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International Conference

WARSHIP 2009: AIRPOWER AT SEA

17 - 18 JUNE 2009

THE NEW CONNAUGHT ROOMS, LONDON, UK

WARSHIP 2009: A

17 - 18 J

With conflicts increasingly taking place far away from land based air support, the role of naval based air power and the need to deploy a comprehensive range of naval based aircraft has become ever greater. RINA's 2009 conference in its highly successful Warships series will focus on Airpower at Sea.

Aircraft have developed rapidly in recent years and each generation of planes and helicopters present a new set of requirements and challenges to be met by the vessels carrying them. This is especially true of the latest trend towards Unmanned Air Vehicles (UAVs). These are now common for reconnaissance and surveillance and are on the brink of moving into a direct combat role. The vessels that carry these aircraft have long service lives and must be designed to take account of future developments with both minimal time spent out of service and cost due to updates.

day 1

09.00 - 09.30 **Coffee and Registration**

10.00 - 10.35 **Keynote Address:**
Tony Graham, Director, Capital Ships

10.35 - 11.10 **Development of the Queen Elizabeth Class Aircraft Carriers**
D Downs, ACA, UK

The Manufacturing Phase contract for the Royal Navy's new aircraft carriers HMS Queen Elizabeth and HMS Prince of Wales was awarded to BVT Surface Fleet Ltd, on behalf of the Aircraft Carrier Alliance on the 1st July 2008. Since then much progress has been made with the development of the design of the ships, the procurement of systems and equipment, the civil engineering works necessary to provide the facilities to build the ships and the build and integration strategies in preparation for the start of full scale production in June this year. This paper provides an outline description of some of the key technologies incorporated within the ships. It describes the alliance arrangements between BVT, Thales Naval, Babcocks, BAE Systems and the MoD that will ensure best value for money for the RN.

11.10 - 11.40 **Coffee**

11.40 - 12.15 **Integrating the JSF F35-B into the Queen Elizabeth Class Aircraft Carriers- Design Challenge or Opportunity**
A Lison Royal Navy, UK

The paper discusses the design challenge and opportunity presented by the integration of the Short Take Off and Vertical Landing (STOVL) variant of the Joint Strike Fighter into the UK's Queen Elizabeth Class Aircraft Carriers. It will expose the unique opportunity of designing and building an aircraft carrier around a brand new aircraft – the first time this has ever been done. However, the challenge of managing the ship-air interface of two large acquisition programmes requires a disciplined set of engineering processes to understand the technical risks across the interface between ship platform and air system. As a 5th generation STOVL aircraft, the technical challenge that the JSF brings to the maritime environment will be described and the paper discusses how the project teams are jointly managing the process. Finally, the key role of the Aircraft Carrier Alliance and the Aircraft Design Authority will be illustrated.

12.15 - 12.50 **The Design of HMS Queen Elizabeth and HMS Prince of Wales**
S Knight, Thales Naval Limited, UK

The paper describes the evolution of the United Kingdom's new aircraft carriers HMS Queen Elizabeth and HMS Prince of Wales – the biggest warships ever to be constructed by the UK. It addresses some of the fundamental drivers on the principal dimensions, form, arrangement and overall configuration of the ships and then proceeds to describe the three fundamental iterations of the design, resulting in the so called DELTA design – the configuration presently under construction at various shipyards in the UK. The paper discusses the reasons for the overall configuration of the carriers including the twin island arrangement, the deck edge lifts, the location and size of the hangar, and the power and propulsion configuration.

12.50 - 13.50 **Lunch**

13.50 - 14.25 **Propeller And Rudder Design For The Queen Elizabeth Class Aircraft Carriers**
G Grunditz and B Thorp, Rolls-Royce, Sweden
J Fisher, Thales Naval Systems, UK

The high ship speed and highly loaded propellers in combination with strict requirements on vibrations and radiated noise ensures the design of the propellers and rudders are at the cutting edge of today's technology. The propeller design has to be carefully considered to ensure a high cavitation inception speed, low noise and vibration levels. The ABP, Adjustable Bolted Propeller has a number of advantages compared to a monoblock Fixed Pitch Propeller and these are set out in the paper. A propeller design is very dependent upon the wake field or the inflow condition it is operating in and therefore the design of the stern hull lines and propeller shaft line have to be carefully considered to ensure as good environment for the propeller as possible.

14.25 - 15.00 **The Hydrodynamic Development of the Queen Elizabeth Class Aircraft Carrier**
T Dinham-Peren, BMT SeaTech Limited, UK
A Harris and L Sears, Aircraft Carrier Alliance, UK
N Ireland, QinetiQ, UK

This paper describes the process followed to select a basis form that met the hydrostatic criteria while minimising the vessel's resistance. Hydrostatic constraints imposed by ship stability requirements, internal volume and other geometry considerations are described. Work undertaken to optimise propulsive efficiency is covered including the selection of number and diameter of propellers, in conjunction with suppliers of the electric propulsion system, propellers and shaftline. The influence on the design solution due to factors such as cavitation performance and propeller-induced vibrations are discussed.

15.00 - 15.30 **Coffee**

15.30 - 16.05 **Numerical Methods To Predict Heat Transmission And Structural Effect On The Flight Deck Due To JCA Vertical Landing**
D Bray and J Wise, Frazer-Nash Consultancy Limited, UK

The Aircraft Carrier Alliance Platform Structures Team is designing the hull structure for the Royal Navy's Queen Elizabeth Class (CVF). During the design process a potential risk has been identified resulting from, the high thermal load produced by the efflux from the Joint Combat Aircraft (JCA) during vertical landing operations. This thermal load may influence the structural performance of the flight deck material and cause thermal issues for equipment located in the compartments below. Numerical methods have been developed, using a combination of computational fluid dynamics and finite element methods, to model the impingement of the JCA jet plume and resulting heat transfer into and throughout the flight deck structure.

16.05 - 16.40 **Optimising the Ship/Air Vehicle Interface via Simulation**
I Cox, Systems Engineering & Assessment Ltd, UK
J Duncan, Defence Equipment & Support, Sea Systems Directorate, UK

Over the past six years, the UK MOD has funded the Ship/Air Interface Framework (SAIF) project, in order to develop a flexible simulation capability aimed at the accurate prediction of Ship/Helicopter Operating Limits (SHOLs). A networked version of the Merlin helicopter simulator at the Royal Naval Air Station (RNAS) Culdrose has provided a high fidelity test environment for the SAIF project, whereby results from simulation experiments flown by experienced aircrew can be compared against real flight test data. Experiments have assessed Merlin operations from a variety of different ship types, including the Type 45 and CVF. In addition to the pilot-in-the-loop studies, the SAIF project has also considered how Computational Fluid Dynamics (CFD) ship airwake models can be analysed early in the concept ship design phase, in order to provide a more optimal ship design for aircraft operations.

16.40 - 17.00 **General Discussion**

17.00 - **Evening Drinks Reception**

day 2

09.00 - 09.30 **Coffee and Registration**

10.00 - 10.35 **Flight Deck and Aviation Facility Designs for Future Frigates and Destroyers**
A Crow, N Osborne and A McCrimmon, BVT Surface Fleet, UK

This paper presents an investigation into the flight deck and aviation facility designs for future frigates and destroyers. General aviation characteristics as well as specific design issues for mono hull or trimaran platforms are considered. Flight Deck layouts are proposed that maximise aircraft availability while minimising the impact on the other design aims of the ship. Two designs (with variants) are presented to illustrate aviation arrangements. One is similar in size to the Type 23 platform and the other is based on the Type 45 platform. The paper also reviews the hull form options and whether a mono hull or trimaran configuration is more suited to the aviation facility.

10.35 - 11.10 **Future Proofing Frigate Aviation**
M Waugh, ANZAC, RAN, Australia

Frigates now days can be highly successful multi-role warships with advanced organic aviation capability operating on sustained deployments. However design margins typically erode before half-life is reached and the operators desire for capability upgrade never slackens. Margin management is as much customer expectation driven as it is proven naval architecture systems engineering where feasibility studies and trade-off options lead to better utilisation of real estate for warfighting improvement. Medium Size Helicopters are the multi--role stalwarts of frigate aviation. The helicopters themselves evolve to meet future needs and the design margins for real estate, electrical power, safe ammunition stowage and maintenance access are progressively consumed. Evolution tends towards heavier and larger designs that at worst case no longer fit into the hangar or the handling system becomes inadequate. Unmanned Aerial Vehicles are becoming key enablers for littoral and asymmetric warfare. Their integration into an existing platform present their own challenges not limited to launch and retrieval.

11.10 - 11.40 **Coffee**

11.40 - 12.15 **Feasibility Studies for VTOL UAV Autonomous Operations with the Possibility of Ship board Auto Recovery using Quiescent Period Prediction**
B Ferrier, Hoffman Engineering Corp , USA
J Duncan, Defence Equipment & Support, MoD, UK
P Crossland, QinetiQ, UK
D Ludwig, Office of Naval Research, USA

The purpose of this NATO sponsored Future Naval Capabilities UAV project is to demonstrate the feasibility to automatically signal the initiation of UAV descent. This Project studies the potential operational gains associated with the accuracy and length of the forward motion prediction for a variety of shipborne systems, particularly in medium and heavy seas. The project focuses on the development of the theoretical and experimental aspects of ship motion prediction in blue and brown waters, leading to production of a technical demonstrator. The objective is to recover the UAV on-board a moving vessel within reasonable safety margins regardless of the seaway. The Energy Index, the operative component of the Landing Period Designator, identifies quiescent periods to initiate aircraft descent based on aircraft deck limit definitions. Dynamic Interface simulation provides the physical information from which initial deck limits might be derived. Energy Index quiescent indications for UAV recovery opportunities are presented outside of current operating limits.

12.15 - 12.50 **The Ship Design Challenge of Naval Unmanned Aerial Vehicles**
D Andrews and R Pawling, Design Research Centre, UCL

A wide range of concepts, uses and configurations have been proposed and investigated for Naval Unmanned Aerial Vehicles (UAVs). Operational experience, however, has centred on small vehicles being operated within the ship's existing aviation facilities, provided to support larger manned (usually rotary-wing) aircraft. The wide variety in UAV and UCAV types suggests that new ship configurations, or new applications of existing configurations, could be developed to enhance the use of unmanned aircraft at sea. This paper describes design work undertaken by the UCL Design Research Centre to investigate possible ship configurations for operating different types of UAVs. Each concept was designed using the UCL Design Building Block approach, realised as the SURFCON tool as part of the Graphics Research Corporation PARAMARINE ship design system.

12.50 - 13.50 **Lunch**

13.50 - 14.25 **HALSS - Affordable Air Lift Platform for Navy and Humanitarian Missions**
I Mizine and R Schaffer, CSC Advanced Marine Center,
B vom Saal and R Thorpe, Herbert Engineering Corp.,

The paper describes the results of the design of a Heavy Air Lift Support Ship (HALSS), a large Trimaran ship capable of operating the C-130J Hercules aircraft. To ensure necessary speed of wind over the deck for aircraft landing and take off operations the HALSS Trimaran concept is designed to have a top speed of 35 knots. The concept of the HALSS is to provide support for military elements in Seabasing, strategic mobility and focused logistics during the undertaking of expeditionary warfare missions. The HALSS Trimaran concept offers a large flight deck operations area, with a relatively long runway length suitable for the operations of C-130J and KC-130 fixed wing aircraft. The paper discusses building strategy and cost estimates. Nuclear version of HALSS is also considered. Mission efficiency is ensured by utilizing existing and affordable C-130Js airplanes.

14.25 - 15.00 **A Lighter-Than-Air Approach to Naval Airborne Early Warning & Control**
N Bradbeer, Design Research Centre, UCL

Airborne Early Warning and Control (AEW&C) is accepted as an important function for the modern naval task group. Lighter-than-air vehicles offer many of the qualities which are required for AEW&C; namely sufficient altitude for long detection range, long endurance on station, high availability and low cost of operation. Tethered unmanned airships, or aerostats, are a mature, well-understood technology. This paper proposes an AEW&C system for a naval surface task group based on a radar equipped aerostat operated from a dedicated tender vessel. The system is designed to deploy with a CVF task group and offer AEW&C performance comparable to the current and likely future RN AEW&C. The paper explores possible options for the tender vessel, including designs based on monohull, SWATH or trimaran hullforms. The advantages of each of these configurations are discussed and the system compared to fixed-wing and rotary-wing options in terms of availability, capability and cost of ownership.

15.00 - 15.30 **Coffee**

15.30 - 16.05 **Real Option Reasoning in Defence Acquisition**
S Yasseri, KBR

Major defence systems like aircraft carriers can typically take more than a decade from conception to rollout. The value of a system usually diminishes with time because of emerging technologies as well as changes in needs. Defence needs can be classified as cost-reducing, mission-enhancing, and mission-enabling. Many of defence initiatives (technology development, capability enhancement and deployment of new systems) are multistage projects in themselves, where the decision maker can decide to expand, scale back, maintain the status quo or abandon. Real options "on" projects considers the valuation of technology, (which technology to choose), while real options "in" projects considers building flexibility into the design and hence making it adaptable and future proof, which is achieved by influencing the system architecture. This paper examines the real options reasoning "on" and "in" the project and associated tools for design adaptability. We also offer a set of simple computational procedures that quantifies the option value of a technology.

16.05 - 16.40 **The Affordable Aircraft Carrier - Aircraft Tie Down Points - Small, Relatively Simple, But Not Insignificant**
R Lawrence, Frazer-Nash Consultancy Ltd
A Mosnier, Aircraft Carrier Alliance

The Royal Navy's Queen Elizabeth Class of Aircraft Carrier (CVF) is breaking new ground in newbuild naval vessels through the philosophy of a commercially driven design. By driving out costs at all stages of the design, significant project savings are being achieved. Frazer-Nash Consultancy has collaborated with the ACA in the design of the aircraft tie down points. These are responsible for securing the ship's most expensive piece of machinery to the deck, and whilst by no means a complex component, must meet a set of requirements very specific to the vessel / aircraft combination. Based on the most suitable existing design, the 4,200 aircraft tie down points per vessel would come at an estimated total cost (purchase and installation) in excess of £10M.

16.40 - **General Discussion**

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