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## SUBMARINES AND UNDERWATER TECHNOLOGY

INSIGHT - CAPABILITY - COMMITMENT



SYSTEMS AND ENGINEERING TECHNOLOGY

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## WHY FRAZER-NASH?

At Frazer-Nash Consultancy we provide a wide variety of submarine expertise and experience. Our Submarines Team, which includes Naval Architects, Marine Engineers and Electrical Engineers, can deliver a wide range of capabilities from concept design through to detailed Systems Engineering.

Frazer-Nash's broad experience, covering both the design and operation of submarines, makes us perfectly placed to deliver innovative solutions to complex problems. Our balance of technical disciplines and operational experience allows us to complement the delivery of new and innovative underwater technologies with a firm understanding of the problem and the potential solutions.

## WHAT WE OFFER

Frazer-Nash offers a range of technical skills and expertise for the design and assessment of underwater technologies and submarine systems. We provide design support and independent verification of underwater platforms, from whole submarine designs through to individual systems and components.

These skills include:

- Underwater technology development and design management
- Advanced hydrodynamic and structural analysis of submarines and underwater technology, including:
  - Shock and signatures analysis
  - Computational Fluid Dynamics (CFD) modelling of complex underwater forms
  - Submarine systems operation and performance analysis
  - Stability and seakeeping analysis
  - Electrical systems design and analysis
  - Propulsion and power train optimisation and performance analysis
- Concept and pre-concept submarine design
  - Naval Architecture
  - Mechanical and Marine Engineering
  - Electrical Engineering
  - Nuclear Systems expertise
- Requirements development for submarines and underwater technology
- Safety audits and independent design assessment

## CONCEPT DESIGN

### Hydra Submarine Concept

The ultimate cost and capability of an underwater system depends heavily on the decisions made at the concept stage. That's why our approach considers the impact of early stage decisions across the platform's life cycle. Our work with Babcock developing the Hydra modular submarine family highlights our capability to bring innovative and forward-thinking solutions to the development of new technologies.

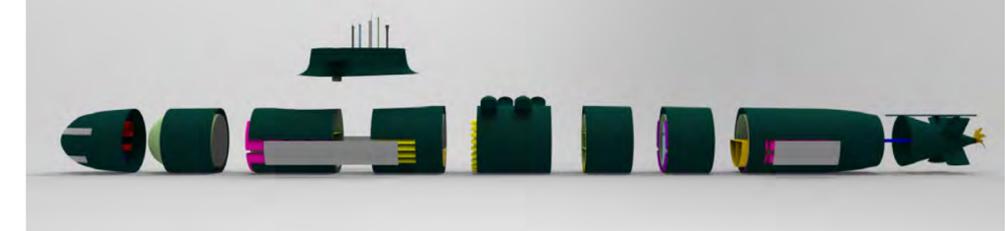
Frazer-Nash and Babcock collaborated on a private venture concept to develop a family of six modular submarine variants known as Hydra.

All of the Hydra variants are fully-balanced designs; 'Hydra-alpha' was developed as a basic, single-hulled, diesel-powered submarine. 'Hydra-zeta' was developed as the full-capability variant with a double hull, Vertical-Launch System, Auxiliary Underwater Vehicle hangar and Air Independent Propulsion module.

Each 'Hydra' variant has different levels of capability underpinned by distinct, modularised technologies. The six variants of the 'Hydra' family demonstrates modularity in terms of:

- Mission modularity
- Refurbishment modularity (at both system and whole-boat levels)
- Design modularity

Below Hydra-zeta, the full-capability variant of the Hydra concept submarine family



©Courtesy of Babcock International

## TECHNOLOGY DEVELOPMENT

Below Seafox unmanned underwater vehicle for removing underwater mines



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### Unmanned Systems

Frazer-Nash is at the forefront of the development of naval unmanned systems. We work for research organisations, governments and system suppliers to understand both the costs and benefits associated with the adoption of this evolving technology.

Working in conjunction with a system supplier and government research organisation we generated a generic assessment of the safety of operating unmanned systems autonomously, over-the-horizon. We examined five different mission scenarios, a range of vehicle types and a variety of potential targets to understand the hazards presented by the new scenarios that are made possible by the use of autonomous systems. This allowed us to identify a range of mitigations which provided guidance for regulators, designers and operators to ensure the safe exploitation of even the most sophisticated systems.

## TECHNOLOGY ASSESSMENT

### Testing Methodology and Impact Assessment

Frazer-Nash can provide comprehensive testing methodologies for the impact assessment of new technologies on the performance of submarine platforms.

We have worked with Thales, BAE Systems and Atlas Elektronik to quantify the benefits of automation when using Target Motion Analysis on submarine sonar systems.

An Experimental design was produced, describing how to test the Automation Systems and containing relevant research questions and performance metrics and measures. These included the effectiveness of the automation process and information flow, the level of situational awareness, task timings, workload and spare cognitive capacity.

We provided the customer with results showing that the Automation Systems significantly improved performance and reduced the workload of the operators.

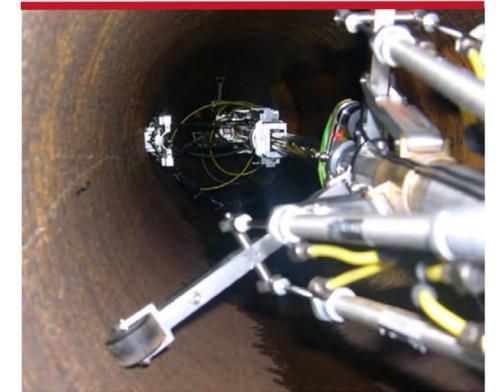
Below Automation systems screen outputs



©Courtesy of BAE Systems

## IN-SERVICE SUPPORT

Below The in-bore Inspection system known as 'The Ferret'



### Innovative Tailshaft Maintenance

As part of our Submarine Asset Integrity Management expertise, Frazer-Nash helped to develop new technology to reduce the costs of maintenance for submarine tailshafts.

Submarine tailshaft inspection and replacement is expensive, requiring a substantial period in dry dock. To reduce costs and mitigate the risks of tailshaft corrosion, Frazer-Nash helped deliver the In-Bore Inspection System for Babcock, in partnership with Imes Group Ltd and Sonovation BV.

The result was a tool that helped maintain safety to an acceptable level, whilst also gathering data to understand and monitor key tailshaft risks such as corrosion and cracking. The In-Bore Inspection System has made a significant impact on boat availability and maintenance costs, since the need for tailshaft removal is much reduced.