DRONES IN THE MARINE ENVIRONMENT

This is the second and final part of a two-part series about drones in the South African marine environment. Compiled by Andre P. Meredith, Adrian Niken and Hannes van Wyk this article focuses on the advantages and disadvantages of these incredible unmanned aircraft.

So why should we make use of drones in the marine environment? This is a good question. Why spend money on a fairly new technology when manned aviation could potentially provide the same solutions? Realistically unmanned aviation will, in all probability, never completely replace manned systems. For certain tasks a manned asset will always be required, or be the better option.

But in many cases unmanned systems can complement the work being performed by manned aviation - and in some instances could even replace manned systems altogether.

USERS AND BENEFICIARIES

The general public aside (in respect of personal use), there are potentially many hundreds of commercial and government users of and beneficiaries for this technology. The list below is certainly not conclusive, but provides a clear indication of the extent and potential widespread impact (a positive one, at that) the employment of drone technology in the marine environment might have.

To get a clearer understanding of why

ACTIVITY	USERS/BENEFICIARIES
Long Range Maritime SAR	DOT, SAMSA, NSRI, DOD, commercial shipping
Coastal SAR	NSRI, SAPS, tourism
Coastal and Marine Surveillance	DOT, SAMSA, DAFF, DEA (SANParks), DOD
Maritime Security	SAPS, DOD, DAFF
Commercial Fisheries	DAFF, DEA, SAMSA, fishing industry
Recreational Fishing	General public
EEZ Patrol	DOD, DAFF, commercial shipping
Marine Mining Support	DMRE, mining sector, energy sector
Recreational Photography	General public, tourism
Professional Photography	DAC, tourism, media, real estate
Climate, Weather and Sea State	DAFF, DEA (SAWS), SAMSA, DST
Disaster Management	SAPS, DOD, DEA, DAFF, emergency services
Coastal Populace Monitoring and Development	DHS, DTI, Stats SA, industry, business sector
Medical Support	DOH, emergency services, pathology, shipping
Commodities and Logistics	DOT, DAFF, commercial shipping, fisheries
Wreck Surveillance	DAC, DEA, SAMSA
Education	DBE, DHET, schools, tertiary institutions
Marine Research	DST, DOD, tertiary institutions

TABLE KEY

DOT	Department of Transport	SAMSA	South African Maritime Safety Agency
NSRI	National Sea Rescue Institute	DOD	Department of Defence
SAPS	South African Police Services	DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs	DMRE	Department of Mineral Resources and Energy
DAC	Department of Arts and Culture	SAWS	South African Weather Services
DST	Department of Science and Technology	DHS	Department of Human Settlement
DTI	Department of Trade and Industry	DOH	Department of Health
DBE	Department of Basic Education	DHET	Department of Higher Education and Training

Potential Users and Beneficiaries from Drones in the Marine Environment

unmanned systems should even be considered as useful tools in the marine environment, let us look at some of the pros and cons of this technology.

Disadvantages

- **(Potentially) High initial outlay:** Drone systems consist of more than just the frame - this is true for airborne or water-borne systems. In addition to the aircraft, boat or submersible, initial outlay also includes the control and telemetry systems, launch and recovery systems (design-dependent), storage, transportation (size-dependent) and other support systems. A complete Drone system can be costly to acquire, but once it has been purchased and integrated, it can be very affordable to operate.
- **Bad weather operations:** Drones, by nature of their design, tend to weigh less and be comparatively smaller than manned counterparts of similar performance and mission capability. Small and/or light aircraft (and surface vessels) do not normally fare well in bad weather, particularly if strong wind or gusts prevail, or during periods of major swells or strong wave action. Drones earmarked to operate in such conditions will have to be designed from the outset to literally and figuratively be able to weather the storm and be capable of competing tasks.
  On the flipside, manned aviation is also prone to being affected by inclement weather, and all aircraft have specific operating limits regarding bad weather operations. Drones, however, are devoid of on-board crews and other persons, potentially giving operators the edge if they need to 'push the envelope' to get a critical mission completed; loss of the airframe under such conditions is simply a material loss, without additional human casualties.
- **Marine SAR Limitations:** Most unmanned aircraft employed for maritime SAR missions will inevitably only be able to perform searches, and not be able to actually rescue someone (physically lift someone from the sea or off a ship). This is obviously design-dependent and future M-SAR drones having hover capability may be able to provide a way to do this – but current, proven manned helicopters or tilt-rotor systems already have this ability. In addition, having someone on-board to assist with the hoisting operation simplifies this segment of a rescue, and an unmanned hoisting operation may prove too 'impersonal' for most SAR operators to consider.
  A SAR drone can, however, be equipped with an air-deployable survival canister containing, amongst others, a life raft. This will afford survivors at sea the chance to remove themselves from the sea, until a manned rescue platform (helicopter, ship) arrives to lift them to safety.
- **Legislation:** The legislative process towards the obtaining of a Remote Operating Certificate (ROC), which legalises commercial drone operations in South Africa, is a long, tedious and expensive process. Current indications are that it could take up to (or even in excess of) two years to obtain an ROC, which also implies no legal operations for two or more years, while the process runs. This, unfortunately, incurs expenses on the part of the applicant, potentially with zero income (depending how the company's business is structured) until the ROC has been issued and the drone can be operated for profit.
  The South African aviation legislator is said to be streamlining the ROC process towards faster results, but at the time of going to press this was hearsay only. Potential commercial operators of drones in the SA marine environment will have to be prepared for a lengthy administrative process to enable them to become legal drone operators.

Advantages

- **Affordable to operate:** Once procured and integrated, drones are very affordable to operate. Obviously this is a factor of its design, and how it is employed, but compared with manned aircraft of equal performance, size and mission, a drone would in most cases not be more expensive to operate.
- **Flexibility:** Drones are very flexibly, and many types can be refitted with different payloads and be utilised for multiple types of work. This reduces acquisition cost, and maximises the fleet for optimal use.
- **Reduced risk:** Removal of a pilot and other crews from the airframe or vessel reduces risk, particularly where the drone needs to be sent into dangerous weather conditions or out over vast 'marine deserts' many miles from the nearest land. If a mechanical or environmentally-induced failure does occur, and the drone cannot be saved, it incurs only material losses, and not losses to human life.
  The marine environment is also an ideal place to experiment with the concept of a 'unified airspace' where drones and manned aviation can co-exist. The airspace above our maritime claims and territories are fairly 'barren', especially when compared with the overland regions. This provides a near-sterile airspace to test the concept in, especially when controlled by test authorities. In addition, having a zero-population-density count below the flight path of the drone (with the exception of occasional shipping) further reduces risk to third parties, in the event of a critical system failure.
- **Response time:** Small drones can often be deployed quickly, at short notice, requiring very little preparation. Electric versions require no refuelling (providing batteries are prepared), and many don't require extensive and complex preventive maintenance. This makes response times – especially in the event of a crisis or disaster – short and can significantly speed-up the commencement of a mission.
- **Persistence:** The monotony of many tasks associated with the marine environment, plus the huge expanse of ocean to be covered at times, requires persistence and endurance. Humans are not always ideally suited to either, which is why many specially-designed maritime aircraft are large enough to accommodate sleeping berths, kitchens, rest areas, lavatories and other items to help prolong such missions. Drones do not need any of this, and personnel on the ground involved in such endeavours can be rotated easily and frequently to ensure that alertness is maintained.
  Drones (if so designed) could potentially stay aloft for days, and human interaction could be further reduced if it is equipped with smart sensors to help automatically locate 'objects of interest.
- **Portability:** Small drones can be man-portable and even at times hand-launched. This could be useful if the area from which it is to be flown or recovered is inaccessible by vehicle or if it has to be launched or recovered on-sea. Mid-sized drones could be ship-borne and launched and recovered from a large boat, something not readily possible with a manned asset. The aforementioned is largely design-dependent, but the general size and weight of small to medium sized drones makes this completely feasible, and can be a significant asset to a ship or a boat.
  In addition to these operational advantages, drones can also be an important educational tool (as a frontrunner within the 4th Industrial Revolution and Industry 4.0), showcasing the technologies to young minds and thereby stimulating novel ideas to catalyse technological advancement.
  Drones can also be an essential tool to entities involved in marine research, providing access to otherwise inaccessible or hostile environments. Examples include the various unmanned airborne, water-borne and underwater vehicles being utilised by the Institute for Maritime Technology (IMT) for research and data collection using side-scan technologies, tethered flight, low-light optical payloads, counter-drone technologies and many other forms of sea and sub-sea research.

SELECTING A DRONE

So which drone do I select? This is another tough question to answer. The short answer is that the type of drone to be selected would be predominantly task-dependent, i.e. selected based on the task

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requirements, most notably performance and payloads. The potential hostility of the marine environment should be borne in mind when selecting the drone, and the performance of the drone must meet the most extreme task requirements. This could include range and area to cover, the measure of persistence required, the minimum time required to reach a point of interest and altitude requirements.

Also to be factored in is overall robustness of the drone, including the volatility of the environment (the effects of strong wind, corrosive effects, electromagnetic compatibility, operation in precipitation, temperature effects) and system reliability (quality of design, components and assembly).

If the drone is to be carried and operated from a surface vessel (boat, ship) the user should consider special design characteristics to facilitate the aforementioned, including storage whilst at sea, ease of handling on-board the vessel, launch method, recovery method, and so on. This could have a significant effect on type selection, and may require selection of a drone of specific design ("purpose-designed") or significant design changes to an existing drone type.

The selection of the payload will be critical to ensure that the drone is optimally utilised; after all, the drone is simply the vehicle that carries the payload (which does the actual "work") to the place of importance. Without a properly-selected payload, the drone would be worthless. Payloads could include special SAR payloads, marine-optimised cameras, marine-optimised thermal sensors, rangefinders, traditional radars, synthetic aperture radars, electronic signal interception devices, dipping sonar, magnetic anomaly detectors, cargo containers, chemical agent release systems, towing systems, object release systems, and any other system imaginable to help get the job done.

The final factor to take into account when selecting a drone for maritime work would be regulatory requirements, as applicable to the work envisioned and the perceived level of risk to third parties within the proposed area of responsibility. SACAA Part 101 should be consulted to help determine any such requirements having a potential bearing on the selection of the drone type; best to do this before the drone is selected, of course!

Whichever drone is going to be selected, the starting point is always a clear and proper understanding of what the drone will be used for. This paves the way for all other requirements, and ultimately will filter through to selection (or development) of the most optimal drone type.

TECHNICAL CHALLENGES

The South African drone development industry is well-established, and many companies, both large and small, have developed cutting-edge drones. These include not only 'major industry' role-players, such as Denel Dynamics, Paramount Advanced Technologies, the CSIR, Milkor, Epsilon and Tellumat, but also a plethora of smaller companies and SSMEs. Many of the systems produced by these developers may be immediately useful for maritime work, or easily adaptable to meet specific requirements.

Regardless of who develops the drone, the marine environment will inevitably add additional complexity to designs and may lead to the solving of a number of technological challenges.

Here are a few potential "technical hurdles" that may need solving along the way:

- **Performance**
  - Vast flight areas and extended flight ranges
  - Long endurance/persistence
  - Communications ranges and related technology (e.g. SATLINK for BRLOS operations)
  - Fast time-to-target (e.g. Maritime SAR and disaster support)
  - Performance in strong wind and low ambient temperatures (icing conditions)
- **Special abilities**
  - Ship-borne operation (storage, handling, take-off, recovery)
  - Special propulsion requirements/ arrangements (confined ship-borne operations)
- **Durability, reliability and dependability**
  - Corrosion resistance (marine environment)
  - Weather tolerance (moisture, sea salt, gusts, rain, low temperatures)
  - Quality of design, components and assembly (vital to allow system availability and dependability for critical tasks, e.g. SAR, disaster support, security, etc)
- **Payload performance**
  - Task-specific (custom payloads)
  - Marine-optimised (good performance in a marine environment)
  - Marine-hardened (durability and reliability)

The list above is by no means conclusive, but gives an idea of the technical challenges that may need to be addressed to produce an effective and efficient unmanned system for operation within the marine environment. ✈