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NAVAIS
New Advanced Value Added Innovative Ships

D1.1: Initial requirements

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4.0	28-9-2018	Draft for Peer Review – Newer Format
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6.1	5-11-2018	Update of text in the ToR in Annex E.
7.0	12-11-2018	Final Version

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CONTENTS

List of symbols and abbreviations

3D Experience	PLM tool of Dassauls Software used in the project
DoW	Description of Work
DP	Dynamic Positioning
EC	European Commission
EU	European Union
GA	General Assembly
I/O	Input/output
IPR	Intellectual Property Rights
KPI	Key Performance Indicator
MoE	Measure of Effectiveness
MoP	Measure of Performance
NAVAIS	New, Advanced and Value-Added Innovative Ships
RMP	Risk Management Plan
RPM	Rotations per Minute
SC	Steering Committee
SE	Systems Engineering
ToR	Terms of Reference
URN	Underwater Radiated Noise
WP	Work Package

Beneficiaries abbreviations

NMTF	STICHTING NETHERLANDS MARITIME TECHNOLOGY FOUNDATION
MDEM	MARIN DIZAJN INGINIRING MYKOLAYIV
DSGa	SANTIERUL NAVAL DAMEN GALATI SA
MEGA	MARINE ENGINEERING SRL
BV	BUREAU VERITAS MARINE & OFFSHORE REGISTRE INTERNATIONAL DE CLASSIFICATION DE NAVIRES ET DE PLATEFORMES OFFSHORE
MARIN	STICHTING MARITIEM RESEARCH INSTITUUT NEDERLAND
VITO	VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK N.V.
DUT	TECHNISCHE UNIVERSITEIT DELFT
DS	DASSAULT SYSTEMES
DSGo	SCHEEPSWERF DAMEN GORINCHEM BV

ET	EEKELS TECHNOLOGY BV
HELIOX	HELIOX BV
DSNS	DAMEN SCHELDE NAVAL SHIPBUILDING B.V.
SBI	SCHUNK BAHN- UND INDUSTRIETECHNIK GMBH
CMT	CENTER OF MARITIME TECHNOLOGIES EV
SEA	SHIPYARDS AND MARITIME EQUIPMENT ASSOCIATION OF EUROPE

1. EXECUTIVE SUMMARY

During the preparation phase of NAVAIS, many aspects of the scope of the project and the interaction between work packages were defined. However, to ensure smooth cooperation in the project, further fine-tuning of both aspects is required. This deliverable aims to achieve that fine-tuning.

1.1. Problem definition

The NAVAIS work plan, though extensive, is open for different interpretations by the participants. The desired result may be clear, but how it can be achieved needs to be discussed. Care should also be taken that both the receiving and sending Work Packages (WPs) are aware of each other's expectations. A first investigation showed that many intermediate deliveries were not mentioned at both the generating task and the receiving task, potentially leading to incorrect timing of intermediate deliveries as well as not assigning responsibility for the delivery at all.

Besides the above described issue, especially the use of words related to modularity required clear definitions. Many are open for multiple interpretation and in order to understand each other, a single definition for the entire project should be used.

1.2. Technical approach and work plan

To facilitate recognition, the work was further subdivided over 11 different Engineering goals. Each goal is represented by one or more Tasks, either consecutive or parallel. Using this subdivision each required element of information was identified and checked for availability. Especially element from other engineering goals were checked for both content and timing. This has led to a number of adjustments for each WP. The most notable ones are:

- T1.1.5 is executed under WP5, hence not executed as a separate sub-task in WP1
- T4.2.2 is extended with the decision to create a flexible tool
- T5.2.0 is created: "3DEXP enablement environment. which concerns the enablement program currently put in place by DS"
- T5.4.8 is created: "Create a Modelica content library in the 3DEXPERIENCE Platform."

Besides the adjustment of tasks, extra internal deliverables have been established to allow a smooth running and timely delivery of required data and tools within the project. These extra deliverables are:

- T2.4.1 D2.A Detailed shore based facilities, Ferry Class, operational scenarios
- T2.4.2 D2.B Functional requirements for the battery system
- T2.3.3 D2.C Battery Requirement only
- T2.4.3 D2.D Preliminary design description to optimise
- T2.3.4 D2.E Access to a filled module library
- T3.4.3 D3.A Preliminary design description to optimise
- T3.3.4 D3.B Access to a filled module library
- T4.3.8 D4.A URN in DP-mode concept model
- T4.4.8 D4.B URN in off-service conditions concept model

Besides these adjustments, a number of new risks were identified as well. The complete list is presented below:

- Many definitions and uses exist for the vocabulary on modularisation. To ensure a good understanding between participants a glossary with project vocabulary and interpretations, including examples is generated and will be updated all throughout the project. Any uncertainty in definition will be treated and clarified here. (relates to WP1-7)
- The E-Ferries automated docking system is in principle heavily dependent on the progress of the ferry design for details on its requirements. This increases the risk of not having enough time to create a working prototype. This risk will be mitigated by accepting uncertainty on the details of the requirements and starting this process before all information is available. (WP 2)
- Data from the model test may be insufficiently reliable to create URN prediction tools. This will be monitored during the tests but in the worst case might require extra (unbudgeted) tests to achieve its goal. (WP 4)
- Work on URN prediction tools has a confidential nature. Annex 3 and 5 may need to be updated to make sure this work is sufficiently protected. (WP 4)
- The modularisation principle cannot be developed on time or requires adjustments later on. This can be mitigated by close cooperation between the parties in WP 2/3 and WP 5. (WP 5)
- Both simulation packages mentioned are not suitable, Delmia may lack capabilities and Plant Simulation, may not access required information. The only way to mitigate this is to use plant simulation off line, a less desirable solution, but workable. (WP 5)
- Although the risk of insufficient data for simulation was mentioned already, this risk should also include the mismatch of design data created and data required for production simulation. The level of detail of the simulation should match the design details that can be provided. To mitigate this risk T1.3 will also assess the proposed detail level of the Design, the Simulation and the platform, though earlier cooperation on this will further mitigate this risk. (WP 5)

1.3. Results

In this deliverable, the scope of NAVAIS is defined and the Input and Output (I/O) relations are made explicit. Furthermore, the project risk table is revised. During the first year of the project additional actions by all technical WPs will be executed in order to ensure that, by the time the detailed modelling of the vessels and software starts, the project will have achieved the required focus through well-founded decisions.

2. INTRODUCTION

This report is the deliverable of task 1.1. The task objectives are:

- Initial requirements setting for platform-based ferry and workboats product families that are suitable for modular design and production practices.
- Attuning of the initial requirements and specify these for each Work Package 2-6

2.1. Task/Sub-task text

- T1.1.1: Prepare initial Terms of Reference (ToR) as a starting point for determining WP's 2-6 requirements.
- T1.1.2: Using the ToR, organise/execute a first expert workshop with WP's 2-6 representatives: determine initial WP's requirements and review the risk Table 3.2b.
- T1.1.3: Prepare a first draft report of requirements and disseminate the report to the WP's 2-6 partners.
- T1.1.4: Organise/execute a final Workshop to attune sub-task T1.1.2 Requirements, approve the reviewed risk Table 3.2b and provide a Risk Management Plan (RMP).
- T1.1.5: Capture requirements to be set up into the 3DEXPERIENCE Platform
- T1.1.6: Prepare the final report of requirements. Herewith the first milestone is achieved.
- T1.1.7: Prepare the task deliverable

2.2. Analysis

The description of work details the interaction between work packages, after an initial analysis it was discovered that many I/O relations were incomplete in the description. Figure 1 shows a matrix of all sending and receiving tasks. Crosses mean there is an I/O relation, however red squares mean this I/O relation is currently one-sided, so either it is mentioned as an input, but not as and output or vice versa.

Care should also be taken that both the receiving and sending WPs are aware of each other's expectations. These misalignments may lead to incorrect timing of intermediate deliveries as well as not assigning responsibility for the delivery at all. These interactions have not been described in the proposal to this level of detail, but are crucial for the proper execution of the project. The timing of intermediate deliveries and chosen approaches to reach identified targets need to be clarified.

				Recieving WP / Task																														
	Inconsistency in Proposal			WP 1					WP 2						WP 3					WP 4				WP 5							WP 6			
	X	direction of flow	DoW	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	2.6	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	5.1	5.2	5.3	5.4	5.5	5.6	5.7	6.1	6.2	6.3	6.4
Sending WP / Task		Dow		X																														
	WP 1	1.1			X	X			X						X					X				X	X		X				X			
		1.2				X	X	X																										
		1.3					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
		1.4						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
		1.5																																
	WP 2	2.1			X					X	X	X	X																					
		2.2									X																							
		2.3				X	X					X	X															X						
		2.4					X						X	X													X							
		2.5					X	X				X																X						
		2.6					X																						X					
	WP 3	3.1		X	X											X	X	X																
		3.2				X	X										X																	
		3.3																X	X									X						
		3.4					X	X											X								X							
		3.5					X	X																					X					
	WP 4	4.1			X																X	X	X											
		4.2										X						X																
		4.3				X	X	X				X						X																
		4.4										X						X																
	WP 5	5.1			X						X						X								X	X	X	X	X	X				
		5.2				X	X		X	X	X	X	X	X	X	X	X	X	X							X	X	X	X	X				
		5.3							X	X	X	X	X	X	X	x	X	X	X								X							
		5.4									X	X		X			X	X	X									X		X				
		5.5																											X					
		5.6											X						X															
		5.7						X																	X				X					
	WP 6	6.1																													X	X	X	X
		6.2																															X	
		6.3				X	X	X																										X
		6.4						X																										

Figure 1: NAVAIS task input-output network

Besides the above described issue, especially the use of words related to modularity required clear definitions. Many are open for multiple interpretation and in order to understand each other, a single definition for the entire project should be used.

2.3. Approach

This report is the result of a 3-month process, executed at the beginning of the NAVAIS project. Over the course of two meetings and a number of update rounds of the requirements via e-mail, the projects requirements and plans were attuned to deal with deficiencies in input/output relations identified above as well as several others that came to light during the detailed study of the requirements and tasks for each partner. Through the General Assembly and a specific workshop held by the end of this task, all partners are now fully aligned for the project considering the cross input from other work packages. The task descriptions and assignments will be further detailed in the subsequent work package deliveries D2.1-D6.1.

3. PLAN

3.1. Objectives

- Initial requirements setting for platform-based ferry and workboats product families that are suitable for modular design and production practices.
- Attuning of the initial requirements and specify these for each Work Package 2.

3.2. Planned activities

Prepare ToR

Prepare intermediate alignment report

Prepare final alignment report

Review Risk Table

Create a Risk Management Plan (RMP)

Organise two workshops

Create D1.1

3.3. Resources and involved partners

- Partner DUT (lead) and DSGo prepare the ToR, organises the workshops, prepare reports and deliverable
- Partners DSGo, NMTF, DS, BV, MARIN, DUT, CMT, VITO and Heliox participate in the workshops and assist with the reports. Partner DS implement the requirements in the DS 3DEXPERIENCE Platform.

3.4. Timeline

No original time line was available at the start of this task, only a deadline at the end of month 2.

4. PLAN EXECUTION

4.1. Introduction

Early June 2018, at the kick-off meeting with the General Assembly (GA), it was agreed that we would not only apply Systems Engineering as a method to achieve modularisation of the designs, but also to apply it to the project in general, allowing all participants to become acquainted with it. Overall, 11 engineering objectives for the project were identified, divided over work packages WP1-5. Results such as dissemination were not included in this list as these are not engineering related and therefore less suited to be solved using SE. The list is presented below:

1 Modular Approach, WP 5, T5.1/5.3
2 Modular Ferry, WP 2, T2.1/T2.2/T2.3/T2.4/T2.6
3 Modular Workboat, WP 3, T3.1-T3.5
4 Power System, WP 2, T2.5
5 Modular Production System, WP 5, T5.1/T5.5/T5.6
6 Modular production Simulation, WP 5, T5.1/T5.5/T5.6
7 Modular Design Platform (DS3D), WP 5, T5.1/T5.2/T5.4/T5.7
8 Assessment Tool, WP 1, T1.2
9 Automated Design Tool, WP 5, T5.4
10 Impact reduction measure selection, WP 4, T4.1/T4.2
11 URN prediction tools, WP 4, T4.1/T4.3/T4.4

After the GA in June 2018, all WP leaders were provided with templates and examples and asked to deliver three elements; a detailed description of work for each subject within their WP, with task assigned to SE-process steps. This template also contained identified risks for the project. A context diagram and an objective breakdown to help communicate and check the outcome of each engineering process.

Each WP-leader called the WP-group together over the course of the months following the GA, to detail the work to be done and select approaches to be taken, where this was not yet defined. In August 2018 all intermediate deliverables were collected and combined to form a detailed integrated overview of all tasks, steps and timings. This detailed overview and the resulting deficiencies were discussed in a workshop on the 11th of September 2018, after which the detailed project plan, the risk table and this report were finalised.

Parallel to this, and with high priority, a start was made with a glossary, in August 2018, which contains the most important definitions for the project, to improve the communications between participants and the reporting of the project. The current status of this glossary is available in Annex C. This glossary is a living document and will be continually extended with new definitions, in case discussions arise on such elements during the project.

4.2. Performed activities

T1.1.1: Prepare initial Terms of Reference (ToR) as a starting point for determining WP's 2-6 requirements.

ToR were established see Annex E

T1.1.2: Using the ToR, organise/execute a first expert workshop with WP's 2-6 representatives: determine initial WP's requirements and review the risk Table 3.2b.

The first expert workshop was combined with the GA, due to the holiday season. Important input from all partners was collected at this event. Also, the decision to use Systems Engineering for this project as well as the establishment of the 11 engineering objectives was approved here.

T1.1.3: Prepare a first draft report of requirements and disseminate the report to the WP's 2-6 partners.

The report was replaced by an excel-file on all engineering goals and send around for comments and input. After an update this process was repeated to complete the input before the second workshop.

T1.1.4: Organise/execute a final Workshop to attune sub-task T1.1.2 Requirements, approve the reviewed risk Table 3.2b and provide a Risk Management Plan (RMP).

The workshop was held on the 11th of September 2018 with all WP-leaders of WP1-5. The work on the RMP was moved to WP 7, T7.2 as this is a project management element. The review of the risk table can be found in Annex E

T1.1.5: Capture requirements to be set up into the 3DEXPERIENCE Platform

This was a doubling of the work done in T5.1 and T5.2 by DS, so was not performed under T1.1.

T1.1.6: Prepare the final report of requirements. Herewith the first milestone is achieved.

The excel with assignments, requirements, sub-deliveries and in- output relations was supplemented with a figure according to the BPMN methodology (Business Process Model Network). The overview result can be found in Annex B, furthermore detailed engineering goals BMPN's were also created for clarity.

T1.1.7: Prepare the task deliverable

All efforts and suggested changes to the project plan were brought together in this D1.1.

4.3. Deviations from the plan

Given the limited time and need for flexible communication with all partners, excel was preferred over a written report for the communication on the project alignment and attuning of the requirements.

WP 6 was not extensively checked as it contained no engineering goals and would not interfere with the planning of WP 1-5. Instead, they did follow the progress and could use this as input for their own Deliverables.

T1.1.5 was not executed under T1.1 due to doubling of work with WP 5

The work on the RMP was moved to WP 7, T7.2 as this is a project management element, it is part of D7.2.

5. ATTUNING THE REQUIREMENTS OF WP 1-5

This chapter will, per Work Package, discuss the goals to be achieved, their timing and further clarify the approach chosen, if not discussed in the DoW already. Changes to the content will also be discussed in these sections. Finally, identified risks will be mentioned as well. These risks are of a lower level, but may influence the final risk overview in Chapter 5. The SE approach as described in "Systems Engineering, Principles and Practice" by A. Kossiakoff et al. is used as the basis for the description template. It defines 8 steps in the development process. However, not all goals will need to go through all steps as in many cases there is no physical product. For completeness' sake the steps are mentioned here and shortly explained:

1. Needs Analysis: In this phase the objectives of the system are translated to a set of (quantified) requirements for the system
2. Concept Exploration: The solution space is explored to identify as many solutions as possible in combination with their varying performances
3. Concept Definition: A solution is chosen and further detailed
4. Advanced Development: The uncertain/high risk parts of the system are developed and tested
5. Engineering Design: All components are created/designed/selected.
6. Integration and Evaluation: The design is extensively tested.
7. Production and Deployment: A full production is designed, tested and started
8. Operations and Support: The system is supported throughout its life time.

Each of the first 6 mentioned phases has four sub-steps that are all roughly identical:

a. Requirement Analysis
b. Functional Definition
c. Physical Definition
d. Design Validation

The last two phases are not the design of the system anymore and have different sub-steps. Phase 7 is divided in production preparation and production operation, while phase 8 contains installation, in-service support and major upgrades. To not take up unnecessary space, these sub-steps are not shown in the figures in this chapter, but are underlying the details shown. Besides this it was discovered that the project plan did not assign any tasks to the last operational step. Hence when operation is supported, an end month, much later than the finishing of the task is presented in this step, however no subtasks are assigned.

5.1. Work Package 1

Work Package 1 contains only one engineering goal: "8. Assessment Tool". Besides this it contains four other deliverables: this document and three assessments to be carried out. This task officially has no input from other tasks, while the assessments are clear deadlines for the other tasks. First the engineering task is described, followed by adjustments to content and finally specific risks to this work package are discussed.

5.1.1. Discussion of the process for "8. Assessment Tool".

The assessment tool actually is an individual task, with a number of underlying assessments. The assessments are described in detail in T1.3-T1.5 and should be taken into account for this task. The mid-term assessment differs from the intermediate and final assessment as it assesses tools and approaches on their success, where the other two assess the resulting design of the Ferry and Workboat on it's technical, production and economical success. The tool is primarily focussed on the latter two assessments.

			Define													Define				Implement									Implement		Run & Validation		
8. Assessment Tool			Needs Analysis				Concept Exploration				Concept Definition					Advanced Development				Engineering Design				Integration and Evaluation					Production and Deployment		Operations and Support		
1 Executed in Task	T1.2.1		T1.2.1	T1.2.1	T1.2.1	T1.2.1	T1.2.1	T1.2.1	T1.2.1	T1.2.1	T1.2.2/T1.2.3					T1.2.2/T1.2.3				T1.2.2/T1.2.3				T1.2.2/T1.2.4					T1.2.5				
2 Linked Official Delivery (Output)																														D1.2			
3 Required Offical Delivery (Input)			D2.1/D3.1/D4.1/D5.1																														
4 Required other inputs (WPx)			-																														
5 Finished in Month	M6									M9													M10							M12			M30
6 Partners Involved																																	
a DSGO			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x
b TUD			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x

Figure 2: Process description of "8. Assessment Tool"

In Figure 2, this split is represented by the parallel execution of T1.2.2 with T1.2.3 & T1.2.4. They both derive their input from T1.2.1. This task requires input from D1.1-D5.1. Most of these deliverables have a deadline in Month 6 of the project, meaning this development can only start after that. As SE is applied to the entire project, the input that should be contained in the deliverables D1.1-D5.1 should be a Context diagram, objective breakdown, functional breakdown and the resulting Measures of Effectiveness (MoE) and Measures of Perfomance (MoP). The latter two, MoE and MoP are of course depending on the scenarios under which they are determined, this means that these scenarios will also need to be discussed in these deliverables.

5.1.2. Adjustments to the Content

T1.2.1. is extended with the details on the assessment for clarity:

Prepare Terms of Reference (ToR) for the assessment model and for the supporting tools. This will follow the SE approach, requiring the objectives breakdown of the relevant goals:

Midterm Assessment:

1. Modular Approach,
6. Modular Production Simulation,
7. Modular Design Platform,

Intermediate Assessment/ Final Assessment (technical and economical):

2. Modular Ferry
3. Modular Workboat

Besides this clarification it is also decided that T1.1.5: "Capture requirements to be set up into the 3DEXPERIENCE Platform" is skipped here as it is a duplicate of T5.1.5: "The NAVAIS working environment embedded in the DS 3DEXPERIENCE Platform" and fits much better in the content of WP5

Also, the Risk Management Plan will be part of D7.2 and not D1.1 as this is a project management element.

5.1.3. WP risks identified

The main risk for WP1 is that the assessment model(s) are not ready on time, however the deadline for the models is set in the DoW at Month 12 of the project, while the first Assessment is planned for M18. Besides the first economic assessment is not executed till M36. So the impact of this risk is very low.
The only other risk is that the assessment criteria determined at the start are not relevant anymore once the assessment is executed, due to new insights during the development. With the relatively short development time for the midterm assessment, this risk is small and for the technical and economical assessment of the vessel concepts, this risk is mitigated by updating the objectives and MoEs/MoPs if this happens.

5.2. Work Package 2

Work Package 2 contains two engineering goals: "2. Modular Ferry" and "4. Power System". Linked to these goals are six deliverables. There are no deliverables or tasks not related to these goals. According to the DoW, this task primarily receives input from WP 5. In case of WP 2 the word classification in the GA indicates assignment of the vessel options to classes, not to be confused with the approval process for drawings and constructions, also referred to as classification. First the engineering tasks are described, followed by adjustments to content and finally specific risks to this work package are discussed.

5.2.1. Discussion of the process for “2. Modular Ferry”.

WP 2 is responsible for one of the main aspects of this project de delivery of a digital version of a Modular Ferry. The engineering goal modular ferry is therefore a large one, with many different tasks assigned to it. Although it is a digital product, its production will also be tested with the use of a simulation model developed in WP 5.

		DEFINE												DEFINE												Implement		Run & Validation
2 Modular Ferry		Needs Analysis				Concept Exploration				Concept Definition				Advanced Development				Engineering Design				Integration and Evaluation				Production and Deployment		Operations and Support
1 Executed in Task	T2.1	T2.2.1	T2.2.1	T2.2.2	T2.2.2	T2.2.3	T2.2.3	T2.2.4	T2.2.5	T2.3.1	T2.3.2	T2.4.1	T2.4.2	T2.4.3	T2.4.3	T2.4.3	T2.4.3	T2.3.3	T2.3.4	T2.3.4	T2.4.4	T2.4.5	T2.4.5	T2.4.6	T2.3.5/T2.4.7	T2.6.1-T2.6.3	T2.6.4-T2.6.7	
2 Linked Official Delivery (Output)	D2.1				D2.A/D2.B				D2.2				D2.C				D2.D				D2.E				D2.3/D2.4		D2.6	
3 Required Offical Delivery (Input)										D5.2			D4.2					D5.3	D5.4							D5.6		
4 Required other inputs (WPx)																			D4.A/D4.B									
5 Finished in Month	M6				M8				M9				M12				M18		M21		M24				M30		M45	
6 Partners Involved																												
a NMTF										x	x														x			
b MDEM												x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
c DSGa	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
d MEGA										x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
e BV														x	x	x	x	x	x	x	x	x	x	x	x			
f MARIN												x	x	x	x	x	x							x	x			
g VITO												x	x	x	x	x	x							x	x			
h DUT								x		x	x																	
i DS																		x	x	x					x			
j DSGe																												
k DSGo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
l DEGd										x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
n ET	x	x	x									x	x	x	x	x	x		x	x	x	x	x	x	x			
n HELICX												x	x											x	x			
p SBI	x	x	x									x	x	x	x	x	x		x	x	x	x	x	x	x			
q CMT																										x	x	

Figure 3: Process description of “2. Modular Ferry”

In Figure 3, the development of this tool is presented, including the tasks involved in each phase of the process. Task 2.3 and Task 2.4 run in parallel in this approach. The first task (2.3) is concerned with filling the database with a platform and modules to apply to the ship The second task (2.4) is concerned with designing a relevant ship. As both tasks will be feeding of each other, they are executed in parallel. For the success of this sub-project a large number of deliverables are important. The 3DExperience system needs to be working (D5.2), but also a clear handbook on how to do Systems Engineering and modularisation (D5.4 and D5.3 respectively) should be available. Finally for the final step a working modular production simulation model will need to be available (D5.6).

5.2.2. Discussion of the process for “4. Power System”.

The power system is such an important aspect of the modular ferry design that is has been given its own engineering goal and is defined as a separate sub-project. This does mean that its progress and work will be heavily intertwined with the engineering goal of the Modular Ferry.

			DEFINE													DEFINE				Implement								Implement	Run & Validation
4 Power System			Needs Analysis				Concept Exploration				Concept Definition					Advanced Development				Engineering Design				Integration and Evaluation				Production and Deployment	Operations and Support
1 Executed in Task	2.1.4		T2.5.1	T2.5.1	T2.5.1	T2.5.1	T2.5.2	T2.5.2	T2.5.2	T2.5.2	T2.5.2	T2.5.2	T2.5.2	T2.5.2		T2.5.3	T2.5.3	T2.5.3	T2.5.3	T2.5.4	T2.5.4	T2.5.4	T2.5.5	T2.5.6	T2.5.7	T2.5.7	T2.5.8		
2 Linked Official Delivery (Output)																											D2.5		
3 Required Offical Delivery (Input)			D2.1																										
4 Required other inputs (WPx)			D2.A/D2.B													D2.C													
5 Finished in Month	M6					M9								M12					M14			M16	M23			M28	M30		
6 Partners Involved																													
f VITO			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x				x	x	x	x	x		
h HELIOK			x	x	x	x	x	x	x	x	x	x	x	x						x	x	x	x	x	x	x	x		
i SBI			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		
j ET			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		
o DSNS			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		

Figure 4: Process description of “4. Power System”

It should be noted that this process also requires no input from other work packages, therefore extra intermediate deliverables have been created to ensure the right data is available and that the work lines up with the ferry design. Also care should be taken to use the same (ship) designs as other work packages do, to allow alignment of the results. The prediction tools created will be used in the design processes of WP 3 and 4 so timing is crucial. Besides of the results the tools can be used to update the input of the impact reduction tool described in 5.4.1. This should be avoided by accepting uncertainty on the requirement details and contemplating adjustments of the output where required.

5.2.3. Adjustments to the Content

It should be noted that several inputs to this work package have been clarified and added based on a discussion between WP-leaders on the 11th of September 2018. As presented in the overview, several intermediate deliverables are identified, that are required for a timely delivery of information to another sub-project or work package. These are:

- T2.4.1 D2.A Detailed shore based facilities, Ferry Class, operational scenarios

- T2.4.2 D2.B Functional requirements for the batery system
- T2.3.3 D2.C Battery Requirement only
- T2.4.3 D2.D Preliminary design description to optimise
- T2.3.4 D2.E Access to a filled module library

Furthermore the following subtasks description has been extended for clarity:

- T2.4.7 has become: Review of the modular design process*, approval of the process by BV* and prepare the task deliverable

Finally DSNS will be added as a contributing partner for the work in T2.5 and Deliverable D2.5.

5.2.4. WP risks identified

There are two major risks for the sub-projects in WP 2. Both are related to the timing of other deliveries. The progress of the modular ferry design and modularisation is depending on the timely decisions to be made in WP 5 on these aspects. However application might lead to new insights and may require adjustments to the process, delaying work on the design.
The same goes for the power system, as it will require a lot of input on the design of the modular ferry, there is not a lot of time to build and test the prototype. This could be risk as it might delay the input required for the SEECAT model in turn. The mitigation would be to start earlier, without detailed information and to create a more flexible/scalable solution.

5.3. Work Package 3

Work Package 3 contains one engineering goals: "3. Modular Workboat". Linked to these goals are five deliverables. There are no deliverables or tasks not related to these goals. According to the DoW, this task primarily receives input from WP 5. In case of WP 3 the word classification in the GA indicates assignment of the vessel options to classes, not to be confused with the approval process for drawings and constructions, also referred to as classification in common language. Within NAVAIS this is exclusively referred to as approval. First the engineering task is described, followed by adjustments to content and finally specific risks to this work package are discussed.

5.3.1. Discussion of the process for "2. Modular Ferry".

WP 3 is responsible for one of the main aspects of this project de delivery of a digital version of a Modular Workboat. The engineering goal modular workboat is therefore a large one, with many different tasks assigned to it. Although it is a digital product, its production will also be tested with the use of a simulation model developed in WP 5.

		DEFINE												DEFINE				Implement								Implement		Run & Validation
3. Modular Workboat		Needs Analysis				Concept Exploration				Concept Definition				Advanced Development				Engineering Design				Integration and Evaluation				Production and Deployment		Operations and Support
1 Executed in Task	T3.1	T3.2.1	T3.2.1	T3.2.2	T3.2.2	T3.2.3	T3.2.3	T3.2.4	T3.2.5	T3.3.1/T3.3.2/T3.4.1/T3.4.2				T3.4.3	T3.4.3	T3.4.3	T3.4.3	T3.3.3/T3.3.4/T3.4.4				T3.4.5	T3.4.5	T3.4.6	T3.3.5/T3.4.7	T3.5.1-T3.5.3	T3.5.4-T3.5.7	
2 Linked Official Delivery (Output)	D3.1								D3.2								D3.A				D3.B				D3.3/D3.4		D3.5	
3 Required Offical Delivery (Input)										D5.2			D4.2					D5.3	D5.4							D5.6		
4 Required other inputs (WPx)																			D4.A									
5 Finished in Month	M6								M9				M12				M18		M21		M24				M30		M45	
6 Partners Involved																												
a NMIF		x		x						x																		
b MDEM								x			x			x	x	x	x	x	x	x	x	x	x	x	x			
c DSGa																											x	
d MEGA								x			x			x	x	x	x	x	x	x	x	x	x	x	x			
e BV														x	x	x	x	x	x	x	x	x	x	x	x			
f MARIN															x	x	x											
g DUT								x		x	x																	
h DS								x											x									
i DSGe																												
j DSGo		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
k DSGd																												
l ET																												
n DSNS		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
n CVT																										x	x	

Figure 5: Process description of "3. Modular Workboat"

In Figure 5 the development of this tool is presented, including the tasks involved in each phase of the process. Task 3.3 and Task 3.4 are run in parallel in this approach. The first task (3.3) is concerned with filling the database with a platform and modules to apply to the ship, the second task (3.4) is concerned with designing a relevant ship. As both tasks will be feeding of each other, they are executed in parallel. For the success of this sub-project a large number of deliverables are important. The 3DExperience system needs to be working (D5.2), but also a clear handbook on how to do Systems Engineering and modularisation (D5.4 and D5.3 respectively) should be available. Finally for the final step a working modular production simulation model will need to be available (D5.6).

5.3.2. Adjustments to the Content

It should be noted that several inputs to this work package have been clarified and added based on a discussion between WP-leaders on the 11th of September 2018. As presented in the overview, several intermediate deliverables are identified, that are required for a timely delivery of information to another sub-project or work package. These are:

- T3.4.3 D3.A Preliminary design description to optimise
- T3.3.4 D3.B Access to a filled module library

Furthermore the following subtasks description has been extended for clarity:

- T3.4.7 has become: Review of the modular design process*, approval of the process by BV* and prepare the task deliverable

5.3.3. WP risks identified

There is one major risk for the sub-projects in WP 3. It is related to the timing of other deliveries. The progress of the modular workboat design and modularisation is depending on the timely decisions to be made in WP 5 on these aspects. However application might lead to new insights and may require adjustments to the process, delaying work on the design.

5.4. Work Package 4

Work Package 4 contains two engineering goals: "10. Impact reduction measure selection" and "11. URN prediction tools". Linked to these goals are four deliverables. There are no deliverables or tasks not related to these goals. According to the DoW, this task only receives this deliverable D1.1 as input from other tasks. This will primarily cover the timing of intermediate deadlines as input for the further clarification of the requirements. First the engineering tasks are described, followed by adjustments to content and finally specific risks to this work package are discussed.

5.4.1. Discussion of the process for "10. Impact reduction measure selection".

WP 4 is responsible for investigating as many available measures for impact reduction of the ships studied as possible. However, there are a lot of options available and a factor that is often overlooked is the dependencies between solutions. Solutions can be excluding others or at least hindering their performance, e.g. sails will block the sun from solar panels. On the other hand, they can be a prerequisite, e.g. there is no use for solar panels without batteries. These are obvious elements but to find a good combination of measures to achieve the intended objective will be difficult. To facilitate this, it was decided to try to create a tool that can help in this process. This tool should provide clear procedures and the option to easily add both impact reducing measures as well as impact during the remainder of the project. This will increase flexibility of the tool and thus in the execution of the current project and future projects where the tool will be applied.

The creation of this tool is an extension of the original goal, which was only to select the impact reduction technologies. However, because there might be technologies missing (or new technologies being developed) that could influence the selection. Therefore, it was decided to make a flexible tool where new technologies or new rules can be included later on. Then a new selection can be made based on that new input. This also makes the process future-proof such that yards can use it after completion of the NAVAIS project.

			DEFINE													DEFINE				Implement									Implement		Run &		
10. Impact reduction measure selection			Needs Analysis				Concept Exploration				Concept Definition					Advanced Development				Engineering Design				Integration and Evaluation					Production and Deployment		Operations and Support		
1 Executed in Task			T4.1.1	T4.1.2	T4.1.2	T4.1.4	T4.2.1	T4.2.1	T4.2.1	T4.2.1	T4.2.2	T4.2.2	T4.2.2	T4.2.2		T4.2.2	T4.2.2	T4.2.2	T4.2.2	T4.2.2	T4.2.2	T4.2.2	T4.2.2	T4.2.3	T4.2.3	T4.2.3	T4.2.3		T4.2.5	T4.2.6			
2 Linked Official Delivery (Output)						D4.1				-				-					-				-				-			D4.2			
3 Required Offical Delivery (Input)	D1.1		-				-				-					-				-				-					-				
4 Required other inputs (WPx)			-				-				-					-				-				-					-				
5 Finished in Month	M3					M6				M8				-					-				M12				M12			M12			M30
6 Partners Involved																																	
a MARIN			x	x	x	x	x	x	x	x														x	x	x	x		x	x	x	x	x
b NMIIF			x	x	x	x	x	x	x	x														x	x	x	x		x	x	x	x	x
c BV			x	x	x	x	x	x	x	x														x	x	x	x		x	x	x	x	x
d DUT			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x
e DSGo			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x
f DSNS			x	x	x	x	x	x	x	x														x	x	x	x		x	x	x	x	x

Figure 6: Process description of "10. Impact reduction measure selection"

In Figure 6, the development of this tool is presented, including the tasks involved in each phase of the process. The deadline within the DoW was set to month 12, while the work can start in M3, with the availability of D1.1. The requirements analysis deliverable (D4.1) is due for month 6, which will conclude the first phase of the tool development. This deliverable should contain an analysis of available rules and regulations as well as a Context diagram, an objective breakdown, a functional breakdown and the resulting Measures of Effectiveness (MoE) and Measures of Perfomance (MoP) for this impact reduction measures selection tool. As the tool has no assessment in WP 1, its use throughout the project will be its assessment, requiring no scenarios to be discussed for application in WP 1.

5.4.2. Discussion of the process for "11. URN prediction tools".

Besides the selection tool, WP 4 is also responsible for delivery of Underwater Radiated Noise (URN) prediction tools for both ferries in transit and while entering/exiting a harbour and for workboats in Dynamic Positioning (DP). Since current URN prediction models do not cover all of these operating conditions, model tests are planned for month 9-12 of the project. These will provide the data required to generate and validate prediction tools for the URN due to pressure side cavitation (for the ferry when slowing down while entering a harbour) and for URN generated by a thruster in bollard pull (for the workboat in DP). This is an important intermediate aspect of this sub-project and sets deadlines for tasks before it. The diverse prediction objectives also explain why in Figure 7 below so many tasks are found in parallel: the work is similar, but the goal differs per vessel type. The model tests can be found in Figure 7 below under the advanced development, the tasks mentioned there are linked to model test work.

			DEFINE													DEFINE				Implement									Implement	Run & Validation
11. URN prediction Tools			Needs Analysis				Concept Exploration				Concept Definition					Advanced Development				Engineering Design				Integration and Evaluation					Production and Deployment	Operations and Support
1 Executed in Task			T4.1.3	T4.1.3	T4.1.3	T4.1.4	T4.3.1/T4.4.1				T4.3.2/T4.3.3/T4.4.2					T4.3.4/T4.3.5/T4.4.3/T4.4.5				T4.3.6/T4.3.7/T4.4.6/T4.4.7				T4.3.8/T4.4.8			T4.3.9/T4.4.9			
2 Linked Official Delivery (Output)	D1.1					D4.1				-				-					-				D4.A/D4.B				D4.3/D4.4			
3 Required Offical Delivery (Input)											-					-				-				-						
4 Required other inputs (WPx)											-					-				-				-						
5 Finished in Month	M3					M6				M9				M9					M12				M21				M30			
6 Partners Involved																														
a MARIN			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x			
b NMTF			x	x	x	x																					x			
c BV			x	x	x	x	x	x	x	x	x	x	x	x						x	x	x	x	x	x	x	x			
d DUT			x	x	x	x																					x			
e DSGo			x	x	x	x	x	x	x	x	x	x	x	x						x	x	x	x	x	x	x	x			
f DSNS			x	x	x	x	x	x	x	x	x	x	x	x						x	x	x	x	x	x	x	x			

Figure 7: Process description of "11. URN prediction tools"

It should be noted that this process also does not require input from other work packages, though care should be taken to use the same designs as other work packages do, to allow alignment of the results. The prediction tools created will be used in the design processes of WP 3 and 4, so timing is crucial.

5.4.3. Adjustments to the Content

T4.2.2 is extended with the decision to create a flexible tool to achieve this objective the new text will be:
"*Define selection criteria on the basis of the identified rules and regulations for the selected operational areas, see sub-task T4.1.1, and the suitability for road ferries up to 450 passengers and 150 cars capacity and workboats up to 500 GT. Capture the criteria and the selection of the right measures in a tool that deals with the complex relations between solutions. Based on the applicable rules, regulations and selected KPIs (Key Performance Indicators), the tool should provide a selection of technologies that ensure that the final design will meet those requirements (rules and KPIs).*" Due to this tool and as it is not required by WP2 and WP3 before month 15, the deadline for the deliverable will be postponed by 3 months.

As presented in the overview, several intermediate deliverables are identified, that are required for a timely delivery of information to another sub-project or work package. These are:

- T4.3.8 D4.A URN in DP-mode concept model
- T4.4.8 D4.B URN in off-service conditions concept model

5.4.4. WP risks identified

There are a number of risks identified, besides missing the deadline. The choice of setting up a model for the selection of impact reducing measures mitigates a lot of these. Both missing or new regulations as well as missing or new technologies can easily be implemented at a

later stage. It was suggested to do part of the work within a master thesis. If a student cannot be found in time, this will not be an option, the restrictions on participants hours may mean that the model as currently foreseen might not be possible in that case. However, the deliverable and selection of techniques will not be at risk.

Related to the URN tools, there are two major risks. Much of the work already done on such tools is confidential. This may require updating the Annex 3 and 5 to satisfy all participants on that matter. A second risk is related to the model tests, results might not be useful due to various reasons (background noise, interference, scalability, etc). As MARIN is a professional organisation they will monitor this during trials, however in the worst case extra (unbudgeted) model tests may need to be performed. Some exploratory tests will be carried before the actual test campaign to check whether the background noise levels are sufficiently low.

5.5. Work Package 5

Work Package 5 is the solution creation centre of this project, it therefore consists of five engineering goals: "1. Modular Approach", "5. Modular Production System", "6. Modular production Simulation", "7. Modular Design Platform (3DEXP)" and "9. Automated Design Tool". Linked to these goals are seven deliverables (D5.1-D5.7). There are no further deliverables or tasks outside of these goals. According to the DoW, this workpackage (WP5) only receives this deliverable D1.1 as input from other tasks. In case of WP 5 the word classification in the GA does refer to the approval process, unlike the other WP's (2 and 3) where it refers to the assignment of the vessel options to a class of platforms or modules. First the engineering tasks are described, followed by adjustments to content and finally specific risks to this work package are discussed.

5.5.1. Discussion of the process for "1. Modular Approach".

This relatively short term sub-project has the goal to define a modular approach, both for the ferries and the workboats. What level to achieve what to consider etc. This is the key to success for the entire project. It will need to balance all requirements from all involved, not only clients and designers, but also software limitations and classification standards.

			DEFINE													DEFINE				Implement								Implement		Run & Validation		
1. Modular Approach			Needs Analysis				Concept Exploration				Concept Definition					Advanced Development				Engineering Design				Integration and Evaluation				Production and Deployment		Operations and Support		
1 Executed in Task			T5.1.1		T5.7.1		T5.1.2	T5.7.2	T5.1.6		T5.3.1-T5.3.4			T5.3.5		T5.3.6		T5.3.7	T5.3.8													
2 Linked Official Delivery (Output)									D5.1					-					D5.3													
3 Required Offical Delivery (Input)	D1.1						-				-																					
4 Required other inputs (WPx)																																
5 Finished in Month	M4								M6					m9					m12													M15
6 Partners Involved																																
a DSGO			X	X	x	x	X	x	X	X	X	X	X	X		X	X	X	X													
b DS			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x													
c DUT			x	x			x		x	x	x	x	x			x	x	x	x													
d DSNS			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x													
e MDEM					x	x		x			x	x	x	x		x	x	x	x													
f MEGA					x	x		x								x	x	x	x													
g CMT			x	x			x		x	x	x	x	x	x		x	x	x	x													
h DSGa					x	x		x								x	x	x	x													
i BV			x	x	X	X	x	X	x	x	x	x	x	x		x	x	x	x													

Figure 8: Process description of "1. Modular Approach"

Figure 8 shows the assignments involved in this task. The boundaries of Task 5.7 have been chosen subject wise, as with many other tasks in the description. Considering this goal is part of the sub-tasks which are relevant for this task, the others will take place in other sub-projects of WP 5. The main contributing task here is T5.3 resulting in D5.3 as well as D5.1 as part of this goal.

5.5.2. Discussion of the process for "5. Modular Production System".

This engineering goal is to identify how to approach modular production. The idea is that all relevant Damen yards form one pool of production entities, each with their own characteristics. An approach will need to be developed to best match current production demand with the available positions. This may lead to savings in time and money for Damen, so it is an important improvement aspect on its own. However a modular, more serial produced vessel configuration, will possibly lead to bigger benefits.

			DEFINE													DEFINE				Implement									Implement		Run & Validation		
5. Modular Production System			Needs Analysis				Concept Exploration				Concept Definition					Advanced Development				Engineering Design				Integration and Evaluation					Production and		Operations and Support		
1 Executed in Task	T5.1.4		T5.5.1				T5.5.2-T5.5.5				T5.5.2-T5.5.5					T5.5.2-T5.5.6			T5.5.7														
2 Linked Official Delivery (Output)																			D5.5														
3 Required Offical Delivery (Input)	D1.1																																
4 Required other inputs (WPx)																																	
5 Finished in Month	M4					M6				M9				M12					M18														
6 Partners Involved																																	
a DSGO			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x														
b DS			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x														
c DUT			x	x	x	x													x														
d DSNS			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x														
e MDBM																																	
f MEGA			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x														
g CMT			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x														
h DSGa			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x														
i BV																																	

Figure 9: Process description of "5. Modular Production System"

Two observations can be made about Figure 9; firstly there is no input from other work package required outside of this report, which is only for clarification. Secondly 4 subtasks will be performed in parallel, rather than consecutively. This may obscure some details, but is understandable given the subjects. Although relevant the link to the 3DExperience (T5.5.6) has moved to the next sub-project as it relates more to the simulation, than the development of the production concept.

5.5.3. Discussion of the process for "6. Modular production Simulation".

The subproject of production simulation, is naturally strongly linked with the set-up of modular production. It is the implementation of these ideas into a virtual system. Still to be picked is the simulation software, as well as the investigation of the link type possible between Plant Simulation and Dassault 3D experience. Besides testing modular production, this work package will also function as a virtual assembly of the created ships. To check the impact of the design on production. For this to function it is crucial that the simulation production detail and the ship design detail match. If the design detail is lower than the simulation detail, this will be impossible (the other way around is no issue).

			DEFINE													DEFINE				Implement									Implement		Run & Validation		
6. Modular Production Simulation			Needs Analysis				Concept Exploration				Concept Definition					Advanced Development				Engineering Design				Integration and Evaluation					Production and Deployment		Operations and Support		
1 Executed in Task	T5.1.4		T5.1.4/T5.6.1				T5.6.3				T5.6.3					T5.6.4				T5.5.6/T5.6.2/T5.6.3/T5.6.4				T5.5.6/T5.6.2-T5.6.6					T5.6.5&6	T5.6.7			
2 Linked Official Delivery (Output)	D1.1																													D5.6			
3 Required Offical Delivery (Input)																D5.5				D5.2									D2.4/D2.5/D3.4				
4 Required other inputs (WPx)																																	
5 Finished in Month	M4					M6								M18					M21				M24					M27		M30			M45
6 Partners Involved																																	
a DSGO			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x			
b DS			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x			
c DUT			x	x	x	x																											
d DSNS			x	x	x	x	x	x	x	x	x	x	x	x																x			
e MDEM																																	
f MEGA			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x			
g CMT			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x			
h DSGa			x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x			
i BV																																	

Figure 10: Process description of "6. Modular production Simulation"

Figure 10 depicts the process, based on the current sub-task descriptions. The main work within this task falls under T5.6, including D5.6. As no task is dedicated to creating the actual simulation, T5.6.3 has been given this role in the figure above. This does mean that is will start before T5.6.2, though this is primarily cosmetic.

5.5.4. Discussion of the process for "7. Modular Design Platform (DS3D)".

Although the Modular Approach is pivotal to the project, the actual design platform is the spider in the web of sub-projects. It will be both key in structuring all other projects as well as receiving and storing the results of all other projects. The main risk here is that we are in a development project and our knowledge on what we need will grow with the project, possible requiring several updates of the platform. This risk is mitigated as much as possible by assigning two round of implementation updates to this sub-project. First an experimental set-up is foreseen to get to know the system, followed by studies on the case ship, which is finally followed by the actual ships and libraries.

			DEFINE													DEFINE				Implement									Implement		Run & Validation
7. Modular Design Platform			Needs Analysis				Concept Exploration				Concept Definition					Advanced Development				Engineering Design				Integration and Evaluation					Production and Deployment		Operations and Support
1 Executed in Task	T5.1.5		T5.2.0	T5.2.1	T5.2.2	T5.7.3	T5.2.3	T5.2.4	T5.2.5	T5.2.6	T5.4.1	T5.4.2	T5.4.3			T5.4.4	T5.7.4	T5.4.4	T5.4.4	T5.4.5			T5.7.4	T5.4.6/T5.4.8			T5.4.7		T5.7.5	T5.7.6	
2 Linked Official Delivery (Output)										D5.2																	D5.4			D5.7	
3 Required Offical Delivery (Input)	D1.1															D5.3															
4 Required other inputs (WPx)																															
5 Finished in Month	M4									M9				M9					M12				M18				M21			M45	
6 Partners Involved																															
a DSGO			x	x	x	x	x	x	x	x	X	X	X	X		X	x	X	X	X	X	X	x	X	X	x	X		x	x	
b DS			X	X	X	x	X	X	X	X	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	
c DUT			x								x									x	x	x		x	x		x				
d DSNS			x	x	x	x				x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	
e MDEM			x	x	x	x	x	x	x	x			x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	
f MEGA			x	x	x	x	x	x	x	x			x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	
g CMT			x	x					x	x																					
h DSGa			x	x	x	x			x	x																					
i BV			x	x	x	X		x	x	x	x	x	x	x		x	X	x	x	x	x	x	X	x	x	X	x		X	X	

Figure 11: Process description of "7. Modular Design Platform (3DEXP)"

This two phase approach is also clear form Figure 11, two tasks are present within this sub-project; T5.2 and T5.4. In the end parts of T5.7 are represented dealing with the class approval of the vessel. It is not exactly the right description above the task, but as the deadline for this task is two years after that of T5.4, it has been put there to not lose tasks in these overviews, or create even more sub-projects.

5.5.5. Discussion of the process for "9. Automated Design Tool".

The final engineering goal or sub-project of WP 5 is the automated design tool. Ships are complex systems where many choices on components are influencing multiple functionalities. The design of a ship is described as a wicked problem, one can only understand the problem, once a solution is generated. With the added complexity of modules the level of uncertainty on the correct solution increases rather than decreases. The number of components is limited, which should reduce the solution space, however for an optimal design it is necessary to be able to identify if a component is missing. Thus sub-project will attempt to create an automated and optimised translation of the concept design into a selection of relevant (and to be created) modules.

				DEFINE														DEFINE				Implement									Implement		Run & Validation			
9. Automated Design Tool				Needs Analysis				Concept Exploration				Concept Definition						Advanced Development				Engineering Design				Integration and Evaluation					Production and Deployment		Operations and Support			
1 Executed in Task	T5.4.5			T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5			T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5	T5.4.5			T5.4.5	T5.4.5				
2 Linked Official Delivery (Output)																																									
3 Required Offical Delivery (Input)				D5.2				D5.3				D5.4																													
4 Required other inputs (WPx)												D2.D/D3.A						D2.E/D3.B																							
5 Finished in Month	M6						M12				M18				M24						M30				M42					M42				M48							
6 Partners Involved																																									
a MDEM				x	x	x	x																																		
b MEGA				x	x	x	x																																		
c DUT	x			x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x			x	x								
d DS				x	x	x	x	x	x	x	x																														
e DSGo	**x**			**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**			**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**			**x**	**x**								
f DSNS				x	x	x	x	x	x	x	x																														

Figure 12: Process description of "9. Automated Design Tool"

Figure 12 represents the process and tasks within this process. It should be clear that this process only involves one sub-level task, namely the optimisation. This was done to not make the outcome of the project dependent on the success of this tool. However, if the tool is successfully developed and implemented, it will make the output of this project much more desirable as a solution for ship design.

5.5.6. Adjustments to the Content

DS spends significant time on enablement of the consortium for using their software. Especially the early stage introduction has no task assigned to it. To allow for this, a new subtask T5.2.0 will be created: "3DEXP enablement environment. which concerns the enablement program currently put in place by DS". Further work on this will be considered part of both T2.3 and T3.3. The content of T5.4.5 is not extended, however the execution is assumed to also contain the creation of a tool for this purpose. Furthermore the deadline for T5.2 has been extended to M9 (original M6), with crucial parts still available in M6 (T5.2.1 and T5.2.2). Besides, T5.2.3, will be adjusted as follows: "Develop and test the data exchange format and the importer/exporter functions using the case ship from WP5 task T5.3." The part of the Modelica library was removed, this will be added as an additional task to T5.4 as it requires much more time to be filled and completed. This will not interfere with the progress of the project, as these specific tools are required much later. The main platform will still be available early on in the project. With this change the new task T5.4.8 is created: "Create a Modelica content library in the 3DEXPERIENCE Platform.". Due to the addition of this library to T5.4, the delivery D5.4 will be moved to M21 instead of M18.

5.5.7. WP risks identified

For the simulation, there are currently two options mentioned, Plant Simulation from Siemens and Delmia from Dassault. In a worst case scenario Delmia may not be sufficient for the goals of this project and Siemens may not be able to access the right information. Working with export files and extra databases will mitigate this problem, but is less desired as a solution.

A second risk concerning the simulation is the vessel details required for the simulation. If these details are not foreseen in the platform, or in the design of the ships, it will be difficult to run a satisfactory simulation. To mitigate this, the details should be part of the mid-term check in T1.3 at least and preferably also be discussed regularly between the parties involved.

6. I/O OVERVIEW AND TIMING

This chapter summarises the inputs from other work packages identified in the descriptions of chapter 3. The focus in this deliverable has been on inputs to clearly identify what is required from another work package to successfully perform the work. Therefore this chapter will first present a summary of the task distribution over the engineering goals, as well as the detailed overview of tasks and deliverables. For clarity the input table is shown , in Section 4.1, identifying and describing all inputs, including their timing. This is sorted per WP as was chapter 3. The second section (4.2) is a table where these inputs are sorted per delivering WP, this way an output table is created, allowing project members to easily identify deliveries and timing of this delivery.

6.1. Task summary and overview

The task summary below shows the rough assignment of tasks to the various engineering goals of the project, different work packages are indicated by different colours to help identification. In the Appendix A, a more detailed overview is given, which combined all data of Chapter 3 and helped time all intermediate steps and deliveries correctly.

		DEFINE												DEFINE				Implement								Implement		
		Needs Analysis				Concept Exploration				Concept Definition				Advanced Development				Engineering Design				Integration and Evaluation				Production and Deployment		
1 Modular Approach	T1.1	T5.1*	T5.7*	T5.1*	T5.7*	T5.1*	T5.7*	T5.1*	T5.7*	T5.3	T5.3	T5.3	T5.3	T5.3	T5.3	T5.3	T1.3											WP 1
2 Modular Ferry (Platform-based product families)	T2.1	T2.1	T2.1	T2.1	T2.1	T2.2	T2.2	T2.2	T2.2	T2.2	T2.2	T2.2	T2.2	T2.3	T2.3	T2.3	T2.3	T2.3	T2.3	T2.3	T1.4	T2.4*	T2.6*	T2.4*	T1.5			WP 2
3 Modular Workboat (Platform-based product families)	T3.1	T3.1	T3.1	T3.1	T3.1	T3.2	T3.2	T3.2	T3.2	T3.2	T3.2	T3.2	T3.2	T3.3	T3.3	T3.3	T3.3	T3.3	T3.3	T3.3	T1.4	T3.4*	T3.5*	T3.4*	T1.5			WP 3
4 Power System	T2.1	T2.5	T2.5	T2.5	T2.5	T2.5	T2.5	T2.5	T2.5	T2.5	T2.5	T2.5	T2.5	T2.5	T2.5	T2.5	T2.5	T2.5	T2.5	T2.5	T1.4	T2.5	T2.5	T2.5	T1.5			WP 4
5 Modular Production System	T5.1	T5.5	T5.5	T5.5	T5.5	T5.5	T5.5	T5.5	T5.5	T5.5	T5.5	T5.5	T5.5	T5.5	T5.5	T5.5	T5.5											WP 5
6 Modular production Simulation	T5.1	T5.1*	T5.6*	T5.1*	T5.6*	T5.6	T5.6	T5.6	T5.6	T5.6	T5.6	T5.6	T5.6	T5.6	T5.6	T5.6	T1.3	T5.6	T5.6	T5.6	T5.6	T5.6	T5.6	T5.6	T5.6	T5.6	T5.6	
7 Modular Design Platform (3DEXP platform environment)	T5.1	T5.7	T5.2	T5.2	T5.2	T5.2	T5.2	T5.2	T5.2	T5.4	T5.4	T5.4	T5.4	T5.7	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T1.3	T5.7	T5.7	
8 Assesment Tool	T1.1	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	T1.2	
9 Automated Design Tool	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	T5.4	
10 Impact reduction measure selection	T1.1	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	T4.2	
11 URN prediction tools	T1.1	T4.1	T4.1	T4.1	T4.1	T4.3*	T4.4*	T4.3*	T4.4*	T4.3*	T4.4*	T4.3*	T4.4*	T4.3*	T4.4*	T4.3*	T4.4*	T4.3*	T4.4*	T4.3*	T4.4*	T4.3*	T4.4*	T4.3*	T4.4*	T4.3*	T4.4*	

* alternating Tasks are performed in paralel here

Figure 13: Engineering goals, task coverage summary.

The overview has led no adjustments in timing compared to the original DoW. Extra sub-deliverables have been defined, these were treated in the previous chapter The complete list with updated deadlines is given in [] while the input and output relations are available in **Fout! Verwijzingsbron niet gevonden.** and 6.4.

6.2. Overview of all deliverables (final and intermediate)

Deliverable		WP	Partner	Type	Month
D1.1	Attuning of requirements and KPI's	WP1	DUT	R	M4
D1.2	Assessment model	WP1	DUT	R	M12
D1.3	Mid-term assessment	WP1	DUT	R	M18
D1.4	Intermediate assessment	WP1	DUT	R	M36
D1.5	Final assessment	WP1	DUT	R	M45
D2.1	Detailed requirements	WP2	DSGo	R	M6
D2.A	Detailed shore based facilities, Ferry Class, operational scenarios	WP2	DSGo	R	M6
D2.B	Functional requirements for the batery system	WP2	DSGo	R	M6
D2.2	Analysis ferry market	WP2	DSGo	R	M9
D2.C	Battery Requirement only	WP2	DSGo	R	M12
D2.D	Preliminary design description to optimise	WP2	DSGo	other	M24
D2.3	Synthesis platform-based ferry family	WP2	DSGo	R	M30
D2.4	Demonstrate modular ferry design	WP2	DSGo	DEM	M30
D2.E	Access to a filled module library	WP2	DSGo	other	M30
D2.5	Electric. power distribution and storage system	WP2	VITO	DEM	M30
D2.6	Demonstrate modular ferry production	WP2	DSGo	DEM	M45
D3.1	Detailed requirements	WP3	DSGo	R	M6
D3.2	Analysis workboat population	WP3	DSGo	R	M9
D3.A	Preliminary design description to optimise	WP2	DSGo	other	M24
D3.3	Synthesis platform-based workboat family	WP3	DSGo	R	M30
D3.4	Demonstrate modular workboat design	WP3	DSGo	DEM	M30

D3.B	Access to a filled module library	WP2	DSGo	other	M30
D3.5	Demonstrate modular workboat production	WP5	DSGo	DEM	M45
D4.1	Detailed requirements	WP4	MARIN	R	M6
D4.2	Energy and emissions technologies	WP4	DSGo	R	M15
D4.A	URN in DP-mode concept model	WP4	MARIN	other	M21
D4.B	URN in off-service conditions concept model	WP4	MARIN	other	M21
D4.3	URN in DP-mode	WP4	MARIN	R	M30
D4.4	URN in off-service conditions	WP4	MARIN	R	M30
D5.1	Detailed requirements	WP5	DS	R	M6
D5.2	Working environment	WP5	DS	other	M9
D5.3	Modularisation principles	WP5	DSGo	R	M12
D5.4	Modular design procedure	WP5	DSGo	R	M21
D5.5	Modular production	WP5	CMT	R	M18
D5.6	Simulation tool production	WP5	CMT	other	M30
D5.7	Approval procedures	WP5	BV	R	M45
D6.1	Detailed requirements	WP6	SEA	R	M6
D6.2	Website and dissemination tools	WP6	SEA	DEC	M6
D6.3	Involvement of SME supply chain	WP6	SEA	R	M45
D6.4	Final PEDR version and MARCOM	WP6	DSGo	R	M48
D7.1	Project management tool	WP7	NMTF	other	M6
D7.2	Procedure manual	WP7	NMTF	R	M6
D7.3	QA procedure	WP2	NMTF	R	M6

6.3. INPUT sorted per WP

Id	INPUT WP / Task	OUTPUT WP / Task	Timing	Description
D2.1	WP1	WP2	M6	Context Diagram, Objectives Breakdown, Functions, MoEs and MoPs and Scenarios
D3.1	WP1	WP3	M6	Context Diagram, Objectives Breakdown, Functions, MoEs and MoPs and Scenarios
D4.1	WP1	WP4	M6	Context Diagram, Objectives Breakdown, Functions, MoEs and MoPs and Scenarios
D5.1	WP1	WP5	M6	Context Diagram, Objectives Breakdown, Functions, MoEs and MoPs
D1.1	WP2	WP1	M3	Updated scheduling and project details
D2.1	WP2	WP2	M6	Shore based facilities, Ferry Class, operational scenarios
D2.C	WP2	WP2	M12	System requirments for the bateries?
D2.A	WP2	WP2	M8	Detailed shore based facilities, Ferry Class, operational scenarios
D2.B	WP2	WP2	M8	Functional requirements for the batery system
D2.5	WP5	WP2	M30	Ship-to-shore and battery system
D4.2	WP2	WP4	M15	Selection criteria propulsion method + short list technologies
D4.A	WP2	WP4	M21	Silent model thruster
D4.B	WP2	WP4	M21	Silent model off Design
D5.2	WP2	WP5	M9	Working 3DExperience
D5.3	WP2	WP5	M12	Handbook on how to create a modular approach
D5.4	WP2	WP5	M18	Procedurs for modular design and functioning platform
D5.6	WP2	WP5	M30	Working Simulation Model and its data requirements
D1.1	WP3	WP1	M3	Updated scheduling and project details
D4.2	WP3	WP4	M15	Selection criteria propulsion method + short list technologies
D4.A	WP3	WP4	M21	Silent model thruster
D5.2	WP3	WP5	M9	Working 3DExperience
D5.3	WP3	WP5	M12	Handbook on how to create a modular approach
D5.4	WP3	WP5	M18	Procedurs for modular design and functioning platform
D5.6	WP3	WP5	M30	Working Simulation Model and its data requirements
D1.1	WP4	WP1	M3	Updated scheduling and project details
D2.D	WP5	WP2	M18	Access to a filled module library
D2.E	WP5	WP2	M24	Preliminary design description to optimise
D3.A	WP5	WP3	M18	Access to a filled module library
D3.B	WP5	WP3	M24	Preliminary design description to optimise
D5.2	WP5	WP5	M6	Working 3DExperience
D5.3	WP5	WP5	M12	Handbook on how to create a modular approach
D5.4	WP5	WP5	M18	Procedurs for modular design and functioning platform

6.4. OUTPUT sorted per WP

Id	OUTPUT WP / Task	INPUT WP / Task	Timing	Description
D1.1	WP1	WP2	M3	Updated scheduling and project details
D1.1	WP1	WP3	M3	Updated scheduling and project details
D1.1	WP1	WP4	M3	Updated scheduling and project details
D2.1	WP2	WP1	M6	Context Diagram, Objectives Breakdown, Functions, MoEs and MoPs and Scenarios
D2.1	WP2	WP2	M6	Shore based facilities, Ferry Class, operational scenarios
D2.A	WP2	WP2	M8	Detailed shore based facilities, Ferry Class, operational scenarios
D2.B	WP2	WP2	M8	Functional requirements for the batery system
D2.C	WP2	WP2	M12	System requirments for the bateries?
D2.5	WP2	WP5	M30	Ship-to-shore and battery system
D2.D	WP2	WP5	M18	Access to a filled module library
D2.E	WP2	WP5	M24	Preliminary design description to optimise
D3.1	WP3	WP1	M6	Context Diagram, Objectives Breakdown, Functions, MoEs and MoPs and Scenarios
D3.A	WP3	WP5	M18	Access to a filled module library
D3.B	WP3	WP5	M24	Preliminary design description to optimise
D4.1	WP4	WP1	M6	Context Diagram, Objectives Breakdown, Functions, MoEs and MoPs and Scenarios
D4.2	WP4	WP2	M15	Selection criteria propulsion method + short list technologies
D4.A	WP4	WP2	M21	Silent model thruster
D4.B	WP4	WP2	M21	Silent model off Design
D4.2	WP4	WP3	M15	Selection criteria propulsion method + short list technologies
D4.A	WP4	WP3	M21	Silent model thruster
D5.1	WP5	WP1	M6	Context Diagram, Objectives Breakdown, Functions, MoEs and MoPs
D5.2	WP5	WP2	M9	Working 3DExperience
D5.3	WP5	WP2	M12	Handbook on how to create a modular approach
D5.4	WP5	WP2	M18	Procedurs for modular design and functioning platform
D5.6	WP5	WP2	M30	Working Simulation Model and its data requirements
D5.2	WP5	WP3	M9	Working 3DExperience
D5.3	WP5	WP3	M12	Handbook on how to create a modular approach
D5.4	WP5	WP3	M18	Procedurs for modular design and functioning platform
D5.6	WP5	WP3	M30	Working Simulation Model and its data requirements
D5.2	WP5	WP5	M6	Working 3DExperience

D5.3	WP5	WP5	M12	Handbook on how to create a modular approach
D5.4	WP5	WP5	M18	Procedurs for modular design and functioning platform

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. Conclusions

The plan adjustments, task assignments and (internal-) delivery description and planning presented here, is the result of a detailed study of the original plan and the agreed upon requirements. The discussions along the way have helped clarify intentions of all partners and identified mismatches and updated requirements. The willingness of all partners to adjust planning and content when necessary to achieve our common goals showed that our cooperation has strength.

7.2. Recommendations

The recommendations below are summing up of all adjustments required to the Grant Agreement already discussed in Chapter 5.

WP 1:
T1.2.1. is extended with the details on the assessment for clarity:
Prepare Terms of Reference (ToR) for the assessment model and for the supporting tools. This will follow the SE approach, requiring the objectives breakdown of the relevant goals:
Midterm Assessment:

1. Modular Approach,
6. Modular Production Simulation,
7. Modular Design Platform,

Intermediate Assessment/ Final Assessment (technical and economical):

2. Modular Ferry
3. Modular Workboat

Besides this clarification it is also decided that T1.1.5: "Capture requirements to be set up into the 3DEXPERIENCE Platform" is skipped here as it is a duplicate of T5.1.5: "The NAVAIS working environment embedded in the DS 3DEXPERIENCE Platform" and fits much better in the content of WP5

Also, the Risk Management Plan will be part of D7.2 and not D1.1 as this is a project management element.

WP2:

- T2.4.1 D2.A Detailed shore based facilities, Ferry Class, operational scenarios
- T2.4.2 D2.B Functional requirements for the battery system
- T2.3.3 D2.C Battery Requirement only
- T2.4.3 D2.D Preliminary design description to optimise
- T2.3.4 D2.E Access to a filled module library

Furthermore the following subtasks description has been extended for clarity:

- T2.4.7 has become: Review of the modular design process*, approval of the process by BV* and prepare the task deliverable

Finally DSNS will be added as a contributing partner for the work in T2.5 and Deliverable D2.5.

WP3:

- T3.4.3 D3.A Preliminary design description to optimise
- T3.3.4 D3.B Access to a filled module library

Furthermore the following subtasks description has been extended for clarity:

- T3.4.7 has become: Review of the modular design process*, approval of the process by BV* and prepare the task deliverable

WP4:

T4.2.2 is extended with the decision to create a flexible tool to achieve this objective the new text will be:
"*Define selection criteria on the basis of the identified rules and regulations for the selected operational areas, see sub-task T4.1.1, and the suitability for road ferries up to 450 passengers and 150 cars capacity and workboats up to 500 GT. Capture the criteria and the selection of the right measures in a tool that deals with the complex relations between solutions. Based on the applicable rules, regulations and selected KPIs (Key Performance Indicators), the tool should provide a selection of technologies that ensure that the final design will meet those requirements (rules and KPIs).*" Due to this tool and as it is not required by WP2 and WP3 before month 15, the deadline for the deliverable will be postponed by 3 months.

As presented in the overview, several intermediate deliverables are identified, that are required for a timely delivery of information to another sub-project or work package. These are:

- T4.3.8 D4.A URN in DP-mode concept model
- T4.4.8 D4.B URN in off-service conditions concept model

WP5:

DS spends significant time on enablement of the consortium for using their software. Especially the early stage introduction has no task assigned to it. To allow for this, a new subtask T5.2.0 will be created: "3DEXP enablement environment. which concerns the enablement program currently put in place by DS". Further work on this will be considered part of both T2.3 and T3.3. The content of T5.4.5 is not extended, however the execution is assumed to also contain the creation of a tool for this purpose. Furthermore the deadline for T5.2 has been extended to M9 (original M6), with crucial parts still available in M6 (T5.2.1 and T5.2.2). Besides, T5.2.3, will be adjusted as follows: "Develop and test the data exchange format and the importer/exporter functions using the case ship from WP5 task T5.3." The part of the Modelica library was removed, this will be added as an additional task to T5.4 as it requires much more time to be filled and completed. This will not interfere with the progress of the project, as these specific tools are required much later. The main platform will still be available early on in the project. With this change the new task T5.4.8 is created: "Create a Modelica content library in the 3DEXPERIENCE Platform.". Due to the addition of this library to T5.4, the delivery D5.4 will be moved to M21 instead of M18.

8. BIBLIOGRAPHY

1. NAVAIS Grant Agreement

ANNEX A: PUBLIC SUMMARY

During the preparation phase of NAVAIS, many aspects of the scope of the project and the interaction between work packages were defined. However, to ensure smooth cooperation in the project, further fine-tuning of both aspects is required. This deliverable aims to achieve that fine-tuning.

Problem definition

The NAVAIS work plan, though extensive, is open for different interpretations by the participants. The desired result may be clear, but how it can be achieved needs to be discussed. Care should also be taken that both the receiving and sending Work Packages (WPs) are aware of each other's expectations. A first investigation showed that many intermediate deliveries were not mentioned at both the generating task and the receiving task, potentially leading to incorrect timing of intermediate deliveries as well as not assigning responsibility for the delivery at all.

Besides the above described issue, especially the use of words related to modularity required clear definitions. Many are open for multiple interpretation and in order to understand each other, a single definition for the entire project should be used.

Technical approach and work plan

To facilitate recognition, the work was further subdivided over 11 different Engineering goal. Each goal is represented by one or more Tasks, either consecutive or parallel. Using this subdivision each required element of information was identified and checked for availability. Especially element from other engineering goals were checked for both content and timing. This has led to a number of adjustments for each WP. The most notable ones are:

- T1.1.5 is executed under WP5, hence not executed as a separate sub-task in WP1
- T4.2.2 is extended with the decision to create a flexible tool
- T5.2.0 is created: "3DEXP enablement environment. which concerns the enablement program currently put in place by DS"
- T5.4.8 is created: "Create a Modelica content library in the 3DEXPERIENCE Platform."

Besides the adjustment of tasks, extra internal deliverables have been established to allow a smooth running and timely delivery of required data and tools within the project. These extra deliverables are:

- T2.4.1 D2.A Detailed shore based facilities, Ferry Class, operational scenarios
- T2.4.2 D2.B Functional requirements for the battery system
- T2.3.3 D2.C Battery Requirement only
- T2.4.3 D2.D Preliminary design description to optimise
- T2.3.4 D2.E Access to a filled module library
- T3.4.3 D3.A Preliminary design description to optimise
- T3.3.4 D3.B Access to a filled module library
- T4.3.8 D4.A URN in DP-mode concept model
- T4.4.8 D4.B URN in off-service conditions concept model

Besides these adjustments, a number of new risks were identified as well. The complete list is presented below:

- Many definitions and uses exist for the vocabulary on modularisation. To ensure a good understanding between participants a glossary with project vocabulary and interpretations, including examples is generated and will be updated all throughout the project. Any uncertainty in definition will be treated and clarified here. (relates to WP1-7)
- The E-Ferries automated docking system is in principle heavily dependent on the progress of the ferry design for details on its requirements. This increases the risk of not having enough time to create a working prototype. This risk will be mitigated by accepting uncertainty on the details of the requirements and starting this process before all information is available. (WP 2)
- Data from the model test may be insufficiently reliable to create URN prediction tools. This will be monitored during the tests but in the worst case might require extra (unbudgeted) tests to achieve its goal. (WP 4)
- Work on URN prediction tools has a confidential nature. Annex 3 and 5 may need to be updated to make sure this work is sufficiently protected. (WP 4)
- The modularisation principle cannot be developed on time or requires adjustments later on. This can be mitigated by close cooperation between the parties in WP 2/3 and WP 5. (WP 5)
- Both simulation packages mentioned are not suitable, Delmia may lack capabilities and Plant Simulation, may not access required information. The only way to mitigate this is to use plant simulation off line, a less desirable solution, but workable. (WP 5)
- Although the risk of insufficient data for simulation was mentioned already, this risk should also include the mismatch of design data created and data required for production simulation. The level of detail of the simulation should match the design details that can be provided. To mitigate this risk T1.3 will also assess the proposed detail level of the Design, the Simulation and the platform, though earlier cooperation on this will further mitigate this risk. (WP 5)

Results

The scope of NAVAIS is defined and the Input and Output (I/O) relations are made explicit. Furthermore, the project risk table is revised. During the first year of the project additional actions by all technical WPs will be executed in order to ensure that, by the time the detailed modelling of the vessels and software starts, the project will have achieved the required focus through well-founded decisions.

ANNEX B: DETAILED TASK AND CROSS TASK DELIVERY OVERVIEW

Figure 14: Detailed task overview

ANNEX C: CURRENT STATUS OF THE GLOSSARY

Introduction

This documents serves as a glossary for the NAVAIS project. The following terms will be used throughout the NAVAIS project as they are defined below. The attempt was made to use existing definitions of commonly used terms as much as possible, including those used in the NAVAIS project proposal. In some cases the definitions had to be adapted to serve NAVAIS purpose and in other cases entirely new definitions had to be developed.

The definitions are separated into two groups

1. Those related to modular design and production
2. Those related to ship design, systems engineering, and other relevant aspects of the project

Key Modular Design and Production Terms

Component:

A part or element of a larger whole, especially a part of a machine or vehicle.

In general considered to be bought in one piece from the perspective of the leading company, otherwise it is a sub-system. A GPS unit is component from the perspective of the ship builder/electrical equipment supplier. A (ballast) pump is a component as well, even with the drive included.

(ship design) Configuration:
A system that enables a structured definition of a valid design solution from a given set of customer requirements, by applying pre-defined rules and templates to select, scale and synthesize a collection of modules (retrieved from Erikstad, 2009)

A single configuration is derived from the modular product architecture. It is one instantiation of the modular product architecture.

Function:
A specific action or activity that delineates how a particular aspect of a task is to be performed by a physical device, upon receiving an input, that produces a result.

The function remains more or less fixed whereas the purpose (which indicates intention or objective) might change. For example the function of a crane is to shift a load, whereas its purpose (what to shift and why) could be anything the crane operator does.

A function always contains a verb in systems engineering (e.g. turns X into Y, provide power for propulsion)

Interface:

A point where two or more systems meet and interact

Modular Product Architecture:

The scheme by which the functions of a product are allocated to physical components. Describes the structure of a system, in defining the main functions and entities of the system and how these are related to each other.

Can be thought of as more abstract skeleton in which the concrete modules can be placed according to given rules. (adapted from Erikstad 2009).

Modularity / Modularisation:

The degree to which a system is made up of relatively independent but interlocking components or parts. The system's components may be separated and recombined.

In practice, modularisation is the decomposition of a product into building blocks (modules) with specified interfaces, driven by company-specific reasons.

The meaning of the word, however, can vary somewhat by context related to the field of application though there are commonalities:

1. *The division of a larger system into smaller parts or components*
2. *The principle of (relative) self-sufficiency of the individual parts*
3. *The recombination of the parts into multiple end products, according to a set of "rules" given by an overall systems architecture*

Module:

1. Each of a set of physically bounded together standardized parts or independent units that can be used to construct a more complex structure.
2. The physical representation of a function, possesses physical attributes, functional attributes, cost attributes, production attributes, maintenance attributes etc. (NAVAIS proposal, 2017)

A library module possesses:

1. *physical attributes (geometry, weight),*
2. *functional attributes (generates energy, transfers fluids),*
3. *cost attributes,*
4. *production attributes (part lists, part position, purchase info, resources, production instructions, work schedules, certificates etc.),*
5. *maintenance attributes (inspection instructions, maintenance schemes and instructions).*

Modules and their components can be linked in one or more ways. Decomposition, standardization, and exchangeability are the attributes of a modular product.

The suggestion is to apply the word module only to a physically bounded, constructible combination of parts delivering a function. Without the function this becomes a skid (in Damen

jargon). If it has a function but is not physically bounded, e.g. a propulsion train with generators and pods, it will be called a system.

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Platform based product family:

A set of common components, modules, or parts from which derivative products can be developed. (NAVAIS proposal, 2017)

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Basic approaches to product family design are:

1. ***Top-down*** *(pro-active platform) where a company strategically manages and develops a family of products based on a product platform and its derivatives;*
2. ***Bottom-up*** *(reactive design approach) where a company re-designs or consolidates a group of distinct products to standardize components to improve economies of scale and reduce technical risks.*
3. ***Module-based product family****: platform-based product development where product family members are instantiated by adding, substituting and/or removing one or more functionalities from the platform.*
4. ***Scale-based product family:*** *wherein one or more scaling variables are used to "stretch" or "shrink" the platform or a platform system (power train) in one or more directions to satisfy a variety of market niches.*

Product library:

A database that allows multi-user environments to centralize information and behaviour for digital data production. (NAVAIS proposal, 2017)

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Production business rules, documents, and spatial information are stored inside the product library, allowing to enforce and standardize production. Data model information, data validation rules, geographic extents, symbology rules, and map documents can all be managed inside the product library as examples of production business rules. In practice, it is a library of components, assemblies, modules etc. that is used to design and engineer a complex product. The library has features that enable to scale library items and apply parametric design principles.

Product Platform:

A structured, coherent collection of resources, including systems and template hierarchies, textual components, variants, rules and interface definitions, from which a range of customized product definition can be derived. (Erikstad 2009)

System:

1. A set of interrelated components working together toward some common objective. (Kossiakof, et al, 2011).
2. A system is a regularly interacting or interdependent group of physical items forming a unified whole and continually influence one another (directly or indirectly) to maintain their activity and the existence of the system, in order to serve a purpose (achieve the goal of the system). Systems have
    a. inputs, outputs and feedback mechanisms,
    b. maintain an internal steady-state despite a changing external environment,

c. display properties that are different than the whole but are not possessed by any of the individual elements, and
d. have boundaries that are usually defined by the system observer.

A ship propulsion system receives energy from a source (fuel), converts the energy into a different (rotational) form and receives feedback as to maintain a constant output despite changing external conditions. Systems may contain sub-systems that have own function, input, output and feedback mechanism.

System boundaries are preferably chosen in such a way that they minimize the number of interface.

System-of-interest:

A particular system whose effectiveness is under investigation.

System-of-system:

A system whose system elements are systems themselves.

Other Relevant NAVAIS Terms:

Activity:

A set of cohesive tasks of a process.

Basic design:

Hull geometry suitable for model tests, class drawings, hydrodynamic calculations and component selection based on functional technical specification. (NAVAIS proposal, 2017)

Concept design:

The process starts with the mission requirements that are usually specified by the ship owner and based on market scenarios. The concept design includes the ship type, deadweight or payload, type of propulsion, service speed, service area, endurance at sea, position keeping (eventually), class society and class notation. (NAVAIS proposal, 2017)

Design method:

The approach or technique used to initiate the design procedure. (NAVAIS proposal, 2017)

Design process:

A series of transformations taking place with the aim to translate user needs into a defined configuration of the ship functional systems and their assemblies and components. (NAVAIS proposal, 2017)

Design procedure:

The sequence in which design process activities are deployed. (NAVAIS proposal, 2017)

Contract design:

Determination of the ship characteristics and main equipment, to be annexed to the contract: general arrangement, technical specification on functional level, diagrams of main piping systems. (NAVAIS proposal, 2017)

Detail design:

Details providing information for manufacture, assembly and testing: fairing of the body plan, defining all structural components, material specs and production information for cutting, shaping, assembling, joining and surface preparation of structures, pipes and other outfit items, integration and installation information for all equipment, applicable standards and norms. (NAVAIS proposal, 2017)

Emissions:

Any form of energy, solid or particle that is emitted by the vessel to its environment

KPI (Key Performance Indicator):

A quantifiable measure used to evaluate the success of a component, system, configuration, etc. in meeting objectives for performance.

Measure of effectiveness:

A criterion used to assess changes in system behaviour, capability, or operational environment that is tied to measuring the attainment of an end state, achievement of an objective, or creation of an effect.

Measure of performance:

The measure that characterizes physical or functional attributes relating to the working of the system, measured, or estimated under specific testing and/or operational environmental conditions.

Mission:

A statement identifying the scope of an operation, that is the kind of transport or other service type will be provided, primary customers or market, geographical region of operation, in short:

- Key market: target or customer
- Contribution: what service to be provided to that client

- Distinction: what make the service unique, so that the client would choose you?

Performance:

A description of how well or bad something works.

Preliminary design:

Determination of main hull dimensions and form coefficients, and all elements necessary and sufficient to estimate OPEX and CAPEX: preliminary hull geometry, arrangement and compartmentation (sufficient to estimate stability and mission-critical capacities), first estimate of propulsive power, ship lightweight. (NAVAIS proposal, 2017)

Procedure:

Describes the order in which the activities and tasks need to be executed, whereas a process just describes the set of interrelating activities.

Process:

A set of interrelated or interacting activities which transforms inputs into outputs.

Product Data Management/PDM:

Product data management is the use of software or other tools to track and control data related to a particular product. It usually involves product technical specifications, manufacture specifications, materials and more. The use of PDM allows to track the various costs associated with the creation and launch of a product. PDM is part of product lifecycle management.

Product Lifecycle Management/PLM:

Often used as an umbrella concept that includes engineering CAD, PLM is an enabling framework to help connect, organize, control, manage, track, consolidate and centralize all the mission-critical information that affects a product. PLM offers a process to streamline collaboration and communication between product stakeholders, engineering, design, manufacturing, quality, operational life cycle support and other key disciplines.

Ship design:

The combination of details or features defining the configuration of the ship functional systems and their assemblies and components, in fact the properties and location of all ship components. (NAVAIS Proposal, 2017)

Systems engineering:

A methodical, disciplined approach for the design, realization, technical management, operations, and retirement of a system.

System management:

The management of those processes, activities, and tasks within the system boundaries of the system-of-interest that makes the system work.

Task:

An action to contribute to the achievement of one or more outcomes of a process.

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Erikstad, S.O. 2009. Modularisation in Shipbuilding and Modular Production. Working Paper, NTNU.

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ANNEX D: REVIEW AND REVISION OF THE RISK TABLE

In the NAVAIS proposal, a risk table was created, which is shown below. The fine-tuning of requirements and KPIs has led to new insights concerning the risks. Therefore, the table is updated, based on a workshop held on September 11, 2018, which was attended by 8 participants.

Table 0-1: Original risk table

	Description of risk Likelihood L/M/H	**WPs involved**	**Proposed risk-mitigation measures**
1	Insufficient data available for proof of concept assessment/**L**	WP1	Relying on already published and available data and research plus the partners involved in the project.
2	Insufficient data for defining product family classes/**L**	WP1-2	Consult market analysis sources for road ferries and multi-use workboats
3	E-ferry automatic docking/ recharging system fails test/**H**	WP2	Set detail requirements for critical functions/components. Design reviews and detail test plan.
4	Proof of concept E-ferry and workboat designs fails/**M**	WP2-3	Selection of benchmark criteria cost/lead-time and review of market benchmarks including societal costs.
5	Insufficient data for developing/ adapting URN predicting tools/**L**	WP4	Set requirements for data in Detail test plan. Test equipment before carrying out model tests
6	Modularisation principles cannot be developed, not applicable/**M**	WP5	Use case-ship and expert resources to identify modularisation options
7	Modular design procedure/**M**	WP5	Detail plan for step/by step design imaging case ship.
8	Insufficient data for modular production simulation/**H**	WP5	Get production data from case ship, data on production facilities and performance from partner DSGo network
9	Approval procedure of pre-engineered modules not possible/**M**	WP5	Set Terms of Reference and criteria for approval. Set requirements to design/engineering information and maintenance procedures for pre-engineered modules
10	Delayed, incorrect inputs from other WPs/**M**	WP's 1-6	Monitoring WP's progress. Shaping assessment model such that it works also with limited input
11	Failed or limited exploitation of results. Partners do not or are not able to make use of the project outcome as planned. External parties not convinced/**M**	WP1, WP6	A draft Plan Exploitation and Dissemination of Results (PEDR) is prepared. The PEDR will be monitored and updated in a dedicated WP (6). For external parties a Stakeholders Community will be built (WP6 task T6.3). Innovation management measures are scheduled in WP6
12	Building of the SME-forum stagnates/**L**	WP6	Comprehensive dissemination measures and close involvement of the
13	Low technical quality of deliverables or reports/**M**	WP1-7	QA quality criteria and procedures and peer reviewers involvement will ensure deliverables quality.

14	IPR protection fails: leakage of knowledge to external parties/**L**	WP1-7	Consortium Agreement includes measures for IPR protection. Review/approve Dissemination activities.
15	Non performing or low-performing partners/**L**	WP1-7	Partners selected on their expertise. SC will monitor partners' performance, problems first be dealt with at WP-level. Non-performing partner are replaced.
16	Withdrawal of partner(s) from consortium/**L**	WP1-7	EC Grant Agreement contains partners' obligations. The Consortium Agreement state the liabilities
17	Failing communication between partners prevent full use of the consortium potential/**L**	WP1-7	The SC/GA and WP's regular meetings will foster the collaboration and communication between partners. Demo leaders are experienced project managers.

In addition to the risk register above, the following potential events were identified which, if these materialize, pose a risk to the project:

- Many definitions and uses exist for the vocabulary on modularisation. To ensure a good understanding between participants a glossary with project vocabulary and interpretations, including examples is generated and will be updated all throughout the project. Any uncertainty in definition will be treated and clarified here. (relates to WP1-7)
- The E-Ferries automated docking system is in principle heavily dependent on the progress of the ferry design for details on its requirements. This increases the risk of not having enough time to create a working prototype. This risk will be mitigated by accepting uncertainty on the details of the requirements and starting this process before all information is available. (WP 2) As a mitigation of this DSGo already started on detailing out the ferry design in basic engineering, to be able to:
    - Define a realistic ferry design to be modularized
    - Provide input for the docking and charging systems
    - Provide reference material for other WP's
- Data from the model test may be insufficiently reliable to create URN prediction tools. This will be monitored during the tests but in the worst case might require extra (unbudgeted) tests to achieve its goal. (WP 4)
- Work on URN prediction tools has a confidential nature. Annex 3 and 5 may need to be updated to make sure this work is sufficiently protected. (WP 4)
- The modularisation principle cannot be developed on time or requires adjustments later on. This can be mitigated by close cooperation between the parties in WP 2/3 and WP 5. (WP 5)
- Both simulation packages mentioned are not suitable, Delmia may lack capabilities and Plant Simulation, may not access required information. The only way to mitigate this is to use plant simulation off line, a less desirable solution, but workable. (WP 5)

- Although the risk of insufficient data for simulation was mentioned already, this risk should also include the mismatch of design data created and data required for production simulation. The level of detail of the simulation should match the design details that can be provided. To mitigate this risk T1.3 will also assess the proposed detail level of the Design, the Simulation and the platform, though earlier cooperation on this will further mitigate this risk. (WP 5)

This leads to the following revised risk table.

Table 0-2: revised risk table

	Description of risk Likelihood L/M/H	**WPs involved**	**Proposed risk-mitigation measures**
1	Insufficient data available for proof of concept assessment/**L**	WP1	Relying on already published and available data and research plus the partners involved in the project.
2	Insufficient data for defining product family classes/**L**	WP1-2	Consult market analysis sources for road ferries and multi-use workboats
3	E-ferry automatic docking/ recharging system fails test/**H**	WP2	Set detail requirements for critical functions/components. Design reviews and detail test plan.
	The E-Ferries automated docking system is in principle heavily dependent on the progress of the ferry design for details on its requirements. This increases the risk of not having enough time to create a working prototype./**M**	WP2	This risk will be mitigated by accepting uncertainty on the details of the requirements and starting this process before all information is available. Also DSGo has already started on the basic design of an example ferry, to make sure that enough information is available.
4	Proof of concept E-ferry and workboat designs fails/**M**	WP2-3	Selection of benchmark criteria cost/lead-time and review of market benchmarks including societal costs.
5	Insufficient/contaminated data for developing/ adapting URN predicting tools/**L**	WP4	This will be monitored during the tests but in the worst case might require extra (unbudgeted) tests to achieve its goal
	Work on URN prediction tools has a confidential nature	WP4	annex 3 and 5 may need to be updated to make sure this work is sufficiently protected
6	Modularisation principles cannot be developed, not applicable/**M**	WP5	Use case-ship and expert resources to identify modularisation options, close cooperation between the parties in WP 2/3 and WP 5
7	Modular design procedure/**M**	WP5	Detail plan for step/by step design imaging case ship.
	Both simulation packages mentioned are not suitable, Delmia may lack capabilities and Plant Simulation, may not access required information./**L**	WP5	use plant simulation off line, a less desirable solution, but workable
8	Insufficient data for modular production simulation/**H**	WP5	Get production data from case ship, data on production facilities and performance from partner DSGo network

	mismatch of design data created and data required for production simulation/**M**	WP5	The level of detail of the simulation should match the design details that can be provided. To mitigate this risk T1.3 will also assess the proposed detail level of the Design, the Simulation and the platform, though earlier cooperation on this will further mitigate this risk
9	Approval procedure of pre-engineered modules not possible/**M**	WP5	Set Terms of Reference and criteria for approval. Set requirements to design/engineering information and maintenance procedures for pre-engineered modules
10	Delayed, incorrect inputs from other WPs/**M**	WP's 1-6	Monitoring WP's progress. Shaping assessment model such that it works also with limited input
11	Failed or limited exploitation of results. Partners do not or are not able to make use of the project outcome as planned. External parties not convinced/**M**	WP1, WP6	A draft Plan Exploitation and Dissemination of Results (PEDR) is prepared. The PEDR will be monitored and updated in a dedicated WP (6). For external parties a Stakeholders Community will be built (WP6 task T6.3). Innovation management measures are scheduled in WP6
12	Building of the SME-forum stagnates/**L**	WP6	Comprehensive dissemination measures and close involvement of the
13	Low technical quality of deliverables or reports/**M**	WP1-7	QA quality criteria and procedures and peer reviewers' involvement will ensure deliverables quality.
14	IPR protection fails: leakage of knowledge to external parties/**L**	WP1-7	Consortium Agreement includes measures for IPR protection. Review/approve Dissemination activities.
15	Non performing or low-performing partners/**L**	WP1-7	Partners selected on their expertise. SC will monitor partners' performance, problems first be dealt with at WP-level. Non-performing partner are replaced.
16	Withdrawal of partner(s) from consortium/**L**	WP1-7	EC Grant Agreement contains partners' obligations. The Consortium Agreement state the liabilities
17	Failing communication between partners prevent full use of the consortium potential/**L**	WP1-7	The SC/GA and WP's regular meetings will foster the collaboration and communication between partners. Demo leaders are experienced project managers.
	Many definitions and uses exist for the vocabulary on modularisation, creating confusion amongst participants./**H**	WP1-7	To ensure a good understanding between participants a glossary with project vocabulary and interpretations, including examples is generated and will be updated all throughout the project. Any uncertainty in definition will be treated and clarified here.

ANNEX E: TERMS OF REFERENCE

In this overview the terms of reference are described. This will be done by detailing three elements: objectives, capabilities, approach, scope (limitations).

Objectives:

The overall objective of NAVAIS is to "Quickly create an optimal low impact vessel using systems Engineering". This objective can be broken down (as part of the systems engineering approach) into first, second and even third order objectives. This is done in Figure 15 (number in brackets relate to the engineering goal below). The shown objective breakdown has led to the identification of 11 engineering goals for the project. Once achieved successfully and integrated with each other, the entire project can be considered a success. The 11 engineering goals identified are (related tasks in brackets):

1. Establish a Modular Design Approach, WP 5, T5.1/5.3
2. Create a Modular Ferry Family, WP 2, T2.1/T2.2/T2.3/T2.4/T2.6
3. Create a Modular Workboat Family, WP 3, T3.1-T3.5
4. Design an Electric Power System, WP 2, T2.5
5. Establish a Modular Production System, WP 5, T5.1/T5.5/T5.6
6. Create a Modular production Simulation, WP 5, T5.1/T5.5/T5.6
7. Design and Implement a Modular Design Platform (DS3D), WP 5, T5.1/T5.2/T5.4/T5.7
8. Create an Economic Assessment Tool, WP 1, T1.2
9. Research an Automated Design Tool, WP 5, T5.4
10. Support Impact Reduction Measure Selection, WP 4, T4.1/T4.2
11. Research New URN Prediction Tools, WP 4, T4.1/T4.3/T4.4

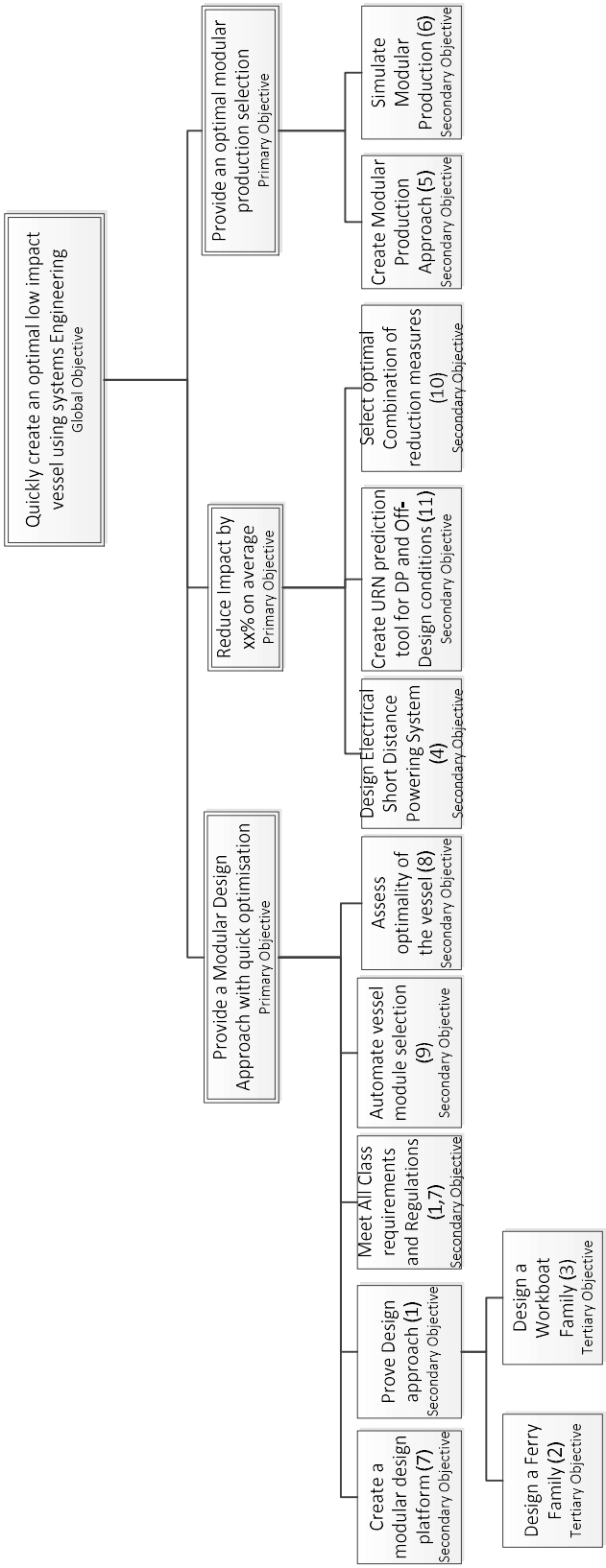

Figure 15: Objective Breakdown for NAVAIS

Capabilities:

The most important capability NAVAIS will achieve is a design approach, captured both in procedures and a platform that will allow a significant reduction in design lead time. Figure 16 is taken from the GA, but most clearly illustrates this capability.

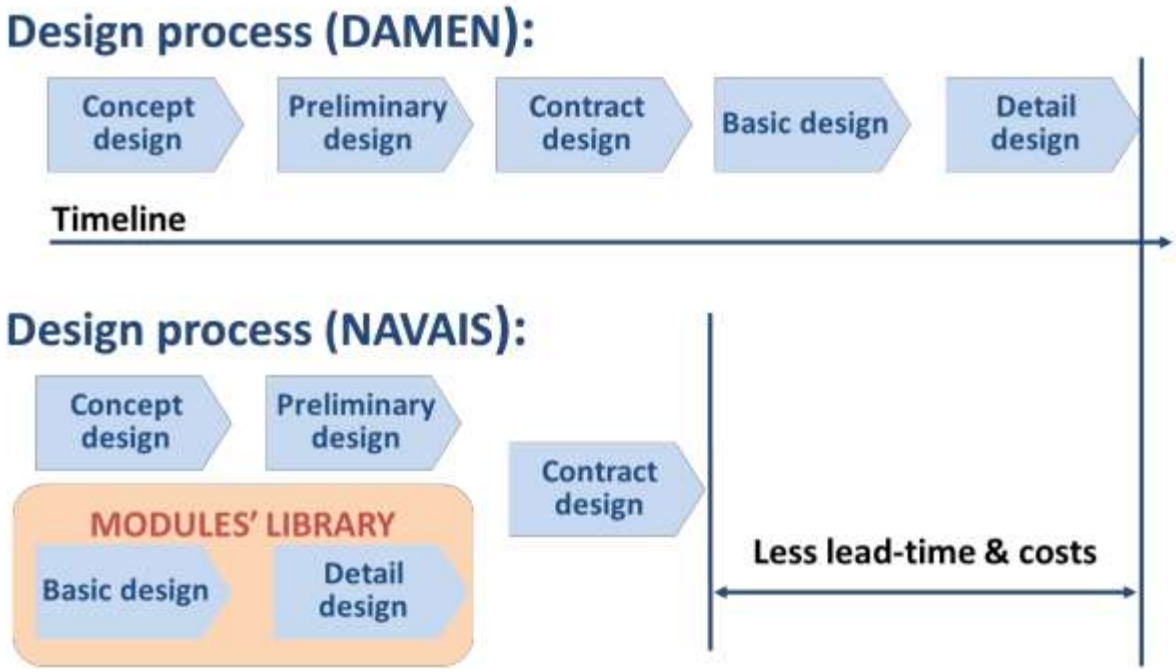

Figure 16: NAVAIS Design Time Reduction Capability

Further capabilities are related to the ability to effectively reduce the impact vessels have. This will be paramount to providing shipping options to a society with an increased awareness of their impact on the environment.

In slightly more detail the following key results will be obtained:

Key result 1: Modularisation principles for platform-based ship-product family designs

Key result 2: Module library (database) for passenger/road ferries and multi-use workboats

Key result 3: System engineering-based modular design procedure

Key result 4: Modular production method

Key result 5: TRL9-rated digital twin of a modular low-impact E-400 passengers/120 cars ferry design

Key result 6: TRL9-rated digital twin of a modular multiuse workboat equipped for aqua culture

Key result 7: Low impact and low energy and emissions design/operation principles

Key result 8: Validated Underwater Radiated Noise (URN) predicting tools for highly loaded propellers

Approach:

The approach within NAVAIS Is based on three main ideas:

Platform-based product families: A solution to the above dilemma is found in platform-based product family principles i.e. a group of related products that share common features, components, subsystems, interfaces and manufacturing processes that satisfy a variety of market niches. Platform-based product families are efficient and effective means to obtain sufficient product variety to satisfy a range of customer demands in support for mass customization.

Modular ship architecture: The choice for a platform-based product family raises the question of the product architecture, that is concerned with how the function of any product is organised into physical parts, such as assemblies and components. The product overall function is decomposed in a number of sub-functions needed to achieve the overall function. Likewise, assemblies and parts must be assigned to carry out these sub-functions and in-turn the whole function. In modular architecture the different functions of the product are, to the extent possible, allocated to separate product modules, and the interaction between these modules is small or non-existent. Modular architectures are flexible in structure, with highly standardized interoperability and standard connections for subsystems. A modular product system can typically be upgraded by replacement of lesser components with better ones

Modular production engineering environment: A key requirement for competitive production (cost and lead-time) is the ability to distribute production over various locations and increase efficiency through specialization of the individual production units. In a distributed production network, the production process consists of specialized modules at different levels (Fig.1.13). A network consists of production sites where each possesses different specialized workshops or production lines. Those again can be broken down into machines, workers and transport systems, each capable to perform certain processes for producing parts of a product. ICT systems, self-organizing multi-skill working teams and flexible or re-configurable production equipment support this development. The modular production concept allows the optimal use of specialized resources depending on the product, the production units, resources and the actual order book.

Scope:

The NAVAIS solutions may be applicable to all vessels in the future, however for the project the scope is limited by a number of factors:

- The focus is on standardised vessels, for which the modular approach will also enhance the re-use ability of the design, further reducing costs and lead time.
- More specifically the focus is on two specific vessel types:
    - Multi-use workboats (< 500 GT)
    - (electric) ferries, specifically one of 400 passengers and 120 cars

- The concepts are for European waters (urban, inland waterways and short sea),
- Designs cover hull designs, equipment and operations, including optimised land-side interfaces
- Low impact properties (noise, discharges, i.e.) are used in the design and are applicable to other ships types outside NAVAIS.
- Validation to the level of a TRL9-rated digital twin for both vessel types.

The scope has been further detailed in Chapter 5 of the D1.1.

Time & Budget:

These are fixed by the Grant Agreement (GA); the project duration is 48 months, while the budget is fixed at € 7,915,781.75, of which € 6,589,361.38 is provided as subsidy. This represents 837.5 man-hours, divided over 16 partners. Further details can be found in the GA.