Configuration Based Design
Seakeeping
Stability
Powering
Propulsion
Machinery Configuration
...

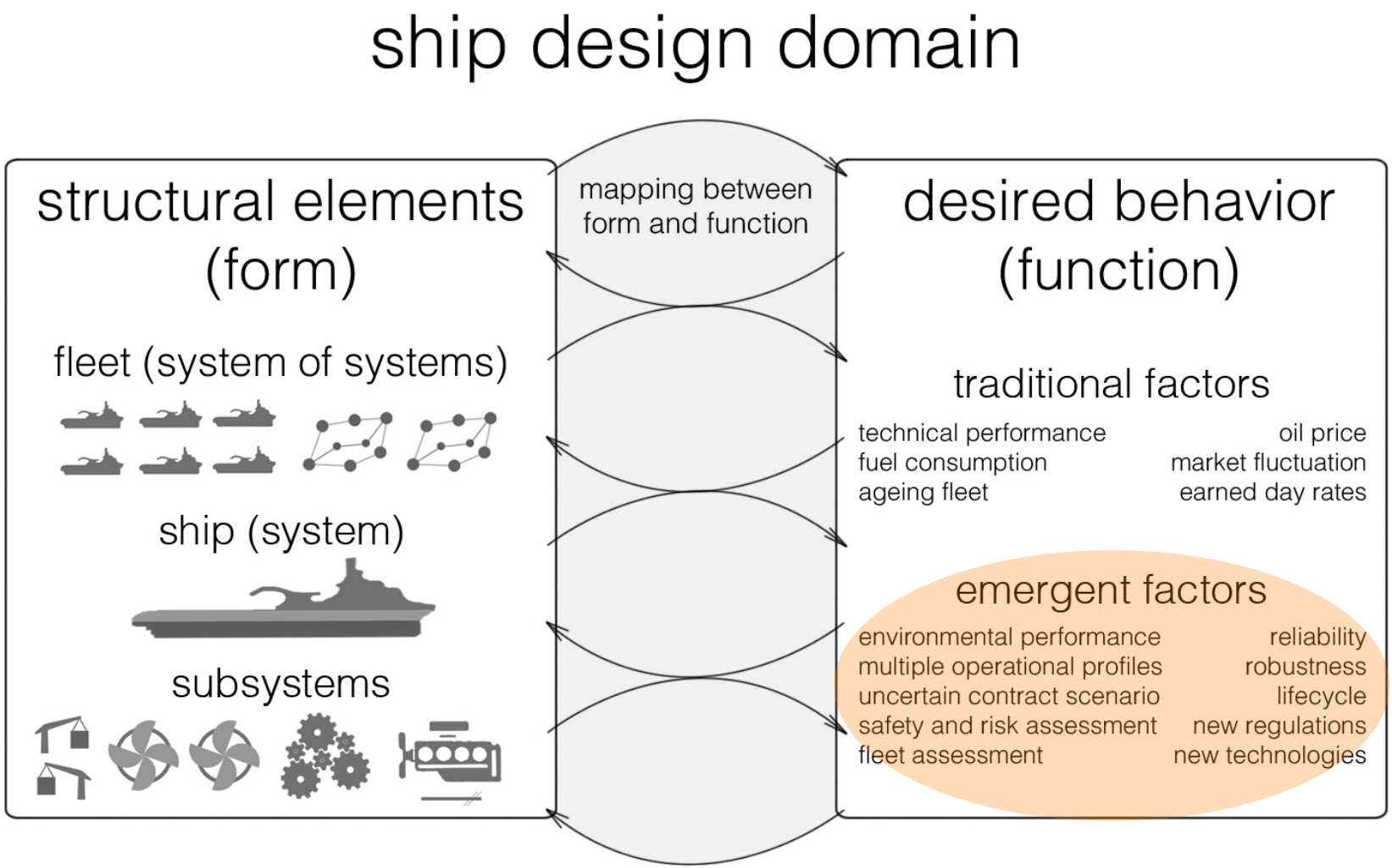
specialized software
"digested" into: word reports,
excel spreadsheets and
power-point presentations

What we mean by a software getting obsolete?



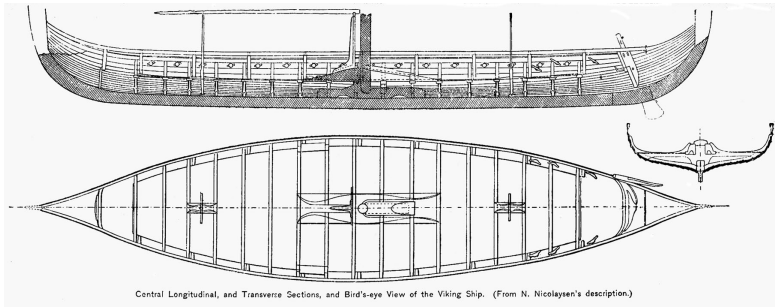
Central Longitudinal, and Transverse Sections, and Bird's-eye View of the Viking Ship. (From N. Nicolaysen's description.)

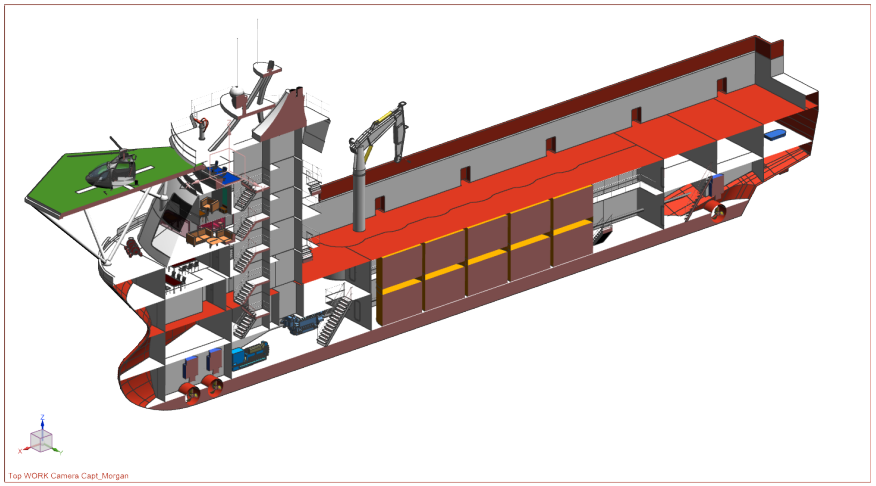
What we mean by a software getting obsolete?



What we mean by a software getting obsolete?

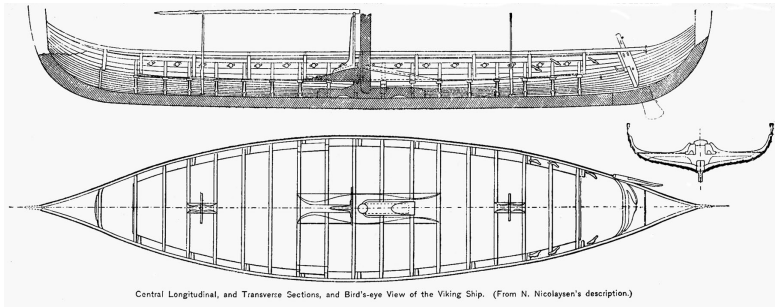
- Not taking into account new ship design domain factors:
  - Ilities (e.g. modularity, operability)
  - Documentation of non technical performance
  - Incorporate stakeholders' expectations
  - Upstream and Downstream value chain
  - Less modeling and (re) analysis time
  - Efficient optimization (multi-criteria)

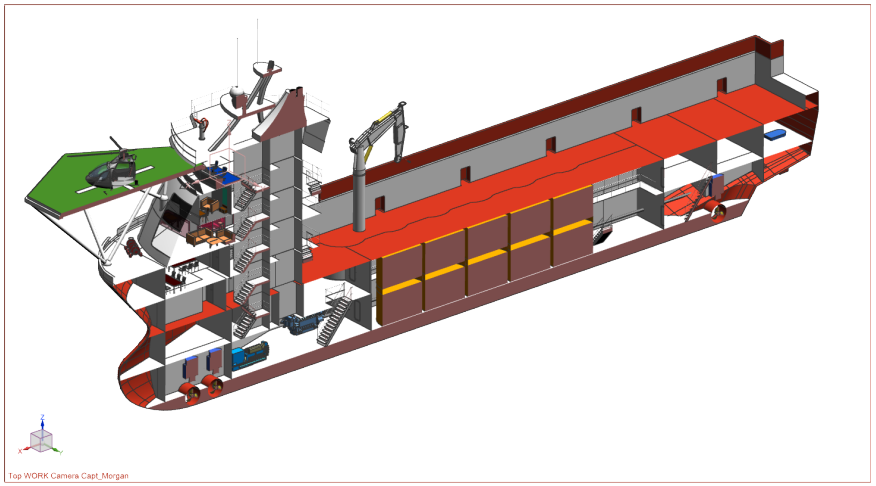




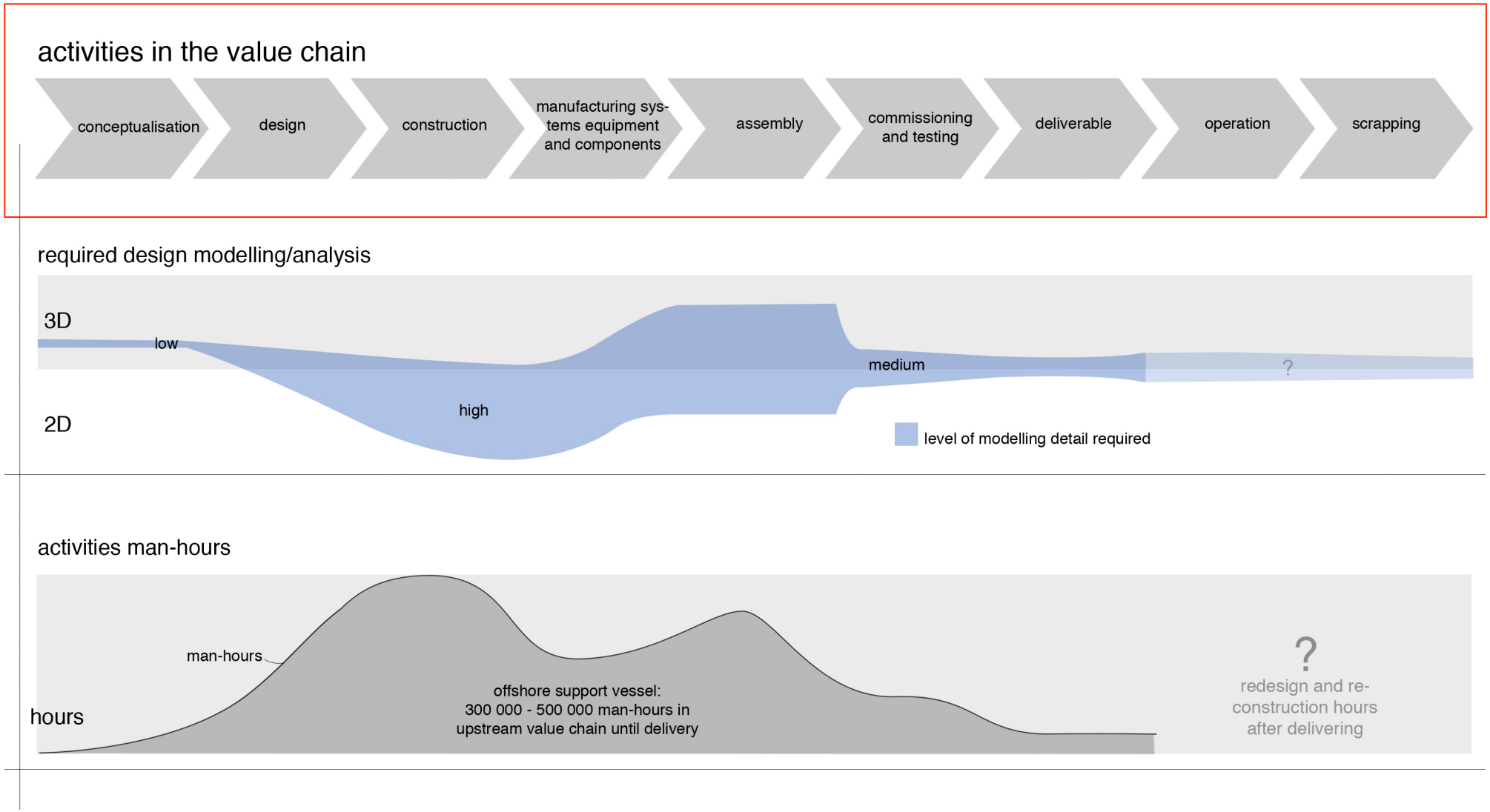
A "modern" software should:

- Focus on holistic
- Take into account whole value chain
- Multiple operational scenarios and future expectations
- Integrate smartly available tools
- Incorporate stakeholders' expectations
- 3D library of components all over the process
- Data accessible to optimization tools
- Standardized all over the clients and suppliers



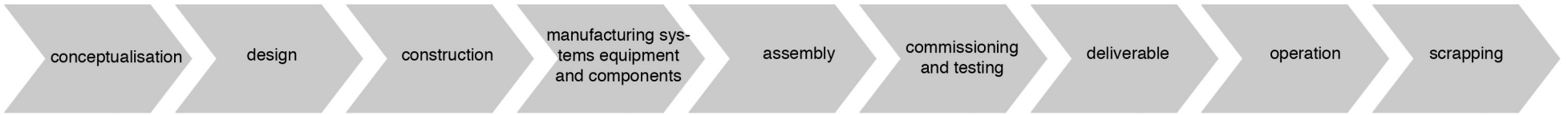


Value Chain Activities

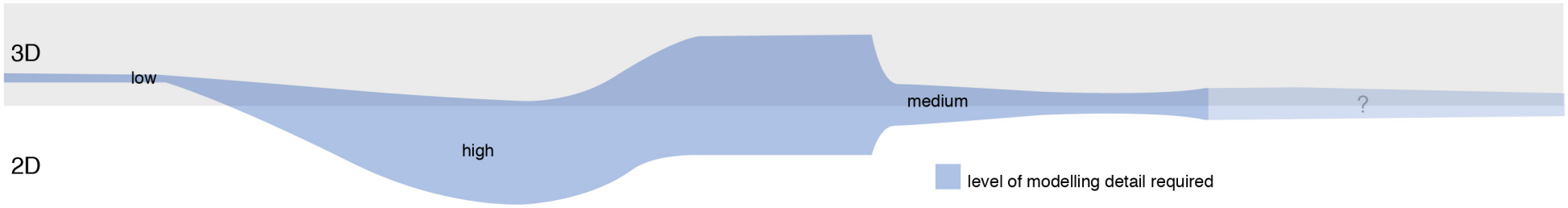


3D all over the process

activities in the value chain

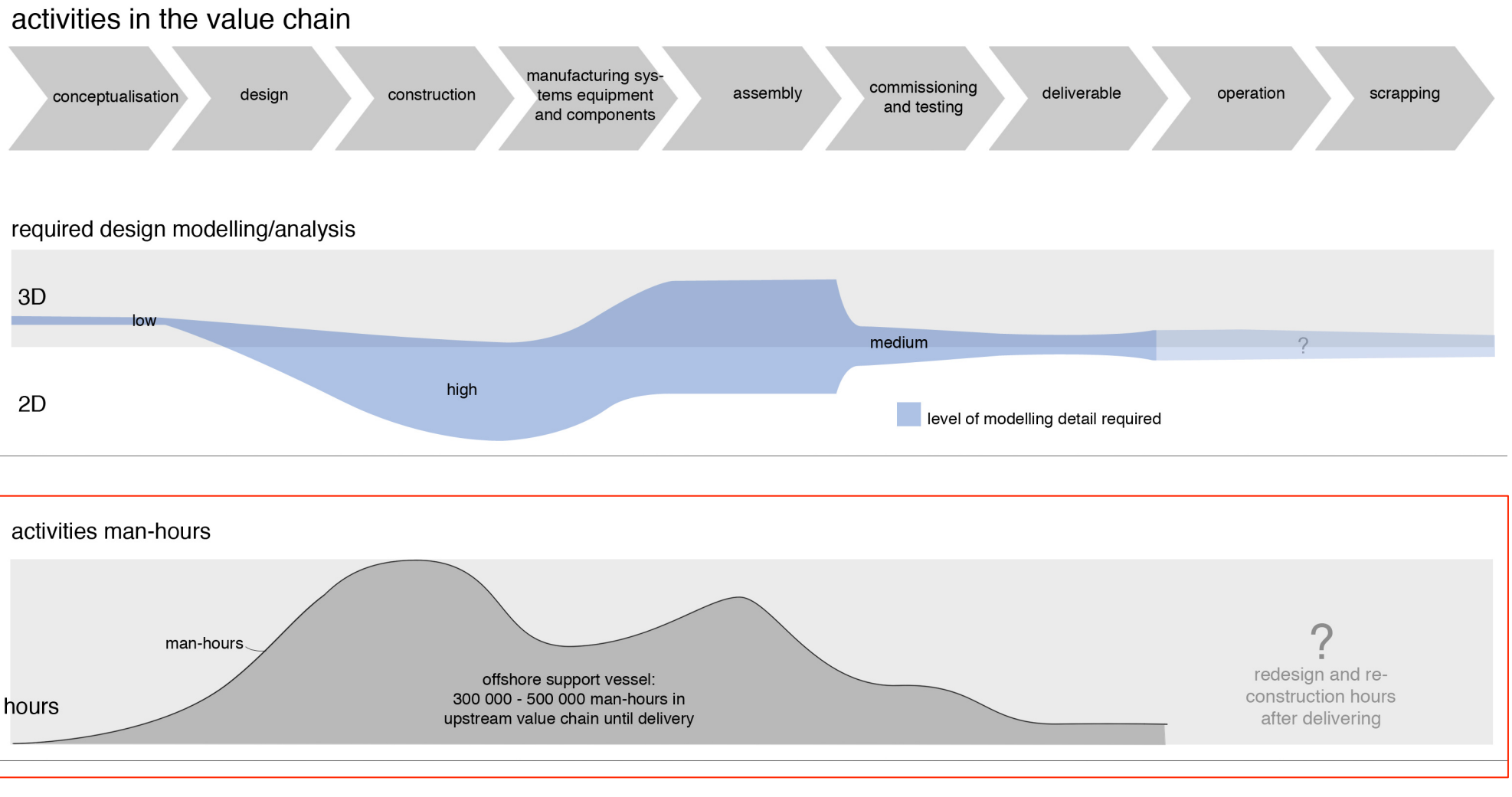


required design modelling/analysis



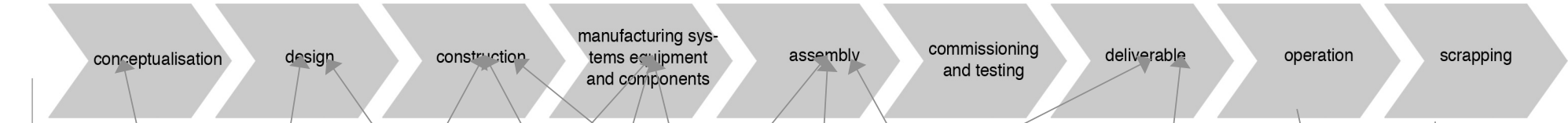
activities man-hours

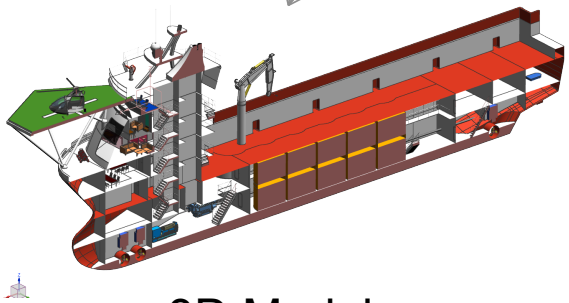
Less time modeling and analyzing



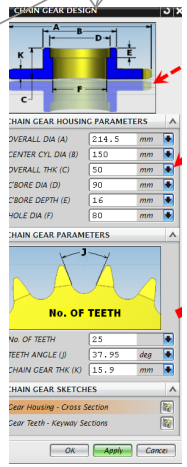
Blocks and pieces of

activities in the value chain

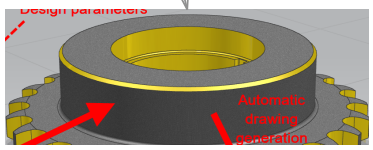




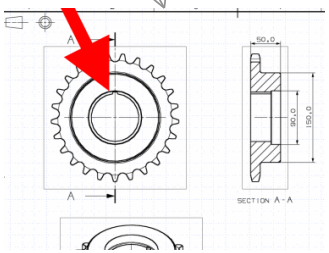
3D Models



Library



3D Modules & Parts



2D Draws

?

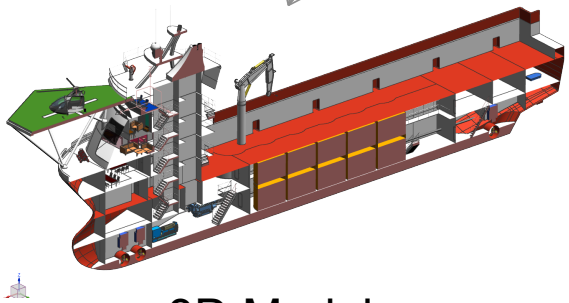
Agenda

- Approaches AND Obsolescence
- What we call as "new ship design approaches"?
- The idea of obsolescence in current maritime engineering software
- **A trending for the future: dealing with a large amount of information**
- Initial Activities

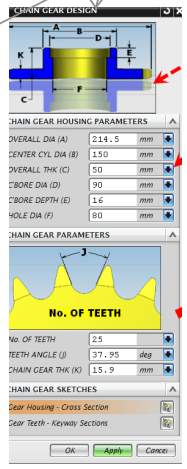
Managing design data and finding "?"

activities in the value chain

conceptualisation | design | construction | manufacturing sys-tems equipment and components | assembly | commissioning and testing | deliverable | operation | scrapping



3D Models



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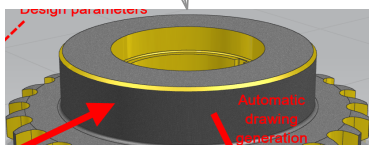
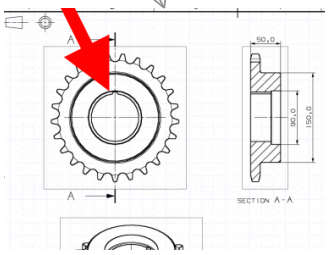


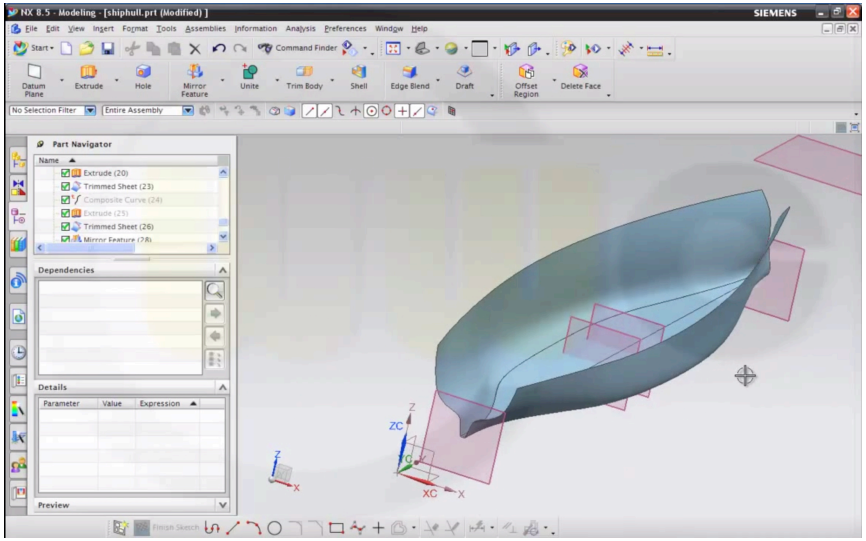
3D Modules & Parts

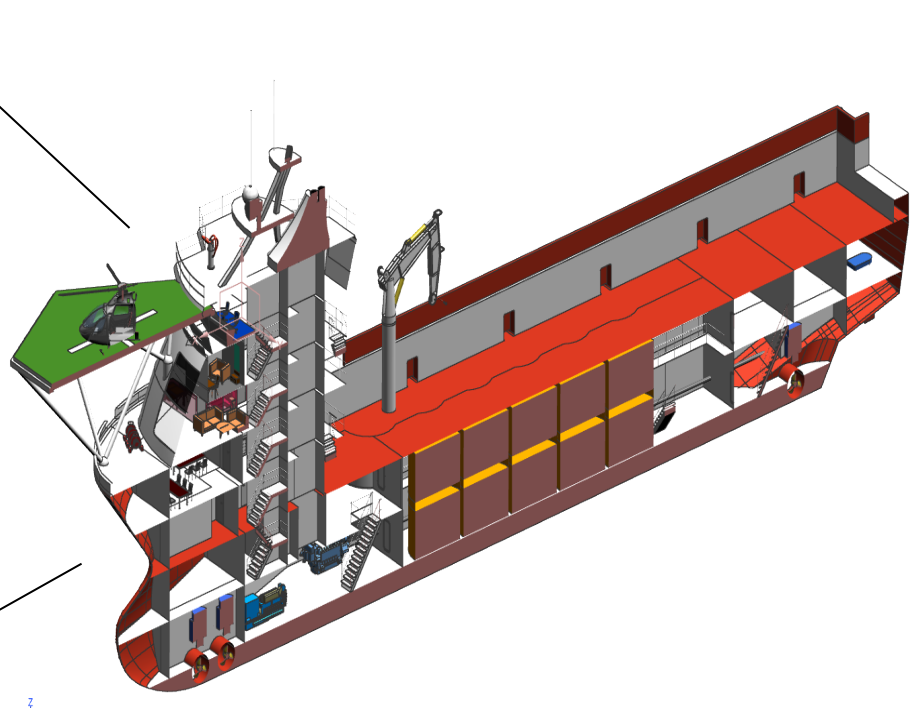


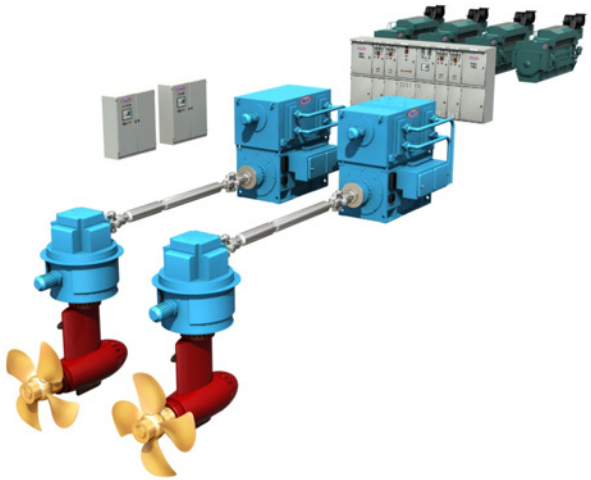
2D Draws

?

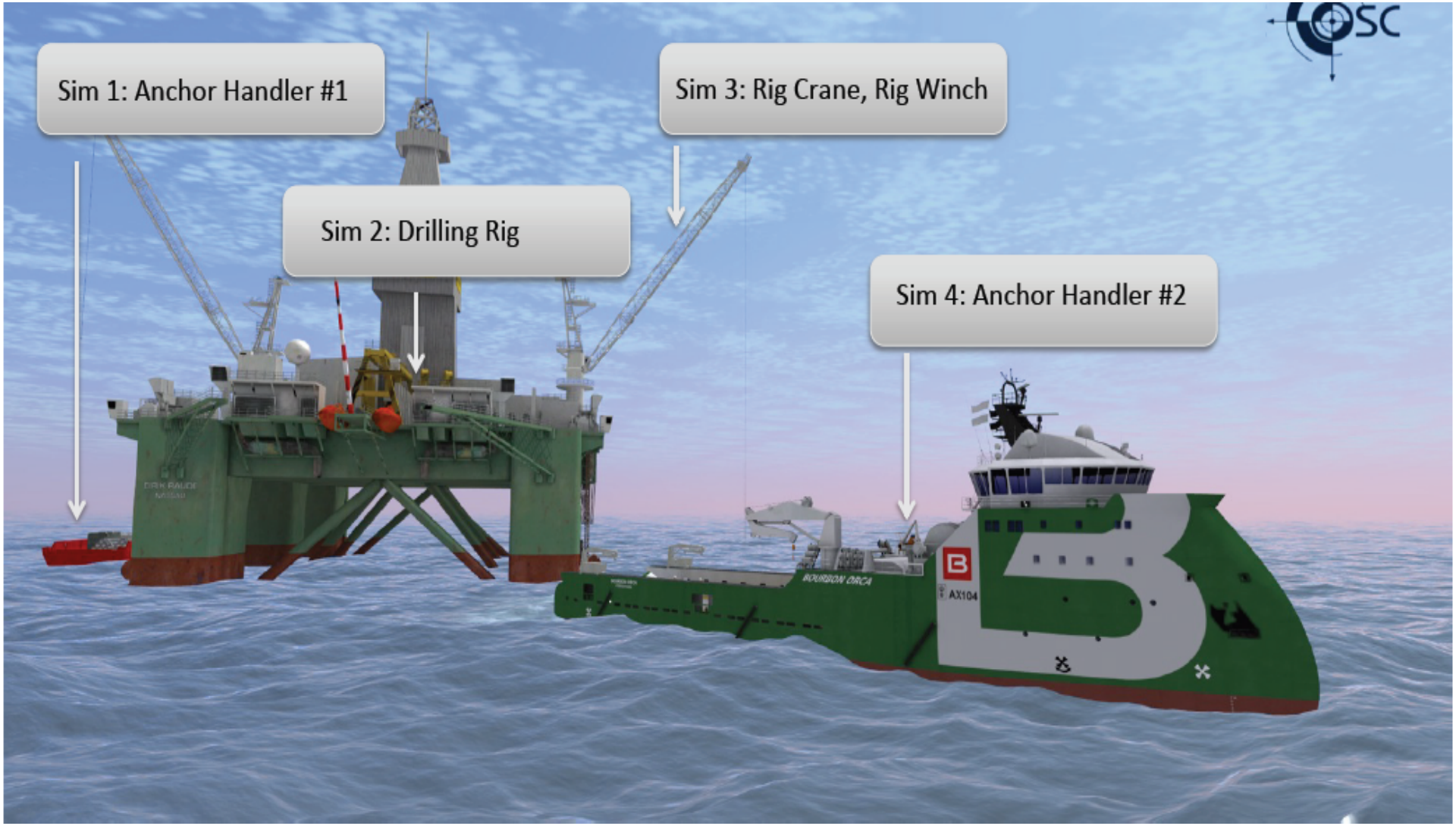
Efficient 3D integration



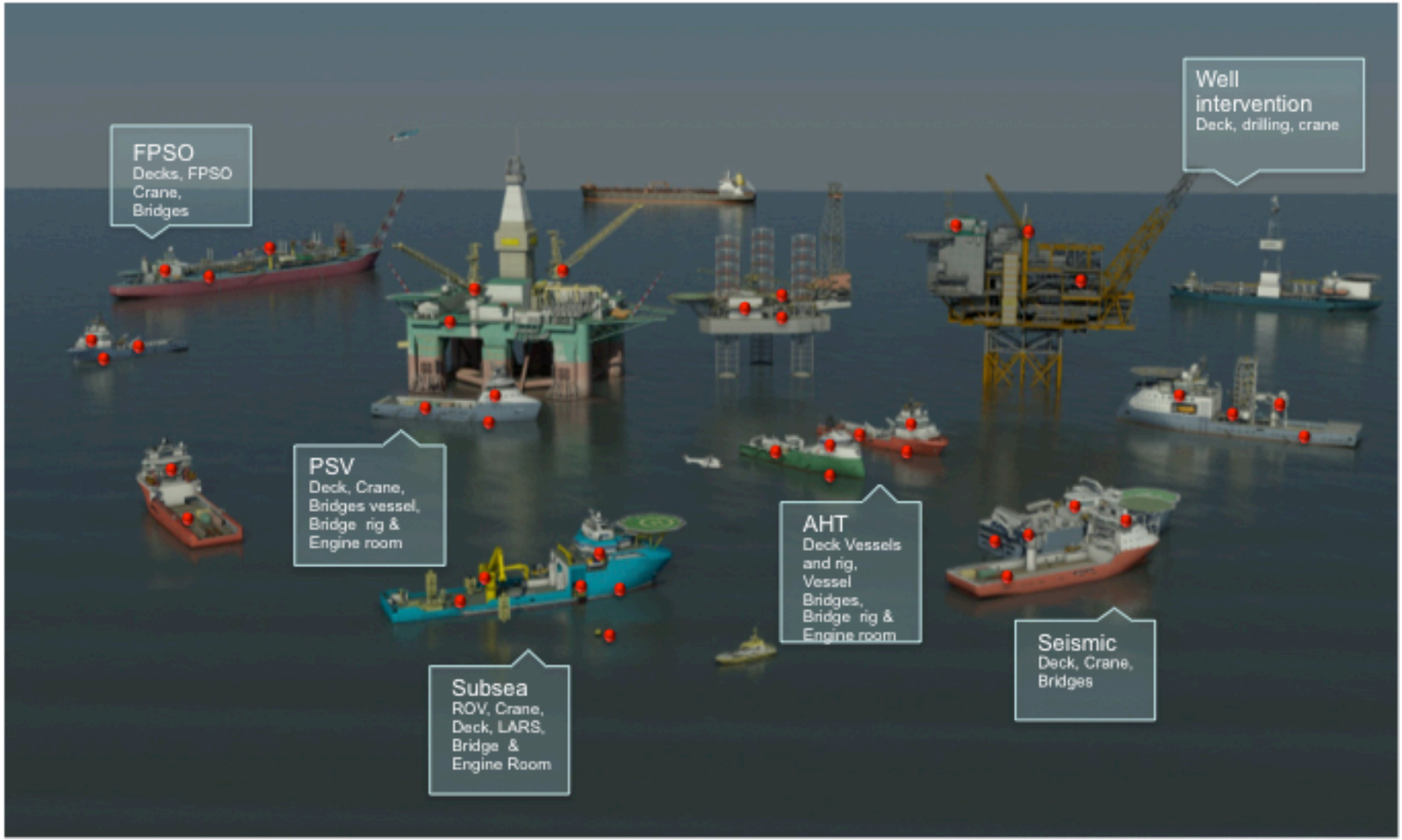




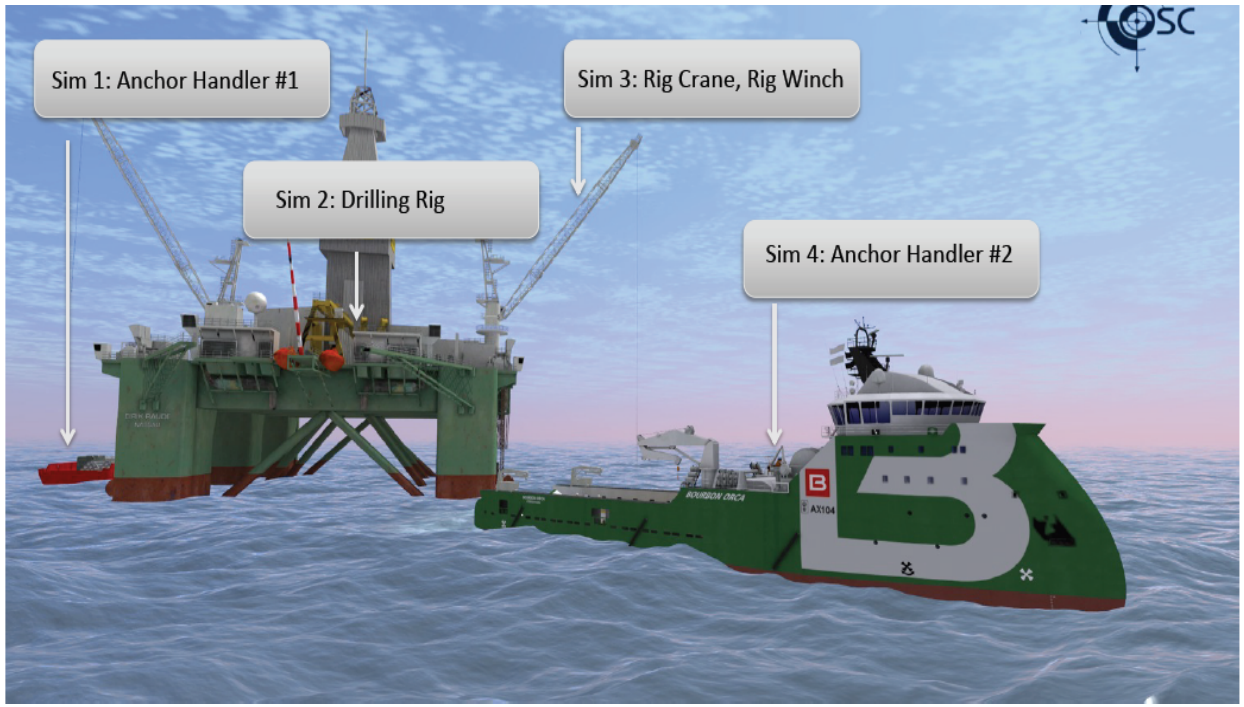
Integrated Operations

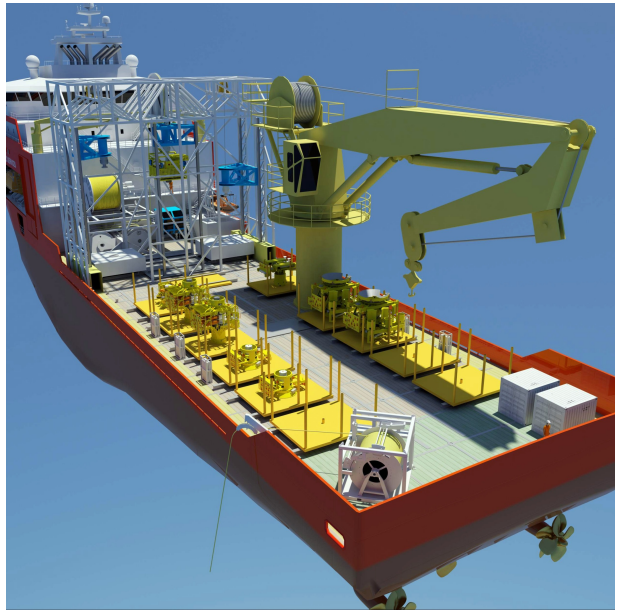


Virtual Systems of Systems



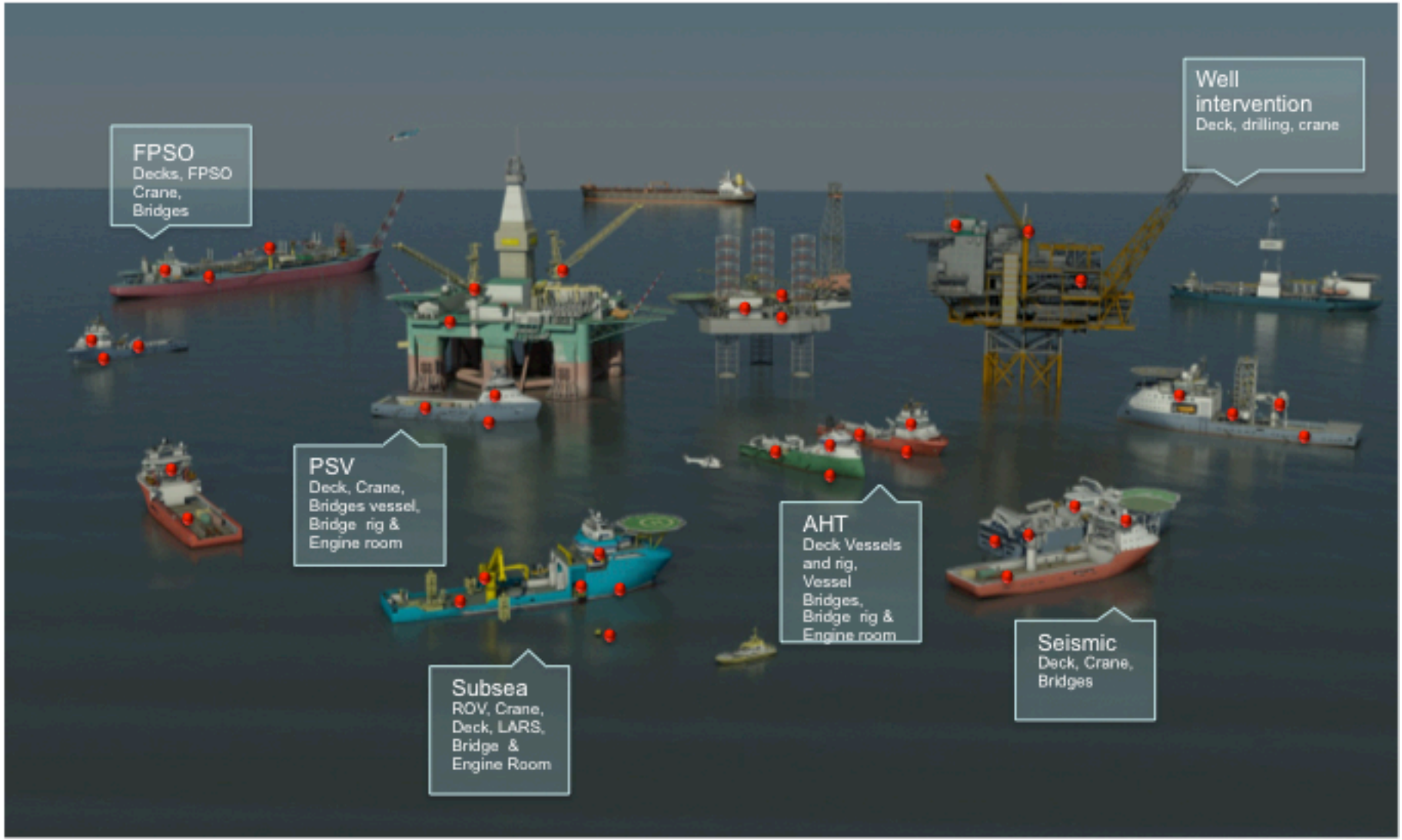
What tools designers would like to have available?





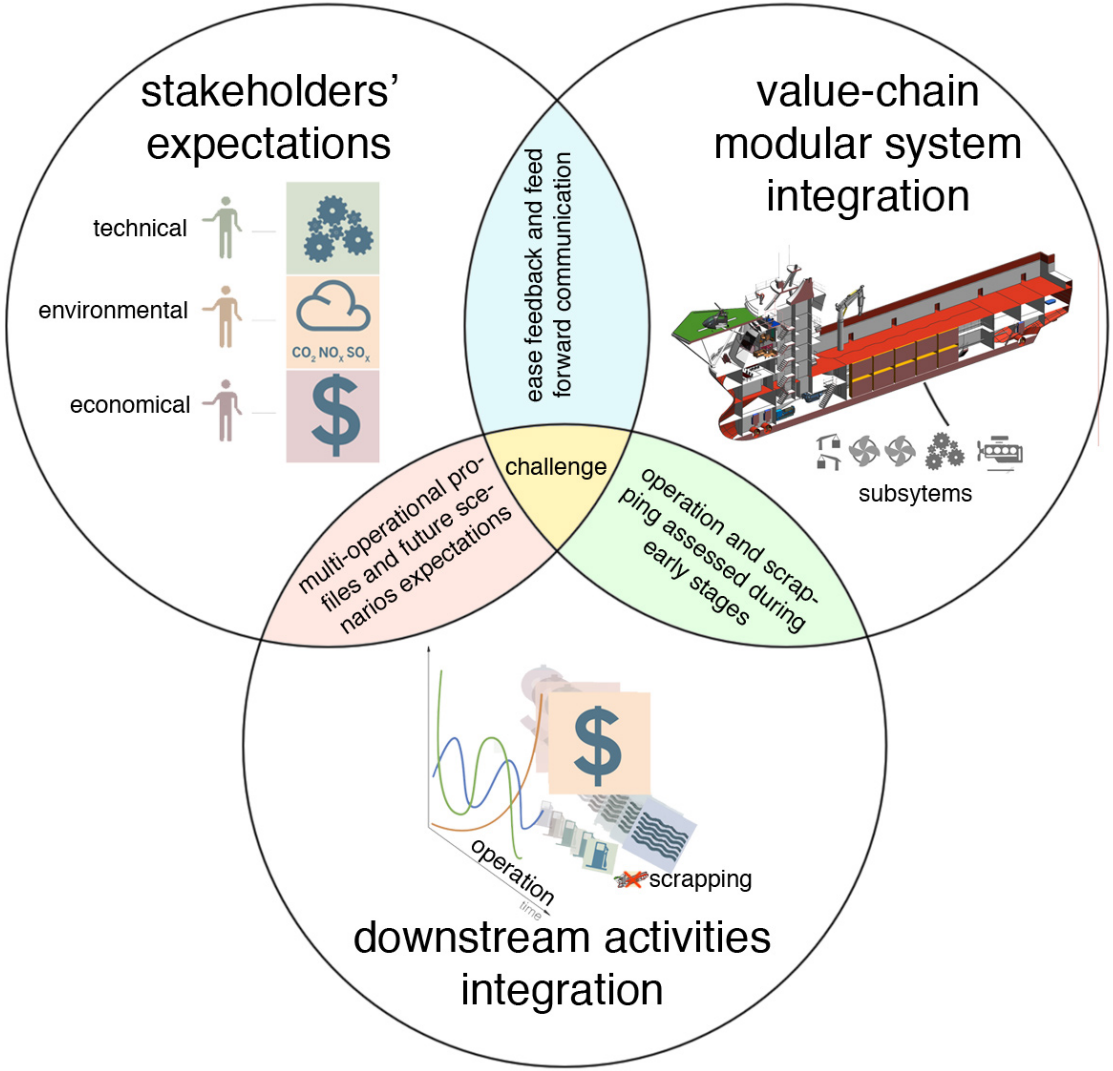
http://youtu.be/GJsogw9fHE0?t=1m49s

Similar Output for Every Component



Future Challenge

- Ease feedback and feed forward communication between stakeholders
- Multi-operational profiles and future scenarios expectations
- Operation and scrapping assessed during early stages



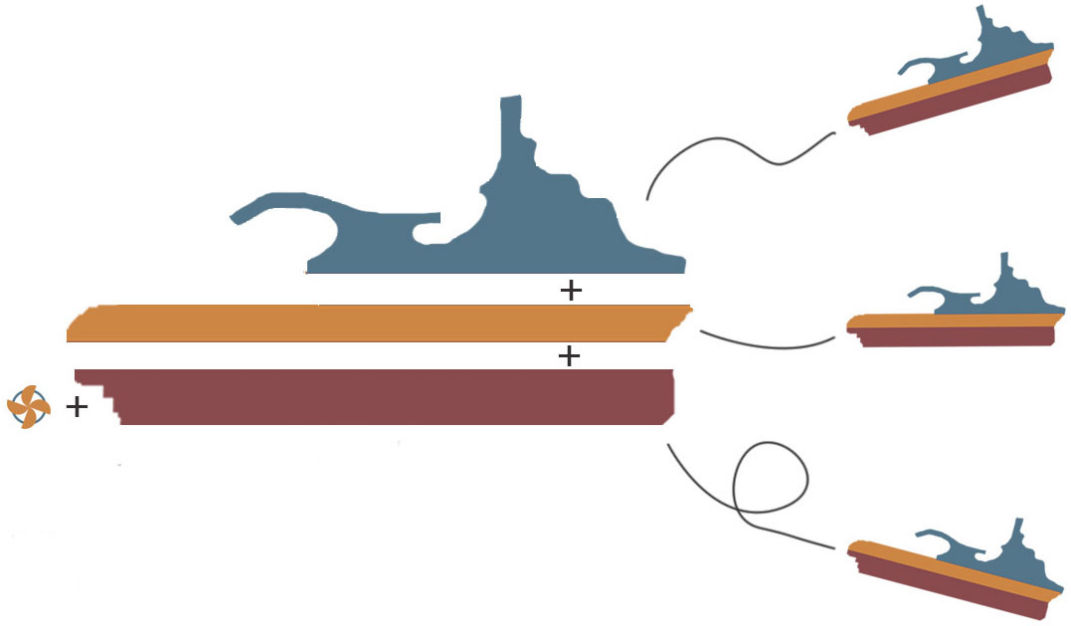
Agenda

- Approaches AND Obsolescence
- What we call as "new ship design approaches"?
- The idea of obsolescence in current maritime engineering software
- A trending for the future: dealing with a large amount of information
- **Initial Activities**

Initial Activities

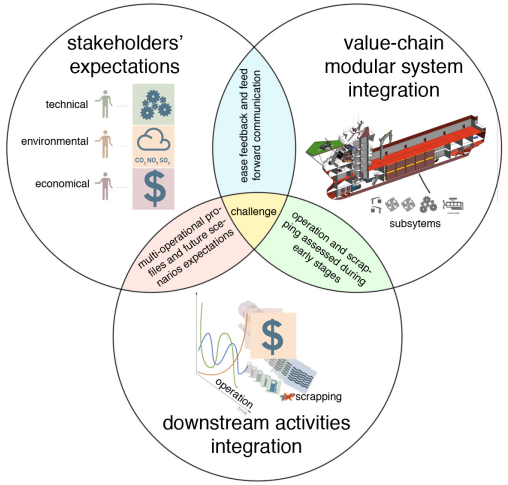
Activities proposed
as part of the

Ship Design and Operations Lab



Initial Activities

- Ease feedback and feed forward communication between stakeholders → Parametric Approach and Efficient Data Communication
- Multi-operational profiles and future scenarios expectations → Epoch-Era and Lifecycle Analysis
- Operation and scrapping assessed during early stages → EMIS Project - Effective Ship Design, Engineering and Fabrication



Initial Activities

- Ease feedback and feed forward communication between stakeholders → **Parametric Approach and Efficient Data Communication**
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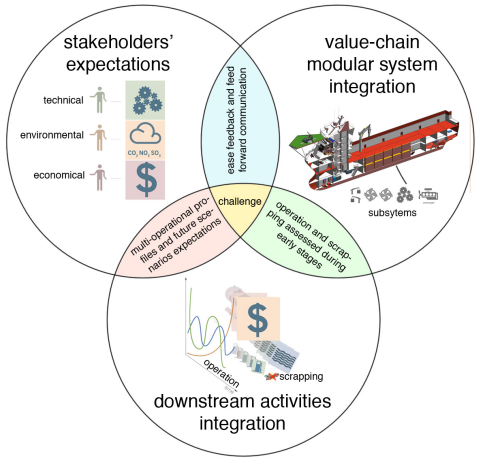
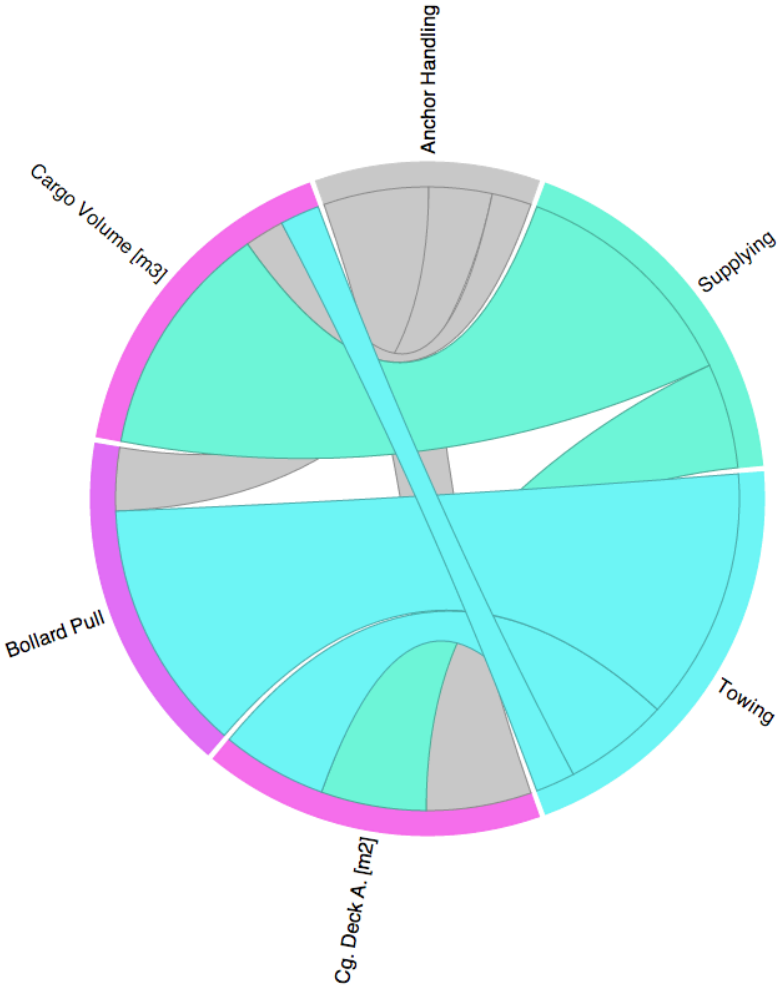
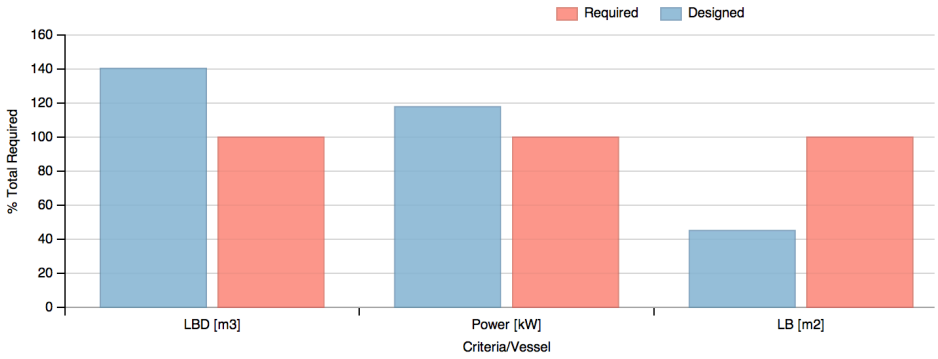


Parameterization and D3





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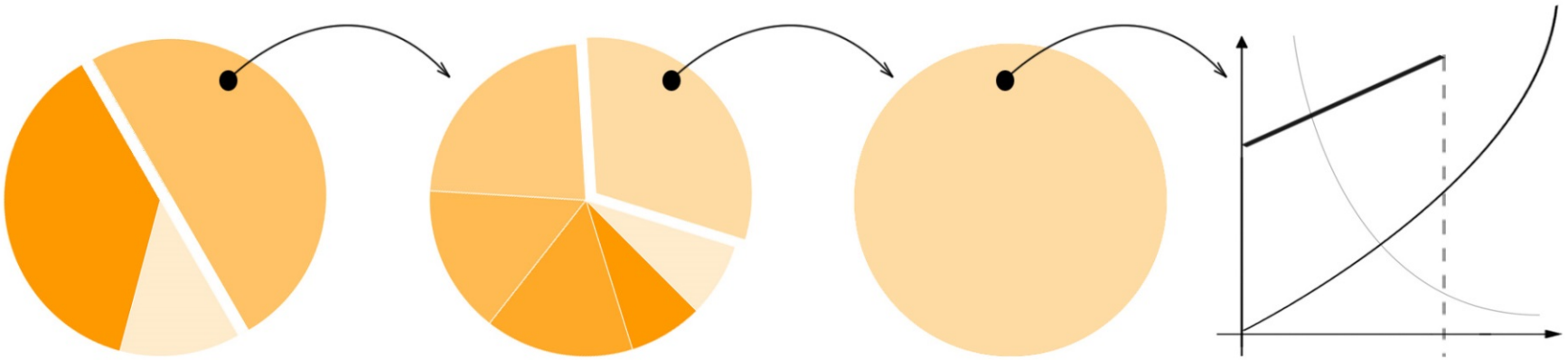
Aalesund University College

Parameterization and D3

Based on Mission-Performance approach



Mission
purpose of design, such as: transportation work, support of offshore operations, safety

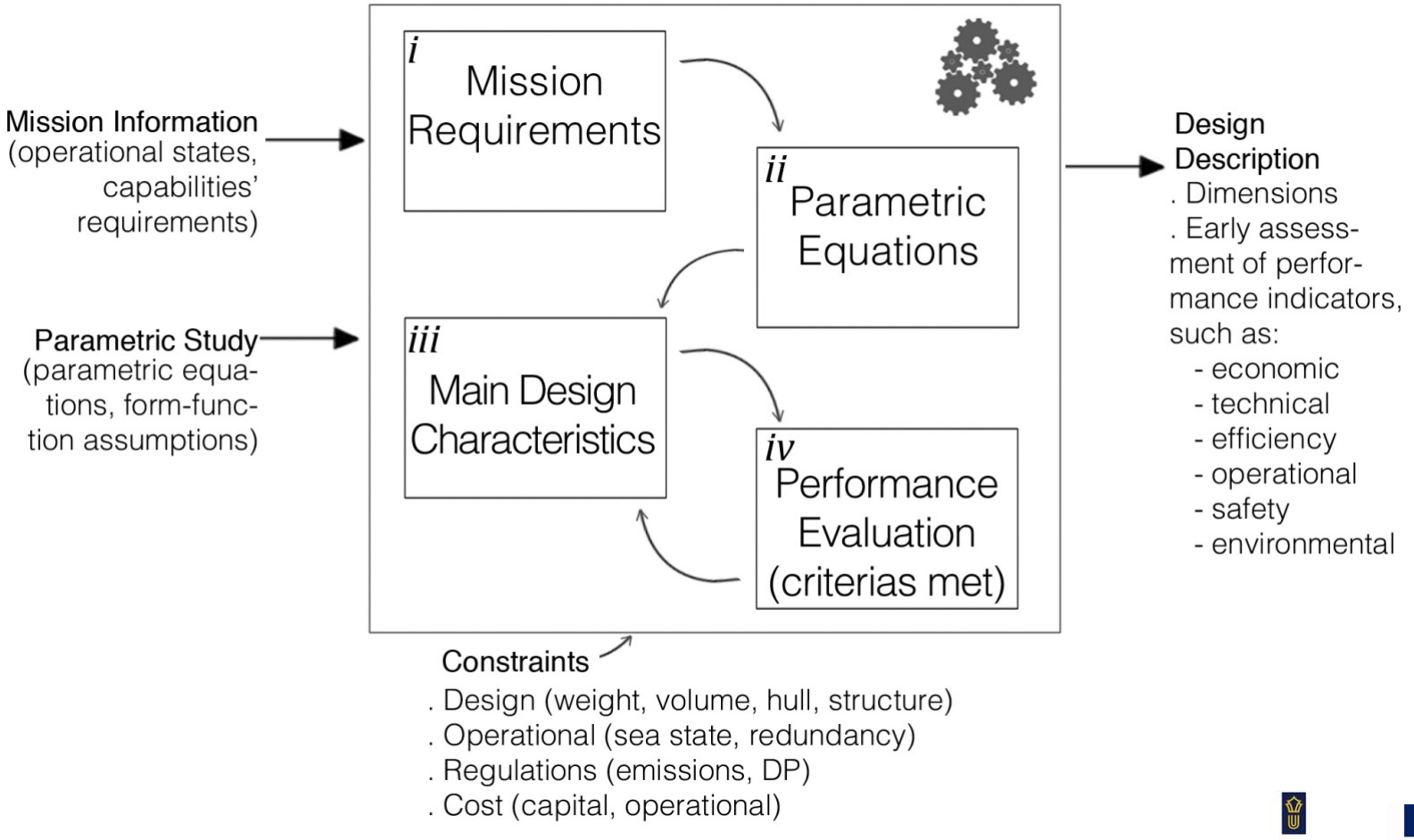
Operational Profiles
ship in service profile, such as: delivering goods (e.g. containers, oil, cars), towing, anchor handling, provinding safety

Operational States
power demand for a specific task, such as: sailing, in port, discharging, loading, towing, anchor handling, stand by, idle

Performance
performance attributes, such as: fuel comsumption, air emissions, powering, loss, capacity on board

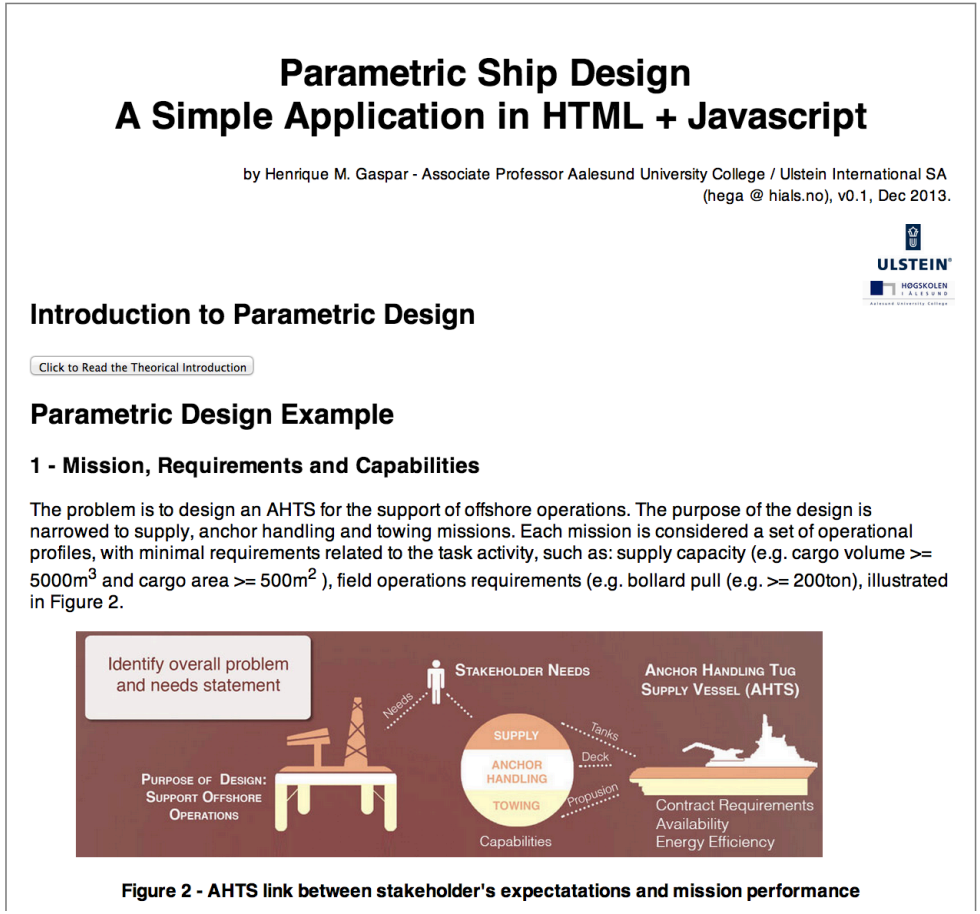
Parameterization and D3

Methodology



Parameterization and D3

- Simple Example – But containing ALL the parts of the methodology
- Web "App":
  - Wider audience
  - Easier to explain the methodology
  - Interactive
  - More complex coding
  - Data-driven documents (D3): able to handle data in an efficient way
  - Research is innovative – case of D3 published for maritime cases



Parametric Ship Design
A Simple Application in HTML + Javascript

by Henrique M. Gaspar - Associate Professor Aalesund University College / Ulstein International SA
(hega @ hials.no), v0.1, Dec 2013.

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Introduction to Parametric Design

Click to Read the Theorical Introduction

Parametric Design Example

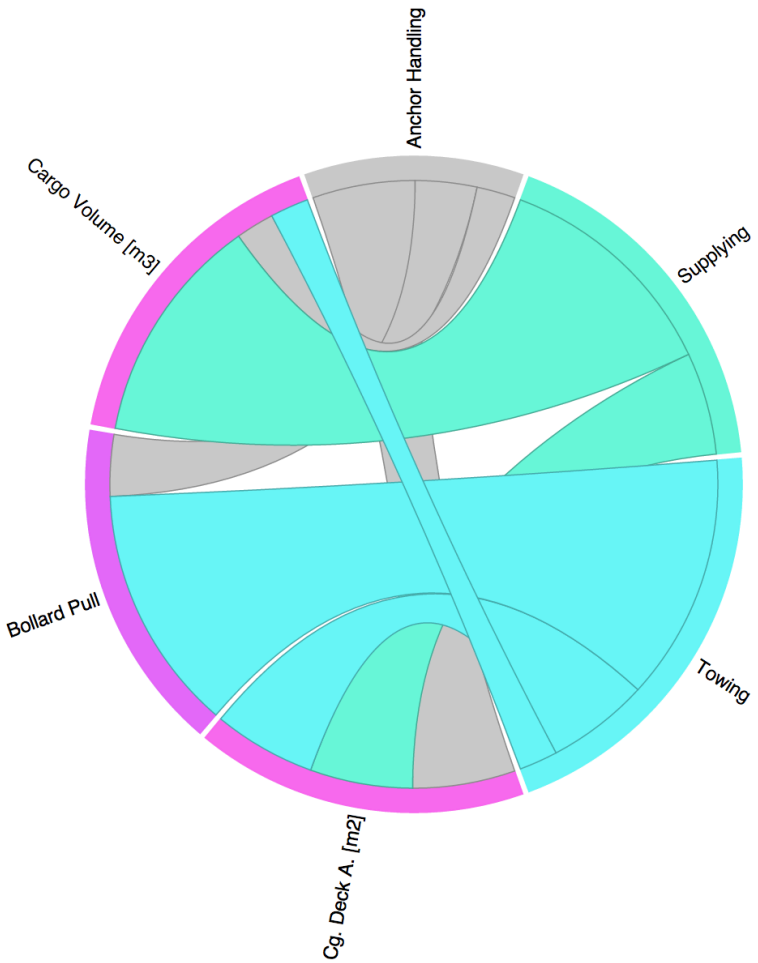
1 - Mission, Requirements and Capabilities

The problem is to design an AHTS for the support of offshore operations. The purpose of the design is narrowed to supply, anchor handling and towing missions. Each mission is considered a set of operational profiles, with minimal requirements related to the task activity, such as: supply capacity (e.g. cargo volume >= 5000m^3 and cargo area >= 500m^2), field operations requirements (e.g. bollard pull (e.g. >= 200ton), illustrated in Figure 2.

Figure 2 - AHTS link between stakeholder's expectatations and mission performance

Parameterization and D3

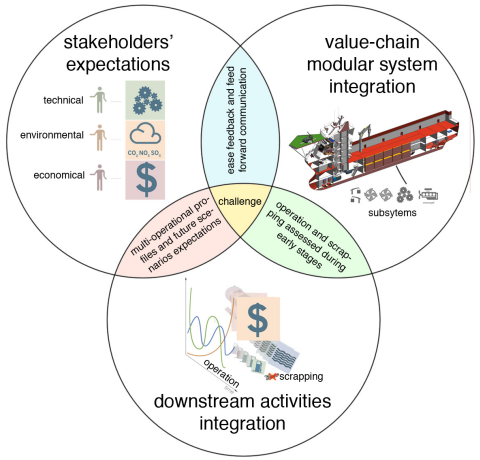
- WEB PAGE



The length of the border represents the total values of the capabilities in percentage, normalized to 100%. The thickness of the line connecting capabilities and operational profiles represents a dependency between the two aspects. The length of the circle border of the operational profiles are related to the amount of vessel capabilities required to perform a that task. Dependencies are filtered when passing the mouse over the borders of the circle.

Initial Activities

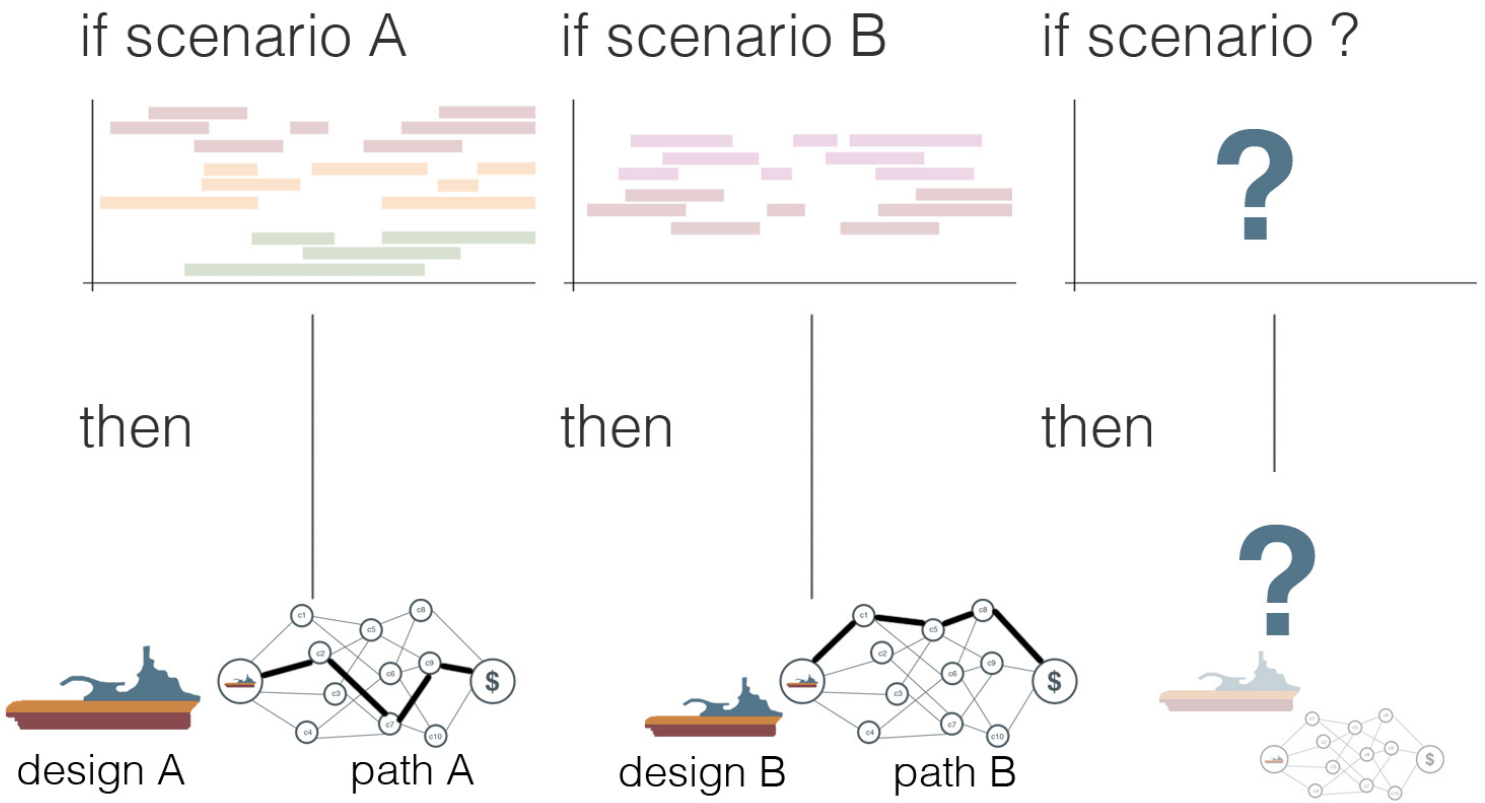
- Ease feedback and feed forward communication between stakeholders → Parametric Approach and Efficient Data Communication
- Multi-operational profiles and future scenarios expectations → **Epoch-Era and Lifecycle Analysis**
- Operation and scrapping assessed during early stages → EMIS Project - Effective Ship Design, Engineering and Fabrication



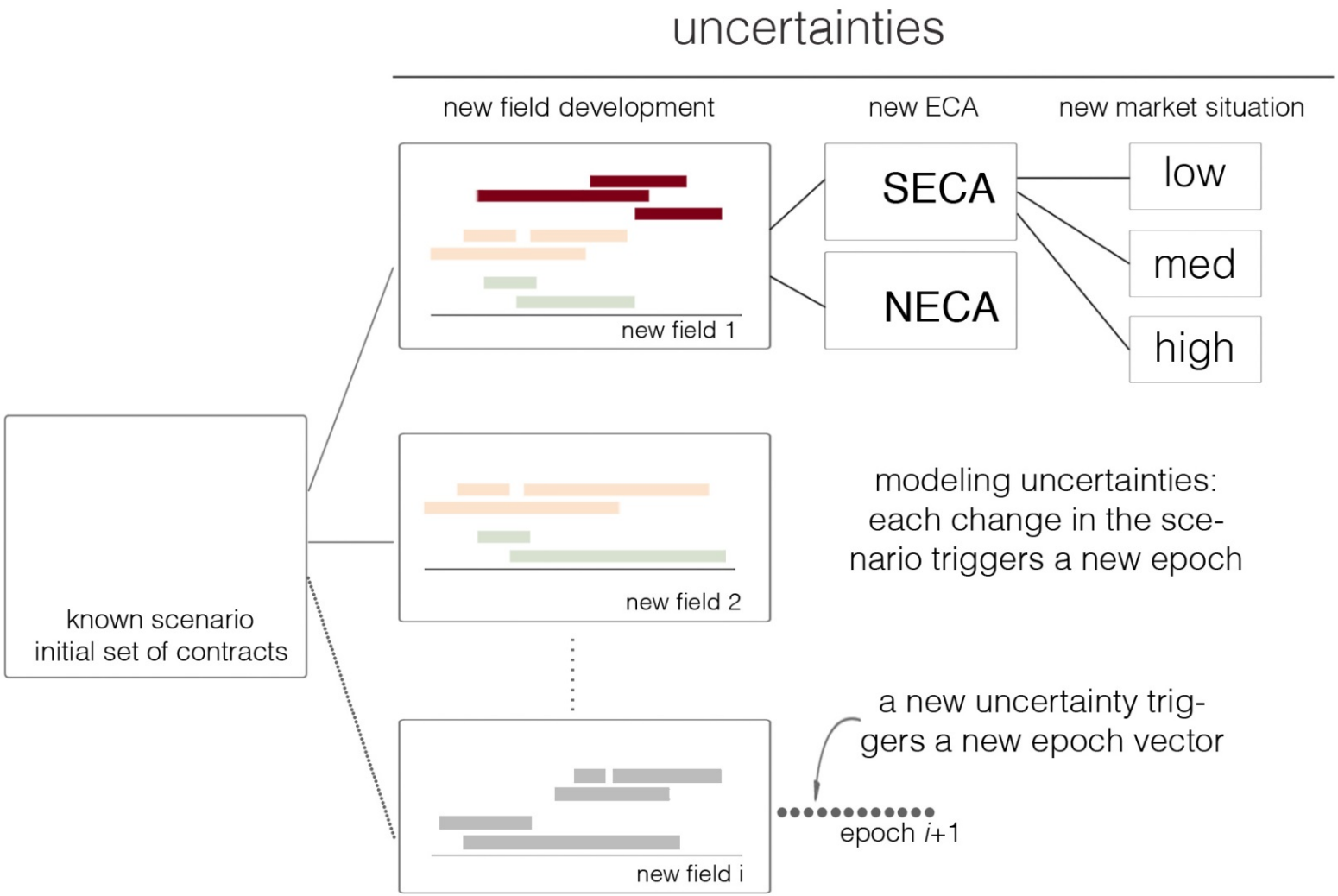
Handling Uncertain Future

scenario uncertainties:

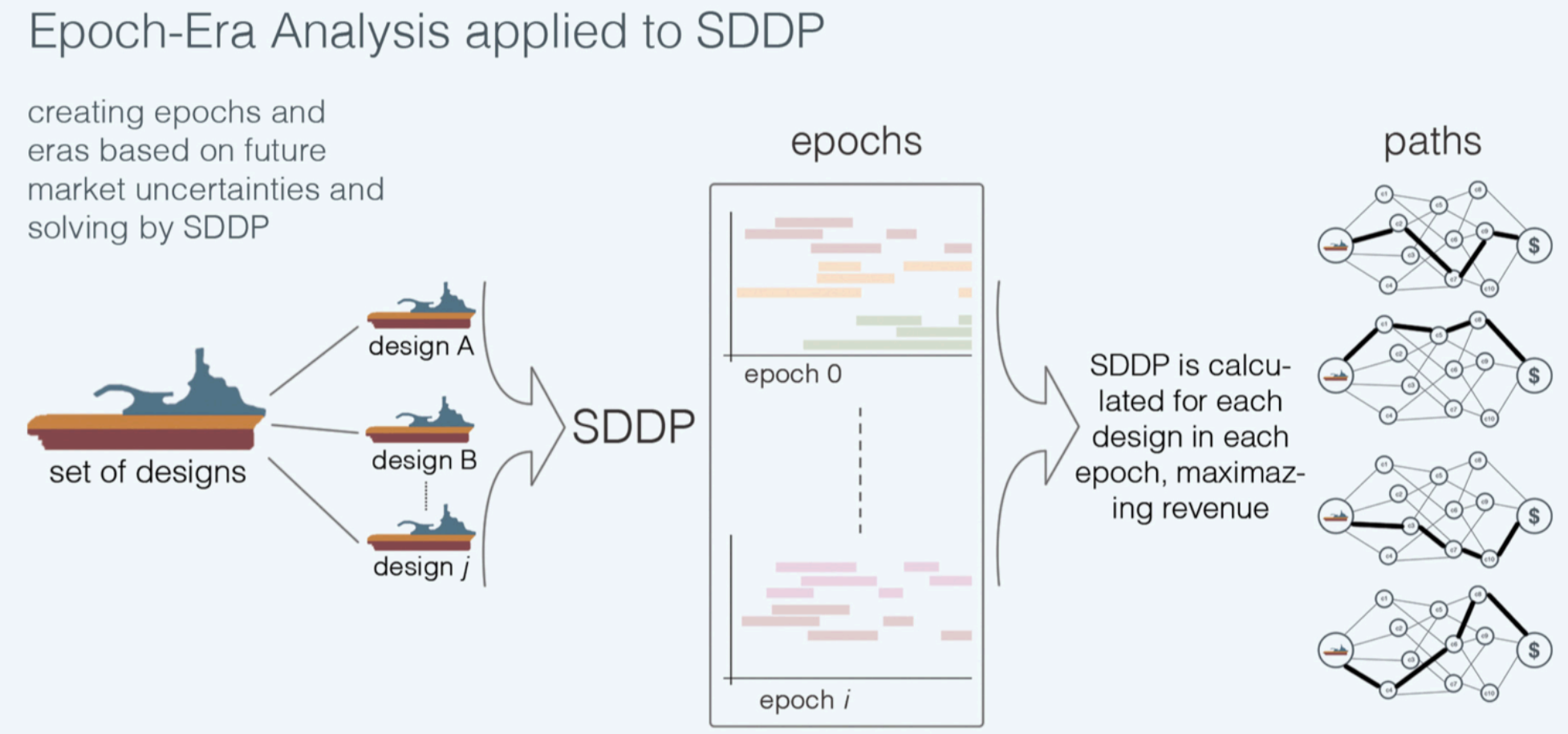
field development
new technology
market
policy / regulations



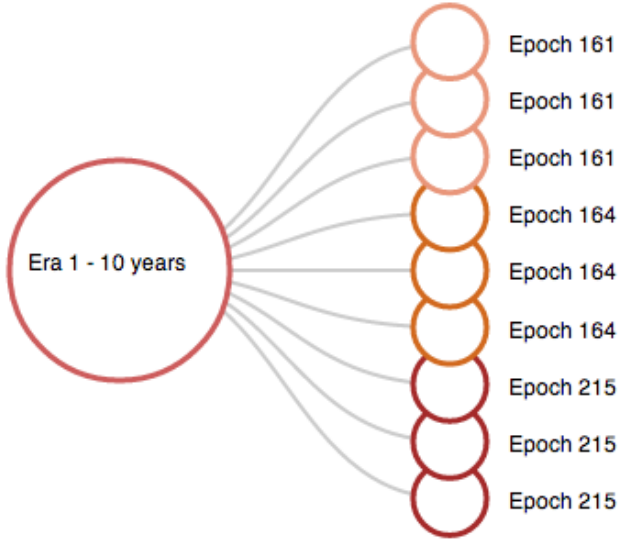
Decomposing Context



Decomposing Designs



Simulating Future Scenarios for Missions at the Arctic via Epoch-Era



http://uscience.org/files/lifecycle.html

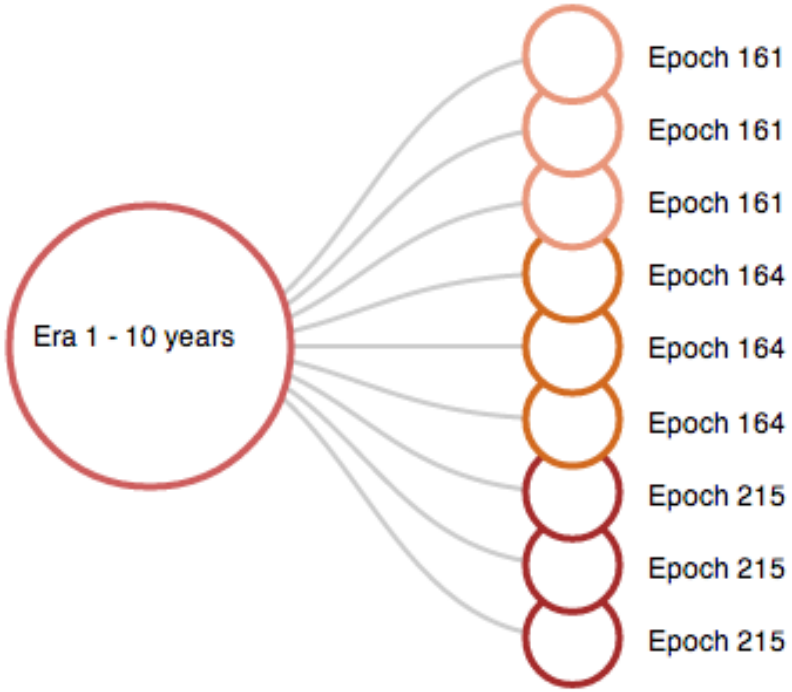
Arctic – Contextual Factors

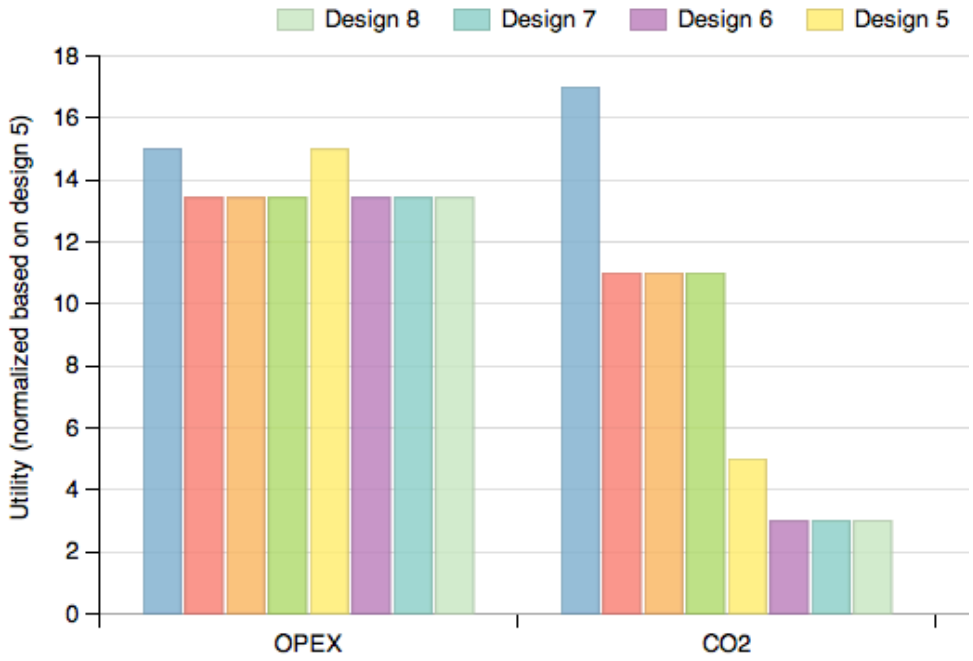
- **Environmental Conditions**: weather and ice conditions, as well as the consequences to operability caused by icing, darkness, fog.
- **Technology Development**: Improve behavior in ice, with advancements in hull structure and propulsion; Improvements in maintenance and reliability of LNG machinery.
- **Infrastructure:** LNG bunkering installations along the arctic; Support and emergency infrastructure within acceptable range/response time, as well as wider ice-breakers available (breadth limitation).

Arctic – Contextual Factors

- **Policy/Regulations**: Future regulations may create a new ECA; new rules connect to regional agreements, political factors or instability. LNG regulations towards…
- **Market/Risk:** Market situation can affect both the use of Arctic routes and LNG fuelled ships. A stronger demand would increase the activity (risky-prone behavior), whilst a weaker demand would lead to more conservative solutions.

Arctic – LNG Case





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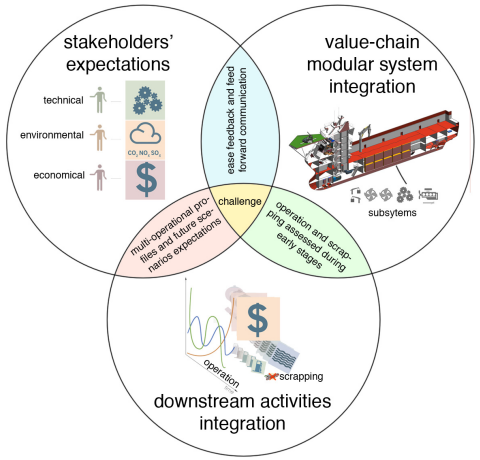
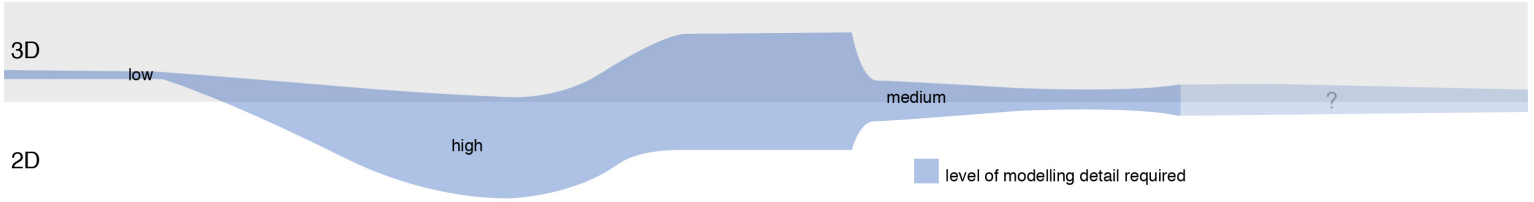


EMIS

activities in the value chain

conceptualisation → design → construction → manufacturing sys-tems equipment and components → assembly → commissioning and testing → deliverable → operation → scrapping

required design modelling/analysis



activities man-hours

current commercial engineering tools & methodology

rhinoceros 3D clickview	CFD - NUMECA NAPA CADMATIC Cadmatic	Empower Hullvisc Dynacap NUMECA ROROPT Nextix AutoCad Cadmatic EDSA EPLAN FoxPro	AutoCad Cadmatic 3D beam TKHeat Nauticus Rules	AutoCad AVEVA suite	AutoCad AVEVA suite	AutoCad AVEVA suite	(epoch-era)	(lifecycle assess-ment)
3D concept model to sales/client	3D modules for analysis (CFD, FEM) libray development	main blocks architec-ture and interface of modules	common library parts, configuration and manufacturing of sub-systems	connect subsystems, check of design rules automatically	aid via reporting and simulation, develop-ment of modules	report and docu-mentation based on a common module library	(take into account a set of possible op-erations)	(include scrapping during design)

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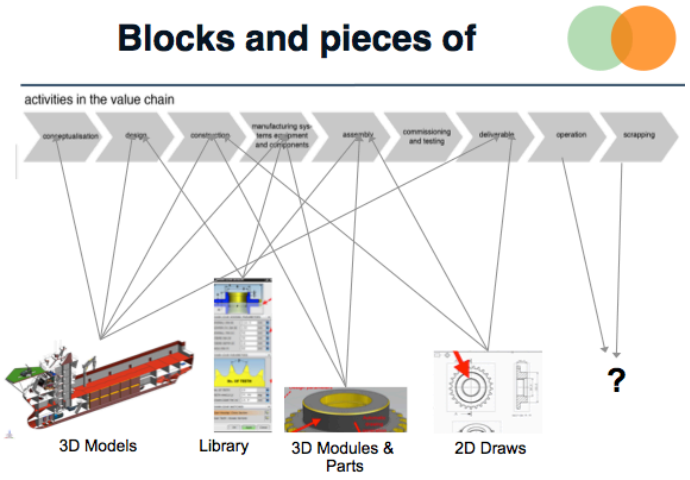
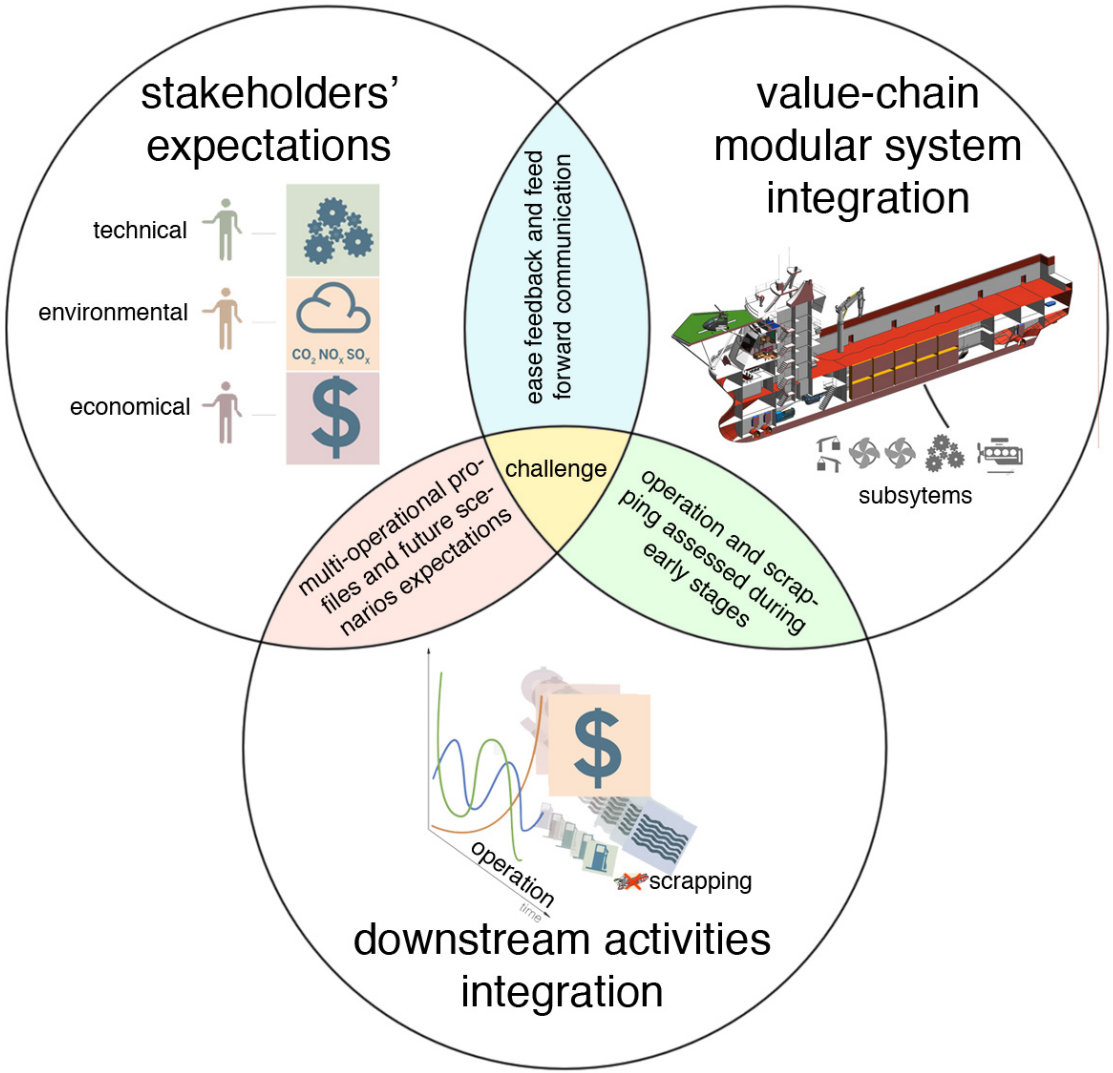
EMIS





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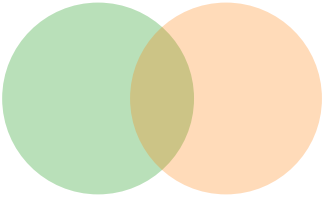
Summary



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Thank you!