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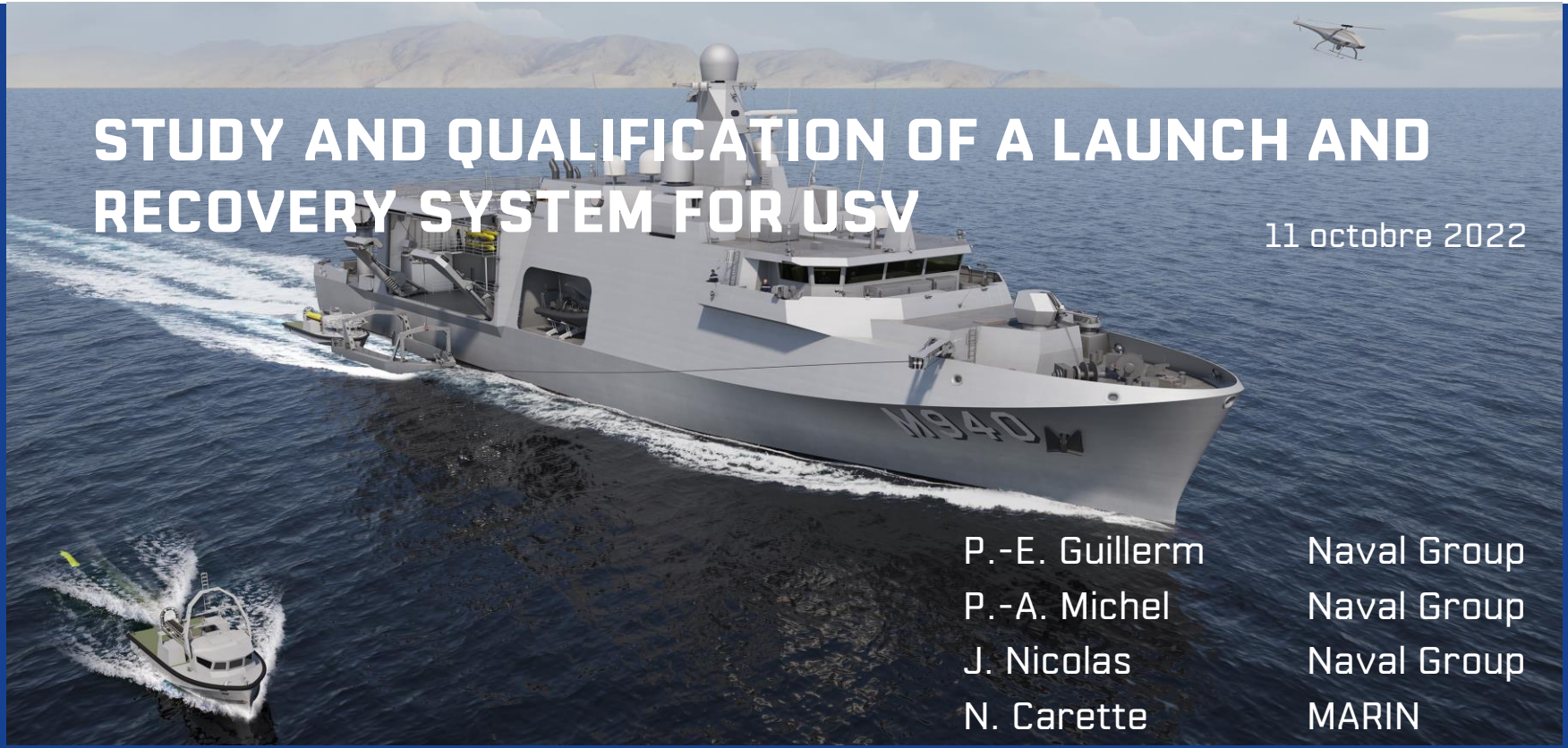
POWER AT SEA



STUDY AND QUALIFICATION OF A LAUNCH AND RECOVERY SYSTEM FOR USV

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INTRODUCTION

USV, AUV, UAV have a growing success for naval operations.
These drones are equipped with electronic sensors which require special precautions.
Handling, launching and recovery of those drones require specific L&R systems.

Specifically for USV many L&R technologies exists with different operating principles.
System operability limits strongly depend on the technology used and on the USV characteristics.

STANAG criteria for those operations are generic and are very useful in an early design stage.
Nevertheless to get actual operability plots of those complex systems, a more complex and accurate evaluation of the system performance is required.

The main advantage an drawback of these studies are :

- Actual operability limits of the system
- But Criteria limits are then dedicated to a specific technology

This presentation introduced the methodology used by Naval group to assess L&R systems for USV.
Simulations, model-tests and sea trials have been used to assess all the phases of the operation.

APPROACH

Stepwise process combining simulations, model tests and sea trials

Multibody Simulations :

- Evaluate several geometries
- Order of magnitude of internal forces and motions

Model tests :

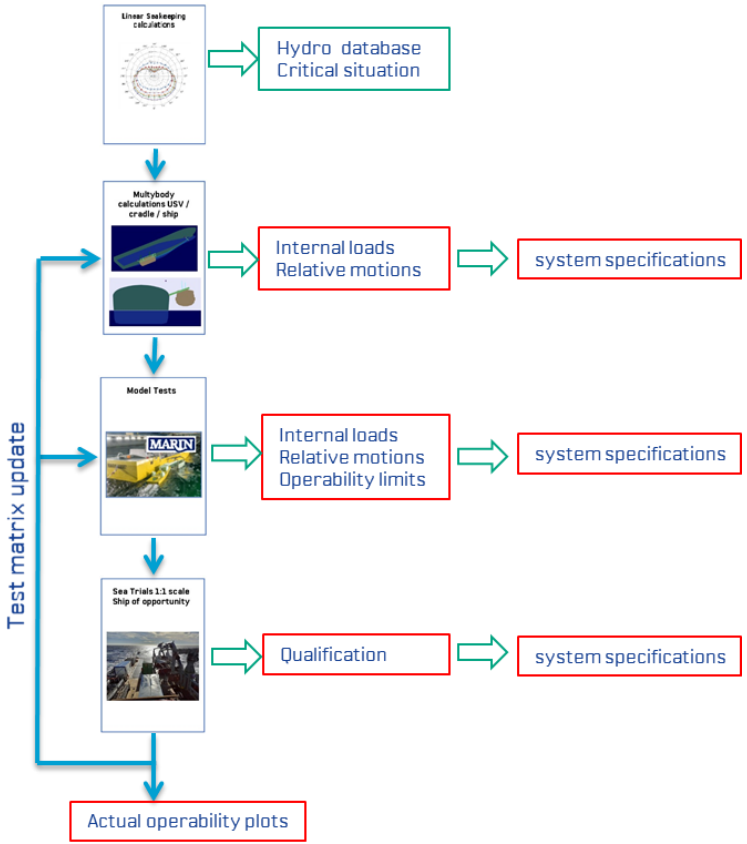
- Global behaviour,
- Internal forces and motions → System and mechanical parts criteria
- Success rate → Operational criteria

Sea trials

- Validation of concept
- Sub-System criteria (can not be modelled)

Iterative process :

- Each study allows to specify the next step
- Analysis allows a feed back for the next batch of tests or simulations
- 3 slots of tests, 2 slots of simulations and 2 sea-trials



SIMULATIONS

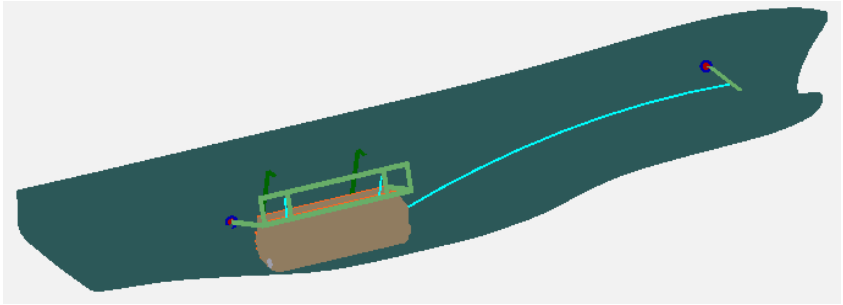
Major applications :

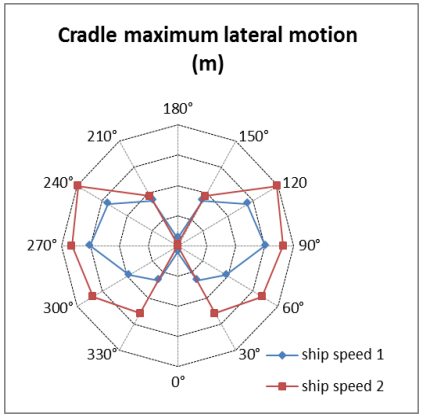
Early stage of the design process :

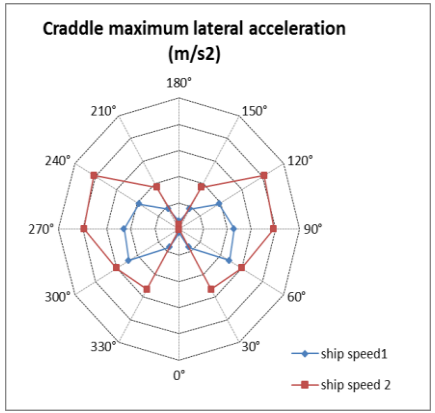
- Evaluate several geometries
- Order of magnitude of internal force and motions
- → inputs for model tests (expected maximum forces on sensors)and test matrix orientation
- → inputs for first specifications

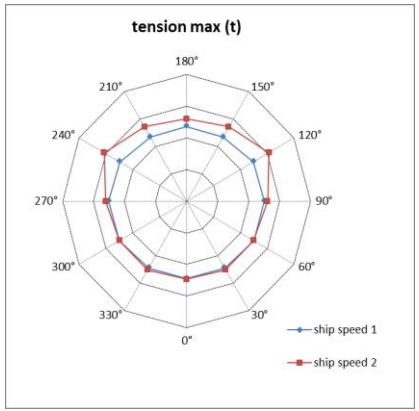
During the design process :

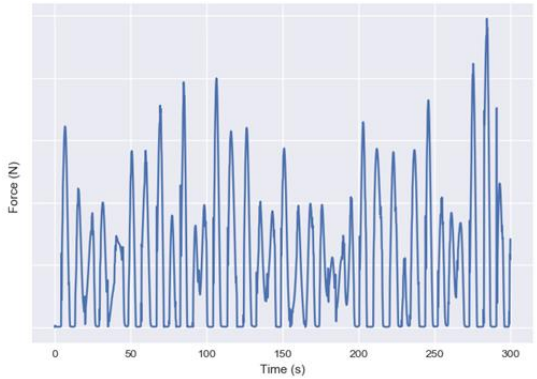
- Specific study for mechanical parts (impact velocity, internal motions)
- →Part or subsystem criteria











MODEL TESTS

Set-ups:

Launch and LARS docking :

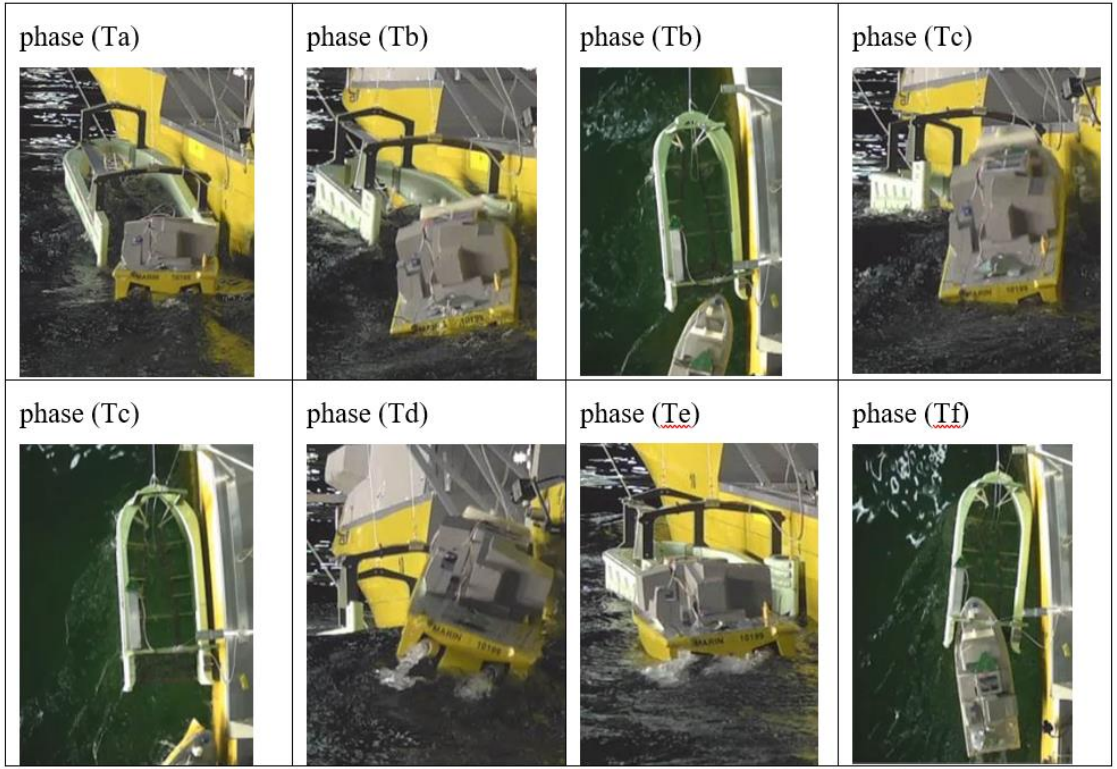
- Free-running mother ship and USV
- Autopilot on the USV for recovery sequence
- Relative motions USV/Cradle/ship
- Different ship speed, wave headings, Sea-state (up to SS6)
- Different cradle geometries
- Estimates of success rate → operational criteria

LARS handling:

- Free-running mother ship
- USV fixed in the cradle
- Hoisting and release sequences
- Relative motions Cradle/ship
- Different ship speed, wave headings,Sea-state (up to SS6)
- Internal forces and motions
- → operational and subsystem criteria

MODEL TESTS

Results for Launch and LARS docking:



Example of recovery test (head seas, 5 kts, Hs=4m (SS6))

MODEL TESTS

Results for hoisting and lowering :

- Data on Internal forces and motions
- Relative roll,
- Winch speed
- Impact force and occurrence
- …

→Allow system specifications to meet the requirements

→ System and subsystem criteria

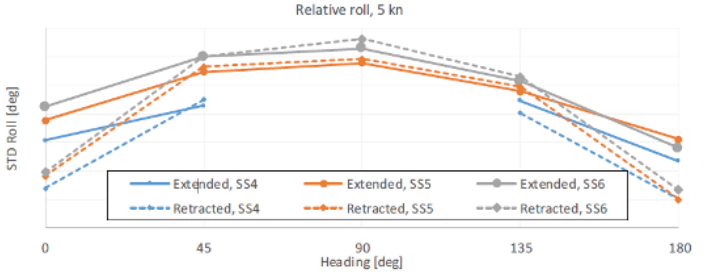
Results for Launch and LARS docking:

- Data on relative motions of the three objects
- Best approach strategy
- Cradle geometry improvement
- Relative yaw, and heave, Mast clearance
- Recovery time
- …

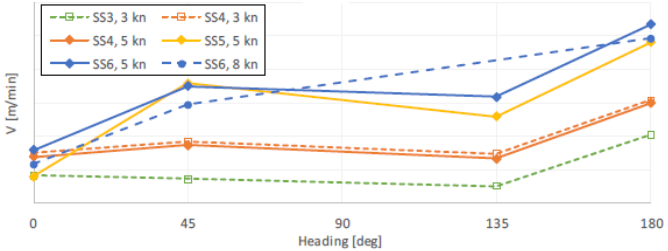
→Estimates of recovery success rate

→ operational criteria

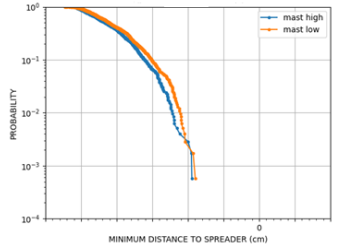
Relative Roll at 5 kts

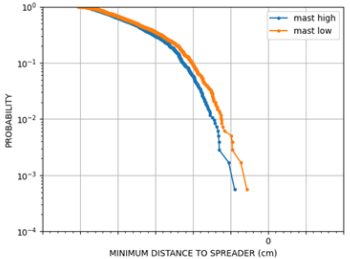


Winches speed



Mast clearance in bow quartering sea,
sea state 5 (left)
sea-state 6 (right).





SEA-TRIALS

Objectives :

- Gain real-life experience
- Confirm conclusions from model tests :
  - LARS handling tests
  - LARS docking tests with a manned and remotely controlled craft.

Measurements :

- Motions of the ship, the cradle and the USV
- Tension in the painter line,
- RPM on hoisting lines,
- LARS loads on arms,
- LARS synchronization of arms

View of the LARS system

CONCLUSIONS

A complementary set of multibody dynamic simulations, model tests and sea trials were conducted to get a deeper understanding of the performance of the system and the driving criteria.

Simulations, tests and trials show very consistent results for similar motions or loadings.

Results gained in the present studies indicate that a very high recovery success rate can be achieved even for the higher sea-states.

These studies provide a set of driving criteria that were used to design the system:

→ LARS handling

- Longi LFE → mechanical criteria
- Lat LFE → mechanical criteria
- Relative roll → mechanical criteria
- Cradle Impact velocity → mechanical criteria
- Cradle Vertical velocity (winch velocity) → mechanical criteria

→ LARS docking

- Relative motions (vert acc. And mast clearance) → operational criteria
- Painter line tension → mechanical criteria
- Success rate → operational criteria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