

Underwater Future Capability

Introduction

TP Group has identified the following challenges faced by nations with submarine capability:

1. Improve current submarine fleet availability;
2. Improve future submarine fleet availability;
3. Decision-making;
4. Affordability / VFM;
5. Equipment advancements.

1 Improve current submarine fleet availability

A nation's submarine fleet can face serious availability challenges due to a combination of the following:

- Late delivery of new boats;
- Continued reliance on older boats (at the wrong end of the reliability bathtub curve);
- Extended Base Maintenance Period / Deep Maintenance Period (DMP) durations.

Improve Existing Solutions

TP Group can support Defence ministries and Submarine Tier 1s in achieving delivery assurance in a shorter schedule by implementing the following solutions.

Improved manufacturing and/or maintenance scheduling and control: Working with Tier 1s to introduce improved manufacturing and/or maintenance scheduling and control based on the Theory of Constraints, Critical Chain Project Management and Lean. Typical results are near 100% reliable delivery against schedules, which are c.25% shorter than traditional approaches coupled with a c.20% reduction in cost. TP Group has experience of applying these techniques within its own operations.

Optimiser software: The application of TP Group's Polaris Optimiser software capability to the optimisation of submarine build/maintenance schedules. Using Artificial Intelligence (AI), this software, originally developed to optimise maintenance of offshore windfarms, is expected to deliver submarine build/maintenance schedules assurance, improved resource efficiency and, consequently, shorter, more consistent programmes of work. This means more boats in the water and therefore an increase in asset availability.

AI driving shorter, more consistent programmes of work

Different Approach to Procurement of Solutions

Leading car manufacturers have, in applying concepts such as Lean, found effective ways to drive their supply chains into making similar improvements.

A typical approach is where a car manufacturer has sent teams of its own experts into suppliers, offering a deal on any identified saving of 1/3 for the supplier, 1/3 for the manufacturer and 1/3 for the end-customer to boost sales (and therefore revenue volume throughout the supply chain). With adjustments to a military procurement model, such an approach could be effective in submarines, and lead to improved Defence ministries-supplier relationships.

Implementation of approaches used in other industries

As a company with both expertise in improvement and manufacturing experience, TP Group is a credible supplier of the Suitably Qualified and Experienced Personnel (SQEP) necessary to support an approach of this sort by Defence ministries.

2 Improve future submarine design & build activities

As well as applying its delivery and availability assurance capabilities on existing fleets, TP Group can apply the same experience and technology to a nation's future underwater capabilities. TP Group is able to offer suite of solutions to improve future submarine fleet design and engineering, through to construction activities.

Different Solutions

There are a wide variety of ways in which future submarines could be designed to be both easier/faster to build. These include:

- Tango Bravo-like technology insertions (e.g. electric podded propulsion, electric actuation, external weapons, non-hull-penetrating sensors etc.) – the conclusions of such reports have been studied by TP Group teams as part of previous contracts:
 - Tango Bravo was a US investigation into what technologies would be required for a new attack submarine with similar capabilities as existing submarines but half the size and build cost.
- Modular design/build;
- Design for support, including placement of key systems in pods external to the main pressure hull.

Using TP Group's experienced Consultancy and Programme Services capability coupled with our Technology and Engineering experience, TP Group is able to support a Tier 1's transition from the traditional submarine build methodologies to these new approaches in submarine design and construction.

Different Approach to Procurement of Solutions

TP Group, as a technology business with a strong submarine heritage, and with a proven ability to build industry-leading collaborative teams, can support Defence ministries in realising the benefit of new technologies by providing an "incubator" for rapid concept development and prototyping.

TP Group is the lead company of the Enterprise Technical Alliance (ETA), one of the 11 companies to form part of the UK MoD's Submarine Enduring Naval Design Partnering. TP Group founded the ETA from a group of eight Small Medium Enterprises (SMEs) to deliver independence, simple contracting, agility and responsiveness that large Tier 1 suppliers cannot match, as well as collaborative working and value for money through small and large-scale support. The ETA's subject matter experts bring experience from a varied skillset, who can work together coherently to explore and investigate innovation through one contracting mechanism.

Leading SMEs to offer simple, agile and responsive support

3 Decision-making

Many Defence programmes, particularly those aimed at making large technological step changes or potentially comprising systems of systems, suffer protracted development phases leading to significant delays to the fielding of a solution. This is sometimes referred to as "paralysis by analysis".

Improve Existing Solutions

Operational Analysis & Approvals: TP Group is an industry-leading provider of Operational Analysis (OA) and UK MoD Investment Decision Support. OA/Approvals experience includes:

- WOC Approvals Support Partner;
- Submarine Dismantling Project;
- Type 26 Frigate;
- Future Maritime Support Programme;
- Skynet 6.

Support right-first-time approach to Approvals

Cost Engineering: TP Group is a leading supplier of cost estimating experience (2nd largest supplier to CAAS and leading provider to Dstl), providing robust estimates to underpin decisions/approvals. This expertise helps

to ensure an efficient/effective approach to analysis and a right-first-time approach to UK MoD Approvals, thus minimising project duration.

Different Solutions

Time Averaged Capability: TP Group has developed an innovative OA technique known as Time Averaged Capability which helps to support an evidence-based case for timely decisions favouring a “good enough now” approach rather than a gold-plated “jam tomorrow” approach. This places an emphasis on rapid deployment of capability.

Different Approach to Procurement of Solutions

TP Group has the capability to support rapid concept development and prototyping for future submarine capability and improved availability

4 Affordability / Value for Money

The submarine domain faces a perennial affordability challenge, which exerts downwards pressure on fleet size. Addressing this is made particularly challenging by factors including:

- High fixed costs of nuclear infrastructure and capability;
- Multiple monopoly suppliers at Tier 1 limiting leverage/opportunities to reduce costs.

Improve Existing Solutions

TP Group has SQEP cost engineers familiar with the Subs/Ships domains and with a strong track record of supporting Single Source Contracting and associated negotiation. This can be used to secure reduced contract costs.

Different Solutions

Potential solutions to improve affordability and value for money for the Future Underwater Capability programmes include:

- Targeted supplier cost reduction on existing solutions.
- Given high fixed costs of infrastructure/industrial capability, submarine procurement costs per annum are high regardless of the product built. Efforts to reduce build duration would allow significantly more capability to be delivered within the same cost envelope. TP Group can contribute to this as per Challenge 1.

Something Else

TP Group has developed a set of AI decision-support tools, further development of which has potential to support reduced manning of future platforms, with a potentially significant effect on through-life affordability.

AntsOnDeck: AntsOnDeck provides Optimised Autonomous Routing in dynamic and complex environments, which has the following benefits:

- Balanced optimisation across multiple user driven parameters – fuel efficiency, risk, time, vibration etc.;
- Mission planning support;
- Rapid rerouting and collision avoidance;
- React in real time to environmental conditions (wind, current, sea state);
- Uses an Agent based behaviour model to explore optimal responses to situations;
- AntsOnDeck is a platform agnostic system developed with an Open architecture, using industry standard data formats to simplify its integration to your system;
- Extensible beyond the surface maritime environment, AntsOnDeck can add value in any domain (land, air and subsurface) that is interested in optimisation of routing to minimise exposure, or maximise search efficiency.

Use of AI for Optimised Autonomous Routing in dynamic and complex environments

5 Equipment Advancements

TP Group currently provides design, manufacture and support for equipment on current UK submarines, and is part of the Successor solution.

Improve Existing Solutions

Atmosphere Control: TP Group could develop a higher efficiency electrolysis cell stack requiring less power therefore reducing cost and size of electrical converter for the cell stack. TP Group is looking at sensor technology that can be incorporated to automatically link O₂ production with submarine atmosphere requirement, thereby reducing crew interaction, and an all in one gas sensor to identify over spec atmosphere. The size of our Combined Oxygen Generating System (COGS) could be reduced by c.10-15% via optimisation of components, pipework, and layout. Additional improvements could also include:

Improve current equipment to be smaller, quieter and more efficient

- CO₂ Scrubber improvements:
 - Fit improved efficiency Scrubber with reduced MEA leak path design;
 - Automatic titration for more accurate measurement/management of MEA and demineralised water, to provide a user improvement and reduce likeliness of overfill or incorrect measurement;
 - Incorporation of automated control to reduce human error.
- Addition of portable or bulkhead mounted carbon monoxide (CO) removal unit for removal of CO in sealed compartments (diesel generator compartment), and passive CO removal for DISSUB;

Heat Exchangers: TP Group has significant experience in developing bespoke thermal solutions integrating high efficiency heat exchangers within challenging spatial constraints.

PMS: having worked on many PMS programmes, TP Group brings experience in developing a more open source, agile PMS that is not based on legacy systems. This has the benefit of providing quicker development and rapid capability.

Different Solutions

TP Group could investigate different solutions, including:

- Installation of super quiet rotating equipment to reduce submarine detectability;
- Development of metal oxide framework scrubber to replace MEA.

Different Approach to Procurement of Solutions

- Source non-ITAR components to reduce lead time and cost;
- Modularise equipment to provide reduced interfaces, improve maintenance and obsolescence management;
- Extend equipment boundary to include peripheral submarine valves and systems within air purification package.

Something Else

TP Group could incorporate COGS O₂ production and H₂ removal with CO₂ removal to make a Combined Oxygen Removal Generation Intelligent System (CORGIS). CORGIS would incorporate the latest O₂ production technology with submarine mission friendly H₂ removal and intelligent CO₂ removal – incorporating automated control, titration, remote monitoring, information assurance and Safety Integrity Level 3 as standard. Bolt-on technology available to improve capability of the equipment depending on customer requirements include: CO removal, catchpot systems for storage of unwanted products, NOX detection, or anything that falls within the existing boundary of atmosphere control / management / operation / maintenance / support. Modularisation of the equipment could allow for multiple parts of the system to be built in parallel to reduce production lead time.

About TP Group

TP Group is a professional services and technology partner with a unique end-to-end approach. Our Consulting & Programme Services team advise clients on strategic problems and implementing technology-driven solutions, whilst our Technology & Engineering team design, manufacture and support mission-critical systems. TP Group has over 50 years of technical expertise and working knowledge of delivering technically advanced solutions in the most challenging environments both under and above the sea.