**UDT 2023**
**Platform Design**

# Covert Coastal CONOPS
# A creative approach to littoral domain awareness in the WEZ
## Introducing Hyper-Sub Platform Technologies' Fast Boat Submarine

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**Abstract –** In the current geopolitical climate there is a clearly identified need for acquiring and maintaining operational advantage through increased maritime domain awareness using small, agile, hard to locate, hard to hit crewed or uncrewed surface and subsurface systems; able to operate alone or in swarms within contested littoral Weapon Engagement Zones (WEZ), while conducting a variety of missions. One solution for such operations being the Hyper-Sub Platform Technologies' (HSP) Fast Boat Submarine (FBS). This paper will explore the unique capabilities and mission profiles of this highly adaptable vessel by describing the key use cases, road mapping ideation and engineering design features which led to the development of this commercial off the shelf (COTS) family of proportionately scalable and modular dual use, dual modality craft, integrated with a suite of the latest embedded, open architecture, autonomous navigation software, interfaced with inertial navigation, optical and acoustic imaging hardware. Additionally, while referring to key concepts of operation as identified in several recent US Dept of Defense and other allied military, open-source documents, this paper will highlight commonality of purpose between these mission profiles and FBS capability. This paper will also include feedback from discussions arising with subject matter experts in the special operations community which has shaped the most recent FBS variant due for client delivery in 2024/2025.

Fig.1. FBS conducting coastal ISR activities.

## 1 Challenge

The end of the Cold War and subsequent three decades has witnessed increasing localized political tensions in the coastal regions of Eastern Europe, Middle East and Asia Pacific, resulting in littoral zone conflict or outright hostilities. The current war involving Russia and Ukraine, continuing territorial incursions in the Arabian Gulf and ongoing sovereign disputes in the South China Sea, between China and Taiwan or North & South Korea being such examples. In parallel, we are witnesses to game-changing developments in remotely supervised, fully autonomous uncrewed technologies, enhanced by Artificial Intelligence and Machine Learning algorithms for automated target recognition, tracking and precision navigation. This has enabled engagement in remote, maritime warfare through the deployment of Uncrewed Surface and Underwater Vehicles (USV/UUV), particularly in complex and high risk, contested, littoral, 'green' or 'brown' waters. However, while eliminating a crewed presence inside an adversary's littoral Weapon Engagement Zone (WEZ) may be desirous, there remain multiple Concepts of Operation (CONOPS), whereby human intervention and Mk.1 eyeballs in the water are necessary. Therefore, I would propose that any solution that might provide commanders the option to switch between crewed or uncrewed missions with varying mission profiles on a common platform must surely be relevant and worthy of further scrutiny.

**Note:** For the purposes of this paper I will use the following definition for WEZ: ***An adversary's range radius for air to surface, surface to surface weaponry, maritime mines and other area denial or anti-access ordnance. - See Fig. 2.***

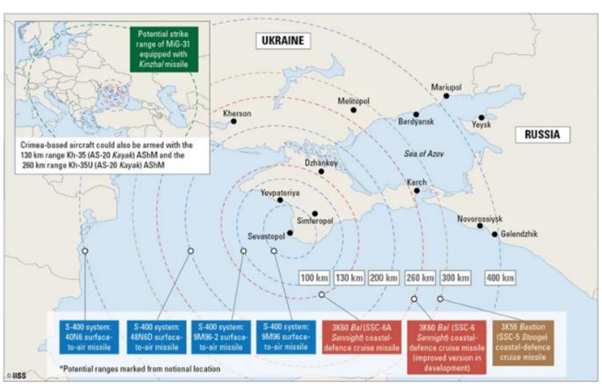


Fig.2 Sevastapol (Russia) Littoral WEZ - Black Sea [1]

## 2 Corroboration

The following quotes from military leadership both identify much sought capabilities for future littoral operations and certainly give credence to the design concept of Fast Boat Submarine (FBS) and its 'raison d'être'.

General David H Berger, USMC:
**"Mobility inside the WEZ is a competitive advantage and an operational imperative". [2]**

Vice Admiral Keith Blount, RN:
**"Required focus on C2 networks in the littoral environment, whereby navies can project power from the sea to the shore seamlessly". [3]**

General Robert B. Neller, USMC & Admiral John M. Richardson, USN:
**"Hard to find, hard to hit platforms, with an ability to conduct sea-based, inshore, maritime raids and amphibious advanced force operations". [4]**

## 3 Creativity

Subsequently, this clearly identified need for a 'mixed solutions approach' to force projection in a contested, littoral WEZ, led Hyper-Sub Platform Technologies Inc. (HSP) to develop the FBS family of long-range, proportionately scalable and multi-modular vessels. A disruptive technology by design and arguably, defining a new class of marine vessel for coastal operations.

FBS is a long-range, 350 NM (648 km) and fast, 31 kt (57 kph) surface vessel, complete with dive tanks, battery packs and pressure proof dry cabin, allowing for extended submerged operations for up to eight personnel, utilizing 'swap-out' mission modules that may be fitted prior to mobilization or even, in-theatre for mission specific activities. In many ways, FBS provides a unique and previously unavailable option, helping to define new approaches to littoral warfare. FBS dual modality capability, allows quick conversion from fast and agile surface vessel to a sustained operations, diesel-electric mini-submarine, enabling crewed or uncrewed missions down to a depth of 500' (152 m) and can totally submerge, out of sight, in only 15' / 4.6m of water.

Additionally, given a vessel draft of 2' 6" (0.8 m), this design approach enables packaged mission sets including offensive or defensive capability for blue, green and brown water, amphibious or special operations tasking.

Whether deployed from a Forward Operating Base (FOB), port, slipway, estuary or delivered in theatre by large transportation aircraft, Landing Craft Dock (LCD), Offshore Patrol Vessel (OPV) or other amphibious sea to shore connector solution; once in theatre, FBS can then roam hundreds of miles above and below the water line and ingress the WEZ, covert, alone or as part of a multi-system, multi-domain, zone security force multiplier.

FBS can also be fitted with swimmer delivery lock-in / lock-out chamber for up to six swimmers plus two crew. Additionally, FBS may be armored and armed with a payload of weapon systems & sensors for multiple mission sets. Furthermore, its robust design and impressive 30,000 lb (13,610 kg) lift capability, allows service as a multi-role, heavy lift asset or even as an in-theatre re-supply platform. Alternatively, FBS could be delivered in uncrewed format, allowing for multiple supervised or full autonomy mission sets.


Fig. 2. FBS – elevator pitch

## 4 Configuration & Construction

The FBS is designed and fabricated by Hyper-Sub Platform Technologies Inc. (HSP) in accordance with all relevant International Association of Classification Society (IACS) certification, to operate as a heavy lift, multipurpose, subsea utility vehicle. Central to its vast range of capabilities are the following key design features:

### 4.1 Sea-frame

Considerable time and thought went into perfecting the design and functionality of the internal sea-frame. A single piece damped unit, constructed from marine grade aluminum. This is the 'back-bone' from which all the major components are attached or supported and is key to allowing a low visibility profile with excellent in-water stability and an extremely shallow draft.

### 4.2 Dry Cabin

The pressure proof, cabin module options are rated for working at 500' (152 m) with a large additional safety margin , are constructed with a mix of acrylic and marine grade aluminum and can also be compartmented for crew, payload and provision of lock in/out chamber for swimmer delivery missions. Each crewed cabin has standby oxygen supply and atmospheric monitors for oxygen ($O_2$), carbon dioxide ($CO_2$) & hydrogen ($H_2$) levels plus scrubbers for removing buildup of $CO_2$. Unlike the majority of 'wet submersible' systems currently available, the air conditioned FBS allows for warm and comfortable transport of personnel, protected from the elements and evasion of other surface or subsea energy. More importantly, once deployed subsea, the dry cabin enables extended duration operations up to or well beyond 24 hours, at depth, free from any risk of decompression sickness or hypothermia, remaining at ambient surface pressure throughout the mission.


Fig. 3. Multiple FBS module variants.

### 4.3 Hull

The FBS incorporates IACS approved naval architect design throughout the engineering and manufacturing process. Current hulls of choice are of proven COTS design and already available on other sea going commercial sports or defense craft. The standard variant is manufactured from marine grade aluminum with a choice of V or

V/W hull format depending on end user operational needs and is capable of operations up to sea state four. Controllable hydroplanes mounted on the hull are employed to adjust the pitch angle for controlling dive or ascent trajectory during subsea operations.

### 4.4 Propulsion

During surface activities, the standard system is propelled by two 480 HP inboard, turbodiesel engines drawing from a 525 US gallons (198 l) fuel tank giving around 350 NM (648 km) range. Once submerged, the vessel switches to electric power using two 60 HP electric over hydraulic thrusters for horizontal propulsion. For vertical movement, two 10 HP vertical thrusters are utilized. All thrusters being used together in cooperation with an auto-navigation package enables FBS station keeping in hover mode or as a ‘virtual’ anchor. Furthermore, additional thruster combinations may be fitted as desired for specific activities or for increased accuracy and capability in currents or swell etc.

Fig. 4. FBS Surface & Subsea propulsion units

### 4.5 Battery Power

For the purposes of subsea propulsion and internal systems power provision, four (or more) banks of batteries are installed. Nominally, FBS is delivered as standard with 22.8 kWh, Absorbed Glass Mat (AGM) batteries providing 270 ah @ 96 VDC. However, multiple battery pack options comprising AGM, and latest lithium-ion variants are currently available, with performance up to 544 kWh delivering a potential maximum submerged range of >600 NM (1100 km) at a speed of 1.4 kt / 2.6 kph. For a fuller example of endurance /speed/range - **See Fig. 5.**

FBS has the ability to recharge its own batteries multiple times during a deployment, by using the engine powered invertors while on the surface. Alternatively, for covert capability, a set of engine snorkels is provided to enable recharge while loitering just below the surface. Although AGM batteries may be considered old technology, they are in general, extremely robust and have a faster recharge rate of around 30 minutes, in comparison with longer endurance lithium batteries which may take up to one hour to replenish. Ideally, a combination of AGM & lithium may be fitted for combining increased endurance and fast re-charge options. It should be noted that current battery technology is developing at such a pace, that HSP is continually revisiting the latest specifications available.

| Battery Load | 22.8kWh AGM only | 68kWh | 136kWh | 272kWh | 544kWh |
|---|---|---|---|---|---|
| Weight (Payload Used) | 1,000lbs AGM only | 750lbs (Nick) 495lbs (Lith.) | 1,500lbs (Nick) 990lbs (Lith.) | 3,000lbs (Nick) 1,980lbs (Lith.) | 6,000lbs (Nick) 3,960lbs (Lith.) |
| Performance @ 1.4 knots | 28nm 20 hrs. | 83.4nm 59.6 hrs. | 166.8nm 119.2 hrs. | 333.6nm 238.4 hrs | 667nm 476hrs |
| Performance @ 2.0 knots | 15.24nm 8 hrs. | 45.5nm 24 hrs. | 91nm 48 hrs. | 182nm 96 hrs. | 364nm 192 hrs. |
| Performance @ 3.0 knots | 6nm 2hrs. | 18nm 6 hrs. | 36nm 12 hrs. | 72nm 24 hrs. | 144nm 48 hrs. |
| Performance @ 3.7 knots | 3.7nm 1 hrs. | 11.1nm 3 hrs. | 22.2nm 6 hrs. | 44.4nm 12 hrs. | 88nm 24 hrs. |
| Performance @ 4.4 knots | 2.2nm 30 min. | 6.5nm 1.5 hrs. | 13nm 3 hrs. | 26nm 6 hrs. | 52nm 12 hrs. |
| Performance @ 4.9 knots | 1.67nm 20 min. | 4.9nm 1 hrs. | 9.8nm 2 hrs. | 19.6nm 4 hrs. | 39.2nm 8 hrs. |
| Performance @ 5.7 knots | .9nm 10 min. | 2.8nm 30 min. | 5.7nm 1 hrs. | 11.4nm 2 hrs. | 22.8nm 4 hrs. |

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Useful for:

- Low threat areas / 2 man subsea loiter missions
- Surface operations allowable within a few miles of the preferred dive location or when snorkel can be used for final area ingress.
- Night time surface or snorkel recharge possible

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Useful when:

- Completely submerged state must be maintained 6 miles from target
- Night time recharge possible

Fig. 5. FBS Battery options and performance

### 4.6 Hyper-Ballast, air-comp. & storage

Another crucial component of FBS design is the comprehensive and robust air storage and delivery system which is required for the following applications:

- Ballast dive tanks
- Air compensation
- Diver operations

In standard format, FBS is fitted with eight 6,000 psi (414 bar) cylinders, although for normal operational requirements these are generally filled to 4,500 psi (310 bar) allowing for an immediate 15,000 lb (6,803 kg) of lift. Seven of the cylinders are configured as an ‘in series’ cascade air bank with the eighth cylinder being isolated from the bank and held in reserve for emergency situations and to double the lift capability. The air bank can be re-filled in around 45 minutes or topped up via 5,000 psi SCBA air compressors powered from the surface engines.

The ability for FBS to dive and surface quickly and efficiently in the littoral zone is a direct result of the design features of the ballast and buoyancy dive tank system or 'Hyper-Ballasting'. This involves a multi-compartmented system drawing from the air bank for its buoyancy requirements. This ballast unit can be flooded rapidly, allowing a fast moving, surface transiting FBS to throttle back and engage dive tanks whilst still in motion, enabling complete submergence in less than one minute and as little as 30 seconds.

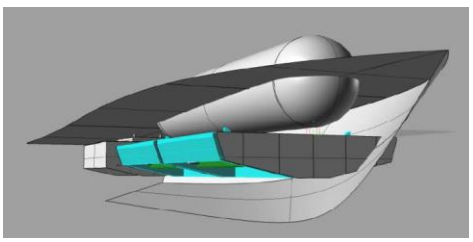

Fig. 6. Ballast dive tank system located in hull.

As previously noted, the cabin is a sealed and pressure proof unit. To save on weight and engineering complexity, for other components whose internal environment needs to be dry, like the engine compartment, surface navigation radome, auxiliary mission equipment, externally mounted electronics units, or components that have air pockets, such as outdrives or oil reservoirs, then HSP has developed an intriguing means of using an air supply grid that compensates these components for changes in pressure at different depths. This simple device is open to the surrounding water column. Then, as the FBS dives and the external pressure increases, water is pushed vertically into a duct that triggers a floating valve which delivers air to the grid from the vessels stored air system. This ensures that all "dry" components, or components that might have air pockets, maintain a constant internal pressure equal to the surrounding water pressure. This allows for components of any shape to be quickly incorporated, manufactured of lighter construction and with fewer engineering interface challenges. In fact, the air compensation circuit is specifically configured to be slightly over-pressured to .004 psi, thus ensuring against water ingress into any air-filled spaces or component should its integrity become compromised. Additional components that might be fitted to the vessel post-delivery, such as weapons computer hard-drive modules, can easily be incorporated into the air compensation circuit at a later date.

Auxiliary air cylinders can also be installed for the provision of feeding SCBA umbilicals for prolonged diver support operations and increased bottom times, or as a rapid re-charging station for SCUBA cylinders etc.

### 4.7 Payloads

The design aesthetic of FBS allows for a large, flat rear deck and additional storage areas either side of the cabin structure. This, when combined with an additional, nominal payload of 3,000 lb (1,360 Kg), enables a large array of auxiliary equipment storage or fitment that could include weapon systems, electronics arrays, UUV systems, diver chariots, or dry-sealed boxes of land-based mission equipment.

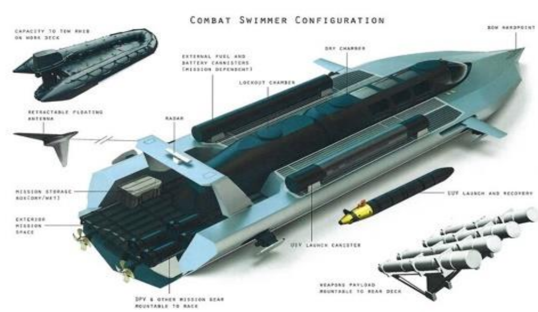


Fig. 7. Potential FBS payloads.

### 4.8 Navigation & communication

FBS takes advantage of all the latest navigation and positioning technologies for both surface and subsea operations. In addition to standard surface radar and VHF comms, Smart Radio Cloud Relay System, Iridium Satcom & GPS, a reel operated buoyant antenna wing option is also available. Furthermore, for subsea operations a mini, hybrid acoustic navigation solution with Doppler

Velocity Log, AHRS motion reference unit, north seeking gyro and depth sensor package allows for mid-water station keeping at altitudes from seabed of 12” (30 cm) to 656’ (200 m) plus, pre-programmable waypoint routing, navigation by target of interest using camera or imaging sonar and a full station keeping software package is also available.

### 4.9 Safety & redundancy

Safety has been paramount throughout the FBS design roadmap process ensuring there should be no single point of failure. As an example, there are three independent methods of surfacing:

- Normal operating system surfacing using the air ballasting buoyancy system.
- Controlled Dead Systems Submerged Recoverability (whereby, vessel can surface with all primary air, electrical and hydraulic systems shut down in a controlled fashion).
- Emergency drop tray surfacing (if required, client can fit a tray of ballast weights on hull to be jettisoned in emergency surfacing situations.

The above take advantage of passive safety characteristics gained through Hyper-ballasting that retain up to 30,000 lb (13,610 kg) of total reserve submerged lift for rapid ascents in the event of the most severe emergencies (including flooded cabin) and always keeps sufficient reserve air to fully activate the buoyancy twice @ 500’ (152 m) depth, using standard air storage configuration.

Additional embedded safety features include:

- Atmospheric monitoring system Various $H_2$, $O_2$ & $CO_2$, Life support $CO_2$ maintained less than 0.5 %, Life support $O_2$ maintained at 19-22 %.
- Emergency life-support: 48 hours per passenger.
- Emergency re-breathers: one each per passenger.
- Halon auto-dump system and other firefighting equipment.
- Submerged EPIRB and VHF antennae deployment for location and communications.
- Dual frequency emergency subsea telephone.

## 5 Concepts of operation (CONOPS)

Given the ultra-shallow draft, low profile and compact design of the FBS, combined with its ability to launch from a riverbank or small jetty and operate covertly for extended periods of time submerged; then certainly littoral zones are an ideal theatre of operations for deployment under a wide-ranging mission brief including general Intelligence, Surveillance and Reconnaissance (ISR). However, this paper would like to further review several persistence mission CONOPS, currently being discussed in defense & security circles around the globe and for which FBS offers an ideal base platform and uniquely adaptable range of solutions.

### 5.1 Amphibious & expeditionary forces

This is where FBS comes into its own as a hugely diverse force multiplier. Small enough to be deployed into theatre or to an FOB or Marine Corps Expeditionary Advanced Base (EAB) on a C5 Galaxy or C-17 Globemaster aircraft. It can also be deployed as part of an amphibious task force from the well deck of a patrol vessel or amphibious LPD, LCS, EPF etc. As previously mentioned, with a 350+ NM (648+ km) range, it can then ingress from over the horizon, enabling FBS to “Persist inside an adversary’s weapon systems threat range, create a mutually contested space, and facilitate the larger naval campaign to supplement traditional amphibious ships and long-range uncrewed systems that can get inside the enemy’s threat range or dispersed formations of crewed and uncrewed ships that challenge enemy targeting and enable the adaptation of disruptive technologies”. **[2]** Also, the modular design of FBS gives commanders multi-role options via mission module change-out in theatre or even between specific operations. Therefore, the specific module fitted to any FBS could change multiple times throughout the various phases of any littoral campaign or even serve as part of a larger Strike Group. Scaling up the size of FBS could also result in a vessel capable of landing a two Squad Platoon of US marines onto the beach as part of a ship to shore connector solution, for example.

In his ‘Planning Guidance Document’ **[5]**, General Berger noted the following “Our forces currently forward deployed, lack the requisite capabilities to deter our adversaries and persist in a contested space to facilitate sea denial”. And “We must continue to seek the affordable and plentiful at the expense of the exquisite and few when conceiving of the future amphibious portion of the fleet; Stand-in forces take advantage of the relative strength of the contemporary defense and rapidly emerging new technologies to create an integrated maritime defense that is optimized to operate in close and confined seas in defiance of adversary long-range precision stand-off capabilities.” Certainly, FBS provides one such “new technology” , in multiple mission formats.

Therefore, a lot of current effort in military circles, is going into reviewing and acquiring commercially available, disruptive technology as an approach to enhancing future amphibious capability solutions that are able to integrate with amphibious transportation projection capability. The US Marine Corps plans for three Marine Littoral Regiments, the Austal built Expeditionary Fast Transport vessels and “UK MOD Future Littoral Strike Ship multi-role concept as part of UK Littoral Response Group operations” **[6]**, all providing such examples.

Fig. 8. Illustration FBS enters Patrol Vessel well-deck.

## 5.2 Special forces

Special Operations personnel already have a wide range of functional, wet-submersible systems to choose from. However, the main shortcoming of these vehicles is that in most cases, they require a large host vessel to deliver them close to their short radius of operations and in every case, with the exception of the Dry Combat Submersible, are severely restricted in the duration and depth of any specific mission for physiological and physical reasons, in that crew and passengers can become debilitated due to water temperatures and must don SCUBA or rebreather equipment once the vehicle leaves the surface, leading to greater risk of decompression sickness. FBS negates both these shortcomings with over the horizon, long range ingress capability and prolonged duration, one atmosphere submergence which can be measured in days and therefore, vastly extends the operations envelope and mission options. Additionally, a full range of individual swimmer delivery vehicles and multi-mission equipment packs can also be stowed aboard and accessed as required. The FBS platform also having the payload capacity to carry and operate a full range of latest technology sensors and weaponry. As Captains James Easton & Joshua Kolo of the Australian Army recommend “In response to the demands posed by a contested, denied, and operationally limited future battlefield environment, SOF needs capacity to employ low tech* methods with high tech augmentation. **[7]**

## 5.3 Fluvial Missions

US Marine Corps Officer, Walker D Mills, an authority on riverine operations, argues that “The USA military is not adequately prepared to use rivers as a maneuver space or to prevent adversaries from doing the same—and it has not been for years. The US military should maintain a dedicated riverine capability in its conventional forces that can be employed in irregular warfare and beyond, and that can be exported to allies and partners in need.” **[8]** FBS increases capability and adds much more value and variety of options for commanders in comparison to standard river patrol vessel operations and fits neatly into this capabilities gap, given its power, agility, ultra-shallow draft and submergibility. FBS also gives a new capability and tactic for peacetime border security patrol. Or as USMC General Berger states “As an interim measure/proof of concept, Mk VI patrol boats or Riverine Command Boats from the NEF Coastal Riverine Force (CRF) may be useful surrogates for experimentation that informs development of some future craft specifically designed for this purpose." **[5]** Certainly, surface only craft are extremely vulnerable in such a narrowly defined area of operations as found in riverine & estuarine zones and the FBS ability to loiter below the surface in less than 16' / 5 m, gives an added dimension for covert activity and could be that 'future craft'.

Dr. John Nash, Australian Army Research Centre notes "The future land force will need to conduct or support anti-air, anti-ship, surveillance, and core infantry and light armoured operations in a littoral environment. Much of the necessary transformation will be of a general nature: drones and loitering munitions will play a part in all land environments, littoral or not, and many changes will be inherently required for future operations**.** **[9] -** FBS provides such a loiter capable platform.

### 5.4 Electronic warfare

The US Office of Naval Research (ONR) is currently seeking "Decentralized and networked EW solutions with low probability of intercept (LPI); low probability of detect (LPD); secure long-haul relay technologies; based on resilient mobile ad-hoc network (MANET) architectures and technologies". **[10]** Certainly, the FBS maneuverability capability and payload capacity, combined with its covert credentials allows for a full range of jamming, spoofing and multi-spectral data gathering and domain awareness capability all on a single, agile crewed or uncrewed platform.

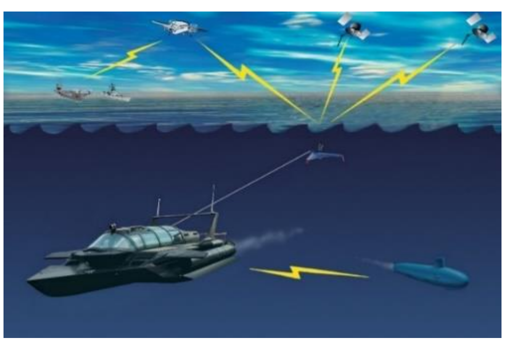

Fig. 9. FBS ELINT, gathering & dissemination.

### 5.5 ASW & ASuW

Almost 160 years after the first ever successful launch of a torpedo system, this weapon remains a relatively low cost, high speed, long-range, low detectability and lethal solution against major high value, surface and subsurface combatants in either regular or asymmetric warfare "anti-access/area-denial capabilities" **[11]**. FBS was designed to enable such upgrade solutions that an end client may wish to integrate post-delivery and indeed a potential HSP client is currently planning for use of the FBS vessel in this role.

Fig. 10. Illustration of FBS with mini-torpedo payload.

### 5.6 UUV/UAV mothership

A recent US congressional research service document highlighted the need to acquire uncrewed vessels as part of an effort to "Shift the Navy to a more distributed fleet architecture, meaning a mix of ships that spreads the Navy's capabilities over an increased number of platforms and avoids concentrating a large portion of the fleet's overall capability into a relatively small number of high-value ships" **[12]** or in other words**,** Neller & Richardson's "Hard to find, hard to hit platforms". **[4].** Therefore, uncrewed variants of FBS with remote, over the horizon control capability would be effectively employed in such a role, providing a mission planning/re-tasking, battery re-charge and data download hub and communications gateway for swarms of smaller UUV and aerial drones on a variety of littoral or even 'blue water' missions.

### 5.7 Combat engineer / salvage & rescue

Again, with up to 30,000 lb (13,600 Kg) of lift capability and payload capacity that might include one or two 6-function robotic arm manipulators and heavy gauge cutting tools, combined with lock in/out chamber and SCBA umbilical for diver support role, then FBS will certainly give additional resources to marine combat engineering units, Seabees - underwater construction battalions, submarine rescue teams and for salvage and recovery, emergency rescue, underwater combat construction & demolition applications or for humanitarian rescue situations.

## 6 Clarification

At the time of this paper's publication, FBS stands at Technical Readiness Level Six (TRL6) with a single R&D vessel currently operating in Florida, USA. However, HSP is in contract negotiation with an 'early adopter' government client with final module design requirements and scope of supply being actively discussed with a view to delivery of multiple systems during 2024 / 2025. In parallel to this, are discussions with a potential client for delivery of a fleet of FBS for the eco-tourism market. Additionally, and in line with the scalable design of the system, there are immediate plans for a 125' (38 m) FBS variant. A smaller, compact, one or two-passenger system may also be developed. Nevertheless, despite robust lifecycle testing and certification of many of the FBS components on other manufacturers' products, much has still to be assessed by way of open water and inclement weather performance characteristics and proofs of concept in regard to specific CONOPS for FBS in the months ahead, including:

- Full sea trials plus surf zone capabilities.
- Subsea current handling.
- Under ice operations.
- Acoustic, radar & thermal signature assessments.
- A review of alternative build materials and design aesthetics.
- Further mission module design.
- Trialing more powerful engines.
- Alternative propulsion fuels – Biofuel, Hydrogen Fuel Cell etc.
- Ongoing development of full autonomy & Artificial Intelligence algorithms.

## 7 Conclusions

Military commanders and strategists are currently seeking new and innovative solutions for acquiring and retaining littoral domain awareness and achieving amongst other things, what Ellison calls "anti-access/area-denial capabilities in the WEZ" **[11]**.
Allied to that is an increased willingness in military circles to assess COTS solutions that can be quickly integrated with latest technologies – Berger's, "the affordable and plentiful at the expense of the exquisite" **[5]** or as predicted by Easton & Kolo of Australian Special Operations, "low tech* approaches will expand in utility as they offer a more cost-effective way to achieve strategic effect that has greater enduring potential to generate asymmetry." **[7]**

***Note: Easton & Kolo define "Low Tech" as:**
*" Those capabilities and concepts that employ commonly accessible technological means (such as commercial off-the-shelf (COTS) drones or autonomous systems, public communications infrastructure, and existing mechanical manoeuvre, i.e. commercial/private vehicles, vessels, and aircraft).*

Therefore, in summary, this paper and accompanying presentation coincide with the dawn of FBS as a viable and commercially available product and its ascension into the defense & security domain possibly defining a new class of vessel with its arrival. The author believes that FBS has surfaced (pun intended) during a perfect storm of the geopolitical / military need and the technological availability of sensor miniaturization, leaps of capability in battery technology and with the emergence of Artificial Intelligence algorithms, over the horizon C4 and readily available autonomous piloting and navigation packages allowing for crewed and uncrewed mission variant choices on the same vessel.

Consequently, for military commanders and strategists seeking new and innovative ways of acquiring operational advantage & persistent domain awareness in the WEZ, packaged in hard to find, hard to hit, crewed or uncrewed systems, HSP Inc. presents the Fast Boat Submarine as a highly adaptable and viable solution.

However, the author will defer the closing remarks to General David H. Berger, Commandant of the United States Marine Corps:

**"Forces that can continue to operate inside an adversary's long-range precision fire weapons engagement zone (WEZ) are more operationally relevant than forces which must rapidly maneuver to positions outside the WEZ in order to remain survivable. These "stand-in" forces attrite adversary forces, enable joint force access requirements, complicate targeting and consume adversary ISR resources, and prevent fait accompli scenarios". [5]**

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