Rubber Ducky Defence White Paper Submission

Rubber Ducky Defence is a small Australian technology start-up business which has developed concepts and designs for a Small Combat Vessel (SCV), 11m in length and featuring a flexible payload, and innovative semi-submersible and self-righting design. We have proposed our craft to the Commonwealth, including through responses to RFPs for SEA 1778 and JP1770. We were invited to put forward a detailed proposal in Round 18 of the Concept Technology Demonstrator Grant. Our detailed proposal was unsuccessful, as was our initial proposal this year for the same grant round. In formal feedback from our Round 18 detailed proposal, it was acknowledged that our proposed craft had a high probability of transitioning into service in either SEA 1180 (the Offshore Combatant Vessel, or OCV) or SEA 5000.

It's our intention that this submission be considered in this context. Despite having a vested interest in getting our craft developed further with the Commonwealth, our efforts thus far have required us to think very deeply about small craft at their potential utility for Australia's defence requirements. We hope that these comments could help inform policy and requirement statements to allow small surface vessels to offer the best possible military utility to the Commonwealth.

Executive Summary
In this submission we wish to make three substantive suggestions:

1. Small surface vessels should be considered as core 'mission modules' or deployable assets for future surface combatants, including the OCV and Future Frigate. Surface vessels have key advantages over other aerial or submerged assets, including their low cost of ownership and operation, as well as long potential endurance on station.
2. Small surface vessels can be used in an extremely wide variety of missions, some of which require a crew (boarding for instance), and some of which might be advantageously undertaken unmanned (mine countermeasures). Whilst accommodating a crew in an aerial vehicle or underwater vehicle generally has drastic design ramifications, a single small surface vessel (4-12m in length) could operate with a crew on some missions, and without a crew on others, without compromising or fundamentally altering major design features. As such, the imperative that deployable modules be comprised of 'unmanned systems' should be eased, at least in the case of surface vessels, perhaps to 'unmanned' or 'de-crewable' rather than exclusively 'unmanned'.
3. If deployable assets or 'mission modules' are to comprise a substantive, or even dominant part of a surface vessel's capability, (and I think there are good reasons why they should be) then considerable effort should be devoted to establishing what the nature of these deployed assets are before the final hull design for the major surface vessel is established. Otherwise, it is highly likely that complications will emerge in the integration of the major vessel with its deployable systems. In particular, launch and recovery systems, crew training requirements, system storage and repair facilities may be particularly complex and costly.

Advantages of Surface Vehicles vs. Aerial or Submerged Vehicles
In our analysis we found that the primary advantage of surface vehicles is in the dramatically reduced cost and complexity of the systems involved. The drivers of cost and complexity in underwater and aerial systems are fundamental, and despite improvements in our capabilities in these areas, are unlikely ever to decline relative to surface vessels.
In particular, aerial vehicles and underwater vehicles have to maintain stability in three dimensions of space, dramatically increasing the complexity of control systems. In comparison, buoyancy is cheap, and until it is lost completely (ie the vessel sinks) can generally keep a craft in a functional state despite some levels of damage, or dramatic changes in payload or payload position which might be intolerable for underwater or aerial systems.

Critically, water vehicles required to move a given payload would typically be about tenth or less the cost of an aerial vehicle required to move the same payload, or a submerged vehicle.

Underwater vehicles also have the advantage over underwater vehicles of being able to access air, and satellite communication. Air allows fossil fuels to be burned, which dramatically increases endurance (rechargeable lithium batteries have less than a twentieth the energy density of diesel). Access to GPS dramatically simplifies navigation, and UHF or VHF radio correspondence allows real-time remote operation.

Surface vessels also have the considerable benefit of being able to remain stationary on station for long periods of time. This is a dramatic advantage over aerial vehicles which must maintain high velocities to stay airborne, and also underwater vehicles which require movement to prevent them from sinking or floating. As such, small surface vessels might advantageously be considered as deployment platforms for other assets and equipment which may be underwater or in the air, such as a towed array, Autonomous Underwater Vehicle, small UAVs, or surveillance kites.

Small surface vessels also have the potential to be remarkably stealthy and difficult targets to engage. Given the continuously changing nature of the surface of the ocean, small radar targets that also bob, and roll along with the waves of the sea can be difficult to identify if appropriately designed, particularly if not moving. Small surface targets that don't protrude as far above water as major surface combatants can also be remarkably difficult to engage from within the plane of the ocean using direct fire. Both these advantageous characteristics could be substantially enhanced if a semi-submerging design is used.

Given the possible advantages possessed by small surface vessels, we would urge the White Paper panel to consider carefully which tasks required in the naval arena (Mine Countermeasures, ASW, Surface Warfare, Patrol, Surveillance, Hydrographic Survey) that small surface vessels could contribute to, including through providing launch and recovery from mother vessel, transport to operating areas, C3I relay, refueling or recharging services to other smaller airborne or underwater systems such as AUVs, UAVs, kites, and towed arrays. It's our conclusion that designing a mission system where as much as possible is done from the surface, rather than as little as possible, will lead the most cost effective and robust capabilities for many naval operations.

**Manned vs. Unmanned Considerations for Surface Vessels**

There have been dramatic advances in the development of unmanned aerial vehicles in the past 10 years. Removing crews from aircraft has allowed dramatic reductions in the minimum size and weight of aircraft, whilst increasing dramatically the possible endurance of missions due to the removal of crew comfort as a consideration. Similarly, underwater vehicles have been developed consistently over the past decades without crews to great effect, as sustaining life (in particular some kind of pressure hull) is necessarily difficult deep underwater.
We would like to point out that most of the Unmanned Surface Vessels that have been
developed and promoted in the past ten years have been of a size and overall nature that
is not at all in conflict with also accommodating a crew. For that matter, it is also
worthwhile pointing out that most of the crewed small surface craft we currently operate
(RHIBs) have been readily adapted to operate in an unmanned role in a number of
different countries around the world. It's our belief that for small surface vessels, an
unnecessary bifurcation has occurred between surface vessels that are exclusively
'manned' or 'unmanned'. A single vessel could easily be both, and many operational
advantages and cost savings could be realised if one were developed as such.

In particular, many operations currently undertaken by RHIBs are necessarily manned. It
is impossible to conduct operations that have an important human element, such as
inspecting a vessel which is probably harmless, or rescuing people in distress, or
conducting boarding operations. There is no reason that the same sort of vessel, if
appropriately designed, could not utilize its empty deck space and spare payload capacity
to drag a mine countermeasure system such as a sonar tow-fish through a suspected
minefield in a pre-programmed patter for hours or days, in an unmanned state.

It's our suggestion that allowing a craft to be optionally manned or unmanned will actually
accelerate the development of improved robotics to enable a greater range of operations
to be undertaken in an unmanned state. Operating on water, particularly where launch
and recovery of other small vehicles, reeling of cables, tight manoeuvres etc are required
can be quite challenging operations to automate, particularly in difficult environments such
as elevated sea states. It's likely that automated systems that function well 80% of the
time will be rapidly developed for many tasks, but some intervention may be required when
things go slightly wrong, as the often do on water, and this would preclude their
acceptance in service. If a craft that could be optionally crewed were available, such
systems may be able to be accepted into service sooner, and operated in a crewed
fashion where required, and without crew when possible. Having a manual operator close
by to observe and intervene in maturing robotic systems would also likely lead to a better
understanding of system failure points, and their more rapid rectification in new designs.

We strongly feel that demanding that surface vessels be entirely unmanned in nature risks
losing the opportunity to conduct a wider range of tasks from common manned or
unmanned small vessels, and participate in the process of developing technologies to
make more of these tasks completely unmanned.

Chick or Egg? Mothership or Module?
If future Australian surface ships, such as the OCV or Future Frigate are to have deployed
systems (or modules) comprise a large component of their capability, then attention to
these systems must be given prior to the selection of the final hull type and design.

Many lessons stand to be learned from the US Littoral Combat Ship, where the chicken
was placed before the eggs. In March 2012, a GAO report remarked that "Navy plans to
procure 24 and deliver 9 LCS sea frames before delivering a single fully capable mission
module." The same report identified numerous program shortcomings, particularly around
launch and recovery systems for the modules, as well as the extended crew training times
and deficient ILS for all the modules and systems.

It's our suggestion that some of these problems could have been avoided, had the nature
and functionality of the mission modules been established prior to the final selection and
construction of the hulls. Launch and recovery systems in particular depend fundamentally on the design of both the mothership and deployed system. Furthermore, considerable advantages and savings can be realised if a common launch and recovery method can be used for deploying multiple modules or vehicles, or if one vehicle can accomplish multiple missions.

Based on current public discussion, it seems probable that the future frigate will have hangar and deck space for at least one, and quite probably two helicopters. We suggest that it be investigated further what other assets might complement, or replace a helicopter. For instance, if the financial resources, deck space, crew and training systems to support the second helicopter could equally well support 4, 6 or perhaps even 8 small surface craft (with only one or two or less operating manned in an ASW mission, for instance) and each craft could still be equipped with a dipping sonar, towed array, or number of sonobuoys, and/or a MU90 torpedo, this might amount to a considerable capability enhancement as more sensors could be simultaneously deployed to the water. The option of housing and launching and recovering 6 or 8 small watercraft for a similar financial investment and physical footprint as a second helicopter may be possible if considered prior to the finalisation of the hull design. It certainly would not be possible if considered after, and as such we urge that considerable investigation be undertaken into the potential of alternative deployed assets prior to procuring the main hull.

As an illustrative suggestion as to the way that a small craft could be configured to accommodate many alternative payloads or modules in either a manned or unmanned fashion, we’ve inserted the following chart: