

*House of Representatives Standing Committee  
on Science and Innovation*

*Inquiry into “Pathways to Technological Innovation”*

*Introducing BAE Systems*

BAE Systems is an international company engaged in the development, delivery and support of advanced defence and aerospace systems. Supported by more than 90,000 employees, the company designs, manufactures, and supports military aircraft, surface ships, submarines, radar, avionics, communications, electronics, and guided weapon systems. Operating in 130 countries across 5 countries, it is a pioneer in technology with a heritage stretching back hundreds of years and is at the forefront of innovation, working to develop the next generation of intelligent defence systems.

For more than 50 years, BAE Systems Australia and its predecessor companies have been designing, integrating and maintaining military systems for Australian Defence. Its 2,600 employees work with the Australian Defence Force and Industry to ensure Defence has the capabilities it needs, when it needs them. With primary sites located in Adelaide, Canberra, Sydney, Williamstown and Melbourne, the company is committed to being the Australian Defence Force’s through-life capability partner in integrated military systems and support solutions. It combines key skills in engineering and systems integration and is a leading provider of battlespace communications, electronic warfare, military air support, air defence, mission support systems and intelligence, surveillance and reconnaissance. BAE Systems Australia’s strategy is executed through five core business areas which include Information Architectures, Force Awareness and Protection, Military Air Support, Airborne Early Warning and Control programs and Operations.

BAE Systems’ R&D activities are focused on applied research in niche areas, as opposed to “blue sky” or basic research. The aim is to increase the Technology Readiness Level (TRL) of research products to a point of maturity such that they can be exercised and exhibited in Capability Demonstrator Programs. In Australia, the research activities are managed separately, but are distributed throughout the Business Units – ie there is no centralised “research cell”.

BAE Systems’ research activities have resulted in the successful commercialisation of a number of technological innovations. One example of this is the Ship Air Defence Model (SADM). BAE Systems is also involved in the ongoing development of the Nulka Active Missile Decoy (AMD) – which is another example a successful Australian technological innovation, with origins in DSTO. The following sections contain an outline of these products, with particular reference to the Standing Committee’s Terms of Reference.

## *The Ship Air Defence Model (SADM)*

SADM is an innovative software product developed and marketed internationally by BAE Systems. It is designed to simulate the defence of naval task-groups against all types of air and surface threats (such as cruise missiles, small fast inshore attack craft and aircraft). The model specialises in simulating key factors that influence the survivability of ships under intense tactical engagements. In order to accomplish this in a realistic way, the product contains highly detailed physics models of a vast array of ship components (including radars and other sensors, command and control systems, electronic warfare systems and weapon systems and communications), very sophisticated threat models (missile dynamics and sensitive seekers that respond appropriately to electronic counter measures), and the environment (atmosphere, electromagnetic wave propagation). The product provides scientists, military tacticians and operators with a common environment to cooperatively develop tactics and conduct trade studies that help understand the best ways of deploying force assets towards the common goal of defending ships. This High Level Architecture (HLA)-enabled model provides a wide variety of analytical outputs, including 3D visualisation. The model calculates numerous measures of effectiveness and provides analysts the freedom to examine the outcomes from many angles, thereby revealing otherwise difficult-to-extract associations of subtle contributory factors. In essence, the product provides a rich environment within which to develop and analyse the performance of ship classes against both hypothetical and known anti-ship threat types in great detail.

SADM was initially developed from the company's Research and Development funding mechanisms, until it reached a self-sustaining level of commercialisation. The main contributor to the successful commercialisation of the product has been the uniqueness of the product (niche) globally, and its applicability to the solution of wide-ranging maritime defence problems. SADM has now been adopted for use by the navies and government research organisations of Australia, Canada, the US, UK, Netherlands, Belgium, Denmark and Sweden. It is also under evaluation by many other NATO and other countries. An interesting side benefit of the product to the user community is that it provides a common-basis for nations to engage in the joint development and dissemination of tactical studies.

The SADM development team within BAE Systems consists of six experienced engineers covering a wide range of engineering disciplines (electronic, radar, mechanical, aerospace and software) and a project manager. The ongoing development of SADM as a product continues to be sourced by two fundamental mechanisms - internal and user-sponsored funding. While core development for future products is funded internally, another component of funding comes from the SADM user community itself - generally the result of tasking by a particular user, to satisfy a unique set of needs. The company retains all intellectual property associated with product development. A significant proportion of the team's annual output is applied to the development of new features, functionality and enhancements, which are principally directed by on-going market research and feedback from the user-base. Considerable emphasis is placed on engaging the customer, and ensuring that the customer remains closely involved in the 'future' of the product. An annual user-group meeting provides a forum for users of all nations to gather and exchange ideas and progress. This approach not only mitigates development risk, but also keeps the

product sharply focussed and relevant. The highly responsive customer focus is crucial to the success and acceptance of the product, especially in consideration of its 'niche' status. Australia's geographical position also necessitates extensive travel for marketing and product support.

## Nulka

The Nulka Active Missile Decoy (AMD) system is designed to protect naval ships from the threat of anti-ship missiles (ASM). The advent of the new technology Exocet missile (early 1970's) required a rethink in protection of expensive naval ships. The Nulka system uses a unique combination of rocket motor and electronic warfare technologies to mislead or seduce enemy ASMs away from the target ship. When launched from a ship, it dashes away, stops, hovers, and decoys incoming missiles.

The Nulka system was developed over a period of 30 years in a collaborative effort between DSTO and originally at the Government Aircraft Factory. The Nulka decoy not only required the development of established technologies, but also innovative development of a method to carry the device away from the ship in a controlled way, to be initiated very quickly and safely. The solution was a cylinder that stood almost vertical, supported by a rocket motor and other special devices to ensure the motor stayed in the vertical position and moved in a controlled manner. The "hovering rocket" was flight tested in 1981 to demonstrate the principles. This technology was later patented in 1981. In recent years, the patent was maintained by BAE Systems.

The development of the "hovering rocket" to a commercial reality (Nulka) occurred under a successful collaboration program between the Governments of Australia and the United States, which began in 1986. The collaboration was a result of a worldwide search from 1981 to 1986, which included representation and marketing at conferences and 'trade fairs' (eg Paris Airshow). After initial difficulty, success was achieved when senior representatives from the RAN and defence started negotiating with the USN in 1985 and with the involvement of the Australian Minister of Defence in the negotiations. An agreement to proceed with Nulka development occurred in 1986.

Nulka is now in service as the primary ship self-defence systems with the US, Canadian and Australian navies. The main contributor to the successful commercialisation of Nulka has been the uniqueness of the product and the persistence of the Australian parties in engaging US/Canadian customers. The technology already has annual sales of more than \$500 million for Australian industries, and sales are expected to grow substantially in coming years.

Nulka is part-manufactured in Australia by BAE Systems. There are approximately 50 people working in the manufacturing of the Nulka system within the company and approximately 50 more external in Australia. The Nulka development team in BAE Systems Australia consists of approximately 30 people of whom the majority are engineers in electronics, software, mechanical design, and advanced control systems and aerodynamics.

Continuous development of the Nulka system has occurred over the past 10-15 years in the areas of flight control, electronics, rocket motor and electronic countermeasures. Further developments have been the result of both BAE Systems and Australian/US government ideas and initiatives. Ideas for improvement generally derive from performance testing in service trials but some are made necessary by obsolescence of components. Other ideas result from the culture of trying to make the product easier to manufacture and hence reduce the cost. Three meetings are held each year to review these proposals and plan development consistent with budgets. The BAE Systems team has a close working relationship with the Australian and international customers, which has contributed to the on-going enhancement of the Nulka product.

The Australian and US Governments primarily jointly fund any Nulka developments. In some cases, BAE Systems has received a direct contract from the USN, which is the first time the USN has engaged directly with an overseas country for developmental work. The Australian and US Governments retain all intellectual property associated with the product development.

In-Service support contracts with the Australian and US government are currently being developed. These are expected to cover repair and maintenance, in service testing and the monitoring of in service reliability in Australia and the USA. These activities will in turn generate further improvements. BAE Systems is also currently supporting three PhD students in the areas of Ship Motion Prediction and Nulka Control Law development. These represent an investment in the longer-term future as well as developing skills in new graduates.