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A Process to Establish the Common Functions Performed by a Multi-Role Vessel

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ABSTRACT

The concept of utilising a base platform that can be reconfigured for different roles using modules is becoming prevalent in minor warship design. These reconfigurable vessels have been designated as Multi-Role Vessels (MRVs). Incorporating different combinations of common functions into the design of a base MRV platform will have varying implications on how the base MRV will look and perform. This report focuses on the requirements and functional analysis activities within an MRV system's concept design phase. Using the iterative nature of these activities, a process is developed that can identify the functions that will be common across the roles that an MRV is to perform. In the process, Systems Engineering approaches and tools are adopted and used in consultation with the stakeholders to identify a set of functions the MRV will perform. The validity of the process is tested using a pilot study for an MRV that will carry out patrol, mine counter measure and hydrographic survey roles.

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Executive Summary

The emergence of unmanned vehicle technology has given rise to the potential for a multi-role vessel (MRV) that is capable of conducting several minor warship roles to be designed. In this concept, unmanned systems will perform functions, such as mine counter measures, previously performed by a single class of vessel. Present concept vessels of this type utilise modularity, where modules containing the equipment to perform the vessel roles are added to / removed from the base vessel. The modular vessel concept presents an interesting design challenge, as the array of functional combinations for the base platform consists of a wide range of common function options. Incorporating different ranges of these functional options into the design of the base platform will have different implications on how it will actually look and perform.

This report focuses on the requirements and functional analysis activities within an MRV concept design phase. In particular, the present work is focused on proposing, then assessing, whether a process to establish the functions that are common to all of the different vessel functions can be implemented. By establishing the common functions of an MRV, some of the possible implications on the design and cost of incorporating them into a base vessel that utilises modularity can be explored early in the concept design phase. The process is aimed at giving the MRV stakeholders deeper insight into the final concept design that could result from their functional requirements. After presenting the process, an assessment in the form of a pilot study using mock stakeholders and a hypothetical MRV that will perform the roles of patrol boat, mine counter measure and hydrographic survey vessels is performed to determine the validity of the process. Finally, some of the implications that performing the common functions identified using the process pilot study will have on the design of a base platform are discussed.

The proposed process to identify the common functions of an MRV contains several key steps that are identified as:

1. Appoint process manager
2. Preliminary requirements and functional analyses
3. Stakeholder requirements and functional brainstorming
4. Final requirements and functional analyses
5. Identify common functions

Once the common functions have been identified, they can be utilised to generate discussion on the implications of incorporating them into the base MRV platform's design. Generating discussion between stakeholders about the implications of their needs on vessel design at an early phase of the development lifecycle, should result in the development of the most capable and cost effective concept design that will meet their needs.

During the pilot study, the preliminary functional analysis identified a total of 75 functions that are required to be performed by a vessel to achieve the functionality of current and short-term future patrol boat, mine counter measure and hydrographic survey vessels. The higher level functions were not decomposed comprehensively, nor were the functions allocated to components in the functional analysis as these Systems Engineering activities were outside the scope of this work. The subsequent stakeholder brainstorming, review and final functional analyses steps within the process to identify the common functions of an MRV uncovered a further 21 functions that the MRV would need to perform.

A list of 29 functions common to patrol boat, hydrographic survey and mine counter measure functions, along with seven further functions that are common to two of these roles, was identified in the pilot study. Some of the implications of incorporating these 36 functions into a base MRV platform's design were then discussed. The 36 functions that were identified are:

Accommodation
Auxiliary
Ballast
Ceremonial
Communication
Mission Command
Vessel Command
Deadweight
Environmental Protection
Hotel Services
HVAC
Interoperability
Boats (Launch, recover and stow)
Maintenance
Medical
Low Speed Manoeuvrability
Mooring
Navigation
Range
Above Water Sensors
Underwater Sensors
Shallow Water
Seakeeping
Stability
Strength
Transit
Training
Deterrent
Munitions Stowage
Helicopter (Launch, recover and stow)
UUV (Launch, recover and stow)
USV (Launch, recover and stow)
UAV (Launch, recover and stow)
ROV (Launch, recover and stow)
Survivability
Towing

The main influences that these common functions would impart on the design of a base MRV platform chiefly concern the space and location required to perform the functions. It is notable that all of these functions influenced the Hull Mechanical & Electrical system design in one form or another.

The proposed process was found to be a valid approach to identifying the common functions that an MRV will be required to perform during the pilot study. It is therefore anticipated that the process could be a valuable tool to provide stakeholders with insights into the implications of incorporating their requirements into an MRV during its concept design phase.

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Brett is a Naval Architect who joined DSTO in 2007. He has previously worked for the RAN in the Directorate of Navy Platform Systems and is currently working in the fields of Naval ship structures, hydrodynamics and Systems Engineering applications to Naval Architecture.

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Acronyms

AAW	Anti-air Warfare
ADO	Australian Defence Organisation
ASW	Anti-submarine Warfare
ASuW	Anti-surface Warfare
C4I	Command, Control, Communications, Computers and Intelligence
DC	Damage Control
FAST	Functional Analysis Systems Technique
FFBD	Functional Flow Block Diagram
HM&E	Hull Mechanical and Electrical
HS	Hydrographic and Oceanographic Survey
HVAC	Heating, Ventilation and Air-conditioning
ICF-MRV	Identify the Common Functions of an MRV
MBSE	Model-Based Systems Engineering
MCM	Mine Counter Measure
MRV	Multi-Role Vessel
OCV	Offshore Combatant Vessel
PB	Patrol Boat
RAN	Royal Australian Navy
ROV	Remotely Operated Vehicle
SE	Systems Engineering
UAV	Unmanned Aerial Vehicle
USV	Unmanned Surface Vehicle
UUV	Unmanned Underwater Vehicle

1. Introduction

Recent developments in unmanned system technology have given rise to the potential for a multi-role vessel (MRV) to be designed that is capable of conducting several minor warship roles [1]. The concept of utilising a single common or base platform that can be reconfigured for different roles using modules is a flow on effect of these developments. In this concept, unmanned systems will perform roles, such as mine counter measures and hydrographic survey, previously performed by a single classes of vessel [1]. Utilising modularity in order to achieve the different roles or functions relies on a base platform that is fitted with some, or all, or any combination thereof, the common functions between the different roles the vessel is to perform. Modules can be installed on, or removed from, the base platform in order to perform each of the specific functions. The modular vessel concept presents an interesting design challenge, as the array of functional combinations for the base platform consists of a wide range of common function options. Incorporating different ranges of these functional options into the design of the base platform will have different implications for how it will actually look and perform. As such, an opportunity for an innovative solution to a challenging problem is available in the base platform's design.

An essential feature in the design of a vessel is the definition of the objective for the vessel [2]. In the context of Australian Defence Organisation (ADO), the objective will be to address a current or prospective capability gap, or need. The identification of this need is the starting point in the ADO capability life cycle, which is divided into the following phases [3]:

a) Needs
b) Requirements
c) Acquisition
d) In-service
e) Disposal

In more generic product terms, the life cycle of a product begins with the identification of a need and extends through the acquisition and utilisation phases as shown in Figure 1. Both of these life cycle models commence with the identification of a need or capability gap. Parts a, b and c of the Defence capability life cycle would sit under the acquisition phase of the product life cycle, whilst parts d and e are in common with the utilisation phase of the product life cycle.

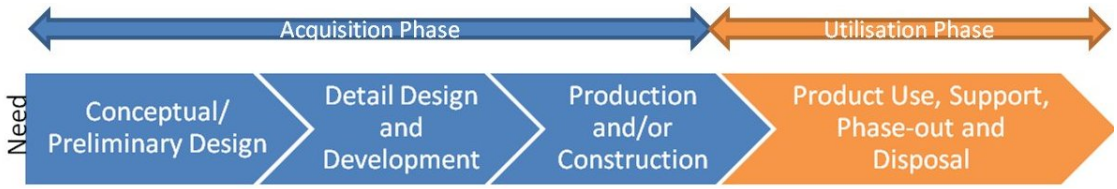

Figure 1: The product life cycle [4]

The area of interest for the work in this report is the concept design phase of the product life cycle. The main activity within a complex system's concept design phase is the translation of the customer, or stakeholder's requirements into a functional baseline [5]. The functional baseline will describe the system level functional architecture that will meet the user needs [5].

Translating the stakeholder requirements into the functional baseline can be termed functional analysis. This is often poorly performed [5]. It is also most often the direct cause of problems later in the system's development cycle [5]. These problems can result in undesirable effects on overall project cost and the ability of the system to perform the stakeholder's needs. A Systems Engineering (SE) framework can provide a valuable tool in large complex technical projects [6], such as a warship, and is particularly useful in the conceptual design phase of a complex system [4] due to the holistic approach employed. There are many models available, but the classical model given by Blanchard and Fabrycky [4] asserts that within a system's concept design phase, the following activities should be performed when utilising an SE approach;

1. Requirements Analysis
2. Functional Analysis
3. Requirements Allocation
4. Trade-off Studies
5. Synthesis
6. Evaluation
7. System Specification
8. Concept Design Review

This report focuses on the requirements and functional analysis activities within an MRV concept design phase. This narrow scope is due to the complexity involved in combining the different platform functions into a single platform's functionality. In particular, the present work is focused on proposing, then assessing, whether a process can be implemented to establish the functions that are common to all of the different vessel functions, using SE tools, as shown in Figure 2.

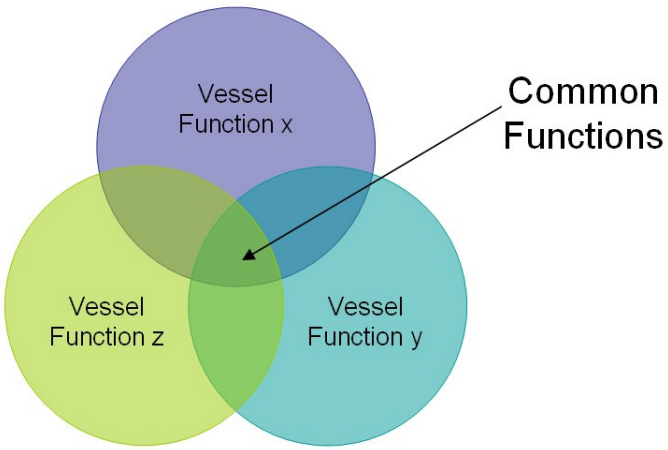

Figure 2: MRV Common Functions

By establishing the common functions of an MRV, some of the possible implications on the design and cost of incorporating them into a base vessel that utilises modularity can be explored early in the concept design phase. The present work seeks not to provide design solutions, but to present a potential process that will assist in establishing the common functions of the roles to be performed by an MRV. The process is aimed at giving the MRV stakeholders deeper insight into the final concept design that could result from their functional requirements. After

presenting the process, an assessment in the form of a pilot study using mock stakeholders and a hypothetical MRV is performed to test the validity of the process. Finally, some of the implications that performing the common functions identified using the process pilot study will have on the design of a base platform are discussed.

2. Systems Engineering Background

The application of SE to the naval environment began with operations research during the Second World War [7] and subsequently, has been applied to total ship system design and acquisition methodology [8]. A journal article from the year 2000 [9] explains some of the ways that the comprehensive approach of SE can be applied to naval ship design. In the article, Calvano [9] makes note of the iterative nature the relationship between functional and requirements analysis. Further, each phase of a capability or product life cycle can be considered as an iterative SE process, such as that shown in Figure 3.

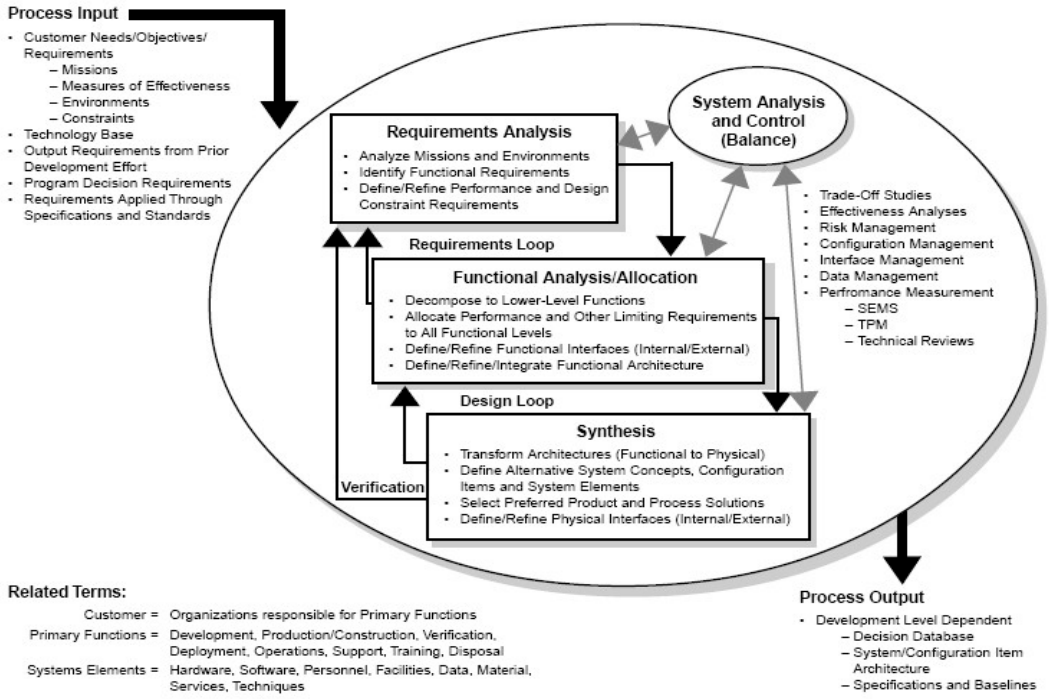

Figure 3: The SE process [10]

The process to establish the common functions of an MRV proposed in this report takes advantage of this iterative nature by only considering some of the requirements and functional analysis parts. While it may appear unusual to consider these parts in isolation, the cyclical nature of the SE process, as shown in Figure 3, implies that the functional definition of the system will be part of the requirements loop. Therefore, the functional architecture will feed back into the development of the system's requirements. This means that only minimal user requirements will be sufficient to perform some requirements and functional analysis of an MRV system during its concept design phase. These can then be fed back into the iterative loop within the concept design phase to be developed further.

The aim of a functional analysis is to identify all of the activities that the system is required to perform and each of these functions should represent *what* must be done, not *how* to do it [9]. The allocation of these functions to physical components is carried out in the synthesis part of the SE process, which is outside the scope of work performed in this report. The functional allocation to components would however, need to be carried out in a full concept design using an SE process. The boundary of the MRV system that will be utilised for the process is deemed to lie around the vessel system. This means that the physical components that the vessel system will interface with, such as embarked boats or unmanned vehicles and infrastructure such as drydocks and wharves, are not considered in the process. Again, in a full concept design process, these could be considered constraints and as shown in Figure 3, they would form part of the SE process input. This would ensure their inclusion in the full concept design's SE process. Once all of the functions for each of the vessel's roles have been identified, then the common functions between the roles can be found, then this information can be later used in the establishment of the vessel's functional baseline.

3. The Proposed Process

A process can be defined as the conversion of inputs into an output of greater value [11]. The inputs into this particular process are the needs, or missions identified by the customer, whilst the output will be the common functions of the different roles of the vessel. The common functions will be of greater value to the customer than the inputs as they will provide valuable insight into the implications of the desired needs on a base platform's design. The proposed process to Identify the Common Functions of an MRV (ICF-MRV) contains several key steps that are identified as:

1. Appoint process manager
2. Preliminary requirements and functional analyses
3. Stakeholder requirements and functional brainstorming
4. Final requirements and functional analyses
5. Identify common functions

Once the common functions have been identified, they can be utilised to generate discussion on the implications of incorporating them into the base MRV platform's design. Generating discussion between stakeholders about the implications of their needs on vessel design at an early phase of the development lifecycle, should result in the development of the most capable and cost effective concept design that will meet their needs.

Graphically, a process diagram for the ICF-MRV process can be seen in Figure 4, with the input into the process shown in the red block and the output in the green block. In the process diagram, the inputs into each step and outputs from each step can also be seen.

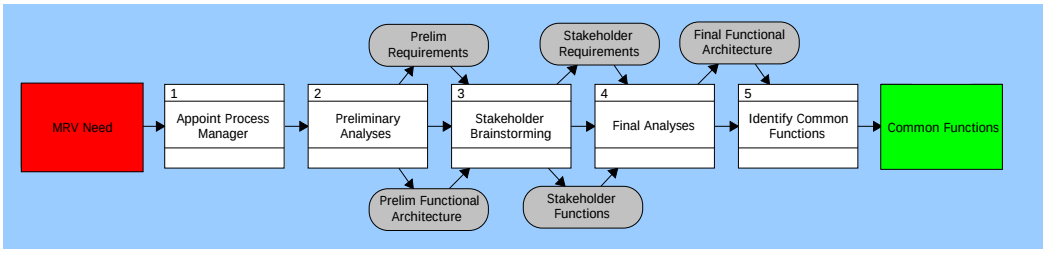

Figure 4: ICF-MRV process diagram

It is assumed that in a real world setting, the person responsible for the early phases of the acquisition would be the person who appoints a suitable process manager. The process manager will have flexibility to carry out the ICF-MRV process steps in the most appropriate way that they see fit. The inputs and outputs for each of the steps are the key items that will ensure the best outcomes for the process. The following sections give some guidance on the aspects that will need to be considered in order to execute the steps within the ICF-MRV process.

3.1 Appointment of Process Manager

Nicholas [12], proposes that a successful project manager has good qualifications in the four categories of personal characteristics, behavioural skills, general business skills and technical skills. Since the ICF-MRV process is essentially a project within the overall acquisition project, the manager responsible for the ICF-MRV process will not need to have skills in all four of these categories. However, good technical skills in the fields of naval architecture / naval vessel operations and SE will be essential. This is due to the process manager being responsible for conducting, or overseeing someone who conducts the preliminary requirements and functional analyses. The process manager will also be interacting with stakeholders who will have good levels of technical knowledge. This will help create mutual respect between all of the process participants, thereby helping to build a cohesive unit that can undertake the process successfully [12].

3.2 Preliminary Requirements and Functional Analyses

Either the process manager or people under their supervision perform the preliminary requirements and functional analyses. These preliminary analyses are carried out so that the process manager is familiar with the functional architecture of the MRV prior to meeting the stakeholders. The process manager then can use their knowledge to guide, but not influence, the subsequent interactions with the stakeholders. This means that the aim of this part of the ICF-MRV process is to construct the preliminary functional architecture for the MRV.

3.2.1 Requirements Analysis

The aim of the requirements analysis performed in this part of the process is to identify the key missions, or operations, and environments that the vessel will be required to perform. For the ICF-MRV process, this will be carried out using a loosely structured approach such as a top-down analysis of each of the missions, or functions that the MRV is to perform, after the need, or problem statement for the MRV is established. Literature reviews on vessels that perform the same, or similar functions can also be used in the analysis. Very little information on the

proposed MRV missions is required at this stage of the process and can be provided by the top-level functions such as the functions x, y and z shown in Figure 2. This is due to the person/s carrying out the analysis having the technical skills in the fields discussed in 3.1 and the nature of the process at this stage requiring that the person/s performing it need to think creatively and freely with minimal structure. This will mean that the process has the potential to lead to a breakthrough in system implementation [13]. The result of this stage of the process will be a preliminary list of the requirements, or missions that the MRV will be required to perform.

3.2.2 Functional Analysis

In this part of the process, the process manager uses the mission requirements identified in the requirements analysis to identify the functions that will need to be performed in order to carry out the missions. A function can be described as "a specific or discrete action (or series of actions) that is necessary to achieve a given objective; that is, an operation the system must perform" [4]. The functional analysis translates the system requirements into functions, which can be subsequently allocated to physical components that will perform the function.

Tools available to the person/s carrying out the functional analysis in this part of the process include SE tools such as top-down functional decomposition, functional flow block diagrams (FFBDs), functional analysis systems technique (FAST) diagrams and functional behavioural diagrams. All of these tools are graphical in nature and are intended to provide the person/s performing them with a clear view of the functional architecture of the MRV system. The use of these tools is a means of minimising the risk of failing to identify functions the MRV will need to perform. The aim of the functional analysis performed in this part of the ICF-MRV process is to present the overall preliminary functional architecture of the MRV system without allocation to physical components.

3.3 Stakeholder Meeting and Brainstorming

After the process manager has completed the preliminary requirements and functional analyses, they should have a sufficient level of knowledge about the proposed MRV system to meet with the stakeholders. The stakeholders in a typical naval MRV acquisition project will include:

- Users (ADO)
- Project Managers
- Contractors
- Regulators

The process manager needs to bear in mind that the aim in this step of the ICF-MRV process is to identify all of the functions the MRV needs to perform. By including stakeholders in the analyses at this stage of the process, the process manager is minimising the risk of failing to identify functions that the MRV will be required to perform. In this part of the process, the process manager is essentially conducting research that uses an approach resembling qualitative research. This is due to this part of the process being conducted in order to gain insights into the nature of an MRV by considering different peoples perspectives [14].

The process to identify functions that the MRV is required to perform is essentially a creative one that requires uninhibited thinking. Some stakeholder's uninhibited thinking could be

restricted by preconceived ideas and being focused on other aspects of an acquisition project than the vessels functionality. This point needs to be emphasised to stakeholders prior to the meeting and reiterated at the beginning of the meeting. This was a lesson learned during the pilot study, which is covered in section 4 of this report. Another important consideration for the process manager in this step is to minimise their influence on the responses of the stakeholders.

Achieving the aim of this step of the ICF-MRV process (identifying all MRV functions) can be done using an array of methods. In general, the following steps will be performed:

- Before the meeting;
  - Identify suitable stakeholders – a broad range of perspectives is desirable, however, stakeholders will need at least some understanding of naval vessel operations.
  - Allow plenty of time when scheduling the meeting duration – people would rather finish prior to the scheduled time than after the scheduled time, so make this a consideration.
  - Invite suitable stakeholders to meeting – be prepared for rejections and no-shows.
- At the meeting;
  - Give a briefing on what the aim of the meeting is and an introductory background on the process, SE and the MRV in question.
  - Define what a mission / requirement and function are
  - Give an example of some of the functions identified for a given mission requirement in the preliminary work (avoid influencing stakeholders by not giving too much detail!) – allow time for any questions.
  - Perform the Analyses – make them enjoyable for the participants;
    - Requirement analysis – Identify potential missions for the different roles that the MRV is to perform. In the group setting, methods such as slip writing, brainstorming and a top-down approach can be used to generate ideas. Record results for each stakeholder.
    - Functional analysis – Start by getting the group to identify the functions they believe will be common to all roles the MRV is to perform then cover each role in isolation. Ideas can be generated using the same techniques as for the requirements analysis. Record results for each stakeholder.
  - Conclude the meeting – Unless there is interest, there is no need to discuss results during the meeting as this will significantly lengthen the meeting duration!
- After the meeting;
  - Review the results
  - Follow up with the stakeholders;
    - Thank the stakeholder's for attending
    - Let them know numbers of functions identified etc.
    - Clarify any requirements / functions that are unclear with the relevant stakeholder

This final step is performed to understand the requirements functions identified by the stakeholders at the meeting. This is due to the differences in human perception giving rise to the potential for, say, three people to express the same concept in three different ways. Any clarification can be done directly with the stakeholder who identified the function. The experience gained during the pilot study covered in section 4 highlighted this phenomenon.

Clarification with a stakeholder usually resulted in the realisation that they had identified a function that the process manager had simply named differently.

Overall, the process manager will need to be flexible and reactive during the stakeholder meeting as the achievement of the aim of the meeting is more important then the method used to achieve it.

3.4 Final Requirements and Functional Analyses

This part of the process merges the preliminary requirements and functional analyses performed by the process manager, with the results of the analyses performed by the stakeholders. Once all the stakeholder's requirements and functions are understood, they can be merged with the requirements and functions identified in the preliminary analysis. This can be done using a top-down approach initially, followed by the use of functional analysis tools such as FFBDs and functional behavioural diagrams to check the updated functional architecture.

3.5 Identify Common Functions

The process manager will now have a clear picture of the functional architecture of the MRV. Identification of the MRV's common functions can be carried out by the process manager using the updated functional architecture. Since the aim of the ICF-MRV process is to provide the stakeholders with insight into the implications of incorporating their needs into the vessel's design, significant functions that may not necessarily be common to all roles, should also be identified. For example, the need to perform helicopter operations during one or two out of three MRV roles will have a significant influence on the design of the base platform due to these operations requiring a flight deck.

The method used to identify the common or significant functions that will be performed by the MRV from within the functional architecture will be flexible and at the discretion of the process manager. Functional hierarchy lists for each of the roles can be used along with cross checking if each of the role functions are kept separate during the functional analyses. Other process managers may have tracked the common functions throughout the functional analyses and will simply need to list them. The end result should be a list of functions that can be used to give the stakeholders valuable insight into the design of a base platform in an MRV concept that utilises modularity to perform some, or all of its roles.

4. Pilot Study

To assess the validity of the process proposed to identify the common functions of an MRV that uses modularity in section 3, a pilot study was carried out. In 2009, the Defence White Paper [15] called for the rationalisation of the Royal Australian Navy (RAN) patrol boat, mine counter measure, hydrographic and oceanographic classes of vessel into a single MRV class. This class of vessel has been termed the Offshore Combatant Vessel (OCV) and the project to deliver this class of MRV is in its infancy. In terms of the product life cycle shown in Figure 1, this project can be seen as currently being in the conceptual / preliminary design phase. As such, the OCV concept provides a useful example of an MRV where the ICF-MRV process can be applied.

4.1 Appoint Process Manager

For the purposes of the pilot study, the author assumed the role of the process manager. The author has graduate qualifications in naval architecture and postgraduate qualifications in SE. This skill set would be representative of the attributes needed by the process manager to perform the role as identified in section 3.1.

4.2 Preliminary Requirements and Functional Analyses

4.2.1 Preliminary Requirements Analysis

The preliminary requirements analysis was conducted by the process manager and began with the development of a need statement, or statement of the problem [4] for the MRV. This was developed using paragraph 9.20 of the 2009 Defence White Paper [15] and states:

> "The MRV shall perform the current and short-term future functions of patrol boats, hydrographic and oceanographic vessels, along with mine counter measure vessels."

The need statement was adopted as the parent level requirement and the preliminary top-level requirements identified as being the need to perform each of the three vessel class functions by themselves. This allowed each of these preliminary top-level requirements, or missions to be analysed in a top-down manner. The top-down requirements analysis was performed using the model-based systems engineering (MBSE) tool CORE®. The CORE® software allows a system's architecture to be developed using a structured approach with different schema classes that facilitate the classical SE activities of requirements analysis, functional analysis, physical architecture synthesis and verification and validation [16]. The decomposition from the parent requirement to the top-level requirement can be seen in Figure 5.

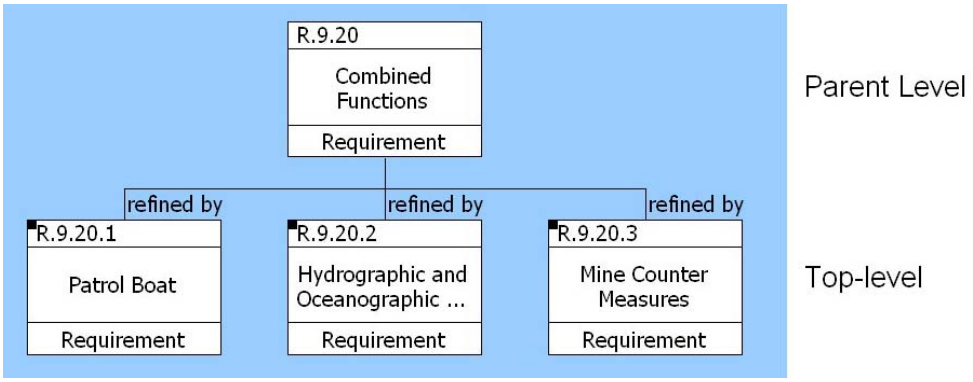

Figure 5: Top-level requirement decomposition

The preliminary second-level requirements were developed using the missions identified in the 2009 Defence White Paper [15], along with engineering judgement to identify the missions that the MRV could be expected to perform. As an example, the preliminary second-level decomposition for the top-level patrol boat requirement, R.9.20.1, is shown in Figure 6.

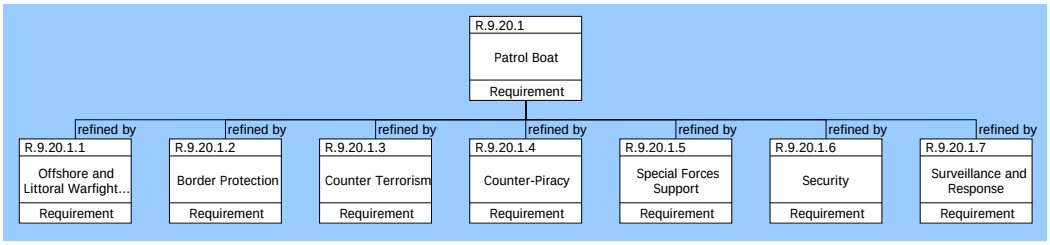

Figure 6: Second-level decomposition for the patrol boat requirement

Decomposition of the requirements to the second level was deemed sufficient for the preliminary requirements analysis. If required, they could be decomposed further during the final requirements analysis. However, it is more likely that the requirements would be further analysed during the course of a full concept design SE process and as such, it is beyond the scope of the present work.

A full list and description, including the relationships of each of the requirements identified for the MRV (from the final analysis) is given in Appendix A.

4.2.2 Preliminary Functional Analysis

During the preliminary functional analysis, the initial identification of the functions that the MRV will need to perform was carried out using an MBSE approach within the SE software package CORE®. Relationships can be established between the schema classes in the software so that a function can be established based on a requirement. This essentially sets up traceability between the functions to be performed by the system and the related requirement. As an example, the relationships between the requirements and functions established for the mine counter measures requirement, which states; “The MRV shall be capable of performing current and short term future mine counter measure vessel roles” is shown in Figure 7.

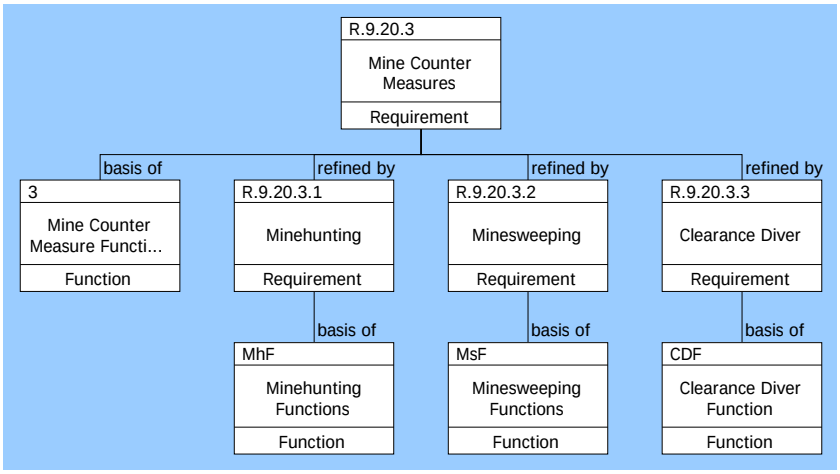

Figure 7: Traceability between requirements and functions for the mine counter measure vessel requirement

The second level and below functions were identified using the second-level requirements, literature reviews and functional analysis techniques such as top-down decomposition and Functional Flow Block Diagrams (FFBDs). FFBDs can be used to identify the functions performed in a process. For example, the functions that decompose hydrographic survey functions were identified using a Future Hydrographic Ships Contemporary Capability Study [17], literature and internet searches on the capabilities of present and future hydrographic ships, along with engineering judgment. The decomposition of the hydrographic survey functions can be seen in Figure 8. To establish the functions involved in the Bathymetric Mapping Function, the partial FFBD shown in Figure 9 was used to outline the functions used in the process of mapping bathymetry.

From Figure 9, the functional flow of the functions involved in conducting the bathymetric mapping function (given the identifier BMF) can be seen by reading from left to right. Firstly, the vessel needs to perform transit, range and deadweight functions simultaneously in order to arrive at the location of interest within sufficient time, with enough stores, fuel and space to embark the mapping equipment. The vessel needs to perform seakeeping (protected waters for shallow mapping or offshore for deep mapping) and motion stabilisation functions that will ensure that the vessel motions will allow the mapping to take place. Low speed manoeuvrability functions will need to be performed so that the mapping equipment such as boats, Unmanned Surface Vessels (USVs), Remotely Operated Vehicles (ROVs) or Unmanned Underwater Vehicles (UUVs) can be launched, recovered and stowed (the L.R.a.S functions). In addition, of course, underwater sensing functions will need to be performed by the mapping equipment or sensors on the MRV hull itself. At the completion of the mapping, the offboard equipment used during the mapping will need to be recovered, which means that the MRV will need to again perform the relevant launch recover and stow function.

The same approach of conducting literature reviews, internet searches and applying SE tools were used to identify the functions that decomposed each of the three top-level functions (PB, HS and MCM). A large amount of information was found on the capabilities of vessels that perform these three roles, which led to a good level of detail being established in the preliminary requirements and functional analyses. A full list and description, including the functional relationships, of each of the functions identified for the MRV (from the final analysis) are given in Appendix B.

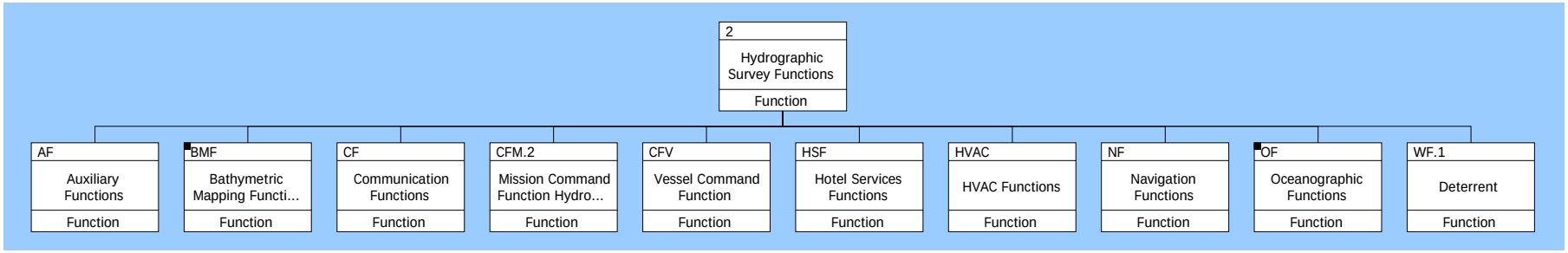

Figure 8: Hydrographic survey functions decomposition

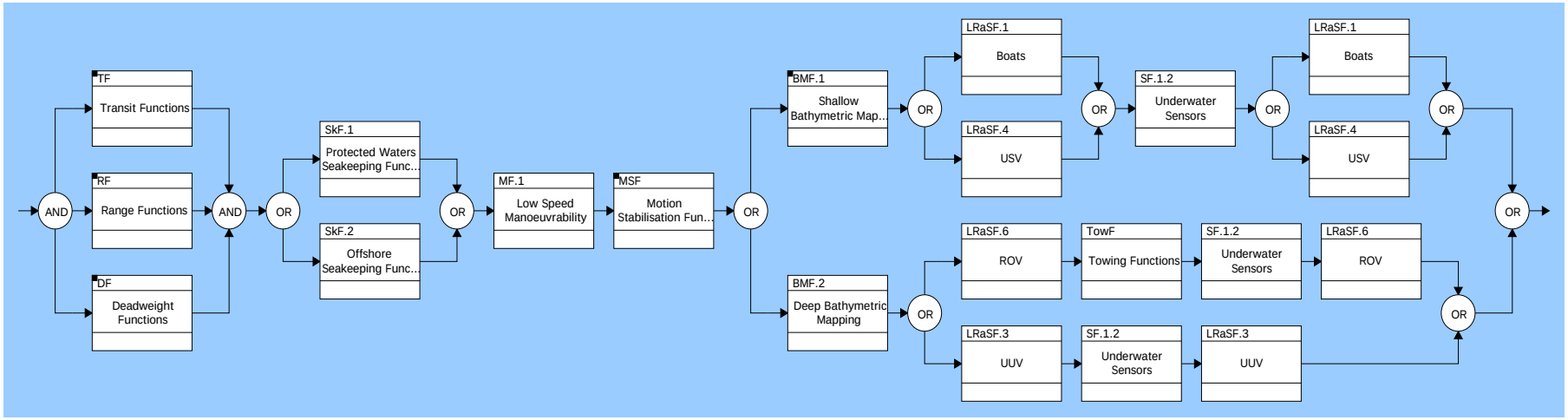

Figure 9: Partial Bathymetric mapping functions FFBD

4.3 Stakeholder Meeting and Brainstorming

For the pilot study stakeholder meeting, three DSTO scientists who had a good level of understanding of naval vessel operations and one RAN officer were identified as being suitable for the purposes of identifying the functions that the MRV will need to perform. To begin the meeting, the process manager gave a background presentation on SE, the MRV and the proposed process. In an attempt to simplify the process, each of the top-level requirements and functions was considered separately using PowerPoint slides with the preliminary second-level missions written on them. To perform the requirements analysis, the "stakeholders" were asked if they could identify any more missions that each top-level function (i.e. patrol boat, hydrographic and oceanographic, and mine counter measure) would be required to undertake. The only mission that was added to the preliminary requirements was the requirement to search for disabled / damaged submarines (subsearch) for the hydrographic survey function.

Following the requirements analysis for each top-level requirement, the "stakeholders" were asked to begin the functional analysis by using the slip writing technique on sticky notes (one function per sticky note) to write down all of the functions that they could identify. They were also asked to write a number on the slip that corresponded with the mission / requirement identifier given on the PowerPoint slides. This would assist the process manager in the final functional analysis to pinpoint where the function should be placed within the MRV's functional architecture. The process was started with the patrol boat function and it became clear that the process manager (the author) had insufficiently defined what a function was. The process manager was asked to provide an example, which helped the stakeholders considerably. After the participants were finished with the patrol boat function, the hydrographic and mine counter measure functions were also analysed (no further examples were required). There was no interest in discussing the results of the functional analysis in the group setting, as everyone agreed it would take far too long. The sticky notes were collected and labelled with each participant's name for later reference.

After the meeting, the process manager checked each participant's functions and then followed up with each of them individually about any functional descriptions that were unclear. In the follow up, the participants also seemed interested to hear about functions they had identified that were not identified in the preliminary functional analysis. Overall, the aim of the meeting was met as a further 21 functions for the MRV were added to those identified during the preliminary functional analysis.

4.3.1 Lessons Learned From the Pilot Study Stakeholder Meeting

While the aim of the meeting was achieved, some valuable lessons were learned that have been incorporated into the recommended steps previously given in section 3.3. The first of these is that the process manager needs to ensure that the stakeholders understand what a requirement / mission and function are. This can be done by giving definitions and examples from the preliminary analysis (while aiming not to influence the stakeholders!).

Another lesson learnt was that the meeting participants knew from the introductory presentation that the aim of the process is to identify the common functions of the MRV. This meant that one or two immediately wanted to identify the common functions before moving onto the others that would need to be performed for each of the three top-level functions. The

author insisted that each top-level function be analysed individually, however, when reviewing the slips, the participants had essentially identified the common functions themselves by noting all of the top-level functions (i.e. PB = Patrol Boat, HS = Hydrographic Survey and MCM = Mine Counter Measure) on the common function slips. This led to the proposed steps given in section 3.3, which call for the common functions to be brainstormed before the individual top-level functions.

Other aspects that were gleaned from the meeting that could be incorporated into future iterations of the ICF-MRV include the use of a more structured brainstorming activity, which could potentially capture weightings for the importance of the identified functions. This would require further research into brainstorming techniques in order to avoid weightings that are overly subjective.

4.4 Final Requirements and Functional Analyses

The final requirements and functional analyses were relatively simple to undertake after the stakeholder's requirements and functions had been understood by the process manager. The final requirements analysis was completed using CORE®, which only necessitated the second-level requirement of subsearch to be included under the hydrographic and oceanographic survey requirement. The 20 additional functions identified during the stakeholder meeting were simply added to the functional architecture at the appropriate level using the CORE® software. Relationships could then be established between the relevant functions to create the final functional architecture of the MRV. The use of the CORE® MBSE tool for the preliminary and final requirements functional analyses was found to be very useful, since it allowed the preliminary system model to be rapidly updated following the stakeholder meeting.

4.4.1 Current and Short Term Future Patrol Boat Functions

The three top-level functions have been identified as Patrol Boat, Hydrographic Survey and Mine Counter Measure functions. Considering the top-level Patrol Boat function in isolation first, only the next two high level functions identified using the approach outlined in section 3 are given for the patrol boat in Table 1. This is due to the large number of functions that were identified for the Patrol Boat function. In the table, the column location represents each function's location within the functional hierarchy. For example, Auxiliary Functions (AF) is located in the second column, which correlates to its location in the second level of the functional hierarchy. Deadweight functions (DF) is placed in the third column as it is identified as a third-level function in this case. The vertical ordering of the functions in the following tables is alphabetical, based on the abbreviation of each function. Full descriptions, including their relationships within the functional architecture, of each of the functions identified for the MRV are given in Appendix B and a completely decomposed hierarchical list for the identified patrol boat functions can be found in Appendix C.

Table 1: High-level patrol boat functions

1	**Patrol Boat Functions**		
	AccomF	Accommodation Functions	
		AccomF.1	Crew Accommodation
		AccomF.2	Austere Accommodation
		DF.2	Area Deadweight

	AF	Auxiliary Functions	
	BF	Ballast Functions	
		DF.3	Volume Deadweight
	BPF	Border Protection Functions	
		BoardF	Boarding Party Functions
		DF	Deadweight Functions
		LRaSF.1	Boats
		LRaSF.2	Helicopter
		LRaSF.5	UAV
		MF	Manoeuvrability Functions
		RF	Range Functions
		SF	Sensor Functions
		ShF	Shallow Water Functions
		SkF	Seakeeping Functions
		TF	Transit Functions
	CerF	Ceremonial Functions	
	CF	Communication Functions	
	CFM	Mission Command Function	
		CFM.1	Mission Command Function Patrol Boat
		CFM.2	Mission Command Function Hydrographic Survey
		CFM.3	Mission Command Function Mine Counter Measures
	CFV	Vessel Command Function	
	CPF	Counter-Piracy Functions	
		BoardF	Boarding Party Functions
		DF	Deadweight Functions
		LRaSF.1	Boats
		LRaSF.2	Helicopter
		LRaSF.5	UAV
		MF	Manoeuvrability Functions
		SF	Sensor Functions
		ShF	Shallow Water Functions
		SkF	Seakeeping Functions
		TF	Transit Functions
		TowF	Towing Functions
		WFL	Littoral Warfighting Functions
		WFO	Offshore Warfighting Functions
	CTF	Counter-Terrorism Functions	
		BoardF	Boarding Party Functions
		DF	Deadweight Functions
		LRaSF.1	Boats
		LRaSF.2	Helicopter
		LRaSF.5	UAV
		MF	Manoeuvrability Functions
		MF.1	Low Speed Manoeuvrability
		MF.2	High Speed Manoeuvrability
		RF	Range Functions
		SF	Sensor Functions
		ShF	Shallow Water Functions
		SkF	Seakeeping Functions
		SvF	Survivability Functions
		TF	Transit Functions
		WFL	Littoral Warfighting Functions
		WFO	Offshore Warfighting Functions
	EPF	Environmental Protection Functions	
		EPF.1	Waste Treatment Functions

	HSF	Hotel Services Functions	
		HSF.1	Catering Functions
		HSF.2	Water Service
	HVAC	HVAC Functions	
	IntF	Interoperability Functions	
	MaintF	Maintenance Functions	
		DF.2	Area Deadweight
		DF.3	Volume Deadweight
	MedF	Medical Functions	
		DF.2	Area Deadweight
	MF	Manoeuvrability Functions	
	MoF	Mooring Functions	
	NF	Navigation Functions	
		DF.2	Area Deadweight
	SF.1.1	Above Water Sensors	
	StabF	Stability Functions	
	StrF	Strength Functions	
	TrF	Training Functions	
	WFL	Littoral Warfighting Functions	
	WFO	Offshore Warfighting Functions	

4.4.2 Current and Short Term Future Hydrographic Survey Functions

Now considering the top-level Hydrographic Survey function in isolation, a hierarchical list of the current and possible future functions that a Hydrographic Survey vessel will need to perform, identified using the methods given in section 3, is shown in Table 2. As for the patrol boat functional hierarchy given in Table 1, the column location of the function identifier represents the function's level within the functional hierarchy. The full hierarchy for the Hydrographic Survey functions is given in Table 2 as there are significantly less functions required than for Patrol Boat functions.

Table 2: Hydrographic survey vessel functions

2	**Hydrographic Survey Functions**		
	AccomF	Accommodation Functions	
	AF	Auxiliary Functions	
	BF	Ballast Functions	
	BMF	Bathymetric Mapping Functions	
		BMF.1	Shallow Bathymetric Mapping
			ShF Shallow Water Functions
		BMF.2	Deep Bathymetric Mapping
		DF	Deadweight Functions
		LRaSF.1	Boats
		LRaSF.3	UUV
		LRaSF.4	USV
		LRaSF.6	ROV
		MF.1	Low Speed Manoeuvrability
		RF	Range Functions
		SF.1.2	Underwater Sensors
		SkF	Seakeeping Functions
		SkF.1	Protected Waters Seakeeping Functions
		SkF.2	Offshore Seakeeping Functions

		TF	Transit Functions
		TowF	Towing Functions
	CerF	Ceremonial Functions	
	CF	Communication Functions	
	CFM	Mission Command Function	
	CFV	Vessel Command Function	
	EPF	Environmental Protection Functions	
	HSF	Hotel Services Functions	
	HVAC	HVAC Functions	
	IntF	Interoperability Functions	
	LRaSF.2	Helicopter	
	LRaSF.5	UAV	
	MaintF	Maintenance Functions	
	MedF	Medical Functions	
	MoF	Mooring Functions	
	NF	Navigation Functions	
	OF	Oceanographic Functions	
		DF	Deadweight Functions
		LRaSF.1	Boats
		LRaSF.3	UUV
		LRaSF.6	ROV
		MF.1	Low Speed Manoeuvrability
		RF	Range Functions
		ShF	Shallow Water Functions
		SkF	Seakeeping Functions
		TF	Transit Functions
	SF.1.1	Above Water Sensors	
	StabF	Stability Functions	
	StrF	Strength Functions	
	SubF	Subsearch Functions	
	TrF	Training Functions	
	WF.1	Deterrent	
	WF.8	Munitions Stowage	

4.4.3 Current and Short Term Future Mine Counter Measure Functions

Considering the top-level Mine Counter Measure function in isolation, a hierarchical list of the current and possible future functions that a Mine Counter Measure vessel will need to perform, identified using the methods given in section 3, is shown in Table 3. As for the patrol boat functional hierarchy given in Table 1, the column location of the function identifier represents the functions level within the functional hierarchy. Again, the full hierarchy for the Mine Counter Measure functions is given in Table 3, as there are significantly less functions required than for Patrol Boat functions.

Table 3: Mine counter measure vessel functions

3	**Mine Counter Measure Functions**	
	AccomF	Accommodation Functions
	AF	Auxiliary Functions

	BF	Ballast Functions	
	CDF	Clearance Diver Function	
		DF.2	Area Deadweight
		DF.3	Volume Deadweight
		LRaSF.1	Boats
	CerF	Ceremonial Functions	
	CF	Communication Functions	
	CFM	Mission Command Function	
	CFV	Vessel Command Function	
	EPF	Environmental Protection Functions	
	HSF	Hotel Services Functions	
	HVAC	HVAC Functions	
	IntF	Interoperability Functions	
	MaintF	Maintenance Functions	
	MedF	Medical Functions	
	MhF	Minehunting Functions	
		DF	Deadweight Functions
		LRaSF.1	Boats
		LRaSF.3	UUV
		LRaSF.4	USV
		LRaSF.6	ROV
		MF.1	Low Speed Manoeuvrability
		RF	Range Functions
		SF.1.2	Underwater Sensors
		ShF	Shallow Water Functions
		SkF	Seakeeping Functions
		SvF	Survivability Functions
		TF	Transit Functions
	MoF	Mooring Functions	
	MsF	Minesweeping Functions	
		DF	Deadweight Functions
		LRaSF.1	Boats
		LRaSF.3	UUV
		LRaSF.4	USV
		LRaSF.6	ROV
		MF.1	Low Speed Manoeuvrability
		RF	Range Functions
		SF.1.2	Underwater Sensors
		SkF	Seakeeping Functions
		SvF	Survivability Functions
		TF	Transit Functions
	NF	Navigation Functions	
	SF.1.1	Above Water Sensors	
	StabF	Stability Functions	
	StrF	Strength Functions	
	TrF	Training Functions	
	WF.1	Deterrent	
	WF.8	Munitions Stowage	

4.5 Identification of Common Functions

In order to identify the common functions between the three top-level MRV functions of patrol boat (PB), hydrographic survey (HS) and mine countermeasure (MCM), the functional hierarchy lists from sections 4.4.1, 4.4.2 and 4.4.3 were exported from the CORE® software into spreadsheets. Crosschecking between the three lists was performed that highlighted the common functions within the three lists.

The functions that would need to be performed during all three of the top-level functions of the MRV are those given in Table 4.

Table 4: MRV common functions

Abbrev.	Name
AccomF	Accommodation Functions
AF	Auxiliary Functions
BF	Ballast Functions
CerF	Ceremonial Functions
CF	Communication Functions
CFM	Mission Command Function
CFV	Vessel Command Function
DF	Deadweight Functions
EPF	Environmental Protection Functions
HSF	Hotel Services Functions
HVAC	HVAC Functions
IntF	Interoperability Functions
LRaSF.1	Boats
MaintF	Maintenance Functions
MedF	Medical Functions
MF.1	Low Speed Manoeuvrability
MoF	Mooring Functions
NF	Navigation Functions
RF	Range Functions
SF.1.1	Above Water Sensors
SF.1.2	Underwater Sensors
ShF	Shallow Water Functions
SkF	Seakeeping Functions
StabF	Stability Functions
StrF	Strength Functions
TF	Transit Functions
TrF	Training Functions
WF.1	Deterrent
WF.8	Munitions Stowage

There were also functions that were possible to identify as being necessary to perform by two of the three MRV roles, which will also have a significant influence on the design of the base platform. These are given in Table 5.

Table 5: Functions identified for two out of the three MRV roles

Abbrev.	Name
LRaSF.2	Helicopter
LRaSF.3	UUV
LRaSF.4	USV
LRaSF.5	UAV
LRaSF.6	ROV
SvF	Survivability Functions
TowF	Towing Functions

The top-level functional architecture of the MRV could now be rearranged to represent the base platform if desired. In this new functional architecture, the common functions given in Table 4 and the functions identified in two of the three top-level functions given in Table 5 would sit alongside the three role functions (PB, HS and MCM) as shown in Figure 10.

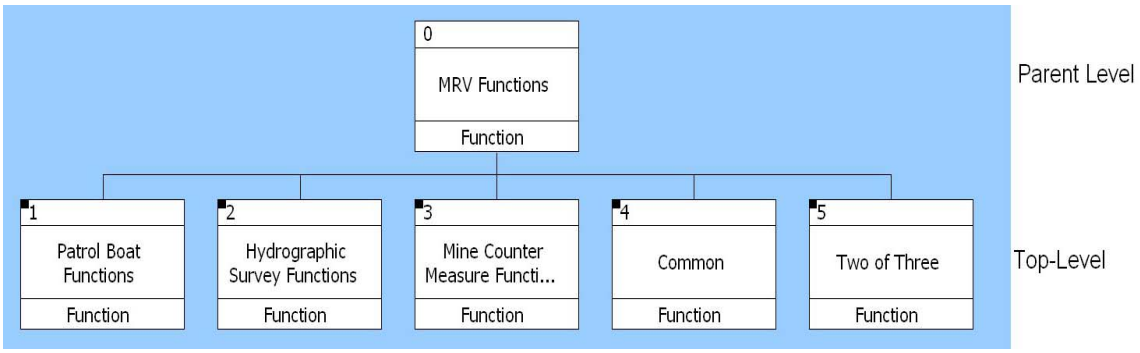

Figure 10: Rearranged top-level functional architecture

Now that these top-level functions for the MRV have been identified, some of the implications of incorporating each of them into the design of a base platform can be discussed.

5. Common Function Implications on Base Platform Design

Duren and Pollard [8] propose that a ship is a composite of many individual systems. These systems are classified as hull, mechanical and electrical (HM&E) systems, command, control, communication, computers and intelligence (C4I) systems, combat systems, embarked vehicles, training systems, services & logistics support. In this section, a description of each of the common functions given in Table 4, along with the functions given in Table 5, is provided. Some of the possible implications on of incorporating them into the design of a base platform, for the classes of systems proposed by Duren and Pollard, are also discussed. Table 6 gives an overview of the vessel systems influenced by each of the common functions. It should be noted that the order of the functions given in Table 6 is not significant, it is simply alphabetically based on the number assigned to each function. The implications of the common functions are discussed in the same order as that given in Table 6.

Table 6: Vessel systems influenced by common functions

Function	HM&E Systems	C4I Systems	Combat Systems	Embarked Vehicles	Training Systems	Services & Logistics
Accommodation Functions	x					
Auxiliary Functions	x	x	x		x	x
Ballast Functions	x	x				
Ceremonial Functions	x				x	
Communication Functions	x	x			x	
Mission Command Function	x	x	x	x	x	x
Vessel Command Function	x	x			x	
Deadweight Functions	x	x			x	x
Environmental Protection Functions	x					
Hotel Services Functions	x	x			x	x
HVAC Functions	x	x			x	x
Interoperability Functions	x	x	x	x	x	x
Boats (Launch, recover and stow)	x			x	x	
Maintenance Functions	x	x	x	x	x	x
Medical Functions	x				x	x
Low Speed Manoeuvrability	x	x			x	
Mooring Functions	x					
Navigation Functions	x	x			x	
Range Functions	x	x				
Above Water Sensors	x	x	x		x	
Underwater Sensors	x	x	x		x	
Shallow Water Functions	x			x		
Seakeeping Functions	x	x				
Stability Functions	x					
Strength Functions	x					
Transit Functions	x					
Training Functions	x				x	
Deterrent	x	x	x		x	x
Munitions Stowage	x		x		x	x
Helo (Launch, recover and stow)	x	x		x	x	x
UUV (Launch, recover and stow)	x	x		x	x	x
USV (Launch, recover and stow)	x	x		x	x	x
UAV (Launch, recover and stow)	x	x		x	x	x
ROV (Launch, recover and stow)	x	x		x	x	x
Survivability Functions	x	x			x	
Towing Functions	x	x			x	

5.1 AccomF – Accommodation Functions

This is the function of providing accommodation and on board habitability for embarked personnel. Accommodation functions are decomposed by crew accommodation, austere accommodation and area deadweight as shown in the hierarchy diagram given in Figure 11. Crew accommodation is the accommodation function required for the vessel's crew. Austere accommodation is the accommodation space that could be used to house embarked personnel, other Defence personnel or detained people.

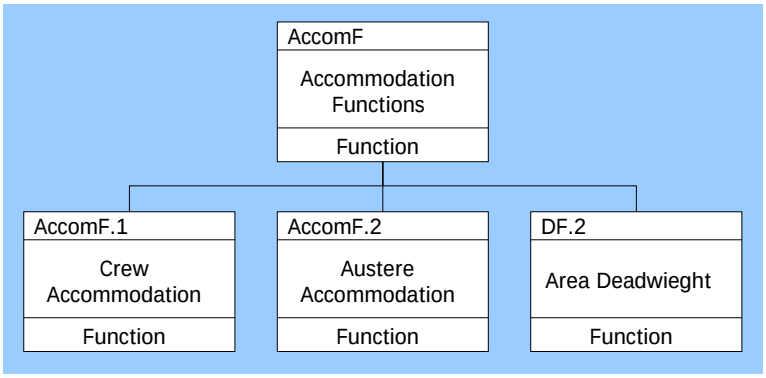

Figure 11: Accommodation functions hierarchy diagram

Crew and austere accommodation functions require the allocation of area within the vessel, therefore, they will have a considerable influence on the HM&E systems design. Some idea of the significant space demands caused by crew habitability can be seen from the initial estimates given in Table 7 that have been sourced from Rawson and Tupper [2] and the RAN Materiel Requirements Set (MRS) [18].

Table 7: Accommodation space estimates for warships

	Officers	**Warrant and Chief Petty Officers**	**Petty Officers**	**Junior Rates**
Cabins (m^2/person)	4.0–28.0	2.4–6.0	2.1	1.6
Wardroom (m^2/person)	2.3–2.5			
Recreation Area (m^2/person)		0.8	0.8	0.55
Dining Area (m^2/person)		0.5	0.5	0.4
Shower/people ratio	1/8	1/15	1/20	1/25
Washbasin/people ratio	1/3	1/5	1/8	1/10
WC/person ratio	1/6	1/10	1/15	1/15
Urinal/person ratio	1/18	1/30	1/45	1/45
Laundry (m^2/person)	0.1–0.3			
Galley (m^2/person)	0.1–0.4			
Canteen (m^2/person)	0.04–0.07			

Notes:
1. Separate allowance to be made for passageways, hatches, etc.
2. Senior officers have larger cabins with their own bathrooms

The space requirements for the austere accommodation function would be similar to the space estimate given for Junior Rates in Table 7. Other accommodation functions that will require the allocation of area within the vessel include fitness facilities, offices and education facilities [18]. The provision of adequate accommodation space on board a vessel can also be seen as impacting on recruitment and retention of RAN personnel. This is due to the detrimental affect on crew morale that a poor environment on board a vessel could have [19].

5.2 AF – Auxiliary Functions

This is the function of providing auxiliary power to the vessel for such systems as electrical and hydraulics. Generally in ship design, this function will require mechanical generators, which can be located in the machinery space, as well as batteries to store the electrical power. This means that the base platform's HM&E systems design will be affected significantly in the incorporation of these functions. The power generated will need to be distributed throughout the vessel and the required load will vary considerably depending on the vessel functions being performed at the time. Large auxiliary power will be required when performing sensor functions, launch, recover and stow functions and any of the warfare functions. The distribution of the electrical power will also affect HM&E system design and integration with C4I and combat systems will be required in the overall base platform design. The ongoing vessel systems, services and logistics support, along with training systems will be affected by auxiliary functions due to the need for personnel training and the fuel and maintenance that performing auxiliary functions will require.

Modularity may allow mechanical generators to be added / removed from the base MRV depending on the second level function to be performed. This will provide flexibility and redundancy in providing the required power, however, this will not be the most efficient way of providing the power due to factors such as the additional weight and complex control systems required [2]. Power generator arrangements can also be affected by the main propulsion machinery used on the vessel. An electrical propulsion system gives the opportunity to be a source of auxiliary power, but such systems usually require surge control equipment when switching demands [2]. Power may also be generated from the propeller shaft, with subsequent losses in propulsive power.

5.3 BF – Ballast Functions

These are the functions of ballasting the vessel so that it will operate at a displacement that is near optimum, in terms of stability, seakeeping and resistance. With the wide range of displacements that the base vessel is likely to have as modules are added removed, ballasting will be necessary to achieve an optimum displacement. These functions will need to be incorporated into the design of the base platform due to the potential for the base platform to operate without any modules embarked. In this situation, it is likely that the base platform would need to be ballasted down to a safe displacement in order to undertake any sort of transit. Ballast functions will have an influence on the design of the HM&E systems as volume will be required for the ballast tanks, which are generally located in the lowest parts of the vessel. The C4I system design will also be influenced since control systems will be required to monitor and operate the ballasting system.

5.4 CerF – Ceremonial Functions

These are the functions that will be performed by the vessel during official ceremonies. The functions that may need to be performed include flying flags / burgees etc. These functions will require aspects such as stowage space for the ceremonial equipment and crew training to be performed. While not a significant capability in terms of the functions the MRV would need to perform, it is a very significant cultural function for a military vessel.

5.5 CF – Communication Functions

This is the function of communicating with other vessels, shore bases and internally within the vessel. These functions will require space to be allocated to the equipment and personnel that will perform the functions. This space will need to be located in close proximity to, if not within, the space where the vessel and mission command functions will be performed, as communication is vital in these functions. Communication functions will affect the HM&E, C4I and training systems design due to the space required by the equipment and personnel, and the training required to perform the functions.

5.6 CFM – Mission Command Function

These are the individual command functions that are mission specific to the PB, HS and MCM functions of the MRV. Mission command functions are decomposed by each of the specific role command functions of PB, HS and MCM as shown in Figure 12.

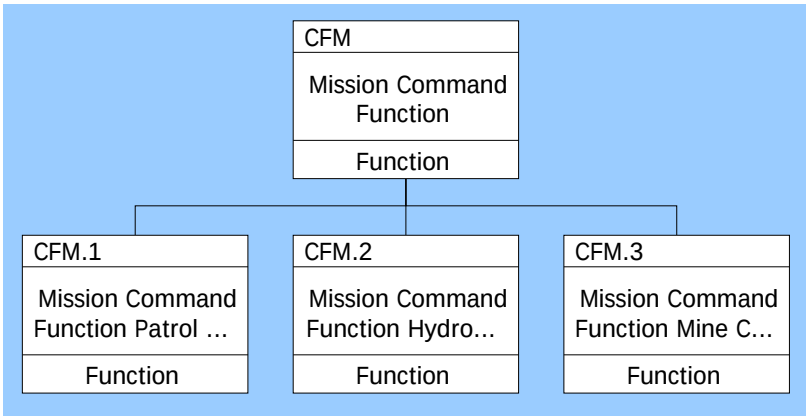

Figure 12: Mission command functions hierarchy diagram

While this function has been identified as being a common function of the base platform, the components involved in each of the three different command functions will vary. The method of including this functional requirement in the base platforms design impacts on all of the Duren and Pollard system classes and provides an interesting design problem. Approaches to resolve the design problem could include the mission command functions being built-in into the modular payload for each function, or a single mission command centre containing all of the components required for each command function incorporated into the base platform's general arrangement.

Other approaches to resolve the design problem will involve any number of combinations of the solutions given here. Each of these approaches will have differing strengths and weaknesses that could be analysed using some form of trade-off study.

5.7 CFV – Vessel Command Functions

This is the function of controlling the non-mission specific functions on board the MRV, such as vessel helm functions and the control of the auxiliary functions. This function will influence the MRV's HM&E, C4I and training systems design due to the space, components and training

needed to operate the components required to perform the functions. Traditionally, the spaces where vessel command functions are performed have been located nearby the mission command functions space. However, in some recent warship designs, such as the United States Navy Arleigh Burke destroyers, the mission command centre is located away from the vessel command functions. Redundancy will be a significant feature in the design of the systems that will perform the vessel command functions in a combatant vessel.

5.8 DF – Deadweight Functions

This is the function of providing space, in terms of volume or area, so that other vessel functions can be performed. An element relationships diagram for deadweight functions, shown in Figure 13, displays the functions to which it is linked by a direct relationship. An element relationships diagram will display the highest level function in a functional architecture to which it is related. For example, in Figure 13 it can be seen that deadweight functions decomposes border protection functions. This will mean that deadweight functions will also be related to the functions that decompose border protection functions, such as boarding party functions and the launch, recover and stow boats function. In another example, deadweight functions is decomposed by volume deadweight, which in turn, decomposes ballast functions. Full details of the relationships between functions can be found in Appendix B.

The use of the term deadweight in this instance represents a slight departure from the accepted terminology used in naval architecture. Deadweight has traditionally been a measure of a merchant vessel's earning capacity [2], but here it is used to recognise the space that will be required to perform the functions shown in Figure 13. Deadweight functions will most significantly influence the HM&E systems design due to the space required to perform the functions affecting the general arrangement of the base platform.

One of the greatest amounts of space that will be required to perform the deadweight functions are the endurance functions. These are the functions that cover the ability of the vessel to remain at sea for different periods of time. It encompasses functions such as storage of provisions, fuel and water. Not only do all of these functions require the allocation of space within the vessel, but also the location of this space needs to be considered in the arrangement of the vessel.

Providing sufficient area and volume to cater for the deadweight requirements of each MRV second level function will be a primary design challenge due to the varying levels of space required by each. One approach could be to design the base vessel to provide the maximum space required by the PB, HS or MCM functions, which will result in the largest ship. However, when performing other functions, spare deadweight will significantly affect all aspects of the vessel's efficiency. Providing deadweight functions through modularity is not without drawbacks either as this will mean operating the MRV at off-design displacements for perhaps two out of the three top-level functions, which again will affect vessel efficiency. However, the use of ballast functions, which will require more deadweight functions, could return the vessel's displacement to its design waterline. Other issues that could arise through the use of modularity include the interfaces between the platform and module. The solution to this design problem will require further trade-off studies.

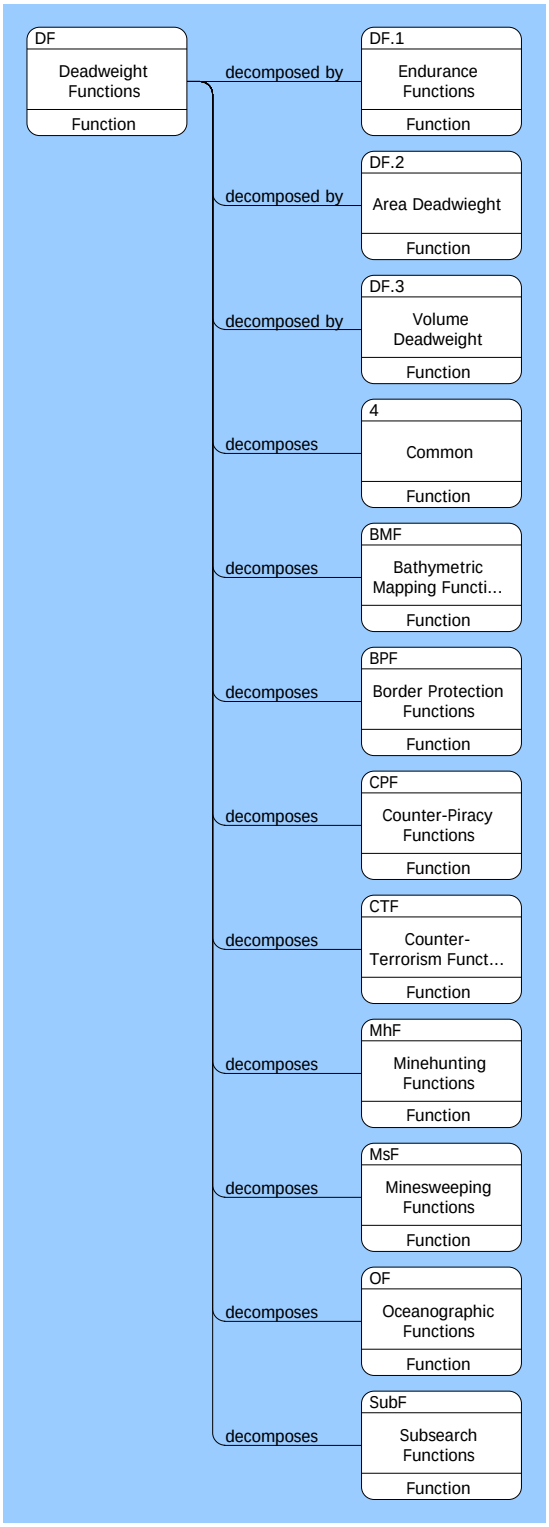

Figure 13: Deadweight functions element relationships diagram

5.9 EPF – Environmental Protection Functions

These are the functions that ensure that the vessel will have minimal environmental impact. They cover the management of all waste products generated during the operation of the vessel and include waste such as sewage, oil, garbage, air emissions, ballast water and biofouling [20]. These systems, such as oil / water separators etc. will have an influence on the design of the HM&E systems of the MRV. As for many of the common functions, the level of equipment required to perform these functions will vary according to the operational loads, such as crew numbers etc, the vessel is subjected to during different operational roles. This will mean that the systems are not likely to be operating at peak efficiency during some of the MRV's operations.

5.10 HSF – Hotel Services Functions

This is the function of providing hotel services, or domestic services, such as black / grey and fresh water services to the spaces within the vessel. Hotel Services Functions is decomposed by catering and water services.

These functions will influence the design of the HM&E and C4I systems and the level of hotel service functions required could vary significantly if the MRV is crewed according to the function being performed. Modularising this function may provide a solution to varying crew numbers, however, as with the resolution of the deadweight functions design problem, the solution is not simple and requires further study.

5.11 HVAC – HVAC Functions

This is the function of heating, ventilation and air-conditioning (HVAC) of the vessel's spaces. HVAC functions will have an influence on the design of the HM&E and C4I systems. Combat system design will also need to incorporate this function into the process, as many combat systems require cooling or temperature-controlled environments. As with many of the common functions, the level of HVAC functions required to be performed will be variable depending on the top-level function being performed and the associated crew numbers and arrangement.

5.12 IntF – Interoperability Functions

These are the functions that will allow the vessel to be interoperable with other vessels of the same class, other RAN vessels and the vessels of our allies. This is typically done by using the same / similar systems between vessels and allies and as seen in Table 6, interoperability functions will influence the design of all of the Duren and Pollard vessel systems. Interoperability functions will not only require consideration of the systems used on board the vessel, but also the structure of the task force with which the MRV will work. The structure of the task force will influence the role of each class of vessel within the group, RAN doctrine and the tactics employed by commanders during operations.

5.13 LRaSF.1 – Boats

This is the function of launching, recovering and stowing of RHIBs, sea boats, survey launches etc. and it involves the interface between the boat and MRV components. It will affect the HM&E, embarked vehicles and training systems design. At present in the RAN fleet, ships boats

are usually stowed in the cradle or davit from which they are launched. This approach differs from some current MRV concept designs, such as the Venator project [1], which utilise stern ramps and space near the ramp to perform this function. While davit launching presents risks to personnel and materiel, particularly during operations in higher sea states due to vessel motions, stern ramp launching and retrieval safety is not yet fully understood. If the MRV is designed with a multihull arrangement, the availability of sufficient space for stern launching of boats, along with other offboard systems, may be an issue. This is due to the hulls of a multihull being of the slender body type.

5.14 MaintF – Maintenance Functions

These functions will provide the vessel with the ability to perform maintenance on the machinery and systems on board the vessel. They will require space for workshops and equipment and spares, along with a significant influence on the development of services and logistics support system design. As such, the maintenance concept for the MRV will be a significant part of the vessel's concept design. This will be due to all of the components that make up the systems defined by Duren and Pollard requiring some form of maintenance to be performed on them at different stages of the MRV's life cycle.

5.15 MedF – Medical Functions

This is the function of providing medical assistance to sick or injured personnel. The level of medical functions provided on naval vessels will depend on the role of the vessel. A combatant vessel will generally have more medical facilities, such as operating theatres and wards, whereas a support vessel may only have a sickbay. The design of the HM&E, training, and services and logistics support systems will be influenced by these functions.

5.16 MF.1 – Low Speed Manoeuvrability

This function will be required when performing functions such as launch and recover and boarding during border protection functions. Incorporating this function into the base MRV design will influence HM&E, C4I and training system design. Components that can be utilised to perform this function include podded propulsors, bow thrusters and retractable azipods. Some vessels simply rely on the main propulsion units to perform this function, but this is more common in designs with twin propulsors that allow turning moments to be generated by reversing thrust on a single unit. Performing this function will also become more difficult in higher sea states. This will mean that the method of performing this function will be dependent on the hullform selected for the base MRV.

5.17 MoF – Mooring Functions

These are the functions that allow the vessel to berth and anchor. Components that usually perform this function include anchors, bollards and mooring lines. The HM&E system design will be influenced by the mooring function, as space will be required to accommodate the components. The component design will require that the heaviest MRV module displacement be used in calculations to ensure adequate holding strength.

5.18 NF – Navigation Functions

These are the functions that allow the vessel to be navigated and will be performed whenever the base MRV is being operated. Components that will perform the functions include navigational radar, GPS, compasses and binoculars. The space required to perform these functions will be located in close proximity to the space where the vessel command functions are being performed due to the need for information flow between the functions. HM&E, C4I and training system design will all be influenced by this function.

5.19 RF – Range Functions

This is the function that covers the ability of the vessel to transit different distances. The greater the vessel's range, the larger the vessels effective area of operation will be [21]. The availability of replenishment at sea (RAS) components will be necessary to perform range functions. The functional decomposition of range functions can be seen in Figure 14.

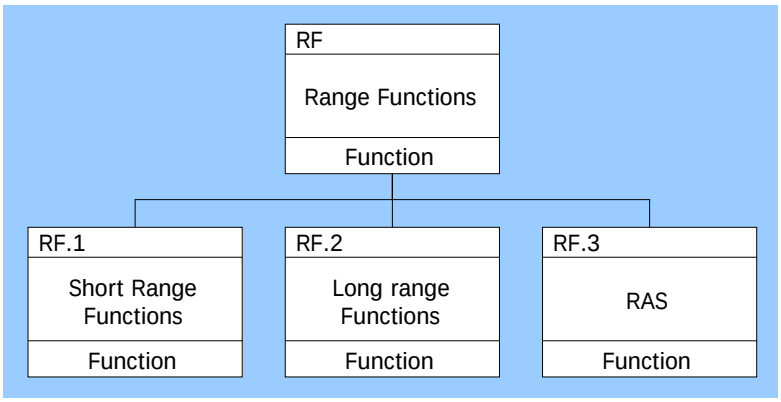

Figure 14: Range Functions hierarchy diagram

This function will influence the HM&E, C4I, services and logistic support and training systems design. The design of these systems to perform the range functions must be done in tandem with the endurance functions, as there is no point in designing for a range of 5000 nautical miles if there are only sufficient endurance functions for five days. The primary systems that will perform this function are the HM&E, control systems and logistic support systems.

5.20 SF.1.1 – Above Water Sensors

The function of monitoring the air environment around the vessel is an important function for a military vessel. The components used to perform this function will have some commonality between the sensors used in performing navigation functions. However, it is likely there will need to be some specialised components needed to perform this function. The location of the sensors that perform this function on board the MRV will need to be considered in the HM&E system's design due to the interference that can occur between different sensors. This function will also influence the vessel's C4I, combat and training system design.

5.21 SF.1.2 – Underwater Sensors

This is the function of monitoring and sensing the underwater environment around the vessel. While this function will be performed during each of the PB, HS and MCM functions, the actual sensor components may be different. Components that perform underwater sensor functions can be hull mounted or towed and the impact on the base platform's HM&E, C4I and training systems will be dependent on which of these types of component are selected to perform this function. The base MRV may be designed with hull mounted underwater sensors incorporated and the towed sensors could be part of a module. The location of any hull mounted underwater sensors will require consideration of the fluid boundary layer thickness. Generally, hull mounted underwater sensors are located near the bow of a vessel, with welds in the surrounding plating ground flush with the plating.

5.22 ShF – Shallow Water Functions

This is the function that will give the vessel the ability to operate in shallow waters. Possible ways of performing these functions could be to restrict the vessel's draft, or use interfacing systems (e.g. RHIBs) to conduct operations in shallow waters. As such, these functions will have a significant impact on the HM&E systems design and the operational concept of the vessel if it is to use embarked systems to perform these functions. Shallow water functions are required to be performed for many of the high-level functions that will be carried out by the MRV. The element relationships diagram that displays the array of functions that shallow water functions is related to, is shown in Figure 15.

5.23 SkF – Seakeeping Functions

Seakeeping functions are the functions that provide the base MRV's ability to operate in different ocean environments. Seakeeping functions are decomposed by the functions shown in Figure 16, which are dependent on the service class required by the MRV. An MRV with good seakeeping performance will improve the habitability for the crew, along with enabling higher speeds and more equipment and resources on board to be utilised in higher sea states.

If unlimited seakeeping functions are required, the MRV will need to be fully operational in ocean environments up to sea state six [22]. At present, most vessels designed to meet this requirement are monohull hullforms due to their ability to have their motions reduced using stabiliser functions and structural integrity. Phenomena such as cross structure slamming tend to make multihull vessels unsuitable for operations in the highest sea states. However, for operations in lower seas, the motion characteristics of multihull vessels could be result in a more capable design, therefore, seakeeping functions will have a significant effect on the HM&E systems design.

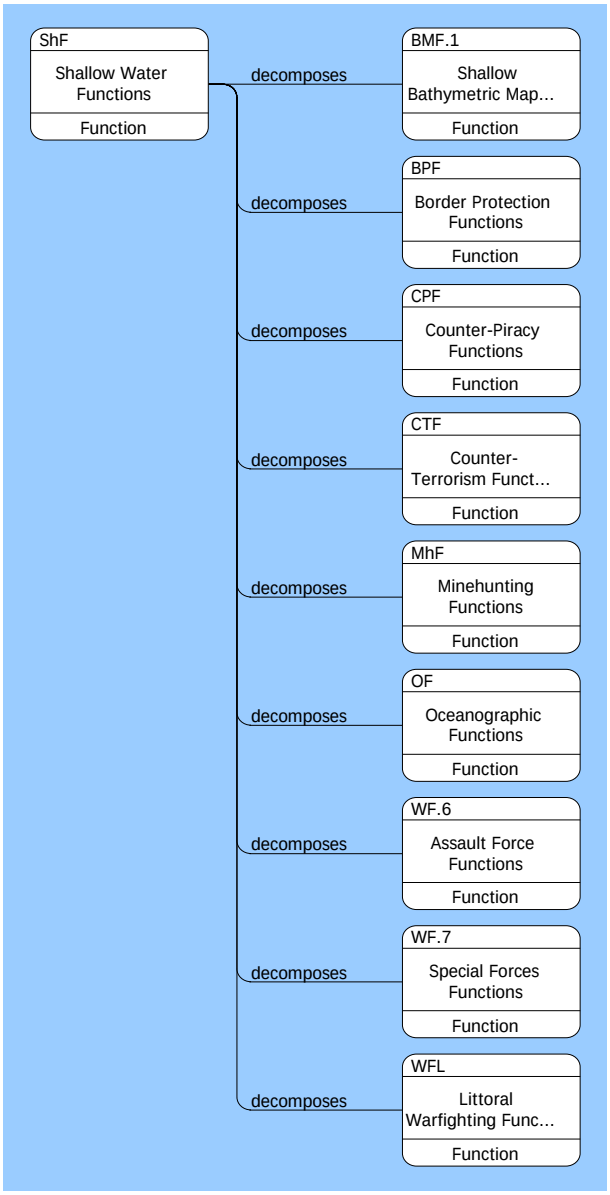

Figure 15: Shallow water functions relationships diagram

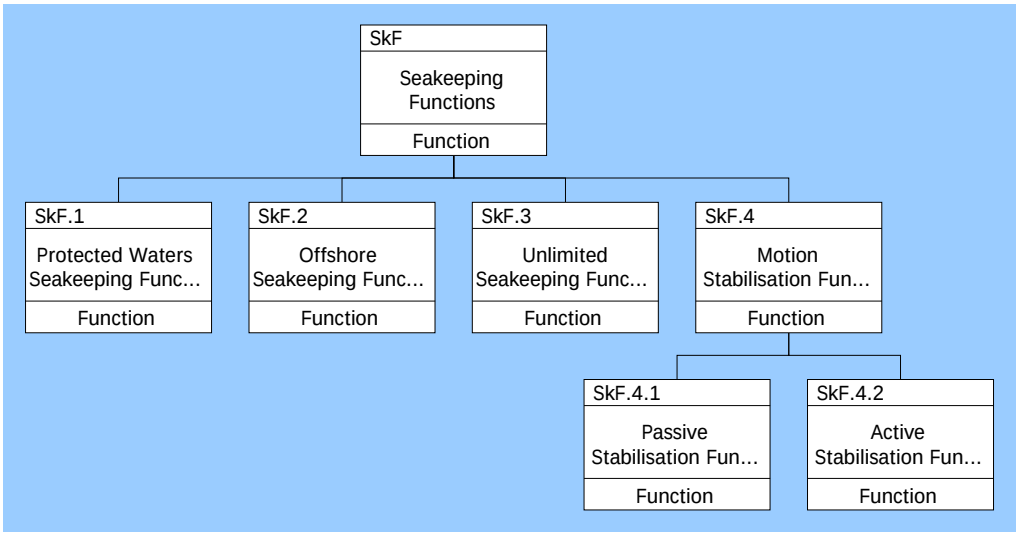

Figure 16: Seakeeping functions hierarchy diagram

From Figure 16, it can also be seen that motion stabilisation functions, which decomposes seakeeping functions, is decomposed into active and passive stabilisation functions. Components that can perform active stabilisation functions include fin and t-foil stabilisers, whilst passive stabilisation can be carried out by components such as bilge keels and passive roll tanks. Again, the components selected to perform this function will be dependent on the base MRV hullform.

5.24 StabF – Stability Functions

This is the ability of the vessel to remain stable when both intact and damaged. It will include aspects such as ballasting and watertight subdivision. Stability functions are one of the fundamental functions that a vessel needs to perform. In particular for warships, damaged stability will be a key consideration in the design of the HM&E systems. This is due to the subdivision of a vessel into watertight compartments that limit the amount of flooding into the ship that can occur in the event of a loss of watertight integrity. The certification of an MRV will be a complex process due to the wide range of displacements that the vessel could potentially operate at when operating with different functional modules. However, ballast functions can be performed to assist in keeping the vessel near its optimum displacement.

5.25 StrF – Strength Functions

This is the function of providing structural strength to the MRV. This function will encompass the initial structural design, as well as the through life maintenance of structural integrity of the vessel. The strength function is another fundamental vessel function and will encapsulate the type of classification that the vessel structure will be designed to meet. These functions will have a significant influence on the vessel's HM&E systems design.

5.26 TF – Transit Functions

These are the functions of transiting the vessel at different speeds. Transit functions are decomposed by low, medium and high-speed transit functions as shown in Figure 17 . At present, patrol functions are the only functions requiring high-speed transit (>16 knots) during constabulary operations. Operationally, it could be advantageous to have a vessel capable of performing HS and MCM functions, being able to transit at high speed. This would allow the vessel to reach an area of interest rapidly before performing HS or MCM functions.

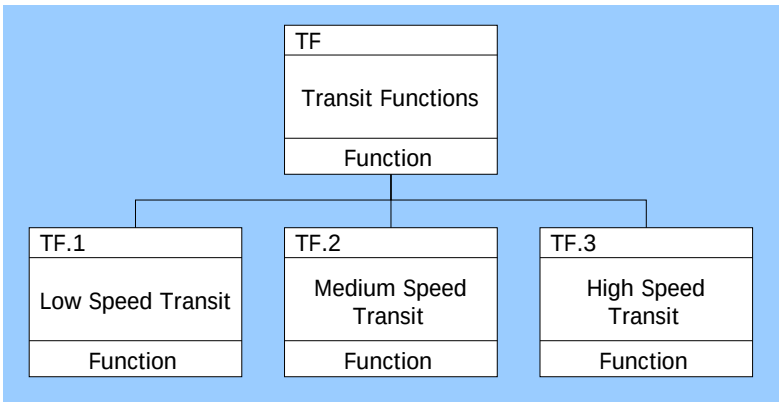

Figure 17: Transit Functions decomposition

The HM&E system design will be most significantly influenced by transit functions. While selecting an appropriate hullform / machinery combination for high-speed functions will be important, the operational profile of the MRV may imply that the vessel will spend the vast majority of time performing low speed functions. A HM&E system trade off study for different hullform / machinery combinations will be necessary to determine the most efficient method of achieving the vessel's operational profile.

5.27 TrF – Training Functions

This function is covers the provision of space and equipment that could be used for training the crew, along with embarked personnel, on board the vessel. Typically, training on board a vessel can be performed either in situ, using the equipment set to training mode, or in available spaces such as messes, hangars and flight decks. This will mean, at some stage during the design process a decision will need to be made regarding the provision of dedicated training areas on board, or whether existing, non-dedicated spaces will be used to perform the training function. Hence, these functions will influence both the HM&E system design, along with the training system design.

5.28 WF.1 – Deterrent

This function is the passive deterrent provided by the presence of a military vessel. It is based on the assumption that a military vessel will have some defensive armament such as a gun and small arms. Deterrent warfare functions will influence the design of HM&E, C4I, combat, training and logistics system design. Any weapon system will heavily influence the arrangement of the vessel in order to accommodate the volume and mass, along with locating

the weapon system away from any interference caused by other systems. The components selected to perform this function will depend on the level of combat effectiveness required for the base platform.

5.29 WF.8 – Munitions Stowage

This is the function of providing space to stow the munitions to be used by the weapons systems on board. As for deterrent warfare functions, the location of the space provided to perform munitions stowage functions will be an important consideration in the base vessel's HM&E system design. The type of combat systems to be used on the MRV will be related to how the munitions are stowed and the space required to perform the function. This relationship extends both ways and as such, munitions stowage functions will influence the vessels combat system design, along with the training and logistics support systems design.

5.30 LRaSF.2 – Helicopter

This is the function of launching, recovering and stowing a helicopter and the functional analysis only identified this function as currently decomposing PB and HS functions. However, in the future, helicopters or UAVs may be utilised to perform some MCM and HS functions. If this function is to be included in the MRV functions, the impact on the base MRV HM&E systems design will be significant due to the space required. Typically, this function would be allocated to flight deck and hanger components, which are located aft on most combatant vessels.

5.31 LRaSF.3 – UUV

The function of launching, recovering and stowing an unmanned underwater vehicle will affect the HM&E, embarked vehicles and training systems design. This function incorporates the interface between the UUV and MRV. It is anticipated that UUVs will play a significant role in several of the functions that will be performed as seen in the element relationships diagram given in Figure 18.

At present, this function is generally performed using cranes or cradle launching and stowage space. However, as with the boats launch, recover and stow function, there is the potential of utilising stern ramps and space aft to perform this function. This arrangement would require compromise in the arrangement of any flight deck that is fitted to the base MRV. This is due to present combatant vessel design trends, where the after deck space has been utilised for helicopter launch, recover and stow functions.

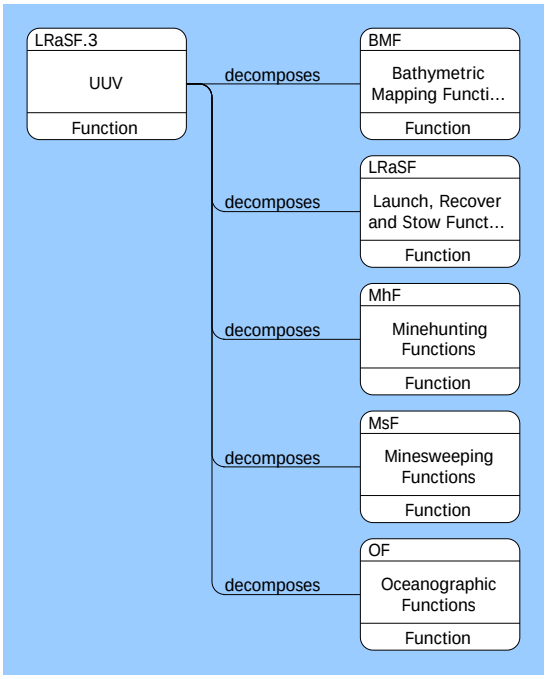

Figure 18: UUV launch, recover and stow functions relationships diagram

5.32 LRaSF.4 – USV

The function of launching, recovery and stowage of an unmanned surface vessel will influence the design of the base platform HM&E, embarked vehicles and training systems, in much the same way as the launch, recover and stowing of boats function covered in 5.13. This is due to present USV designs being based on monohulls that are capable of high speed, which share similar characteristics to current ship's boat designs.

5.33 LRaSF – UAV

This is the function of launching, recovery and stowage of an unmanned aerial vehicle. At present, UAVs can be launched in a variety of ways depending on whether they are rotary or fixed wing. Rotary wing UAVs can be launched and recovered from flight decks in the same way as helicopters, whilst fixed wing UAVs may require catapults for launching and an open space (such as a flight deck) for landing. The need to perform this function will influence the vessel's HM&E, C4I, embarked vehicles and training systems design due to the space and control systems required.

5.34 LRaSF.6 – ROV

This is the function of launching, recovery and stowage of a remotely operated vehicle. This function decomposes the same functions as the launch, recover and stow UUV function due to the potential for ROVs being used to perform the same functions. In the offshore industry, ROVs are generally launched and recovered using a moon pool arrangement [23]. This arrangement is unlikely to be feasible on a combatant vessel, however, catamaran and trimaran hullforms may allow a similar arrangement for launching between hulls. This function may be performed as for boats, UUVs and USVs via a stern ramp in monohull and trimaran hullforms.

5.35 SvF – Survivability Functions

While this function was only directly identified for the PB and MCM vessel functions, it is noted that survivability functions, such as damage control (DC) would be performed across all three top-level functions (e.g. in the event of grounding). Also, it would be impossible to perform survivability functions using modularity, which means they must be incorporated into the base MRV platform design. Survivability functions are decomposed as shown in Figure 19.

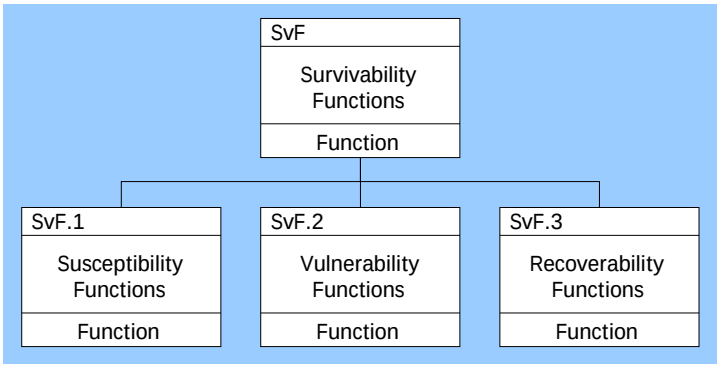

Figure 19: Survivability functions hierarchy diagram

Susceptibility functions are the functions that reduce the vessels signatures, which will influence HM&E system design. Vulnerability functions are the functions of protecting the capabilities of the vessel. These include shock-hardened components and ballistic protection, which will also influence HM&E system design. Recoverability functions are the functions that recover vessel capabilities after a damage event and include HM&E systems such as subdivision and DC functions.

5.36 TowF – Towing Functions

This is the function of towing apprehended vessels and other deployable items such as a side scan sonar during hydrographic survey functions. This function will affect HM&E and training system design due to the space and components required to perform the function. Generally, these functions will need space to be available near the stern of the vessel. However, if stern ramps are used for launch, recover and stow functions, compromises will need to be made.

6. Conclusions

By adopting an SE approach, a process has been proposed to identify the common functions that will be performed by an MRV that utilises modularity to perform its different roles. The proposed process would be undertaken within the concept design phase of an MRV acquisition project. The aim of the process is to provide stakeholders with insights into the implications of incorporating their needs into the design of the base MRV platform. This will aid in ensuring that the most capable and cost effective MRV concept design is developed during the acquisition process. The process utilises the iterative nature of an SE process, such as an MRV's concept design, to begin with only minimal user requirements. These are then used to perform

some requirements and functional analysis of the MRV system in order to establish the functional architecture. This can then be used to identify the common functions and subsequently be fed back into the iterative loop within the concept design phase to be developed further.

After proposing the process (termed the ICF-MRV process), a pilot study was conducted to test its validity. The pilot study used an MRV based on the concept raised by the 2009 Defence White Paper, which called for an MRV that will be required to perform the three roles of Patrol Boat, Hydrographic / Oceanographic Survey and Mine Counter Measures vessels.

The preliminary functional analysis identified a total of 75 functions that are required to be performed by a vessel that was to achieve the functionality of current and short-term future PB, HS and MCM vessels. The higher level functions were not decomposed comprehensively, nor were the functions allocated to components in the functional analysis as these SE activities were outside the scope of this work. The subsequent stakeholder brainstorming and final functional analyses steps within the ICF-MRV process uncovered a further 21 functions that the MRV would need to perform. The use of the CORE® MBSE tool for the preliminary and final requirements functional analyses was found to be very useful, since it allowed the preliminary system model to be rapidly updated following the stakeholder meeting.

A list of 29 functions common to PB, HS and MCM functions, along with seven further functions that are common to two of these roles, was identified in the pilot study. Some of the implications of incorporating these 36 functions into a base MRV platform's design were then discussed. The main influences that these common functions would impart on the design of a base MRV platform chiefly concern the space and location required to perform the functions. Functions such as mission and vessel command, along with navigation and communication functions are typically performed in spaces that are in close proximity on board a vessel.

All of the common functions influenced the HM&E system design in one form or another. The MRV hullform design in particular will be a delicate balancing act. Current design trends for performing the common launch recover and stow functions indicate that these are likely to require space near the stern of a base MRV, which will significantly influence the choice of the vessel hullform. Seakeeping considerations that are dependent on the anticipated areas of operation of the MRV will be another factor that heavily influences a decision on hullform. The solution to the design problem of the base MRV is certain to provide many interesting opportunities. Several different solutions are likely to present themselves, with some form of trade-off study being required to search for the best.

The functional architecture of an MRV developed during the ICF-MRV process has potential to be used further in an MRVs concept design. However, caution would need to be exercised if this architecture were to be used. This is due to the functional architecture developed during the process not considering all of the external systems, such as wharves and drydocks with which the vessel will need to interface. A more complete functional architecture would have the potential to assist in the preparation of the capability definition documents developed during the requirements phase of the capability lifecycle. The ICF-MRV process could be further refined by the use of a more structured stakeholder brainstorming activity. A more structured brainstorming activity could also provide scope for weightings that signify functional importance to be included with each identified function.

The ICF-MRV process was found to be a valid approach to identifying the common functions that an MRV will be required to perform during the pilot study. It is therefore anticipated that the process could be a valuable tool to provide stakeholders with insights into the implications of incorporating their needs into an MRV during its concept design phase.

7. Acknowledgements

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Appendix A: MRV Requirement Descriptions

A full list of the requirements / missions developed for the MRV used in the ICF-MRV process pilot study, along with their attributes as defined in the CORE® software, is given below.

Requirement: R.9.20 Combined Functions	
Created:	Monday, 30 November 2009 at 04:44:41 PM
Creator:	Administrator
Description:	This requirements stems from paragraph 9.20 in the white paper [15], which states; "...Defence will develop proposals to rationalise the Navy's patrol boat, mine counter measures, hydrographic and oceanographic forces into a single modular multi-role class of around 20 Offshore Combatant Vessels combining four existing classes of vessels." The requirement is that; "The MRV shall perform the current and short-term future functions of patrol boats, hydrographic and oceanographic vessels, along with mine counter measure vessels."
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:36 AM
Number:	R.9.20
Origin:	Originating
Type:	Functional
basis of:	Function: 0 MRV Functions Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions
refined by:	Requirement: R.9.20.1 Patrol Boat Requirement: R.9.20.2 Hydrographic and Oceanographic Survey Requirement: R.9.20.3 Mine Counter Measures

Requirement: R.9.20.1 Patrol Boat	
Created:	Friday, 26 February 2010 at 11:22:54 AM
Creator:	Administrator
Description:	The MRV shall be capable of performing current and short term future patrol boat roles.
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:28 AM
Number:	R.9.20.1
Origin:	Originating
Type:	Functional
basis of:	Function: 1 Patrol Boat Functions
refined by:	Requirement: R.9.20.1.1 Offshore and Littoral Warfighting Requirement: R.9.20.1.2 Border Protection Requirement: R.9.20.1.3 Counter Terrorism Requirement: R.9.20.1.4 Counter-Piracy Requirement: R.9.20.1.5 Special Forces Support Requirement: R.9.20.1.6 Security Requirement: R.9.20.1.7 Surveillance and Response
refines:	Requirement: R.9.20 Combined Functions

Requirement: R.9.20.1.1 Offshore and Littoral Warfighting	
Created:	Friday, 26 February 2010 at 11:46:27 AM
Creator:	Administrator
Description:	The MRV shall be capable of undertaking littoral and offshore warfighting roles.
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:33 AM
Number:	R.9.20.1.1
Origin:	Originating
Type:	Functional
basis of:	Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions
refines:	Requirement: R.9.20.1 Patrol Boat

Requirement: R.9.20.1.2 Border Protection	
Created:	Friday, 26 February 2010 at 11:48:14 AM
Creator:	Administrator
Description:	The MRV shall be capable of performing border protection tasks.
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:29 AM
Number:	R.9.20.1.2
Origin:	Originating
Type:	Functional
basis of:	Function: BPF Border Protection Functions
refines:	Requirement: R.9.20.1 Patrol Boat

Requirement: R.9.20.1.3 Counter Terrorism	
Created:	Friday, 26 February 2010 at 11:50:23 AM
Creator:	Administrator
Description:	The MRV shall be capable of performing counter terrorism operations.
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 01:31:37 PM
Number:	R.9.20.1.3
Origin:	Originating
Type:	Functional
basis of:	Function: CTF Counter-Terrorism Functions
refines:	Requirement: R.9.20.1 Patrol Boat

Requirement: R.9.20.1.4 Counter-Piracy	
Created:	Friday, 26 February 2010 at 02:00:03 PM
Creator:	Administrator
Description:	The MRV shall be capable of performing counter-piracy operations.
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:29 AM
Number:	R.9.20.1.4
Origin:	Originating
Type:	Functional
basis of:	Function: CPF Counter-Piracy Functions
refines:	Requirement: R.9.20.1 Patrol Boat

Requirement: R.9.20.1.5 Special Forces Support	
Created:	Friday, 26 February 2010 at 02:02:50 PM
Creator:	Administrator
Description:	The MRV shall be capable of providing support to special forces operations.
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:32 AM
Number:	R.9.20.1.5
Origin:	Originating
Type:	Functional
basis of:	Function: WF.7 Special Forces Functions
refines:	Requirement: R.9.20.1 Patrol Boat

Requirement: R.9.20.1.6 Security	
Created:	Friday, 26 February 2010 at 02:05:26 PM
Creator:	Administrator
Description:	The MRV shall be capable of providing support to security and stability in the immediate neighbourhood.
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:37 AM
Number:	R.9.20.1.6
Origin:	Originating
Type:	Functional
basis of:	Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions
refines:	Requirement: R.9.20.1 Patrol Boat

Requirement: R.9.20.1.7 Surveillance and Response	
Created:	Friday, 26 February 2010 at 02:08:18 PM
Creator:	Administrator
Description:	The MRV shall be capable of performing surveillance and response operations.
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:24 AM
Number:	R.9.20.1.7
Origin:	Originating
Type:	Functional
basis of:	Function: SF Sensor Functions Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions
refines:	Requirement: R.9.20.1 Patrol Boat

Requirement: R.9.20.2 Hydrographic and Oceanographic Survey	
Created:	Friday, 26 February 2010 at 11:42:24 AM
Creator:	Administrator
Description:	The MRV shall be capable of performing current and short term future hydrographic and oceanographic survey vessel roles
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:24 AM
Number:	R.9.20.2
Origin:	Derived
Type:	Functional
basis of:	Function: 2 Hydrographic Survey Functions
refined by:	Requirement: R.9.20.2.1 Bathymetric Mapping Requirement: R.9.20.2.2 Oceanographic Survey Requirement: R.9.20.2.3 Subsearch
refines:	Requirement: R.9.20 Combined Functions

Requirement: R.9.20.2.1 Bathymetric Mapping	
Created:	Friday, 26 February 2010 at 02:11:40 PM
Creator:	Administrator
Description:	The MRV shall be capable of performing bathymetric mapping operations.
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:23 AM
Number:	R.9.20.2.1
Origin:	Originating
Type:	Functional
basis of:	Function: BMF Bathymetric Mapping Functions
refines:	Requirement: R.9.20.2 Hydrographic and Oceanographic Survey

Requirement: R.9.20.2.2 Oceanographic Survey	
Created:	Friday, 26 February 2010 at 02:27:33 PM
Creator:	Administrator
Description:	The MRV shall be capable of performing oceanographic survey operations.
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:30 AM
Number:	R.9.20.2.2
Origin:	Originating
Type:	Functional
basis of:	Function: OF Oceanographic Functions
refines:	Requirement: R.9.20.2 Hydrographic and Oceanographic Survey

Requirement: R.9.20.2.3 Subsearch	
Created:	Friday, 26 February 2010 at 02:29:35 PM
Creator:	Administrator
Description:	The MRV shall have the capability to perform subsearch operations.
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:27 AM
Number:	R.9.20.2.3
Origin:	Originating
Type:	Functional
basis of:	Function: SubF Subsearch Functions
refines:	Requirement: R.9.20.2 Hydrographic and Oceanographic Survey

Requirement: R.9.20.3 Mine Counter Measures	
Created:	Friday, 26 February 2010 at 11:39:56 AM
Creator:	Administrator
Description:	The MRV shall be capable of performing current and short term future mine counter measure vessel roles.
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:21 AM
Number:	R.9.20.3
Origin:	Derived
Type:	Functional
basis of:	Function: 3 Mine Counter Measure Functions
refined by:	Requirement: R.9.20.3.1 Minehunting Requirement: R.9.20.3.2 Minesweeping Requirement: R.9.20.3.3 Clearance Diver
refines:	Requirement: R.9.20 Combined Functions

Requirement: R.9.20.3.1 Minehunting	
Created:	Friday, 26 February 2010 at 02:43:09 PM
Creator:	Administrator
Description:	The MRV shall be capable of performing minehunting operations.
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:31 AM
Number:	R.9.20.3.1
Origin:	Originating
Type:	Functional
basis of:	Function: MhF Minehunting Functions
refines:	Requirement: R.9.20.3 Mine Counter Measures

Requirement: R.9.20.3.2 Minesweeping	
Created:	Friday, 26 February 2010 at 02:44:48 PM
Creator:	Administrator
Description:	The MRV shall be capable of performing minesweeping operations.
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:25 AM
Number:	R.9.20.3.2
Origin:	nil
Type:	nil
basis of:	Function: MsF Minesweeping Functions
refines:	Requirement: R.9.20.3 Mine Counter Measures

Requirement: R.9.20.3.3 Clearance Diver	
Created:	Friday, 26 February 2010 at 02:45:46 PM
Creator:	Administrator
Description:	The MRV shall be capable of performing clearance diver operations
Key Performance Parameter:	false
Last Modified:	Wednesday, 26 May 2010 at 11:03:32 AM
Number:	R.9.20.3.3
Origin:	Originating
Type:	Functional
basis of:	Function: CDF Clearance Diver Function
refines:	Requirement: R.9.20.3 Mine Counter Measures

Appendix B: MRV Function Details

A full list of the functions developed for the MRV used in the ICF-MRV process pilot study, along with their attributes as defined in the CORE® software, is given below.

Function: 0 MRV Functions	
Created:	Tuesday, 17 November 2009 at 04:15:53 PM
Creator:	Administrator
Description:	These are the overall functions to be performed by the MRV
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 11:02:57 AM
Number:	0
allocated to:	Component: MRV System
based on:	Requirement: R.9.20 Combined Functions
decomposed by:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common Function: 5 Two of Three

Function: 1 Patrol Boat Functions	
Created:	Tuesday, 17 November 2009 at 04:05:16 PM
Creator:	Administrator
Description:	These are the functions currently performed by the ACPB, along with anticipated PB functions in the short term future.
Execute Decomposition:	true
Last Modified:	Friday, 19 March 2010 at 01:29:04 PM
Number:	1
based on:	Requirement: R.9.20 Combined Functions Requirement: R.9.20.1 Patrol Boat
decomposed by:	Function: AccomF Accommodation Functions Function: AF Auxiliary Functions Function: BF Ballast Functions Function: BPF Border Protection Functions Function: CerF Ceremonial Functions Function: CF Communication Functions Function: CFM Mission Command Function Function: CFV Vessel Command Function Function: CPF Counter-Piracy Functions Function: CTF Counter-Terrorism Functions Function: EPF Environmental Protection Functions Function: HSF Hotel Services Functions Function: HVAC HVAC Functions Function: IntF Interoperability Functions Function: MaintF Maintenance Functions Function: MedF Medical Functions Function: MF Manoeuvrability Functions Function: MoF Mooring Functions Function: NF Navigation Functions Function: SF.1.1 Above Water Sensors Function: StabF Stability Functions Function: StrF Strength Functions Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions
decomposes:	Function: 0 MRV Functions

Function: 2 Hydrographic Survey Functions	
Created:	Tuesday, 17 November 2009 at 04:07:10 PM
Creator:	Administrator
Description:	These are the functions currently performed by the HS vessels, along with anticipated HS functions in the short term future.
Execute Decomposition:	true
Last Modified:	Friday, 19 March 2010 at 01:29:04 PM
Number:	2
based on:	Requirement: R.9.20 Combined Functions Requirement: R.9.20.2 Hydrographic and Oceanographic Survey
decomposed by:	Function: AccomF Accommodation Functions Function: AF Auxiliary Functions Function: BF Ballast Functions Function: BMF Bathymetric Mapping Functions Function: CerF Ceremonial Functions Function: CF Communication Functions Function: CFM Mission Command Function Function: CFV Vessel Command Function Function: EPF Environmental Protection Functions Function: HSF Hotel Services Functions Function: HVAC HVAC Functions Function: IntF Interoperability Functions Function: LRaSF.2 Helicopter Function: LRaSF.5 UAV Function: MaintF Maintenance Functions Function: MedF Medical Functions Function: MoF Mooring Functions Function: NF Navigation Functions Function: OF Oceanographic Functions Function: SF.1.1 Above Water Sensors Function: StabF Stability Functions Function: StrF Strength Functions Function: SubF Subsearch Functions Function: WF.1 Deterrent Function: WF.8 Munitions Stowage
decomposes:	Function: 0 MRV Functions

Function: 3 Mine Counter Measure Functions	
Created:	Tuesday, 17 November 2009 at 04:08:50 PM
Creator:	Administrator
Description:	These are the functions currently performed by the MCM vessels, along with anticipated MCM functions in the short term future.
Execute Decomposition:	true
Last Modified:	Friday, 19 March 2010 at 01:29:04 PM
Number:	3
based on:	Requirement: R.9.20 Combined Functions Requirement: R.9.20.3 Mine Counter Measures
decomposed by:	Function: AccomF Accommodation Functions Function: AF Auxiliary Functions Function: BF Ballast Functions Function: CDF Clearance Diver Function Function: CerF Ceremonial Functions Function: CF Communication Functions Function: CFM Mission Command Function

Function: 3 Mine Counter Measure Functions	
	Function: CFV Vessel Command Function Function: EPF Environmental Protection Functions Function: HSF Hotel Services Functions Function: HVAC HVAC Functions Function: IntF Interoperability Functions Function: MaintF Maintenance Functions Function: MedF Medical Functions Function: MhF Minehunting Functions Function: MoF Mooring Functions Function: MsF Minesweeping Functions Function: NF Navigation Functions Function: SF.1.1 Above Water Sensors Function: StabF Stability Functions Function: StrF Strength Functions Function: WF.1 Deterrent Function: WF.8 Munitions Stowage
decomposes:	Function: 0 MRV Functions

Function: 4 Common	
Created:	Tuesday, 16 March 2010 at 04:46:38 PM
Creator:	Administrator
Description:	These are the common functions that were identified using the process given in the report
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 01:07:32 PM
Number:	4
decomposed by:	Function: AccomF Accommodation Functions Function: AF Auxiliary Functions Function: BF Ballast Functions Function: CerF Ceremonial Functions Function: CF Communication Functions Function: CFM Mission Command Function Function: CFV Vessel Command Function Function: DF Deadweight Functions Function: EPF Environmental Protection Functions Function: HSF Hotel Services Functions Function: HVAC HVAC Functions Function: IntF Interoperability Functions Function: LRaSF.1 Boats Function: MaintF Maintenance Functions Function: MedF Medical Functions Function: MF.1 Low Speed Manoeuvrability Function: MoF Mooring Functions Function: NF Navigation Functions Function: RF Range Functions Function: SF.1.1 Above Water Sensors Function: SF.1.2 Underwater Sensors Function: ShF Shallow Water Functions Function: SkF Seakeeping Functions Function: StabF Stability Functions Function: StrF Strength Functions Function: TF Transit Functions Function: WF.1 Deterrent Function: WF.8 Munitions Stowage
decomposes:	Function: 0 MRV Functions

Function: 5 Two of Three	
Created:	Tuesday, 16 March 2010 at 04:50:48 PM
Creator:	Administrator
Description:	These are the functions that will need to be performed by two out of the three PB, HS and MCM functions. They will have a significant impact on the design of the base MRV so they are included at the top-level.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 11:03:01 AM
Number:	5
decomposed by:	Function: LRaSF.2 Helicopter Function: LRaSF.3 UUV Function: LRaSF.4 USV Function: LRaSF.5 UAV Function: LRaSF.6 ROV Function: SvF Survivability Functions Function: TowF Towing Functions
decomposes:	Function: 0 MRV Functions

Function: AccomF Accommodation Functions	
Created:	Monday, 1 March 2010 at 10:59:04 AM
Creator:	Administrator
Description:	This is the function of providing accommodation and on board habitability for embarked personnel.
Execute Decomposition:	true
Last Modified:	Wednesday, 17 March 2010 at 11:14:52 AM
Number:	AccomF
decomposed by:	Function: AccomF.1 Crew Accommodation Function: AccomF.2 Austere Accommodation Function: DF.2 Area Deadweight
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: AccomF.1 Crew Accommodation	
Created:	Monday, 1 March 2010 at 02:21:14 PM
Creator:	Administrator
Description:	This is the Accommodation function required for the vessel's crew.
Execute Decomposition:	true
Last Modified:	Wednesday, 17 March 2010 at 11:37:39 AM
Number:	AccomF.1
decomposes:	Function: AccomF Accommodation Functions

Function: AccomF.2 Austere Accommodation	
Created:	Monday, 1 March 2010 at 02:23:06 PM
Creator:	Administrator
Description:	This is the Accommodation space that could be used to house embarked personnel, other Defence personnel or detained people.
Execute Decomposition:	true
Last Modified:	Wednesday, 17 March 2010 at 11:41:07 AM
Number:	AccomF.2
decomposes:	Function: AccomF Accommodation Functions

Function: AF Auxiliary Functions	
Created:	Monday, 23 November 2009 at 05:55:14 PM
Creator:	Administrator
Description:	This is the function of providing auxiliary power to the vessel for such systems as electrical and hydraulics.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:47:58 PM
Number:	AF
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: BF Ballast Functions	
Created:	Friday, 19 March 2010 at 01:28:26 PM
Creator:	Administrator
Description:	These are the functions of ballasting the vessel so that it will operate at a displacement that is near optimum in terms of stability, seakeeping and resistance / speed.
Execute Decomposition:	true
Last Modified:	Friday, 19 March 2010 at 01:32:55 PM
Number:	BF
decomposed by:	Function: DF.3 Volume Deadweight
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: BMF Bathymetric Mapping Functions	
Created:	Tuesday, 24 November 2009 at 02:25:29 PM
Creator:	Administrator
Description:	The function of mapping the ocean floor
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 01:07:32 PM
Number:	BMF
based on:	Requirement: R.9.20.2.1 Bathymetric Mapping
decomposed by:	Function: BMF.1 Shallow Bathymetric Mapping Function: BMF.2 Deep Bathymetric Mapping Function: DF Deadweight Functions Function: LRaSF.1 Boats Function: LRaSF.3 UUV

Function: BMF Bathymetric Mapping Functions	
	Function: LRaSF.4 USV Function: LRaSF.6 ROV Function: MF.1 Low Speed Manoeuvrability Function: RF Range Functions Function: SF.1.2 Underwater Sensors Function: SkF Seakeeping Functions Function: SkF.1 Protected Waters Seakeeping Functions Function: SkF.2 Offshore Seakeeping Functions Function: TF Transit Functions Function: TowF Towing Functions
decomposes:	Function: 2 Hydrographic Survey Functions

Function: BMF.1 Shallow Bathymetric Mapping	
Created:	Tuesday, 24 November 2009 at 02:33:50 PM
Creator:	Administrator
Description:	The function of mapping the ocean floor in depths of up to 200 metres.
Execute Decomposition:	true
Last Modified:	Monday, 1 March 2010 at 02:38:16 PM
Number:	BMF.1
decomposed by:	Function: ShF Shallow Water Functions
decomposes:	Function: BMF Bathymetric Mapping Functions

Function: BMF.2 Deep Bathymetric Mapping	
Created:	Tuesday, 24 November 2009 at 02:34:53 PM
Creator:	Administrator
Description:	The function of mapping the ocean floor in depths of over 200 metres.
Execute Decomposition:	true
Last Modified:	Tuesday, 1 December 2009 at 11:06:25 AM
Number:	BMF.2
decomposes:	Function: BMF Bathymetric Mapping Functions

Function: BoardF Boarding Party Functions	
Created:	Monday, 1 March 2010 at 01:35:49 PM
Creator:	Administrator
Description:	These are the functions that will allow boarding operations to be performed. This will include aspects such as space for stowage of equipment and space for training / briefing activities.
Execute Decomposition:	true
Last Modified:	Tuesday, 9 March 2010 at 04:44:49 PM
Number:	BoardF
decomposes:	Function: BPF Border Protection Functions Function: CPF Counter-Piracy Functions Function: CTF Counter-Terrorism Functions

Function: BPF Border Protection Functions	
Created:	Tuesday, 17 November 2009 at 06:47:24 PM
Creator:	Administrator
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 11:02:35 AM
Number:	BPF
based on:	Requirement: R.9.20.1.2 Border Protection
decomposed by:	Function: BoardF Boarding Party Functions Function: DF Deadweight Functions Function: LRaSF.1 Boats Function: LRaSF.2 Helicopter Function: LRaSF.5 UAV Function: MF Manoeuvrability Functions Function: RF Range Functions Function: SF Sensor Functions Function: ShF Shallow Water Functions Function: SkF Seakeeping Functions Function: TF Transit Functions Function: TowF Towing Functions
decomposes:	Function: 1 Patrol Boat Functions

Function: CDF Clearance Diver Function	
Created:	Monday, 23 November 2009 at 02:49:21 PM
Creator:	Administrator
Description:	The function of embarking, deploying and retrieving clearance divers. This will include space for dive equipment such as tanks and possibly a decompression chamber.
Execute Decomposition:	true
Last Modified:	Tuesday, 9 March 2010 at 04:41:18 PM
Number:	CDF
based on:	Requirement: R.9.20.3.3 Clearance Diver
decomposed by:	Function: DF.2 Area Deadweight Function: DF.3 Volume Deadweight Function: LRaSF.1 Boats
decomposes:	Function: 3 Mine Counter Measure Functions

Function: CerF Ceremonial Functions	
Created:	Monday, 1 March 2010 at 05:05:01 PM
Creator:	Administrator
Description:	These are the functions that the vessel will perform during official ceremonies. Functions could include flying flags / burgees. These functions will require aspects such as stowage space for the ceremonial equipment
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:48:02 PM
Number:	CerF
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: CF Communication Functions	
Created:	Thursday, 19 November 2009 at 05:36:28 PM
Creator:	Administrator
Description:	The function of communicating with other vessels, shore bases and internally within the vessel.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:48:07 PM
Number:	CF
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: CFM Mission Command Function	
Created:	Tuesday, 8 December 2009 at 04:34:05 PM
Creator:	Administrator
Description:	These are the individual command functions that are mission specific to the PB, HS and MCM functions of the MRV.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 11:02:52 AM
Number:	CFM
decomposed by:	Function: CFM.1 Mission Command Function Patrol Boat Function: CFM.2 Mission Command Function Hydrographic Survey Function: CFM.3 Mission Command Function Mine Counter Measures
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: CFM.1 Mission Command Function Patrol Boat	
Created:	Friday, 20 November 2009 at 02:43:22 PM
Creator:	Administrator
Description:	The function of directing the missions of a patrol boat undertaken by the MRV.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 11:03:11 AM
Number:	CFM.1
decomposes:	Function: CFM Mission Command Function

Function: CFM.2 Mission Command Function Hydrographic Survey	
Created:	Tuesday, 1 December 2009 at 11:44:44 AM
Creator:	Administrator
Description:	The function of directing the missions of a hydrographic survey vessel undertaken by the MRV.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 11:03:06 AM
Number:	CFM.2
decomposes:	Function: CFM Mission Command Function

Function: CFM.3 Mission Command Function Mine Counter Measures	
Created:	Tuesday, 1 December 2009 at 11:46:40 AM
Creator:	Administrator
Description:	The function of directing the missions of a mine counter measures vessel undertaken by the MRV.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 11:03:13 AM
Number:	CFM.3
decomposes:	Function: CFM Mission Command Function

Function: CFV Vessel Command Function	
Created:	Friday, 20 November 2009 at 02:42:10 PM
Creator:	Administrator
Description:	The function of controlling the non-mission specific functions on board the MRV. Examples may include vessel helm functions.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 11:03:09 AM
Number:	CFV
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: CPF Counter-Piracy Functions	
Created:	Tuesday, 17 November 2009 at 06:50:03 PM
Creator:	Administrator
Description:	Functions performed to counter piracy and armed robbery at sea.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 01:07:32 PM
Number:	CPF
based on:	Requirement: R.9.20.1.4 Counter-Piracy
decomposed by:	Function: BoardF Boarding Party Functions Function: DF Deadweight Functions Function: LRaSF.1 Boats Function: LRaSF.2 Helicopter Function: LRaSF.5 UAV Function: MF Manoeuvrability Functions Function: SF Sensor Functions Function: ShF Shallow Water Functions Function: SkF Seakeeping Functions Function: TF Transit Functions Function: TowF Towing Functions Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions
decomposes:	Function: 1 Patrol Boat Functions

Function: CTF Counter-Terrorism Functions	
Created:	Tuesday, 17 November 2009 at 06:48:37 PM
Creator:	Administrator
Description:	Offensive functions performed with the aim of preventing, deterring, pre-empt and respond to terrorism.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 01:07:32 PM
Number:	CTF
based on:	Requirement: R.9.20.1.3 Counter Terrorism
decomposed by:	Function: BoardF Boarding Party Functions Function: DF Deadweight Functions Function: LRaSF.1 Boats Function: LRaSF.2 Helicopter Function: LRaSF.5 UAV Function: MF Manoeuvrability Functions Function: MF.1 Low Speed Manoeuvrability Function: MF.2 High Speed Manoeuvrability Function: RF Range Functions Function: SF Sensor Functions Function: ShF Shallow Water Functions Function: SkF Seakeeping Functions Function: SvF Survivability Functions Function: TF Transit Functions Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions
decomposes:	Function: 1 Patrol Boat Functions

Function: DF Deadweight Functions	
Created:	Monday, 23 November 2009 at 05:25:26 PM
Creator:	Administrator
Description:	This is the function of providing space, in terms of volume or area, so that other vessel functions can be performed.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:48:48 PM
Number:	DF
decomposed by:	Function: DF.1 Endurance Functions Function: DF.2 Area Deadweight Function: DF.3 Volume Deadweight
decomposes:	Function: 4 Common Function: BMF Bathymetric Mapping Functions Function: BPF Border Protection Functions Function: CPF Counter-Piracy Functions Function: CTF Counter-Terrorism Functions Function: MhF Minehunting Functions Function: MsF Minesweeping Functions Function: OF Oceanographic Functions

Function: DF.1 Endurance Functions	
Created:	Thursday, 19 November 2009 at 03:39:35 PM
Creator:	Administrator
Description:	This is the function that covers the ability of the vessel to remain at sea for different periods of time. It encompasses functions such as storage of provisions, fuel and water. All of these functions require the allocation of volume within the vessel.
Execute Decomposition:	true
Last Modified:	Tuesday, 9 March 2010 at 04:42:50 PM
Number:	DF.1
decomposed by:	Function: DF.1.1 Short Endurance Function: DF.1.2 Long Endurance
decomposes:	Function: DF Deadweight Functions

Function: DF.1.1 Short Endurance	
Created:	Thursday, 19 November 2009 at 03:44:26 PM
Creator:	Administrator
Description:	This covers functions that enable a vessel endurance of less than 7 days at sea.
Execute Decomposition:	true
Last Modified:	Monday, 23 November 2009 at 05:27:38 PM
Number:	DF.1.1
decomposes:	Function: DF.1 Endurance Functions

Function: DF.1.2 Long Endurance	
Created:	Thursday, 19 November 2009 at 03:46:07 PM
Creator:	Administrator
Description:	These functions cover the ability of the vessel to remain at sea for a period greater than 7 days.
Execute Decomposition:	true
Last Modified:	Tuesday, 9 March 2010 at 04:47:12 PM
Number:	DF.1.2
decomposes:	Function: DF.1 Endurance Functions

Function: DF.2 Area Deadweight	
Created:	Monday, 23 November 2009 at 05:29:27 PM
Creator:	Administrator
Description:	This the function of providing deck space for items such as crew and other spaces, which will be required to be located on board the vessel.
Execute Decomposition:	true
Last Modified:	Wednesday, 17 March 2010 at 11:14:52 AM
Number:	DF.2
decomposes:	Function: AccomF Accommodation Functions Function: CDF Clearance Diver Function Function: DF Deadweight Functions Function: LRaSF Launch, Recover and Stow Functions Function: MaintF Maintenance Functions Function: MedF Medical Functions Function: NF Navigation Functions

Function: DF.3 Volume Deadweight	
Created:	Tuesday, 8 December 2009 at 11:38:21 AM
Creator:	Administrator
Description:	This the function of providing volume for items such as boats, unmanned vehicles shipping containers, which will be required to be stowed on board the vessel. It differs from Area deadweight by the necessity to provide space to objects of a given height that could be more than the standard deckheight on board a vessel.
Execute Decomposition:	true
Last Modified:	Friday, 19 March 2010 at 01:29:23 PM
Number:	DF.3
decomposes:	Function: BF Ballast Functions Function: CDF Clearance Diver Function Function: DF Deadweight Functions Function: LRaSF Launch, Recover and Stow Functions Function: MaintF Maintenance Functions Function: WF.8 Munitions Stowage

Function: EPF Environmental Protection Functions	
Created:	Monday, 1 March 2010 at 02:48:35 PM
Creator:	Administrator
Description:	These are the functions that ensure that the vessel will have minimal environmental impact on the environments that it operates in. This will included systems such as oil / water separator etc.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 01:01:47 PM
Number:	EPF
decomposed by:	Function: EPF.1 Waste Treatment Functions
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: EPF.1 Waste Treatment Functions	
Created:	Monday, 1 March 2010 at 11:09:42 AM
Creator:	Administrator
Description:	These functions will perform the waste management for the vessel.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 01:01:47 PM
Number:	EPF.1
decomposes:	Function: EPF Environmental Protection Functions

Function: HSF Hotel Services Functions	
Created:	Monday, 23 November 2009 at 05:43:17 PM
Creator:	Administrator
Description:	The function of providing hotel services to the spaces within the vessel.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 01:01:41 PM
Number:	HSF
decomposed by:	Function: HSF.1 Catering Functions Function: HSF.2 Water Service
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: HSF.1 Catering Functions	
Created:	Monday, 1 March 2010 at 11:17:20 AM
Creator:	Administrator
Description:	These are the functions of providing catering for the embarked personnel.
Execute Decomposition:	true
Last Modified:	Monday, 1 March 2010 at 11:20:04 AM
Number:	HSF.1
decomposes:	Function: HSF Hotel Services Functions

Function: HSF.2 Water Service	
Created:	Monday, 1 March 2010 at 11:21:15 AM
Creator:	Administrator
Description:	This is the function of providing fresh, grey and black water services to the spaces within the vessel.
Execute Decomposition:	true
Last Modified:	Monday, 1 March 2010 at 11:22:41 AM
Number:	HSF.2
decomposes:	Function: HSF Hotel Services Functions

Function: HVAC HVAC Functions	
Created:	Monday, 23 November 2009 at 05:40:10 PM
Creator:	Administrator
Description:	The function of heating, ventilation and air-conditioning of the vessel's spaces.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:48:59 PM
Number:	HVAC
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: IntF Interoperability Functions	
Created:	Monday, 1 March 2010 at 01:49:53 PM
Creator:	Administrator
Description:	These are the functions that will allow the vessel to be interoperable with other vessels of the same class, other RAN vessels and the vessels of our allies. This is typically done by using the same / similar systems between vessels and allies.
Execute Decomposition:	true
Last Modified:	Friday, 19 March 2010 at 01:28:18 PM
Number:	IntF
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: LRaSF Launch, Recover and Stow Functions	
Created:	Thursday, 19 November 2009 at 02:13:57 PM
Creator:	Administrator
Description:	This function also covers the stowage of the item being launched and recovered.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 11:04:31 AM
Number:	LRaSF
decomposed by:	Function: DF.2 Area Deadweight Function: DF.3 Volume Deadweight Function: LRaSF.1 Boats Function: LRaSF.2 Helicopter Function: LRaSF.3 UUV Function: LRaSF.4 USV Function: LRaSF.5 UAV Function: LRaSF.6 ROV
outputs:	Item: I.2 Threat Information
triggered by:	Item: I.1 Threat Detected

Function: LRaSF.1 Boats	
Created:	Thursday, 19 November 2009 at 02:26:06 PM
Creator:	Administrator
Description:	The function of launching, recovering and stowing of RHIBs, sea boats, etc.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:49:09 PM
Number:	LRaSF.1
decomposes:	Function: 4 Common Function: BMF Bathymetric Mapping Functions Function: BPF Border Protection Functions Function: CDF Clearance Diver Function Function: CPF Counter-Piracy Functions Function: CTF Counter-Terrorism Functions Function: LRaSF Launch, Recover and Stow Functions Function: MhF Minehunting Functions Function: MsF Minesweeping Functions Function: OF Oceanographic Functions

Function: LRaSF.2 Helicopter	
Created:	Thursday, 19 November 2009 at 02:27:27 PM
Creator:	Administrator
Description:	The function of launching, recovering and stowing a helicopter.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:52:39 PM
Number:	LRaSF.2
decomposes:	Function: 2 Hydrographic Survey Functions Function: 5 Two of Three Function: BPF Border Protection Functions Function: CPF Counter-Piracy Functions Function: CTF Counter-Terrorism Functions Function: LRaSF Launch, Recover and Stow Functions
outputs:	Item: I.2 Threat Information
triggered by:	Item: I.1 Threat Detected

Function: LRaSF.3 UUV	
Created:	Thursday, 19 November 2009 at 02:28:48 PM
Creator:	Administrator
Description:	The function of launching, recovering and stowing an unmanned underwater vehicle.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:52:39 PM
Number:	LRaSF.3
decomposes:	Function: 5 Two of Three Function: BMF Bathymetric Mapping Functions Function: LRaSF Launch, Recover and Stow Functions Function: MhF Minehunting Functions Function: MsF Minesweeping Functions Function: OF Oceanographic Functions

Function: LRaSF.4 USV	
Created:	Thursday, 19 November 2009 at 02:32:22 PM
Creator:	Administrator
Description:	The function of launching, recovery and stowage of an unmanned surface vessel
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:52:39 PM
Number:	LRaSF.4
decomposes:	Function: 5 Two of Three Function: BMF Bathymetric Mapping Functions Function: LRaSF Launch, Recover and Stow Functions Function: MhF Minehunting Functions Function: MsF Minesweeping Functions

Function: LRaSF.5 UAV	
Created:	Thursday, 19 November 2009 at 02:35:34 PM
Creator:	Administrator
Description:	The function of launching, recovery and stowage of an unmanned aerial vehicle.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:52:39 PM
Number:	LRaSF.5
decomposes:	Function: 2 Hydrographic Survey Functions Function: 5 Two of Three Function: BPF Border Protection Functions Function: CPF Counter-Piracy Functions Function: CTF Counter-Terrorism Functions Function: LRaSF Launch, Recover and Stow Functions
outputs:	Item: I.2 Threat Information
triggered by:	Item: I.1 Threat Detected

Function: LRaSF.6 ROV	
Created:	Thursday, 19 November 2009 at 02:38:14 PM
Creator:	Administrator
Description:	The function of launching, recovery and stowage of a remotely operated vehicle.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:52:39 PM
Number:	LRaSF.6
decomposes:	Function: 5 Two of Three Function: BMF Bathymetric Mapping Functions Function: LRaSF Launch, Recover and Stow Functions Function: MhF Minehunting Functions Function: MsF Minesweeping Functions Function: OF Oceanographic Functions

Function: MaintF Maintenance Functions	
Created:	Monday, 1 March 2010 at 02:17:17 PM
Creator:	Administrator
Description:	These functions will provide the vessel with the ability to perform maintenance on the machinery and systems on board the vessel. This will required space for workshops and equipment
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:49:14 PM
Number:	MaintF
decomposed by:	Function: DF.2 Area Deadweight Function: DF.3 Volume Deadweight
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: MedF Medical Functions	
Created:	Monday, 1 March 2010 at 01:32:06 PM
Creator:	Administrator
Description:	The function of providing medical assistance to sick or injured embarked personnel.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:49:14 PM
Number:	MedF
decomposed by:	Function: DF.2 Area Deadweight
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: MF Manoeuvrability Functions	
Created:	Thursday, 19 November 2009 at 11:51:27 AM
Creator:	Administrator
Description:	The ability to manoeuvre the vessel including station holding
Execute Decomposition:	true
Last Modified:	Monday, 1 March 2010 at 02:32:52 PM
Number:	MF
decomposed by:	Function: MF.1 Low Speed Manoeuvrability Function: MF.2 High Speed Manoeuvrability
decomposes:	Function: 1 Patrol Boat Functions Function: BPF Border Protection Functions Function: CPF Counter-Piracy Functions Function: CTF Counter-Terrorism Functions

Function: MF.1 Low Speed Manoeuvrability	
Created:	Thursday, 19 November 2009 at 11:52:36 AM
Creator:	Administrator
Description:	This function will be required when performing functions such as launch and recover and boarding during border protection functions.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:49:17 PM
Number:	MF.1
decomposes:	Function: 4 Common Function: BMF Bathymetric Mapping Functions Function: CTF Counter-Terrorism Functions Function: MF Manoeuvrability Functions Function: MhF Minehunting Functions Function: MsF Minesweeping Functions Function: OF Oceanographic Functions Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions

Function: MF.2 High Speed Manoeuvrability	
Created:	Thursday, 19 November 2009 at 11:53:12 AM
Creator:	Administrator
Description:	This function will be required when performing pursuits during border protection functions
Execute Decomposition:	true
Last Modified:	Tuesday, 9 March 2010 at 04:42:00 PM
Number:	MF.2
decomposes:	Function: CTF Counter-Terrorism Functions Function: MF Manoeuvrability Functions Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions

Function: MhF Minehunting Functions	
Created:	Monday, 23 November 2009 at 02:30:30 PM
Creator:	Administrator
Description:	The functions of actively detecting and neutralising individual mines.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 01:07:32 PM
Number:	MhF
based on:	Requirement: R.9.20.3.1 Minehunting
decomposed by:	Function: DF Deadweight Functions Function: LRaSF.1 Boats Function: LRaSF.3 UUV Function: LRaSF.4 USV Function: LRaSF.6 ROV Function: MF.1 Low Speed Manoeuvrability Function: RF Range Functions Function: SF.1.2 Underwater Sensors Function: ShF Shallow Water Functions Function: SkF Seakeeping Functions Function: SvF Survivability Functions Function: TF Transit Functions
decomposes:	Function: 3 Mine Counter Measure Functions

Function: MoF Mooring Functions	
Created:	Friday, 18 December 2009 at 10:54:17 AM
Creator:	Administrator
Description:	These are the functions that allow the vessel to berth and anchor.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:49:23 PM
Number:	MoF
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: MsF Minesweeping Functions	
Created:	Monday, 23 November 2009 at 02:27:38 PM
Creator:	Administrator
Description:	The function of clearing / disposing of mines in a minefield.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 01:07:32 PM
Number:	MsF
based on:	Requirement: R.9.20.3.2 Minesweeping
decomposed by:	Function: DF Deadweight Functions Function: LRaSF.1 Boats Function: LRaSF.3 UUV Function: LRaSF.4 USV Function: LRaSF.6 ROV Function: MF.1 Low Speed Manoeuvrability Function: RF Range Functions Function: SF.1.2 Underwater Sensors Function: SkF Seakeeping Functions Function: SvF Survivability Functions Function: TF Transit Functions
decomposes:	Function: 3 Mine Counter Measure Functions

Function: NF Navigation Functions	
Created:	Thursday, 19 November 2009 at 05:37:33 PM
Creator:	Administrator
Description:	The functions that allow the vessel to be navigated. These will include all of the sensors used in navigation.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:49:33 PM
Number:	NF
decomposed by:	Function: DF.2 Area Deadweight
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: OF Oceanographic Functions	
Created:	Tuesday, 24 November 2009 at 02:29:19 PM
Creator:	Administrator
Description:	These are the functions that will enable roles such as rapid environmental assessment to be performed by the vessel.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 01:07:32 PM
Number:	OF
based on:	Requirement: R.9.20.2.2 Oceanographic Survey
decomposed by:	Function: DF Deadweight Functions Function: LRaSF.1 Boats Function: LRaSF.3 UUV Function: LRaSF.6 ROV Function: MF.1 Low Speed Manoeuvrability Function: RF Range Functions Function: ShF Shallow Water Functions Function: SkF Seakeeping Functions Function: TF Transit Functions
decomposes:	Function: 2 Hydrographic Survey Functions

Function: RF Range Functions	
Created:	Thursday, 19 November 2009 at 01:46:02 PM
Creator:	Administrator
Description:	This is the function that covers the ability of the vessel to transit different distances. The greater the vessel's range, the larger the vessels effective area of operation [21]. The availability of RAS functions will also greatly increase range.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:49:35 PM
Number:	RF
decomposed by:	Function: RF.1 Short Range Functions Function: RF.2 Long range Functions Function: RF.3 RAS
decomposes:	Function: 4 Common Function: BMF Bathymetric Mapping Functions Function: BPF Border Protection Functions Function: CTF Counter-Terrorism Functions Function: MhF Minehunting Functions Function: MsF Minesweeping Functions Function: OF Oceanographic Functions

Function: RF.1 Short Range Functions	
Created:	Thursday, 19 November 2009 at 02:04:59 PM
Creator:	Administrator
Description:	This function covers transits that will be less than 3000 nautical miles at a medium speed transit.
Execute Decomposition:	true
Last Modified:	Tuesday, 9 March 2010 at 04:46:47 PM
Number:	RF.1
decomposes:	Function: RF Range Functions

Function: RF.2 Long range Functions	
Created:	Thursday, 19 November 2009 at 02:08:11 PM
Creator:	Administrator
Description:	This function covers transits of more than 3000 nautical miles at medium speed.
Execute Decomposition:	true
Last Modified:	Tuesday, 9 March 2010 at 04:44:58 PM
Number:	RF.2
decomposes:	Function: RF Range Functions

Function: RF.3 RAS	
Created:	Thursday, 19 November 2009 at 02:09:41 PM
Creator:	Administrator
Description:	This function covers the ability of the vessel to receive fuel and stores from a supply vessel.
Execute Decomposition:	true
Last Modified:	Tuesday, 9 March 2010 at 04:43:53 PM
Number:	RF.3
decomposes:	Function: RF Range Functions

Function: SF Sensor Functions	
Created:	Tuesday, 17 November 2009 at 06:18:55 PM
Creator:	Administrator
Description:	The functions of performing surveillance and detection of threats and items of interest.
Execute Decomposition:	true
Last Modified:	Monday, 1 March 2010 at 05:13:49 PM
Number:	SF
based on:	Requirement: R.9.20.1.7 Surveillance and Response
decomposed by:	Function: SF.1 Electronic Sensors Function: SF.2 Visual Surveillance and Detection
decomposes:	Function: BPF Border Protection Functions Function: CPF Counter-Piracy Functions Function: CTF Counter-Terrorism Functions
outputs:	Item: I.1 Threat Detected

Function: SF.1 Electronic Sensors	
Created:	Thursday, 19 November 2009 at 05:31:45 PM
Creator:	Administrator
Description:	The function of sensing threats and the environment using electronic systems.
Execute Decomposition:	true
Last Modified:	Tuesday, 9 March 2010 at 04:42:23 PM
Number:	SF.1
decomposed by:	Function: SF.1.1 Above Water Sensors Function: SF.1.2 Underwater Sensors
decomposes:	Function: SF Sensor Functions

Function: SF.1.1 Above Water Sensors	
Created:	Friday, 20 November 2009 at 01:07:02 PM
Creator:	Administrator
Description:	The function of monitoring the air environment around the vessel.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:49:58 PM
Number:	SF.1.1
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common Function: SF.1 Electronic Sensors

Function: SF.1.2 Underwater Sensors	
Created:	Friday, 20 November 2009 at 01:08:57 PM
Creator:	Administrator
Description:	The function of monitoring the underwater environment around the vessel.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:49:58 PM
Number:	SF.1.2
decomposes:	Function: 4 Common Function: BMF Bathymetric Mapping Functions Function: MhF Minehunting Functions Function: MsF Minesweeping Functions Function: SF.1 Electronic Sensors

Function: SF.2 Visual Surveillance and Detection	
Created:	Thursday, 19 November 2009 at 05:33:04 PM
Creator:	Administrator
Description:	The function of performing surveillance and detection visually
Execute Decomposition:	true
Last Modified:	Tuesday, 1 December 2009 at 11:29:30 AM
Number:	SF.2
decomposes:	Function: SF Sensor Functions

Function: ShF Shallow Water Functions	
Created:	Monday, 1 March 2010 at 02:35:25 PM
Creator:	Administrator
Description:	This is the function that will give the vessel the ability to operate in shallow waters. Possible ways of performing these functions could be to restrict the vessel's draft, or use interfacing systems (e.g. RHIBs) to conduct operations in shallow waters.
Execute Decomposition:	true
Last Modified:	Thursday, 18 March 2010 at 05:54:55 PM
Number:	ShF
decomposes:	Function: 4 Common Function: BMF.1 Shallow Bathymetric Mapping Function: BPF Border Protection Functions Function: CPF Counter-Piracy Functions Function: CTF Counter-Terrorism Functions Function: MhF Minehunting Functions Function: OF Oceanographic Functions Function: WF.6 Assault Force Functions Function: WF.7 Special Forces Functions Function: WFL Littoral Warfighting Functions

Function: SkF Seakeeping Functions	
Created:	Tuesday, 17 November 2009 at 06:52:22 PM
Creator:	Administrator
Description:	The ability to operate in different ocean environments.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 01:05:39 PM
Number:	SkF
decomposed by:	Function: SkF.1 Protected Waters Seakeeping Functions Function: SkF.2 Offshore Seakeeping Functions Function: SkF.3 Unlimited Seakeeping Functions Function: SkF.4 Motion Stabilisation Functions
decomposes:	Function: 4 Common Function: BMF Bathymetric Mapping Functions Function: BPF Border Protection Functions Function: CPF Counter-Piracy Functions Function: CTF Counter-Terrorism Functions Function: MhF Minehunting Functions Function: MsF Minesweeping Functions Function: OF Oceanographic Functions

Function: SkF.1 Protected Waters Seakeeping Functions	
Created:	Tuesday, 17 November 2009 at 06:57:06 PM
Creator:	Administrator
Description:	The ability to operate on protected waters to the top of sea state 3 [22]. This function also means that the vessel will be required to operate within shallow waters (SML has draft of 2.2 meters) [17]. Could be achieved by ASV/Boats.
Execute Decomposition:	true
Last Modified:	Tuesday, 9 March 2010 at 04:41:43 PM
Number:	SkF.1
decomposes:	Function: BMF Bathymetric Mapping Functions Function: SkF Seakeeping Functions

Function: SkF.2 Offshore Seakeeping Functions	
Created:	Tuesday, 17 November 2009 at 06:58:47 PM
Creator:	Administrator
Description:	The ability to operate to the top of sea state 5 [22].
Execute Decomposition:	true
Last Modified:	Wednesday, 3 March 2010 at 04:17:24 PM
Number:	SkF.2
decomposes:	Function: BMF Bathymetric Mapping Functions Function: SkF Seakeeping Functions

Function: SkF.3 Unlimited Seakeeping Functions	
Created:	Tuesday, 17 November 2009 at 07:00:29 PM
Creator:	Administrator
Description:	The ability to operate to the top of sea state 6 [22].
Execute Decomposition:	true
Last Modified:	Friday, 27 November 2009 at 02:30:43 PM
Number:	SkF.3
decomposes:	Function: SkF Seakeeping Functions

Function: SkF.4 Motion Stabilisation Functions	
Created:	Tuesday, 24 November 2009 at 02:41:37 PM
Creator:	Administrator
Description:	The function of providing motion reduction to the vessel, in order to improve the habitability for the crew, along with enabling functions such as launch recover and stow. Motion stabilisation functions are linked to the seakeeping performance of the vessel.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 01:12:49 PM
Number:	SkF.4
decomposed by:	Function: SkF.4.1 Passive Stabilisation Functions Function: SkF.4.2 Active Stabilisation Functions
decomposes:	Function: SkF Seakeeping Functions

Function: SkF.4.1 Passive Stabilisation Functions	
Created:	Tuesday, 24 November 2009 at 02:50:58 PM
Creator:	Administrator
Description:	Passive motion stabilisation functions do not require any input and include appendages such as bilge keels.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 01:13:00 PM
Number:	SkF.4.1
decomposes:	Function: SkF.4 Motion Stabilisation Functions

Function: SkF.4.2 Active Stabilisation Functions	
Created:	Tuesday, 24 November 2009 at 02:53:25 PM
Creator:	Administrator
Description:	These are the active vessel motion stabilisers that receive inputs in the form of power and control. They include systems such as fin stabilisers and anti-roll tanks.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 01:13:11 PM
Number:	SkF.4.2
decomposes:	Function: SkF.4 Motion Stabilisation Functions

Function: StabF Stability Functions	
Created:	Monday, 1 March 2010 at 02:07:07 PM
Creator:	Administrator
Description:	This is the ability of the vessel to remain stable when both intact and damaged. It will include aspects such as ballasting and watertight subdivision.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:50:16 PM
Number:	StabF
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: StrF Strength Functions	
Created:	Monday, 1 March 2010 at 04:42:11 PM
Creator:	Administrator
Description:	This is the function of providing structural strength to the MRV. This function will encompass the initial structural design, as well as the through life maintenance of structural integrity of the vessel. The strength function will also encapsulate the type of classification that the vessel structure will be designed to meet.
Execute Decomposition:	true
Last Modified:	Wednesday, 26 May 2010 at 11:02:43 AM
Number:	StrF
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: SubF Subsearch Functions	
Created:	Monday, 1 March 2010 at 03:50:23 PM
Creator:	Administrator
Description:	This function will allow the vessel to perform searches for damaged / disabled submarines.
Execute Decomposition:	true
Last Modified:	Monday, 1 March 2010 at 05:14:50 PM
Number:	SubF
based on:	Requirement: R.9.20.2.3 Subsearch
decomposes:	Function: 2 Hydrographic Survey Functions

Function: SvF Survivability Functions	
Created:	Friday, 20 November 2009 at 01:11:37 PM
Creator:	Administrator
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:52:48 PM
Number:	SvF
decomposed by:	Function: SvF.1 Susceptibility Functions Function: SvF.2 Vulnerability Functions Function: SvF.3 Recoverability Functions
decomposes:	Function: 5 Two of Three Function: CTF Counter-Terrorism Functions Function: MhF Minehunting Functions Function: MsF Minesweeping Functions Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions

Function: SvF.1 Susceptibility Functions	
Created:	Friday, 20 November 2009 at 02:17:06 PM
Creator:	Administrator
Description:	The function of reducing the signature of the vessel. This function will cover aspects such as radar absorbing paints, degaussing and a quiet running capability.
Execute Decomposition:	true
Last Modified:	Monday, 1 March 2010 at 03:00:19 PM
Number:	SvF.1
decomposes:	Function: SvF Survivability Functions

Function: SvF.2 Vulnerability Functions	
Created:	Friday, 20 November 2009 at 02:26:11 PM
Creator:	Administrator
Description:	The function of protecting the capabilities of the vessel. These functions could include shock hardening and CBRN defence capabilities.
Execute Decomposition:	true
Last Modified:	Monday, 1 March 2010 at 02:48:23 PM
Number:	SvF.2
decomposes:	Function: SvF Survivability Functions

Function: SvF.3 Recoverability Functions	
Created:	Friday, 20 November 2009 at 02:28:17 PM
Creator:	Administrator
Description:	The functions of recovering capabilities following a damage event. The will include functions such as damage control and fire fighting.
Execute Decomposition:	true
Last Modified:	Tuesday, 9 March 2010 at 04:41:10 PM
Number:	SvF.3
decomposes:	Function: SvF Survivability Functions

Function: TF Transit Functions	
Created:	Tuesday, 17 November 2009 at 05:57:28 PM
Creator:	Administrator
Description:	These are the functions of transiting the vessel at different speeds.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:50:18 PM
Number:	TF
decomposed by:	Function: TF.1 Low Speed Transit Function: TF.2 Medium Speed Transit Function: TF.3 High Speed Transit
decomposes:	Function: 4 Common Function: BMF Bathymetric Mapping Functions Function: BPF Border Protection Functions Function: CPF Counter-Piracy Functions Function: CTF Counter-Terrorism Functions Function: MhF Minehunting Functions Function: MsF Minesweeping Functions Function: OF Oceanographic Functions

Function: TF.1 Low Speed Transit	
Created:	Tuesday, 17 November 2009 at 06:01:38 PM
Creator:	Administrator
Description:	Transiting the vessel at a speed between 0 and 7 knots
Execute Decomposition:	true
Last Modified:	Monday, 30 November 2009 at 04:25:56 PM
Number:	TF.1
decomposes:	Function: TF Transit Functions

Function: TF.2 Medium Speed Transit	
Created:	Tuesday, 17 November 2009 at 05:59:18 PM
Creator:	Administrator
Description:	Transiting the vessel at a speed between 8 and 16 knots
Execute Decomposition:	true
Last Modified:	Monday, 30 November 2009 at 04:25:56 PM
Number:	TF.2
decomposes:	Function: TF Transit Functions

Function: TF.3 High Speed Transit	
Created:	Tuesday, 17 November 2009 at 05:58:23 PM
Creator:	Administrator
Description:	Transiting the vessel at a speed above 17 knots
Execute Decomposition:	true
Last Modified:	Monday, 30 November 2009 at 01:55:19 PM
Number:	TF.3
decomposes:	Function: TF Transit Functions

Function: TowF Towing Functions	
Created:	Thursday, 19 November 2009 at 03:36:26 PM
Creator:	Administrator
Description:	The function of towing apprehended vessels and other deployable items such as a side scan sonar during hydrographic survey functions.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:52:52 PM
Number:	TowF
decomposes:	Function: 5 Two of Three Function: BMF Bathymetric Mapping Functions Function: BPF Border Protection Functions Function: CPF Counter-Piracy Functions

Function: TrF Training Functions	
Created:	Thursday, 30 September 2010 at 11:22:48 AM
Creator:	Administrator
Description:	This is the function of providing facilities for training
Execute Decomposition:	true
Last Modified:	Thursday, 30 September 2010 at 03:58:05 PM
Number:	TrF
decomposes:	Function: 1 Patrol Boat Functions Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common

Function: WF.1 Deterrent	
Created:	Tuesday, 17 November 2009 at 06:09:01 PM
Creator:	Administrator
Description:	This function is the passive deterrent provided by the presence of a military vessel. It is based on the assumption that a military vessel will have some defensive armament such as guns and small to medium calibre arms.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:50:28 PM
Number:	WF.1
decomposes:	Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions

Function: WF.2 ASW	
Created:	Tuesday, 17 November 2009 at 06:11:01 PM
Creator:	Administrator
Description:	Anti-submarine warfare.
Execute Decomposition:	true
Last Modified:	Monday, 1 March 2010 at 10:50:27 AM
Number:	WF.2
decomposes:	Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions

Function: WF.3 AAW	
Created:	Tuesday, 17 November 2009 at 06:11:59 PM
Creator:	Administrator
Description:	Anti-air warfare.
Execute Decomposition:	true
Last Modified:	Monday, 1 March 2010 at 10:50:39 AM
Number:	WF.3
decomposes:	Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions

Function: WF.4 ASuW	
Created:	Tuesday, 17 November 2009 at 06:13:16 PM
Creator:	Administrator
Description:	Anti-surface warfare.
Execute Decomposition:	true
Last Modified:	Monday, 1 March 2010 at 10:50:49 AM
Number:	WF.4
decomposes:	Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions

Function: WF.5 Countermeasures	
Created:	Tuesday, 17 November 2009 at 06:14:20 PM
Creator:	Administrator
Description:	Self protection functions that act against hostile weapon attacks.
Execute Decomposition:	true
Last Modified:	Thursday, 11 March 2010 at 05:10:41 PM
Number:	WF.5
decomposes:	Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions

Function: WF.6 Assault Force Functions	
Created:	Thursday, 19 November 2009 at 02:22:24 PM
Creator:	Administrator
Description:	This is the functional ability to embark / disembark an assault force and equipment.
Execute Decomposition:	true
Last Modified:	Tuesday, 9 March 2010 at 04:43:42 PM
Number:	WF.6
decomposed by:	Function: ShF Shallow Water Functions
decomposes:	Function: WFL Littoral Warfighting Functions

Function: WF.7 Special Forces Functions	
Created:	Tuesday, 17 November 2009 at 06:51:11 PM
Creator:	Administrator
Description:	Functions that involve the use of Special Forces personnel and/or equipment.
Execute Decomposition:	true
Last Modified:	Monday, 1 March 2010 at 05:13:06 PM
Number:	WF.7
based on:	Requirement: R.9.20.1.5 Special Forces Support
decomposed by:	Function: ShF Shallow Water Functions
decomposes:	Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions

Function: WF.8 Munitions Stowage	
Created:	Monday, 1 March 2010 at 10:52:19 AM
Creator:	Administrator
Description:	This is the function of providing room to stow the munitions to be used by the weapons systems on board.
Execute Decomposition:	true
Last Modified:	Tuesday, 16 March 2010 at 04:50:34 PM
Number:	WF.8
decomposed by:	Function: DF.3 Volume Deadweight
decomposes:	Function: 2 Hydrographic Survey Functions Function: 3 Mine Counter Measure Functions Function: 4 Common Function: WFL Littoral Warfighting Functions Function: WFO Offshore Warfighting Functions

Function: WFL Littoral Warfighting Functions	
Created:	Tuesday, 17 November 2009 at 06:45:25 PM
Creator:	Administrator
Description:	These are the warfighting functions that will be performed in the littoral environment.
Execute Decomposition:	true
Last Modified:	Thursday, 11 March 2010 at 05:09:21 PM
Number:	WFL
based on:	Requirement: R.9.20.1.1 Offshore and Littoral Warfighting Requirement: R.9.20.1.6 Security Requirement: R.9.20.1.7 Surveillance and Response
decomposed by:	Function: MF.1 Low Speed Manoeuvrability Function: MF.2 High Speed Manoeuvrability Function: ShF Shallow Water Functions Function: SvF Survivability Functions Function: WF.1 Deterrent Function: WF.2 ASW Function: WF.3 AAW Function: WF.4 AsuW Function: WF.5 Countermeasures Function: WF.6 Assault Force Functions Function: WF.7 Special Forces Functions Function: WF.8 Munitions Stowage
decomposes:	Function: 1 Patrol Boat Functions Function: CPF Counter-Piracy Functions Function: CTF Counter-Terrorism Functions

Function: WFO Offshore Warfighting Functions	
Created:	Tuesday, 17 November 2009 at 06:07:14 PM
Creator:	Administrator
Description:	Theses are the functions that may be performed during conflict in the offshore environment.
Execute Decomposition:	true
Last Modified:	Thursday, 11 March 2010 at 05:09:21 PM
Number:	WFO
based on:	Requirement: R.9.20.1.1 Offshore and Littoral Warfighting Requirement: R.9.20.1.6 Security Requirement: R.9.20.1.7 Surveillance and Response
decomposed by:	Function: MF.1 Low Speed Manoeuvrability Function: MF.2 High Speed Manoeuvrability Function: SvF Survivability Functions Function: WF.1 Deterrent Function: WF.2 ASW Function: WF.3 AAW Function: WF.4 AsuW Function: WF.5 Countermeasures Function: WF.7 Special Forces Functions Function: WF.8 Munitions Stowage
decomposes:	Function: 1 Patrol Boat Functions Function: CPF Counter-Piracy Functions Function: CTF Counter-Terrorism Functions

Appendix C: Complete Patrol Boat Hierarchical Function List

1	**Patrol Boat Functions**					
	AccomF	Accommodation Functions				
		AccomF.1	Crew Accommodation			
		AccomF.2	Austere Accommodation			
		DF.2	Area Deadweight			
	AF	Auxiliary Functions				
	BF	Ballast Functions				
		DF.3	Volume Deadweight			
	BPF	Border Protection Functions				
		BoardF	Boarding Party Functions			
		DF	Deadweight Functions			
			DF.1	Endurance Functions		
				DF.1.1	Short Endurance	
				DF.1.2	Long Endurance	
			DF.2	Area Deadweight		
			DF.3	Volume Deadweight		
		LraSF.1	Boats			
		LraSF.2	Helicopter			
		LraSF.5	UAV			
		MF	Manoeuvrability Functions			
			MF.1	Low Speed Manoeuvrability		
			MF.2	High Speed Manoeuvrability		
		RF	Range Functions			
			RF.1	Short Range Functions		
			RF.2	Long range Functions		
			RF.3	RAS		
		SF	Sensor Functions			
			SF.1	Electronic Sensors		
				SF.1.1	Above Water Sensors	
				SF.1.2	Underwater Sensors	
			SF.2	Visual Surveillance and Detection		
		ShF	Shallow Water Functions			
		SkF	Seakeeping Functions			
			SkF.1	Protected Waters Seakeeping Functions		
			SkF.2	Offshore Seakeeping Functions		
			SkF.3	Unlimited Seakeeping Functions		
			SkF.4	Motion Stabilisation Functions		
				SkF.4.1	Passive Stabilisation Functions	
				SkF.4.2	Active Stabilisation Functions	
		TF	Transit Functions			
			TF.1	Low Speed Transit		
			TF.2	Medium Speed Transit		
			TF.3	High Speed Transit		
		TowF	Towing Functions			
	CerF	Ceremonial Functions				

	CF	Communication Functions			
	CFM	Mission Command Function			
		CFM.1	Mission Command Function Patrol Boat		
		CFM.2	Mission Command Function Hydrographic Survey		
		CFM.3	Mission Command Function Mine Counter Measures		
	CFV	Vessel Command Function			
	CPF	Counter-Piracy Functions			
		BoardF	Boarding Party Functions		
		DF	Deadweight Functions		
		LraSF.1	Boats		
		LraSF.2	Helicopter		
		LraSF.5	UAV		
		MF	Manoeuvrability Functions		
		SF	Sensor Functions		
		ShF	Shallow Water Functions		
		SkF	Seakeeping Functions		
		TF	Transit Functions		
		TowF	Towing Functions		
		WFL	Littoral Warfighting Functions		
			MF.1	Low Speed Manoeuvrability	
			MF.2	High Speed Manoeuvrability	
			ShF	Shallow Water Functions	
			SvF	Survivability Functions	
				SvF.1	Susceptibility Functions
				SvF.2	Vulnerability Functions
				SvF.3	Recoverability Functions
			WF.1	Deterrent	
			WF.2	ASW	
			WF.3	AAW	
			WF.4	AsuW	
			WF.5	Countermeasures	
			WF.6	Assault Force Functions	
				ShF	Shallow Water Functions
			WF.7	Special Forces Functions	
				ShF	Shallow Water Functions
			WF.8	Munitions Stowage	
				DF.3	Volume Deadweight
		WFO	Offshore Warfighting Functions		
			MF.1	Low Speed Manoeuvrability	
			MF.2	High Speed Manoeuvrability	
			SvF	Survivability Functions	
			WF.1	Deterrent	
			WF.2	ASW	
			WF.3	AAW	
			WF.4	AsuW	
			WF.5	Countermeasures	
			WF.7	Special Forces Functions	
			WF.8	Munitions Stowage	

	CTF	Counter-Terrorism Functions		
		BoardF	Boarding Party Functions	
		DF	Deadweight Functions	
		LraSF.1	Boats	
		LraSF.2	Helicopter	
		LraSF.5	UAV	
		MF	Manoeuvrability Functions	
			MF.1	Low Speed Manoeuvrability
			MF.2	High Speed Manoeuvrability
		RF	Range Functions	
		SF	Sensor Functions	
		ShF	Shallow Water Functions	
		SkF	Seakeeping Functions	
		SvF	Survivability Functions	
		TF	Transit Functions	
		WFL	Littoral Warfighting Functions	
		WFO	Offshore Warfighting Functions	
	EPF	Environmental Protection Functions		
		EPF.1	Waste Treatment Functions	
	HSF	Hotel Services Functions		
		HSF.1	Catering Functions	
		HSF.2	Water Service	
	HVAC	HVAC Functions		
	IntF	Interoperability Functions		
	MaintF	Maintenance Functions		
		DF.2	Area Deadweight	
		DF.3	Volume Deadweight	
	MedF	Medical Functions		
		DF.2	Area Deadweight	
	MF	Manoeuvrability Functions		
	MoF	Mooring Functions		
	NF	Navigation Functions		
		DF.2	Area Deadweight	
	SF.1.1	Above Water Sensors		
	StabF	Stability Functions		
	StrF	Strength Functions		
	TrF	Training Functions		
	WFL	Littoral Warfighting Functions		
	WFO	Offshore Warfighting Functions		

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19. ABSTRACT

The concept of utilising a base platform that can be reconfigured for different roles using modules is becoming prevalent in minor warship design. These reconfigurable vessels have been designated as Multi-Role Vessels (MRVs). Incorporating different combinations of common functions into the design of a base MRV platform will have varying implications on how the base MRV will look and perform. This report focuses on the requirements and functional analysis activities within an MRV system's concept design phase. Using the iterative nature of these activities, a process is developed that can identify the functions that will be common across the roles that an MRV is to perform. In the process, Systems Engineering approaches and tools are adopted and used in consultation with the stakeholders to identify a set of functions the MRV will perform. The validity of the process is tested using a pilot study for an MRV that will carry out patrol, mine counter measure and hydrographic survey roles.