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WARSHIP 2011
NAVAL SUBMARINES AND UUVS

29 -30 JUNE 2011
THE GUILDHALL, BATH, UK

day 1

08.30 - 09.00 **Coffee and Registration.**

09.00 - 09.35 **A Vision for an MXV and UXV Enabled Future Submarine**
S. D. Binns, T. Gibbs and R. Eddy, BMT Defence Services, UK

Navies continue to require a covert and rapidly deployable underwater capability. This requirement demands a performance advantage, reduction of risks to operators and the platform itself whilst ensuring that value for money is achieved. Manned (MXVs) and Unmanned off-board Vehicles (UXVs) are a means to help meet this need. However, to date the initial development of these vehicles has commonly taken place independent of the parent platform. As a result there have been challenges in successfully deploying these vehicles from existing submarine designs. This paper aims to explore the potential mix of underwater parent platform and off-board vehicle options available to meet future underwater capability requirements.

09.35 - 10.10 **Towards an Automated Active UUV Dock on a Slowly Moving Submarine**
G. D. Watt, Defence Research and Development Canada - Atlantic
J. A. Carretero and R. Dubay, University of New Brunswick, Canada

Deploying UUVs from submarines enhances the operability of each. UUVs are expensive and need to be recovered after their missions. Man-in-the-loop recovery methods using remotely operated vehicles launched through a torpedo tube are available or under development. However, it is desirable to have an automated UUV recovery method for use in deep water with the submarine underway. The goal of our project is to do this without taking torpedo tubes out of action or imposing size restrictions (compromising endurance) on the UUV, and without requiring the UUV to have excessive docking infrastructure.

10.10 - 10.45 **Underwater Gliders - Force Multipliers for Naval Roles**
A Ray, Indian Navy

Underwater Gliders are a class of UUVs that are characterized by small size, long endurance, low speed, extended mission durations and low cost. Buoyancy-driven Gliders follow a saw-tooth pattern across the ocean depths, periodically transmitting the data collected by on-board sensors. Although developed for oceanographic studies, the potential applications for these vehicles are only limited by imagination. This paper comprehensively surveys the technological development of Underwater Gliders and describes their possible applications for naval roles.

10.45 - 11.15 **Coffee**

11.15 - 11.50 **A Submarine Concept Design - The Submarine as an UXV Mothership**
R G Pawling and D J Andrews, University College London, UK

Current UUV developments have focused on Mine Counter Measures (MCM) and reconnaissance, partly due to the limitations of the UUVs themselves and those imposed by the traditional submarine configuration. There remains the question as to how UUVs can be employed in the wider range of submarine operations. These will require larger more capable UUVs, which will directly impact the configuration of the manned host submarine. The current paper presents the concept design of a "UXV Submarine Mothership", deploying a set of unmanned vehicles. The design draws on advances in UXV technology and utilises an advanced version of the graphically based approach to computer aided design of submarines using the UCL Design Building Block approach

11.50 - 12.25 **Australian SSN - A Possibility or Just Fiction?**
C. J Skinner, DISplay Pty Ltd, and C. Childs, Australia

In June 1965 Scotts of Greenock laid down the first of four RAN Oberon class submarines: by the early seventies they were all based in Sydney. In the early eighties a replacement programme for the Oberons was initiated and this lead to six specially-designed and Australian built Collins class submarines. At the same time the operational focus for submarines moved from Sydney and the Collins class was based near Perth. Time moves on and the future submarine project to replace the Collins has already begun. At no stage has there been any serious consideration of nuclear propulsion for the future submarine. This paper looks at the difficulties and benefits that emerge from the political, business and operational arguments for a nuclear option, whilst giving a realistic view as to when, where, why and how.

12.25 - 13.25 **Lunch**

13.25 - 14.00 **Evaluating the Manoeuvring Performance of an X-plane Submarine**
P Crossland, P Marchant and N Thompson, QinetiQ Ltd, UK

To ensure that submarines are safe to operate, there is a need to quantify the manoeuvring performance of a particular geometry throughout the design process. This may mean, initially, demonstrating that the submarine has sufficient dynamic stability and control authority but, in due course, will lead to a full understanding of the agility of the submarine and the ability of the submarine to recover from emergency scenarios such as hydroplane jams or flooding incidents. This paper describes a four year research programme undertaken to develop the numerical and experimental capability to assess the performance of an X-plane submarine design.

14.00 - 14.35 **Submarine Manoeuvring: Correlating Simulation with Model Tests and Full Scale Trials**
N. Kimber, QinetiQ Ltd, UK

Most of the validation evidence for trajectory simulation comes from free-running model experiments, but these simulations are generally used to predict performance and responses to emergency manoeuvres at full scale. Occasionally an opportunity is granted to conduct sea trials on a full scale platform and this provides vital information for correlation with simulation and model scale data. Details of recent major trials are presented, including the types of manoeuvres conducted and the reasons for their inclusion in the programme. Some comparisons between model and full-scale results are presented, and the issues faced with conducting these types of trial and model experiment are discussed.

14.35 - 15.10 **Full Authority Submarine Control Concept Development**
R. Mansfield, P. Standen, D. Venn, Stirling Dynamics Ltd, UK

Full Authority Submarine Control (FASC) is a new concept for steering and diving systems, and combines Stirling's proven Active Control Technology from the fly-by-wire aircraft industry with extensive experience in producing submarine autopilot and hover control software. FASC is an integrated method of control which encompasses all steering and diving control requirements for the entire speed range of the submarine. The aims of FASC are to reduce operator workload, increase control efficiency and accuracy, and extend the operational envelope. Reductions in development cost and through life cost are also requirements and are informing the system design approach.

15.10 - 15.40 **Coffee**

15.40 - 16.15 **Recovery of Surfaced Disabled Submarines**
A. Watt, BMT Defence Services Ltd and E. Ofosu-Apeasah, MoD, UK

One of the requirements for a submerged submarine is the ability to recover from a significant incident such as fire or collision. In these circumstances, the recovery from the incident may require the submarine to surface and may lead to the submarine becoming disabled on the surface. This paper discusses the scope and results of such work and describes a number of new applications and research areas for sea anchors and drogues which can offer potential benefits. The paper concludes with a number of recommendations that can be applied to improve; emergency response measures, crew knowledge and skills and recovery methods of disabled surfaced submarines.

16.15 - 16.50 **Development of an Integrated Submarine Escape System**
T. Peacock, Babcock, UK

Submarines have evolved significantly in both size and role since the escape method currently used by the Royal Navy was first developed. An ideal escape system would operate successfully at the shallowest of depths and continue beyond the limits of human capability, so that the system itself is not the limiting factor for establishing viable escape. Furthermore the escape tower flood and pressurisation rate would be controlled to reduce the risk of injury and minimise evolution time and air consumption at all depths. This paper outlines the requirements of a modern submarine escape system and describes the work that Babcock is undertaking to develop an efficient, safe, reliable, low maintenance system that can be retro-fitted.

16.50 - 17.00 **General Discussion**

17.00 - **Drinks Reception**

day 2

08.30 - 09.00 **Coffee and Registration.**

09.00 - 09.35 **US Submarine Concept Design Tool**
S. Patten, Naval Sea Systems Command, USA
A. Mackenna, Naval Surface Warfare Center Carderock Division, US

Naval Sea Systems Command (NAVSEA) commissioned Naval Surface Warfare Center Carderock Division to develop Advanced Ship and Submarine Evaluation Tool (ASSET) for Submarines. In addition to cost and schedule efficiency, ASSET Submarine provides technical accountability by having vetted the engineering design processes through US Navy Technical Warrant Holders. This paper recounts the development of ASSET Submarine.

09.35 - 10.10 **An Introduction to a Methodology for the Early Phases in Systems Design of Future Submarines**
M. Nordin, Swedish Defence Research Agency, Sweden

This paper discusses a set of simulation based design (SBD) methods and tools for Naval Integrated Complex Systems (NICS) such as submarines. The prerequisites for the design of NICS are based on Systems theory and are especially useful in the early phases of the design were a structured, creative and traceable methodology is needed. The methodology can be used from the very first step in the design process to meet the needs and requirements of the customer and stakeholders to a balanced and cost-effective result in the form of a preliminary design specification for a submarine. The methodology introduce the use of a generic design object to stimulate an operations analysis simulation and from there extract tactically derived functions and functions requirements.

10.10 - 10.45 **US Technical Authority in Submarine Design and Engineering**
W. Richter and M. Martz, Naval Sea Systems Command, USA

The Naval Systems Engineering Directorate (NSED), within the Naval Sea Systems Command (NAVSEA), is responsible for providing the engineering and scientific expertise, knowledge, and authority necessary to design, build, maintain, repair, modernize, certify, and dispose of the Navy's ships, submarines, and associated warfare systems (excluding naval nuclear propulsion and strategic weapons systems). The NSED is a Technical Authority organization headed by NAVSEA's Chief Engineer. This paper describes the evolution of Technical Authority in the US Navy, and it's relevance to submarine design, construction, maintenance, and modernization.

10.45 - 11.15 **Coffee**

11.15 - 11.50 **Submarine Propulsor Technical Developments - Opportunities and Challenges**
S. Banks, Rolls Royce, UK

The requirements for quieter naval submarines, along with reduced weight and increased affordability, are driving new developments in submarine propulsor technology. This paper will discuss the technical developments which may help to achieve these more demanding future needs. Technologies under development in Rolls Royce include advanced composite materials manufacture and the use of rim drive motors for propulsors. These developments are primarily being driven by the needs of commercial customers and markets. The military sector can therefore take benefit from lower development costs as these technologies mature.

11.50 - 12.25 **Air Independent Propulsion (AIP) - Aluminum as a Fuel**
J. H. Mandy, BMT Fleet Technology Ltd, Canada

Aluminum can store about 100 - 120 times the energy of lead material in the battery of an SSK. Aluminum reacted with oxygen releases energy with an efficiency of some 80%. The reaction takes place in a low temperature solid fuel power cell which uses salt water as its electrolyte. The by-product of the reaction is aluminum oxide which is an inert and benign substance. Aluminum is a non-volatile material which makes it non-flammable and non-explosive. It also has an infinite shelf life. When operating on the surface, oxygen is provided by atmospheric air. Dived operation is supported by a variety of options for oxygen supply This paper analyses the submerged endurance capacity as well as the range, provided by aluminum as the fuel in the context of Upholder Class size SSKs for gravimetric and volumetric parameterization.

12.25 - 13.25 **Lunch**

13.25 - 14.00 **Construction Materials for Small Submersibles**
P. Vinton, Rolls Royce, UK

The commercial industry has a long history of using composite materials for the construction of both manned and unmanned submersibles for use in the offshore industry. Several 'leisure' submersibles are also in use around the world featuring composite construction and in some cases, composite pressure hulls. Generally however the classification societies have been reluctant to classify composites for manned submersibles and so, where classification society approval is required, construction has reverted to known submarine steels. This paper will discuss proposals for classification society approval of composite pressure hulls for small naval submersibles, with consideration of equivalents to existing design rules and safety factors in both submarine and pressure vessel construction.

14.00 - 14.35 **Dynamic Behavior of Ring Stiffened Cylindrical Structure Subjected to Underwater Explosion**
Y. O. Shin and Y. S. Shin, Korea Advanced Institute of Science and Technology, Korea

The dynamic stability of ring-stiffened cylindrical hull structure to underwater explosion is investigated using a finite element approach. One of detrimental collapse instability in tripping is identified in ring stiffened cylindrical structure. Tripping can be defined as a lateral-bending-torsional-buckling behavior of ring stiffener. The stiffener tripping-form of collapse is a sudden and drastic reduction in load-carrying ability resulting total failure. A sensitivity analysis is conducted to investigate instability region for stiffener tripping. The stability region is proposed in terms of ring-stiffener sizing with respect to hull structure configuration.

14.35 - 15.10 **Acoustic Characterisation of Anechoic or Decoupling Coatings**
C. Audoly, DCNS, France

External anechoic and decoupling coatings are used on submarine to reduce acoustic target strength and radiated noise, respectively. Acoustic performance of such coatings is generally assessed by measuring the reflection and coefficients of test panels in a water tank, along frequency and at different static pressures if required. However, these measurements can't give easily an estimate of the actual efficiency of the coating integrated on the hull, more particularly at low frequencies. After a brief presentation of the type of material considered and the parameters to be considered by the naval architect for integration on a submarine, the paper will present a method to evaluate the acoustic efficiency of coatings, taking into account the supporting hull. Some examples will be given.

15.10 - 15.40 **Coffee**

15.40 - 16.15 **Impacts of the Maintenance on the Predefinition of a Submarine**
M Nicod, DCNS, France

This paper aims at assessing how the rhythm of maintenance is linked with the predefinition of a submarine and its global cost. The outlined method enables the architect either to choose an optimized rhythm for a new ship design, or identify the strategies about architecture and technology to be implemented in order to fit with a required rhythm. The ratio Performances /Costs is at the heart of the subject. The central theme is the definition and the costing of several so called Maintenance Concepts: a rhythm of maintenance along with all the technical features requested on the submarine design to achieve it.

16.15 - 16.50 **Incorporating Through Life Support Requirements into Submarine Concept Design**
J. Owen, Babcock, UK

This paper discusses the direct experience gained by Babcock, the UK's Submarine Through Life Support (TLS) provider, through its early engagement in the new submarine programmes. It characterises the TLS scope and requirements in these early phases and explores the benefits and issues presented by such engagement, as experienced by senior members of the Babcock project teams. The approach developed and implemented by the Babcock Through Life Support team; to engage collaboratively with the design team and its processes from the very beginning of the concept phase, is now being cited as "best practice" within the UK MoD.calculations is a practical solution to demonstrate compliance with the damage stability regulations for non-standard loading conditions.

16.50 - 17.00 **General Discussion**

International Conference

WARSHIP 2011: NAVAL SUBMARINES AND UUVS

29- 30 JUNE 2011

THE GUILDHALL, BATH, UK

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The venue for the conference is the Brunswick room, Guildhall, High Street, Bath BA1 5AW

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