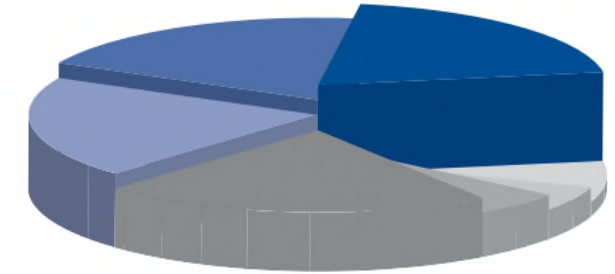
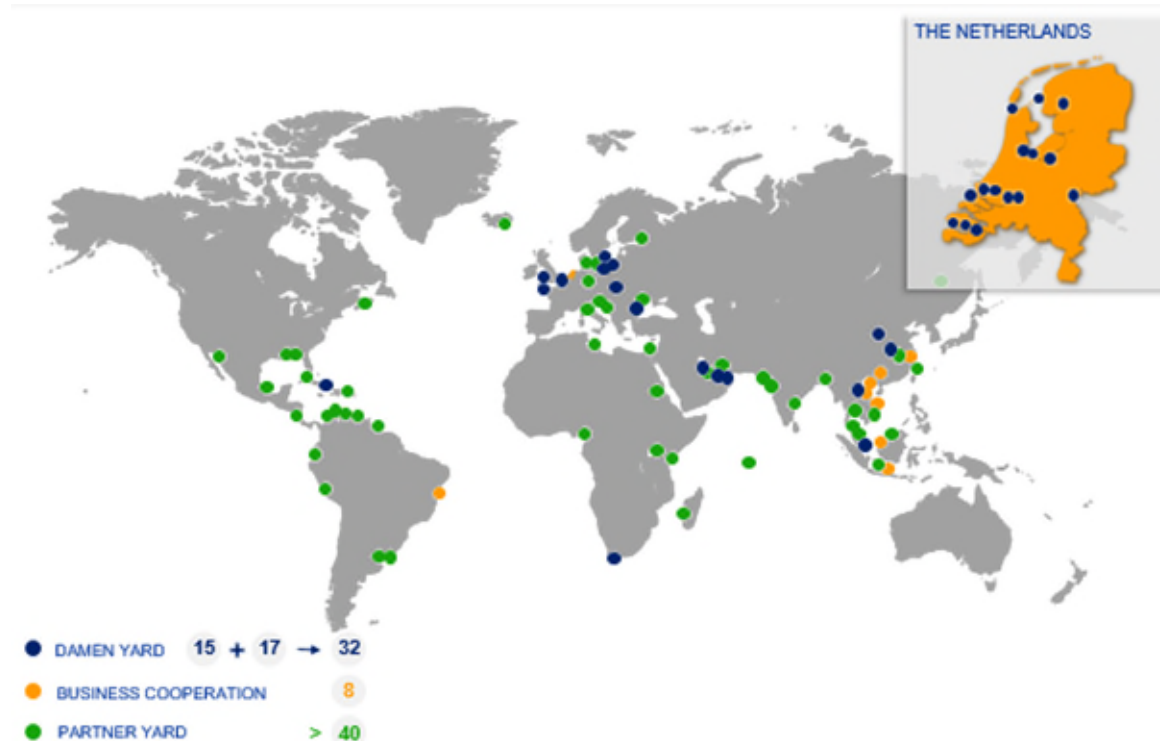


# DAMEN



DEVELOPMENT OF MATERIALS USED IN  
NAVAL SHIPBUILDING

## Introduction DAMEN Shipyards



### NEWBUILDING

- Harbour services and Shipping 22%
- Offshore support 20%
- Security and Safety 20%
- Naval 20%
- Public transport 5%
- Dredging 5%
- Yachts 8%

**150-180 New-builds/year >1500 Repair jobs/year**  
**Steel, Aluminum and Composite shipyards**

## Relative Complexity of a Naval Platform



Platform Complexity Metrics	Battle Tank	Boeing 777	Frigate	Collins Class Submarine
Weight (tonnes)	30	250	3,600	3,000
Length (metres)	7	60	118	78
Number of systems	25	40	60	108
Number of suppliers	600	550	600	1,600
Crew size	4	10	163	43
Number of parts to assemble	14,000	100,000	170,000	500,000
Number of person hours to assemble	5,500	50,000	1,200,000	2,500,000
Construction time (months)	7	14	22	60
Price (AUD \$M)	4	300	600	1,000

## Relative Complexity of a Naval Platform



## Limited Series



**1975-1976**

**2 X TROMP  
CLASS**



**1985 -1986**

**2 X HEEMSKERCK  
CLASS**



**2001-2004**

**4 X ZEVEN  
PROVINCIE  
CLASS**



**2011-2012**

**1 X SIGMA 10513  
2 X SIGMA 9813  
CLASS**



**1978 -1983**  
**12 X KORTENAER  
CLASS**



**1990 -1995**  
**8 X KAREL DOORMAN  
CLASS**



**2007-2009**  
**4 X SIGMA 9113  
CLASS**



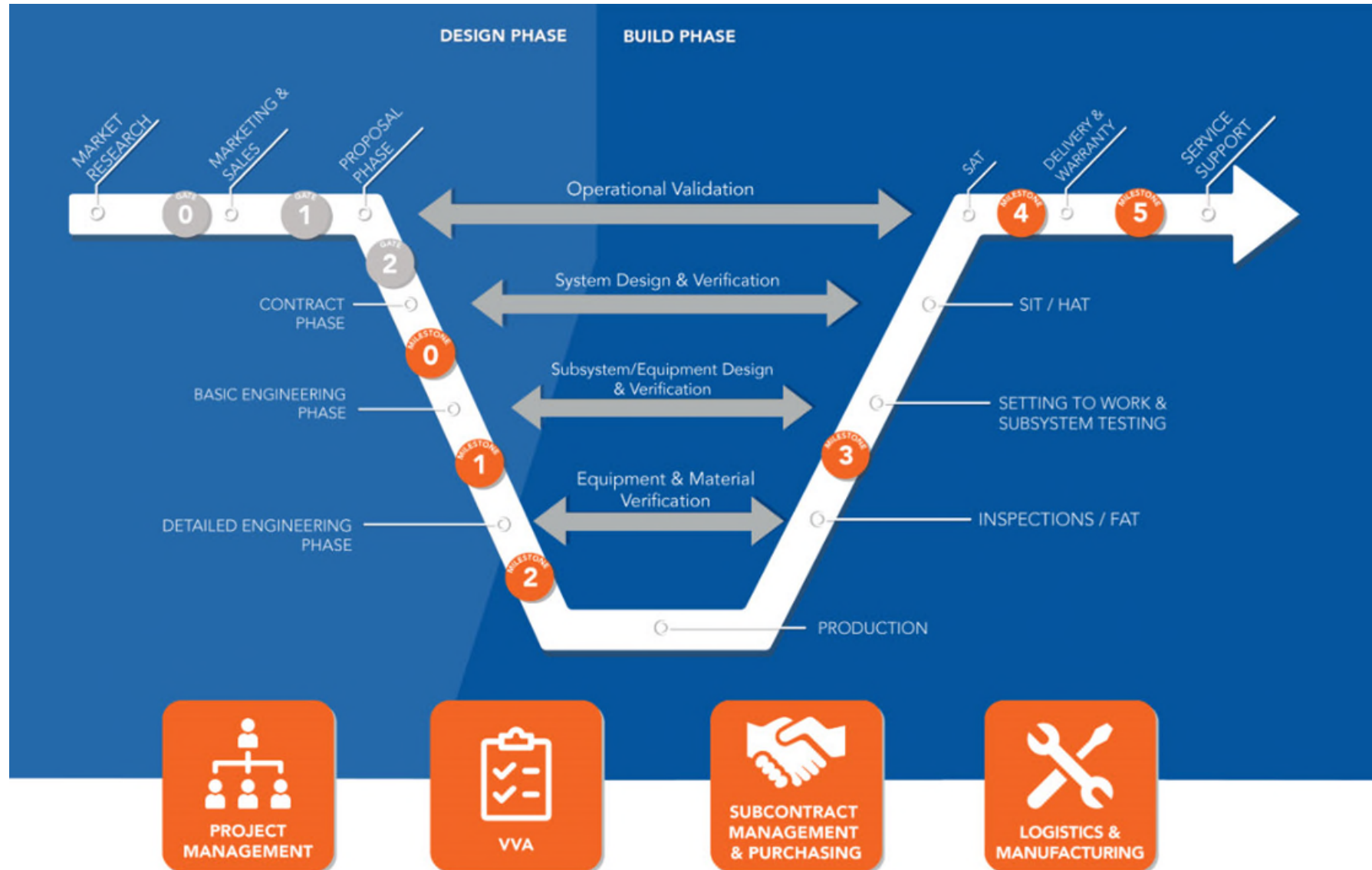
**2010-2013**  
**4 X HOLLAND  
CLASS**



**2014-**  
**2 X SIGMA 10514  
CLASS**



## Engineered To Order Process



## Prescriptive Ruleset derived by experiences from multiple incidents



Wave loading



Stability



Human Factor



Fire safety



LIFE MATTERS



Move Forward with Confidence

Fellowship ,Craftsmanship, Stewardship, Entrepreneurship



## How to introduce new Materials in this system?

In general new technology is not covered by established codes and procedures

Risk based and goal based design allows to prove equivalent safety for new solutions

### Low

Nothing new or unusual  
Well understood issues  
Established practice

Codes & Standards  
**SAFETY RULES**

### Medium

Uncertainty/deviation from  
standard practice. Possible  
safety trade-offs. Economic  
and lifecycle implications.

Engineering  
judgement

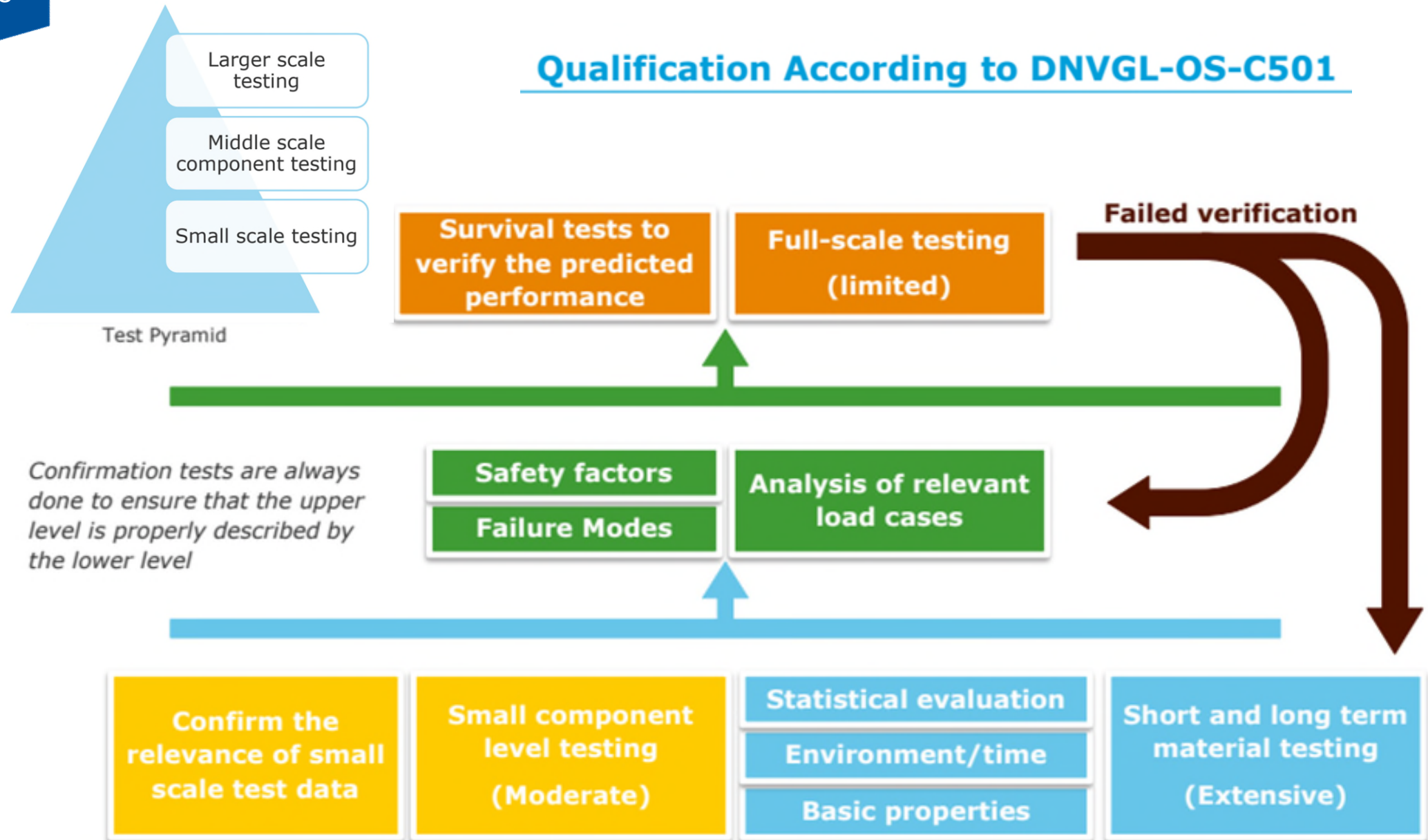
### High

Novel or/challenging  
concepts. Large  
uncertainties. Significant  
safety trade-offs.

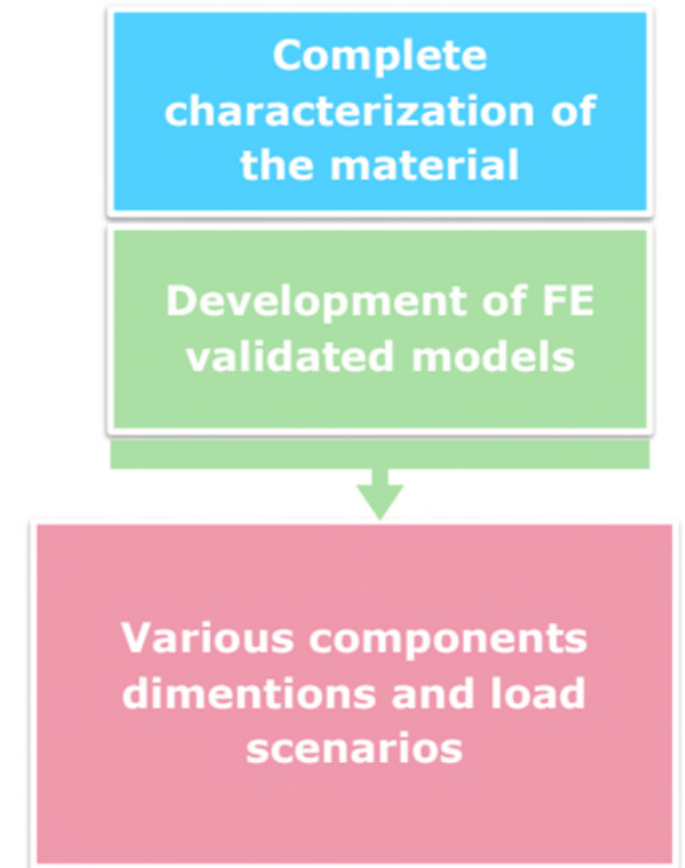
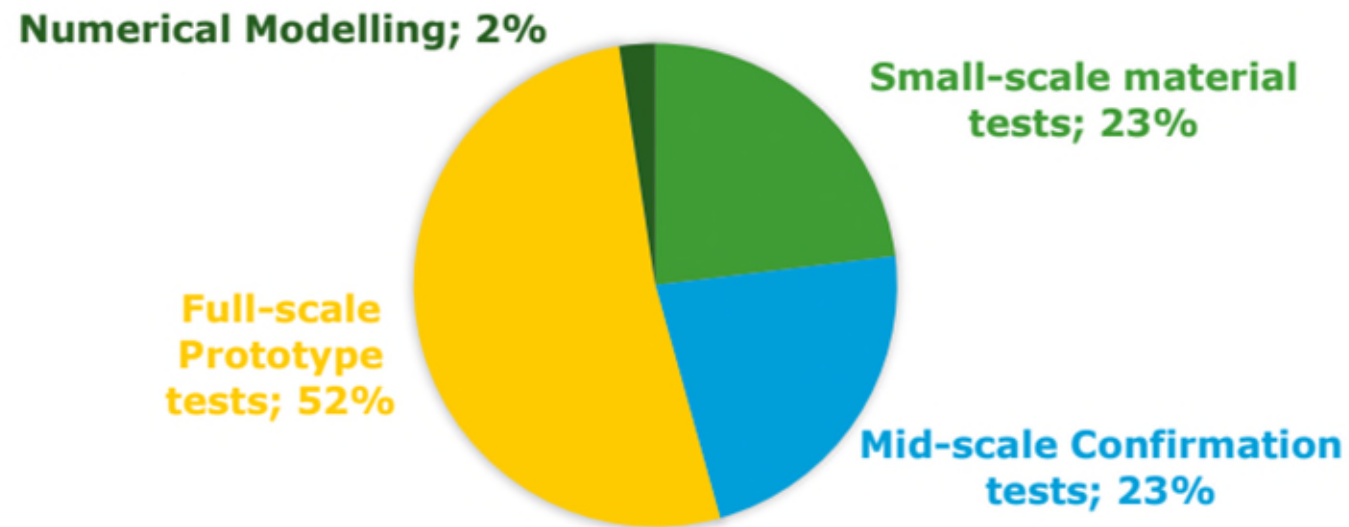
**Risk-based design**

First-principles  
**RISK ASSESSMENT**



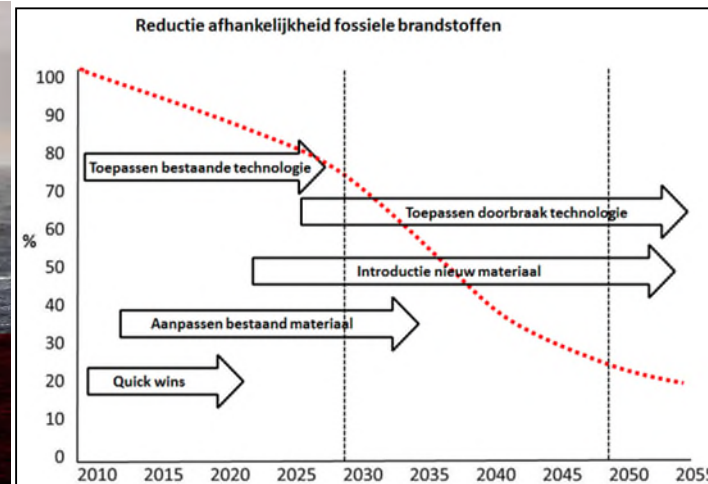
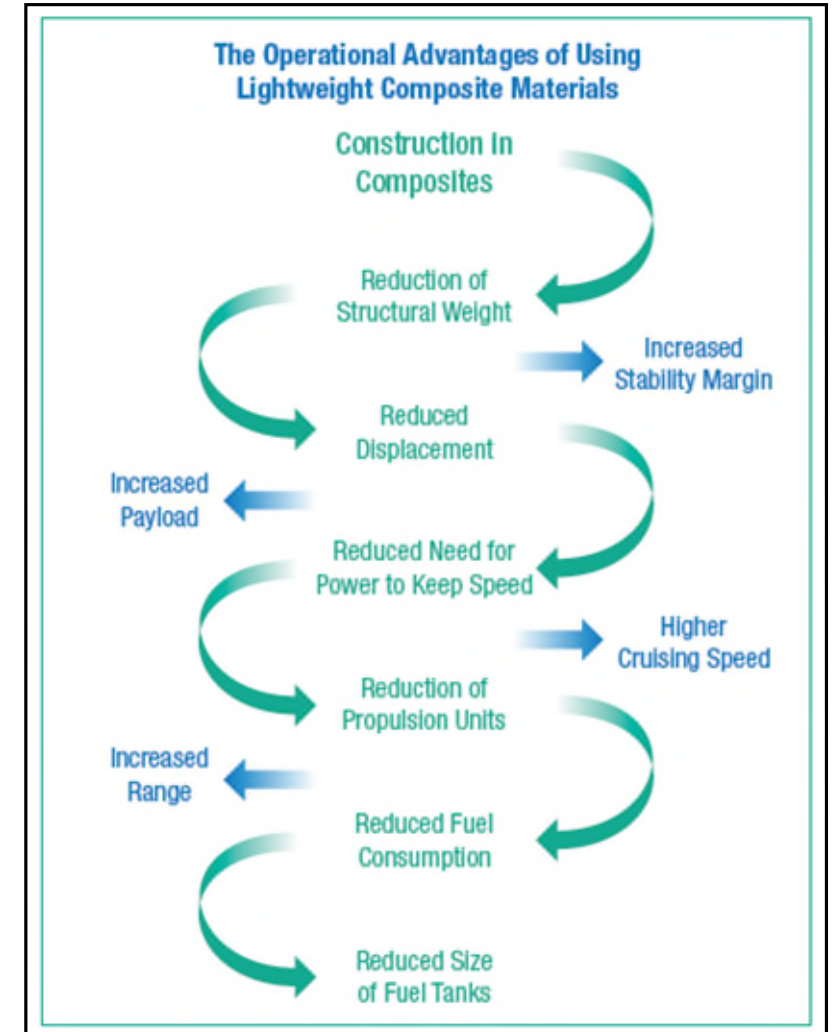
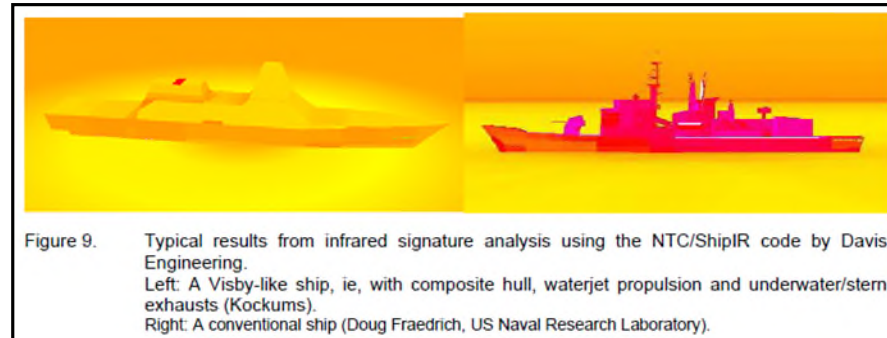


- DNVGL cost study show a typical qualification campaign for a composite pipe system costs more than 3 M\$ if the qualification plan is executed effectively.



Increase performance by reducing:

- Weight
- Signature
- Maintenance
- Vulnerability





# QUALIFY

## LIGHTWEIGHT



### Objectives

1. Evaluate the long-term structural performance
2. reliable inspection and maintenance protocol
3. Certification procedure for adhesively bonded hybrid joints

Interreg 2seas team

Research Institutions – SMEs – End Users – Classification Societies

**Requirements** for SOLAS Classes vessels

**Design**, evaluated by Bureau Veritas

**Materials development**, for robustness

**Composite Infusion Process** for 6 meter high hulls

**Joints development** fit for steel yard conditions

**Risk Based Design** with equivalent safety to steel

**Assembly** at our steel yard DSNS

**Validation testing** witnessed by Bureau Veritas



RAMSSES receives funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme under grant agreement n° 723246.



## Assembly at our steel yard

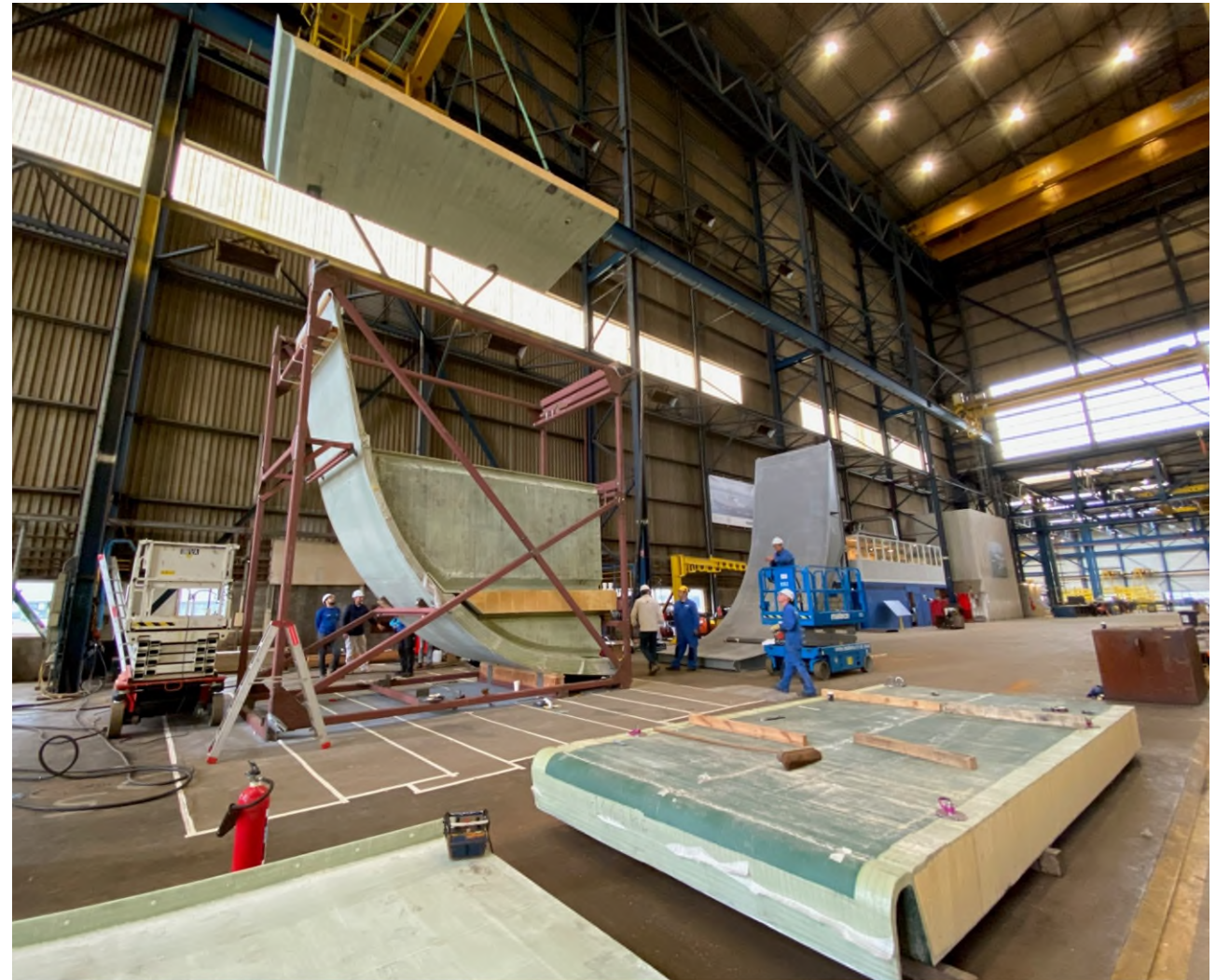
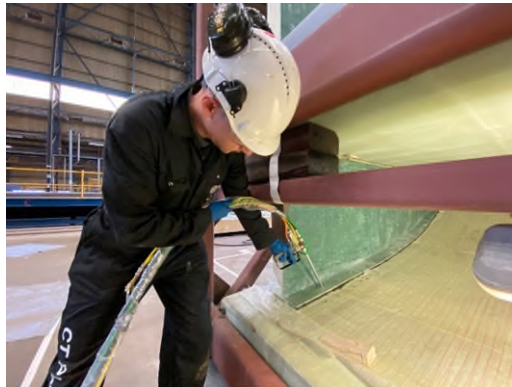
Dealing with

Steel yard conditions

Geometrical tolerances

Industrialized bonding process

Witnessed by Bureau Veritas



RAMSSES receives funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme under grant agreement n° 723246.



## Validation of design by large scale testing

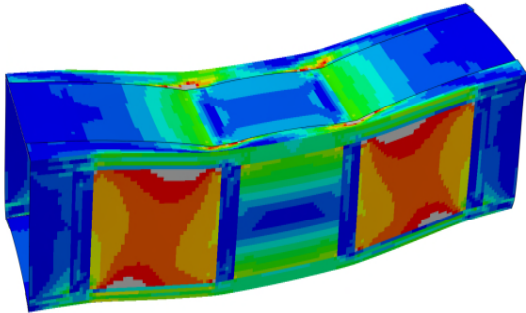
Including

Representative actual wave bending moments

Four point bending on box 8 \* 2 \* 2 meters

Full scale scantlings and joints

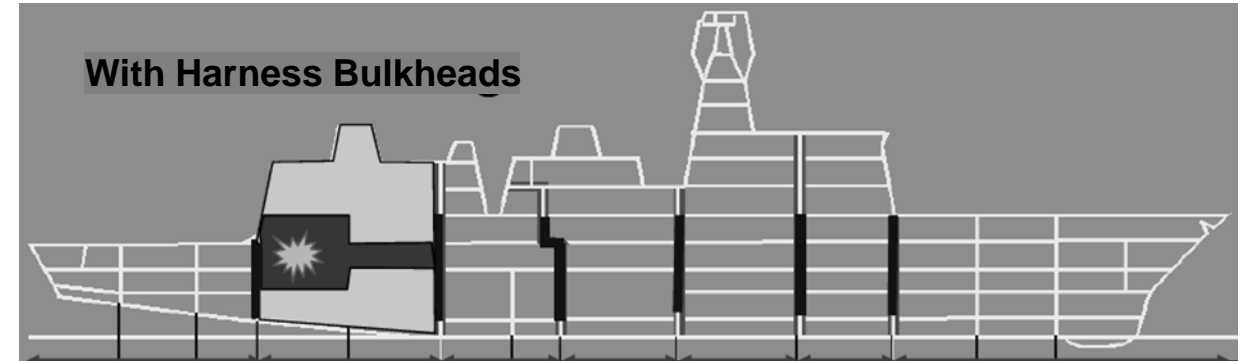
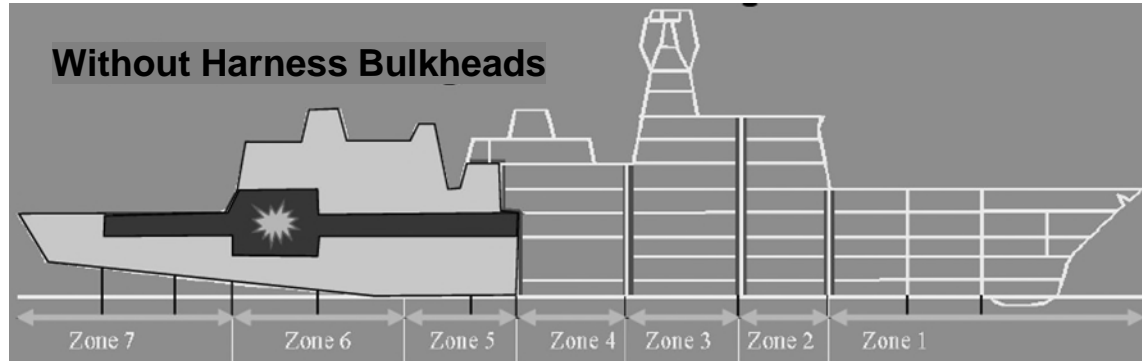
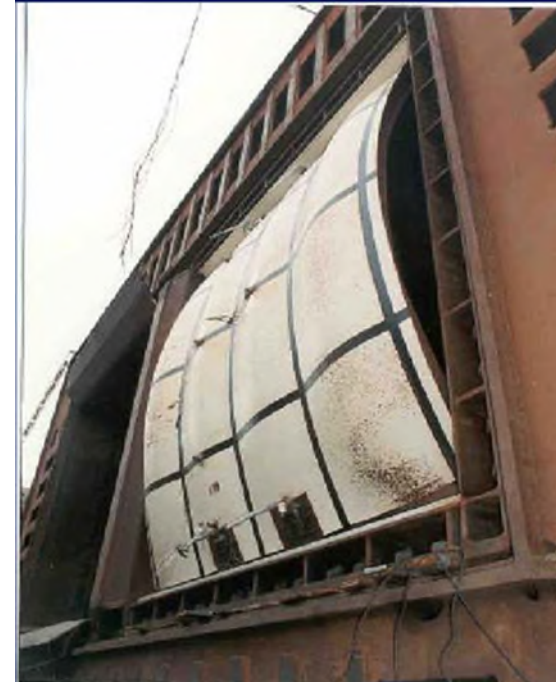
Witnessed by Bureau Veritas



Achieved Design load



RAMSSES receives funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme under grant agreement n° 723246.



Fysical Damage
  Functional Damage



**DAMEN**

An aerial night photograph of a large shipyard. Several large ships are docked at piers, illuminated by bright lights. In the center, a large industrial structure with three tall, dark smokestacks is visible. The water reflects the lights, and the overall scene is dark with some distant city lights in the background.

# DAMEN

OCEANS OF POSSIBILITIES

Development of Materials used in Naval Shipbuilding