COASTAL PATROL INTERCEPTOR FOR WEST AFRICA

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SUMMARY

This paper presents the development of a coastal patrol interceptor concept. The vessel is based on a high-speed trimaran platform, with an aluminium hull and composite superstructure. The outriggers provide improved stability in high sea states over a conventional planing hull. It will provide coastal patrol for fishery protection and anti-piracy in the Gulf of Guinea. Several coastal patrol interceptors would operate from ports along the coast to maximise operational range. The vessel exterior has an aggressive and sleek geometric design language, inspired by stealth aircraft and vessels. This gives the vessel a specific visual presence in the field of operation to help communicate its function.

1. INTRODUCTION

This paper presents a project to develop an interceptor vessel to specifically address the current issued faced in the Gulf of Guinea and other regions of the world that suffer the effects of piracy, drug smuggling, human trafficking and illegal fishing. Through an engagement in Design-Driven Innovation a design scenario was developed through dialogue with cultural and technological interpreters. Namely, a Naval Architect specialising in high-speed craft design, an offshore private security contractor and consultant with significant experience of piracy issues, a HSC human factors consultant and an academic researcher with a research specialism in piracy issues relating to Africa. A detailed analysis of culturally specific issues of the nature of piracy and fishery protection of West Africa combined with a review of current International policy implementation in the area, resulted in a clear identification of the target market and the specification for a vessels to meet the operational requirements in this area.

The global impact of piracy on the world is growing as the economic and social struggle in these deprived regions turn to extreme measures to feed their families and make a stand against the vast wealth that is being gained from the oil and other resources in these seas. Also the impact of Illegal, Unreported and Unregulated fishing (IUU) is uncontrolled leading to fears that this will largely affect the populations on the coast line that are dependent on fish for their source of protein. The current economic situation in these regions restrict individual states from being able to effectively tackle the problem. Unclear definitions over territorial laws and a lack of coordination between these West African nations has enabled piracy to escalate with ambiguities and ways to avoid conviction or capture. The current market lacks a vessel with a common platform on which to base multiple vessels capable of suiting the needs of several operations in different regions around the world. There is a clear need for a multi-role vessel to combat piracy, illegal fishing, human and drugs trafficking. This vessel would need to be able to be constructed from a range of materials for different market price sectors to appeal to wide range of organisations and governments, as well as private maritime security companies.

1.1 THE GULF OF GUINEA

The Gulf of Guinea is an important maritime route for commercial shipping from Europe and America to West, Central and Southern Africa. Its proximity to Europe and North America for the transportation of the low-sulphur crude oil from the region further raises its importance in the global supply of energy. The region produces about 5.4 million barrels of crude oil per day. The United States sources 15% of its supplies from the Gulf of Guinea. China and Japan depend on it for a substantial amount of their oil and gas. It also supplies France and other countries of Europe with Oil and Gas. Oil companies from the West and the East have made huge investments for both onshore and offshore drilling, and since the region has the fastest rate of discovery of new oil reserves in the world, it also attracts new investments for further exploration. Fishing trawlers come to the region from all over the world. Many are there illegally as a result of inadequate security measures. Forestry, agricultural and mineral resources are exported through the Gulf of Guinea to markets in Europe and America. [1]

Figure 1: Map of the Gulf of Guinea

Clearly the region is of significant importance to the world supply of crude oil and resources supplying some of the world's most powerful countries [2]. Economically piracy in the Gulf of Guinea costs the global economy between $740-950 million last year alone and is expected to rise next year. The US has already started to implement forces in the region such as the AMLEP and are examine the possibility of establishing a military base in Nigeria; they also have been steadily increasing spending on Nigeria's armed forces such as acquiring new boats and aircraft for their navy as they have done in Mozambique [3]. The Gulf of Guinea states cannot overcome maritime security challenges without the support of international partners, who need to help them address the root causes of these national security issues [4]. The region is very much reliant upon fish for its edible protein and the affects of IUU in these waters will lead to a much more dramatic impact in the future if these resources are depleted. The estimated value of the fishing industry is between $10-23 billion. If the illegal fishing is not addressed it will have a significant impact on the local populations. The resulting requirement for global aid to support the local communities would far exceed the cost of policing the issue [5].

1.2 OPERATIONAL CHALLENGES

The Gulf of Guinea is a vast expanse of water, stretching almost 6,000km from Senegal to Angola, with weak surveillance and uncoordinated security patrols. The historical focus of local states security policy on land security in the region has left the maritime domain unpatrolled. There has been increased incidence of armed robbery at sea and piracy; theft of hydrocarbon resources on the high seas/illegal bunkering; pipeline vandalism; illegal trafficking in arms, drugs and people; and illegal, unreported and unregulated fishing in the waters of the region. One specific political challenge of the host communities of the rich natural resources of the region is poverty, which is fuelling the illegal activities. There are unclear definitions of piracy and armed robbery at sea, as well as an inadequate legal framework for prosecuting criminals when intercepted. Environmental pollution from exploitation and exploratory activities, and accidents from oil spills are also a significant issue for the region. [1]

For a long time Gulf of Guinea states have neglected to exercise authority over their respective territorial waters due to the fact that they perceived insecurity as a land based phenomenon. Most of these states only observed their seas from the shore. Although the attitude of states to their territorial waters has changed since the recent discovery of oil, few have allocated substantial resources towards their maritime policies and in particular funding their military navies [6]. A key issue is that not all the nations suffer from the piracy impact in the same way, for example countries such as Nigeria are highly affected economically by the piracy of their oil reserves ($1 billion worth of oil is stolen each month) and so they are the leaders in the field in terms of their naval equipment and maritime force numbers. Whereas, other less economically developed countries in the region have symbolic maritime forces, with their navies having less than 1,00 men and fleets of less than 10 launches.

Next there are issues over the political problems facing the states of the region, much of the problem of oil theft may have root causes in Nigeria. The country has a population of around 150 million, and the average age is only 19. The Niger Delta is home to 30 million people, 30% of whom are unemployed. This does not just present an immediate domestic economic problem, but the toxic mix of organised crime, rising small-arms proliferation and insurgency, and high levels of youth unemployment has regional implications too [1]. The rise in piracy has led to an easy way for this young population to take the route of organised crime to help to afford to live and take a stand against the huge influx of wealth being created by the oil extraction that is damaging their local environment. It is this poverty stricken population that has taken non to kindly to the fact that this wealth is maybe not spread across the nation to help to develop these deprived regions or into the public sector (hospitals, schools etc.) However to pinpoint only Nigeria is an unfair representation of the overall problem that needs to be tackled as a region due to attacks occurring in foreign waters. This creates legal issues for the arresting and prosecution of attackers due to the laws surrounding territorial waters, pirates can easily evade capture by moving across territorial waters where they cannot be traced.

2.0 USER SCENARIO

For piracy to be tackled the regions must act on a united front through the co-operation of the likes of ECOWAS and ECCAS to truly deter these criminal organisations from operating in these waters. An example of one step that has been taken is Operation Prosperity, which is the joint patrol of Nigeria and Benin in their respected territories. This would include financial backing from the countries that rely so heavily on the resources in the area such as the way that the US have been supporting Nigeria and Mozambique to be able to afford new vessels and crew for said assets. However, a much more beneficial way to resolve some of the deeper underlying issues would be to create a lower budget vessel using local materials and local craftsmen to not only boost the local economy but also offer new jobs for the construction and manning of the vessels themselves. This aims to directly resolve the social issues faced in the poverty stricken areas whilst broadening the target market whilst keeping to the same platform design. The budget platform would need a different specification and carry out tasks such as intercepting illegal fishing ships due to a low top speed and less on board equipment. Then at the other end of the scale the same design platform could be manufactured using more costly materials using high spec armory for potential exchanges

of gunfire and high-speed pursuit of evading pirates. Using this level of adaptability opens a door to a much larger target market and list of clients all around the globe hoping to use the vessel for a variety of operations. The list of organisations include the likes of ECOWAS or ECCAS which would invest heavily to protect the economic interest in the regions such as the fishing and oil prosperities. Oil firms such as Shell who operate in this region would employ private maritime security companies such as Drum Cussac to protect their oil rigs [7] from attacks especially when $1 billion worth of oil is stolen every month, it is in their best interest to invest in such equipment.

This project uses Nigeria (see Figure 2) as an example infrastructure to implement on a larger scale across the Gulf of Guinea due to the concentration of attacks in these waters. The two main ports are Lagos and Port Harcourt, Port Harcourt being the link to the Niger Delta where some attacks occur within the inland river system. Therefore the proposed patrol craft is designed to support both littoral and riverine environments.

Figure 2: Overview of Nigeria's Geographical position

Initial plans had included the use of an offshore hub from which the Patrol vessel would deploy from, however the infrastructure needed to be put in place was considered to be too expensive and complicated.

However the African Union (AU) is working towards the Rapid establishment of standardized Regional Maritime Headquarters (MHQ), with Maritime Operational Coordination Centres (MOC). The goals of Regional MHQ and MOCs are twofold:

i. to increase the effectiveness and the efficiency of the African Standby Force (ASF) as African Navies participate in integrated operations, a move to improve Africa's Maritime response capabilities.

ii. to improve situational awareness within the African Maritime Domain (AMD), involving all organizations and agencies with a key role in maritime safety and security.

Therefore all Regional MHQs and MOCs would be interoperable (due to the use of Standard Operating Procedures (SOPs)) and inter-linked to both each other and the AU-based MHQs and MOCs to facilitate an information sharing network to enhance situational awareness and subsequent operational capability / performance. An example of the location of MHQs at Lagos and Port Harcourt are shown below in Figure 3.

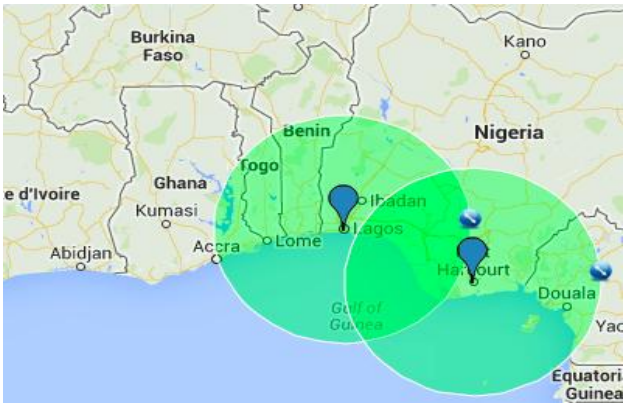

Figure 3: Map of potential Regional Maritime Headquarters (MHQ) at Lagos and Port Harcourt

The MHQs and MOCs will be located along a stretch of 3704km coastline (the total Gulf of Guinea) with the intention of allowing the patrol vessels to replenish their stocks and provide crew rotation, which may take a 24hr turnover period. Crews given improved accommodation at the MHQ allow for an effective down time to recuperate ready for their next deployment. An example operational scenario, based on Nigeria, would see the patrol vessels start from Port Harcourt and Lagos. From here, the vessels would transit 50nm to patrol the 250nm EEZ area, this includes the offshore oil fields and when required into International waters.

3. TARGET CLIENTS / OPERATORS

It is important to understand that patrol vessels may have a single owner, but they have multiple stakeholders who have an influence over their design, procurement and operation. Examples of these stakeholders include:

- The African Union
- Private Maritime Security Companies (PMSC's) e.g. Drum Cussac who are a subcrontractor for Dutch Shell.

- Economic Community Of West African States (ECOWAS) - a regional group of fifteen countries, founded in 1975. Its mission is to promote economic integration in "all fields of economic activity"

The target market is broad in the sense that the vessel could be operated in many areas of the world due to its short draft and stability in heavy seas due to its design. However the AU would be the main client as they hope to reach their AIM for 2050.

With two vessels operating at each MHQ (24 hour changeover and stock replenish), and a third required to cover scheduled maintenance and servicing, it is likely that twelve vessels could be purchased to span the 2000nm coastline of the Gulf of Guinea alone.

4. VESSEL BENCHMARKING, SPECIFICATION AND OPERATIONAL INFRASTRUCTURE

A benchmarking exercise of existing vessels that are currently available in this sector was undertaken. This also identified ways to enhance such craft so as to increase their adoption by the growing littoral patrol vessel sector.

Different countries / geographical regions have different needs and requirements, therefore a range of vessel sizes may be used to support specific applications. Three vessels were documented from the French manufacturer CMN (Cherbourg, France). CMN specialises in naval and interceptor vessels. The three current and proposed vessels examined were:

- DV15 RWS 30 Interceptor
- HSI 32.
- Ocean Eagle 43

4.1 THE DV15

The DV15 RWS 30 Interceptor is designed for coastal patrol, and missions that require high-speed interdiction in littoral waters. The Interceptor has already been sold to the navies of Yemen, Qatar and the UAE. With a length of 16m, the DV15 RWS 30 is capable of speeds in excess of 50 knots and has a range of 350 nautical miles at 45 knots. It is typically equipped with modern maritime and military communication and combat management systems. Its intended missions include deterrence, interdiction [7].

Figure 4. The CMN DV15

4.2 HSI 32

The HSI 32 is a fast interceptor that combines significant intelligence and surveillance capacities with high speed (45 knots) and extended patrol period of 3 days. It is efficient and supports anti-piracy, anti-terrorism, and the control of illicit trafficking missions. The HSI 32 has a range of ~800 nautical miles with a crew of 12. This new interceptor comes with a RIB, deployed via stern launch ramp, and a 360° bridge. Additionally it is fitted with self-defense capabilities including a 20 mm remote weapon system plus two 12.7 mm machine guns with a field of 360° coverage [3].

Figure 5. The CMN HSI 32

4.3 OCEAN EAGLE 43

The Ocean Eagle 43 is a new concept with exceptional performance designed to meet the needs of maritime surveillance and security. The Ocean Eagle 43 is the result of a collaboration between CMN, naval architect Nigel Irens, ProLarge and SeaTeam Aviation companies, two small businesses specialized in logistics and operational projects at sea. The Ocean Eagle 43 is a compact high-performance multifunction vessel that is suited to protect coastal areas, strategic offshore infrastructures. It can also conduct electronic warfare and intelligence missions through the use of 300 Kg class VTOL UAV (such as the SCHIEBEL S100 Camcopter).

It has a range of 3,000 nautical miles at 20 knots, and a top speed of 30 knots that is sustainable over a distance of 1,000 nautical miles. It has limited crew of 7 sailors with accommodation for 8 additional Special Forces. It is fitted with self-defense capabilities consisting in a 20 mm or 30 mm remote weapons station plus two 12.7 mm machine guns providing 360° coverage. A ramp at the stern allows the rapid deployment and recovery of a 7m RIB [3].

Figure 6. The CMN Ocean Eagle 43

5. REQUIREMENT DEFINITION

Each of the example vessels shown above illustrates different design solutions for related tasks / roles. Therefore, an iterative design approach was undertaken to develop a multi-role platform which deliver the range of operational capabilities illustrated in Section 2 above.

5.1 SPECIFICATION

A trimaran hull design, coupled with a stabilisation system offers increased stability and weapon system accuracy to support the required operational effectiveness. Operational capability requires optimized and reliable human performance, therefore functional, comfortable and versatile interior and exterior space is designed to suit the needs of the crew and boarding team. To support the practical delivery of capability, the iconic and striking, stealth inspired design, is utilised to impose deterrence across an area rife with piracy. The conceptual design for the interceptor vessel was developed with the following specifications:

- Overall length: 32m
- Displacement: 62 t
- Immersed depth: 1 m
- Waterline length: 27m
- Beam (inc. sponsons) 14.5m
- Top Speed: 50knts
- Propulsion System: 3 x gas turbines
- Drive system: Waterjets
- Electro-Optical Sensors
- Navigation and surveillance radars
- Command & Control (C2) / combat system
- Satellite communication / datalink
- Gyro Stabiliser for motion control
- Stern Deployed RIB
- Crew:
  - 7 Crew (x2 for rotation)
  - 6 Marine/ RIB crew
- Berths: 8 day beds, 1 private captain suite
- W/C: 2 Wetrooms (shower and w/c)
- 1 x Remote Weapon System
- Life Jackets & Rafts for crew and passengers + location specific Personal Protective Equipment (PPE)
- Area for detained prisoners
- Small arms and ammunition storage
- Medical supplies
- Air Conditioning system
- Ballistic protection

6. EXTERIOR FORM AND HULL DESIGN

6.1 EXTERIOR FORM

The conceptual form collage for the exterior form language of the coastal patrol interceptor is shown in Fig.7. It shows a range of sleek and aggressive geometric forms, conveying a sinister sense of power, presence and capability. In the case of the sports car it conveys ultimate power and capability. These images embody the contemporary form language of military aircraft and vessels. This design language conveys a sense of latent capability as a means of deterrence. The nature of the feature shapes, detailing and surface treatment are to minimise radar signature. The attention to detailing communicate the design meaning of a single purpose, that of ultimate performance potential.

Figure 7: Conceptual form collage

Three design concepts are shown in Figure 8, each has a distinctive design form language. Concept 1 has a flowing speedboat exterior form, with a sculptured organic form for the out riggers. The visual balance

between the window and the flying buttress to which the outrigger is attached, detract from the sense of visual dynamic motion. Concept 2 is a rectilinear design with a strong purposeful presence, it has clean lines and geometric surfaces, resulting in an honest utilitarian feel. The stanchion structure supporting the roof in disproportionate in scale to the other surface features, making it feel static. The architecture style glass combined with the stanchion structure are located in the middle of the deck, the location and shape of these features make the vessel appear static on the water. This vessel has the feel of a untilitarian vessel such as work boat. The hull is a dominant design feature due to the large foredeck area. Concept 3 is strongly informed by the conceptual form collage. It has a sleek, dynamic, aggressive and stealth like form. It has geometric features on a flowing form. The glass areas and geometric surface features produce a cohesive design, but it has an excessive amount of interconntected surfaces. This demonstrates overstyling, form over function, which compromises communicating the functionality of the vessel. The fore superstructure is similar to a stealth aircraft. Here, the fore visual mass causes an imbalance in the visual form, which give the vessel a dynamic sense of motion like that of a speedboat or sportscar.

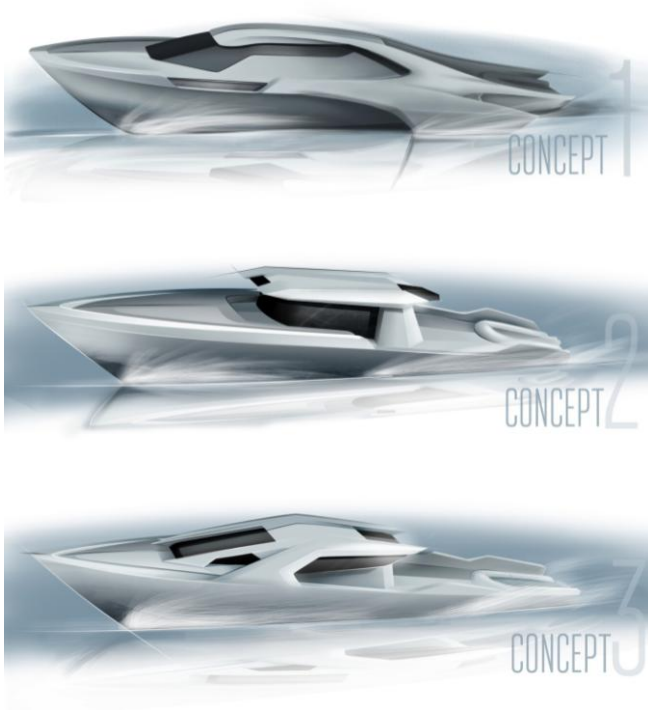

Figure 8: Exterior design concepts

The basis of the patrol boat exterior form are sleek and aggressive geometric forms, this is to convey a sense of power, presence and capability, including the embodiment of the contemporary form language of military aircraft and vessels. This design language conveys a sense of latent capability as a means of deterrence. The nature of the feature shapes, detailing and surface treatment are to minimise radar signature although the signature may at times be increased where the requirement is for deterrence and presence at a distance. The attention to detailing also communicates the design meaning of a single purpose, that of ultimate performance and domination.

The final design of the patrol vessel is shown in side profile in Figure 9 and front 3/4 view in Figure 10. The General Arrangement is shown in Figure 11. The coastal patrol interceptor has a dynamic stance due to the perceived forward momentum caused by the geometric features of the outrigger, which link with the horizontal lines in side profile. This dynamic stance is further emphasized by a common focal point for most of the feature lines in side profile, which is located fore of the bow and just below the shear line. The purposeful outriggers enhance perceived visual mass to make the vessel appear larger than it actually is, giving it a greater presence. They convey a sense of elevated levels of performance and handling, including stability. The use of military stealth design language conveys a sense of technological and high performance capability associated with contemporary military platforms.

Figure 9: Side view of patrol vessel.

Figure 10: Example of Patrol vessel with deployed RIB.

6.2 HULL DESIGN

A trimaran configuration was chosen as it provides both high performance via a slender central hull, a stability provided by the out-riggers and stabilisation control system. Hull resistance was calculated using the Maxsurf software program and the force required to achieve the target speed of 50kts. The predicted minimum power requirement is 6000 kW (8000 hp).

7.0 HUMAN SYSTEMS INTEGRATION

Naval vessels rely on their human crew to deliver the operational capability. The human has many roles and involvement in all aspects of capability development from definition to through life support. A number of governments have dictated that the human must be effectively integrated in to the system – this process is know as Human Systems Integration (HSI) and is defined in documents such as the UK MOD Joint Services Publication (JSP) 912 [8]. The defined HSI process includes a number of domains, these include:

- Manpower
- Personnel
- Training
- Human Factors Engineering (HFE)
- System Safety
- Health Hazards
- Social & Organisational

Each of these domains must be appropriately addressed with the capability definition and design process. Within this project the Human Factors Engineering (HFE) domain has been focused on.

Guidance has previously been developed for HFE for this type of vessel and is published as the High Speed Craft (HSC) HFE Design Guide [9]. Although the guidance is relatively generic to HSC it addresses many issues that are required for this craft. Issues with how to integrate the human into the design process have been highlighted [10] and solutions to address this, such as the use of Digital Human Models (DHMs) described [11].

For anti-piracy, security and naval vessels Command & Control (C2) is one of the most important functions that needs to be supported and facilitated by the vessels design. In todays complex environment the human crew and crafts systems work together as a Joint-Cognitive System [12]. To support effective C2, five multi-role workstations were incorporated. The design of the seats has the system controls built into the armrests to ensure operator reach is optimised. For C2 it is essential that the individuals have the appropriate Situational Awareness (SA) to support risk-based decision-making. For HSC this is delivered by the external view around the craft and the information delivered by the systems, typically via visual displays.

There are a number of defined roles that the crew undertake from their workstations, these include:

- Driver / helm
- Navigator
- Commander
- Communication
- Remote Weapon System operator

Each of these roles and their required tasks can be undertaken from any of the multirole workstations. This provides both flexibility and redundancy within the system. Figures 12 and 13 provide views of the vessels bridge and operations area.

Figure 12: Bridge view of Driver and Navigator workstations

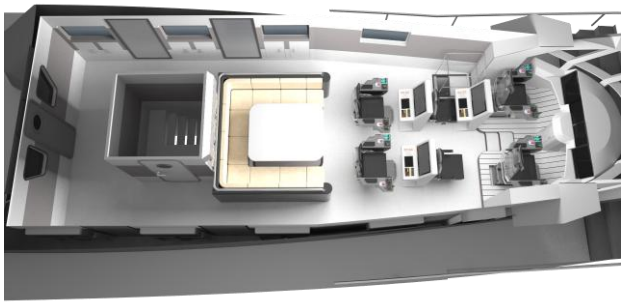

Figure 13: Overview of bridge and operations room

Although it may appear that the vessels out-riggers block the crews external view from the bridge / operations room this is not the case. The side walls of the operations room have video screens that display the external view from roof mounted cameras (including IR capability). In addition, the system provides the capability to include augmented reality overlays for enhanced SA, and the option to use the displays as generic monitors to display other relevant information. In addition, the out-rigger provide ballistic protection for the bridge and operations centre

To deliver it's naval / security capability the vessel has a stern launched Rigid Inflatable Boat (RIB) for VBSS operations. In addition to the identified HSI domains, small HSC have specific HF issues that must be addressed. These include shock mitigation to reduce the risk of fatigue and injury. To address these risks the RIB uses both a novel hull form (Bladerunner, Ice Marine, UK) and shock mitigation seating. The RIB is illustrated in Figures 14 and 15. As with the mother craft, C2 is essential and systems that can cope with the extreme environment must be integrated into the RIBs Joint Cognitive System. Although the RIB may be small it requires system commonality with the mother vessel, and other assets (sea, land and air) to ensure interoperability to deliver effective operational capability.

Figure 14: Image of boarding RIB based on the Blade Runner hull form.

Figure 15: Internal arrangement of RIB showing crew work stations and shock mitigation seating.

8. DISCUSSION

Although the design study was developed as a solution for the West Africa region it has application for deployment in a wide range of geographical regions. The design study principally addressed a number of the HFE aspects but it is essential that the other HSI domains be considered as part of the total-life solution. For example, manning and training often are not given the focus they require. Although the vessels are the high profile assets that provide the demonstrable capability, it is the support functions that occur in the background that support the on-going capability. Recruitment, selection and training are required and the specification of the vessel will dictate the needs of the recruitment / selection – i.e. the fundamental skills and capability of the individuals – and the training commitment needed to develop the individual and team competencies to deliver the required resilient operational capability.

The vessel design uses a range of systems and equipment of varying Technology Readiness Levels (TRLs). Basic systems that need to be highly reliable are sourced from a supply chain that can be maintained in the West Africa area. The C2 systems used are of the current standard used within the naval sector. To further enhance this the concept of Augmented Reality (AR) is used to enhance the crews SA and decision-making. Although AR is not currently the norm within marine / naval vessels the technology exists at a high TRL and therefore requires the system to be configured to overlay and fuse geospatial data with visual and Electro-Optical images.

While the technical platform in its entirety might not be produced locally. The hull form and superstructure could be, with European / South African specialists outfitting the vessel control systems and electronics. Less capable versions of the vessel could be used for river patrol and fishery protection. Using the same design would convey the same potential capability to those committing illegal activities.

9. CONCLUSIONS

The proposed vessel design provides both a technical solution and an aesthetically powerful platform to project the security profile required to improve the safety and economy of the region. By addressing and focusing on the HSI aspects, as well as the traditional naval architecture / engineering, the vessel delivers the operational capability and reliability required. Further to the current design a more effective integration with aviation assets is proposed. This includes UAV deployment and recovery, and the potential for the roof of the bridge / operations room to be used for helicopter drop off and pick-up.

The vessel offers the potential to support a West African transnational force capable of addressing the challenges of piracy and fishery protection. The key issue of social dissent in these areas is poverty. Engaging the local population in the operation of this task force and the creation of the vessels and infrastructure is a critical aspect to economic development. Given the current losses to the international community who are a major consumer of energy natural resources in the region, the cost of developing this capability is marginal.

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Ioannis Chapsos introduced Maritime Security to Coventry University, and subsequently, the Online MA Maritime Security course was launched by the Centre for Peace and Reconciliation Studies (CPRS) research unit in January 2013. He is a retired Captain of the Hellenic Navy, who researches the global trend of privatisation of international security in general and maritime security in particular; he investigates the extent of the states' actual regulation and control over the maritime security industry given the flag-states' responsibility and jurisdiction- using the case study of PMSCs in anti-piracy operations off Somalia since 2005. Due to the globalised nature of the maritime domain, his research identifies the gaps and the risks stemming from the industry's self-regulation and posed in international security in governance, strategy, policy, social and commercial terms.

Dr S McCartan holds the current position of Course Tutor, Boat Design at Coventry University, UK. His key research area is TOI (Transfer of Innovation) from other sectors to the marine industry, in the areas of Design-Driven Innovation (DDI), advanced visualisation and Human Systems Integration(HSI). He leads the EBDIG (European Boat Design Innovation Group) network, which includes: Chalmers University; Genoa University; TU-Delft; and a number of leading European marine design consultancies. He is currently project co-ordinator for the Leonardo TOI project EBDIG-WFSV (European Boat Design Innovation Group - Wind Farm Support Vessels), which aims to develop online training material for Naval Architects in the subject areas of: Human Factors; WFSV design (Industrial Design); WFSV mothership design (Industrial Design).

Dr Trevor Dobbins holds the current position of Director at STResearch Ltd. His experience includes maritime human factors work for the UK MOD, the RNLI and US Navy.

Jon Hill holds the current position of Director at Trident Marine Ltd. He is responsible for providing consultancy support for system design, training and operational support. His previous experience includes holding the position of Warrant Officer within the Royal Marines, with extensive experience of maritime operations and training within the Landing Craft Branch.

Lorne Campbell is an independent Naval Architect, Designer and Consultant specialising in the field of high speed powercraft for all fields of operation. He is a Fellow of The Royal Institution of Naval Architects, a member of the Society of Naval Architects and Marine Engineers and serves on the RINA Small Craft Committee. He has also served on the Royal Yachting Association's Technical/UIM Working Group for Offshore Powerboat Racing.

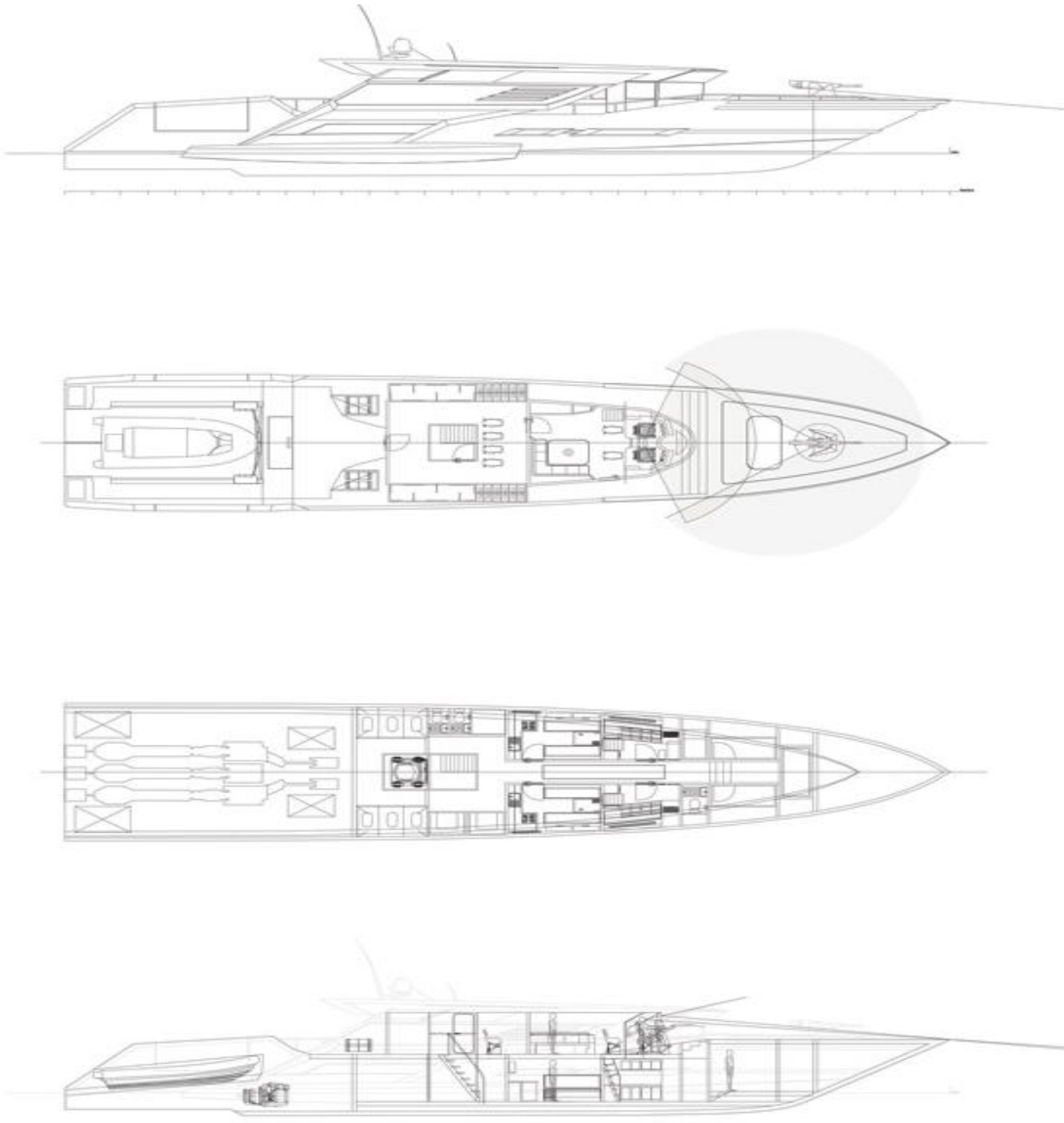

Figure 11: The General Arrangement of the concept patrol interceptor