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Providing an Integrated Naval Training Solution

White Paper

Most navies are facing an increased operational tempo with limited numbers of service personnel and ships, and restricted budgets. Yet high quality training remains critical to maintaining operational capability.

This paper addresses how industry can provide cost effective, flexible training and outlines a recommended business model.

Executive Summary – Providing an integrated naval training solution

The Challenge

Most Navies are facing an increased operational tempo, with limited numbers of service personnel and ships, and restricted budgets. Yet high quality training remains critical to maintaining operational capability. Furthermore, the sophistication of modern systems, the cyber and security threats to those systems plus EMCON restrictions, is constraining their peacetime use and reducing the effectiveness of live training.

The Solution

Navies around the world are therefore seeking help from industry to develop, manage and deliver the training required to support today's complex platforms and operations. They are also recognising the benefits of having an industry partner to assist in the design and management of a total training enterprise that adopts an integrated and 'holistic' approach to training.

A training systems integrator (TSI) acts as a partner throughout the training lifecycle, beginning with requirements definition and an analysis of alternative training approaches through to design and delivery of a training solution to meet the navy's operational requirements. To meet the full range of future missions, a TSI must be equipped to deliver comprehensive training for individuals, teams, units and task forces so they are suitably prepared for joint and coalition operations. Use of networked, modular and configurable training systems within a 'system of systems' provides flexibility and cost-effectiveness. Looking ahead, inclusion of a live-virtual-constructive (LVC) training environment will enhance the resultant integrated naval training solution.

A series of business models are possible ranging from full military design and ownership, with industry in support, to industry delivering a training solution and using industry capital investment to fund training equipment and instructors. In both models, the naval customer approves the training design and sets training standards; in the second he simply pays for the services required.

The Benefits

The industry partner manages all training tasks except those that cannot be delegated, freeing Navy personnel for operational assignments. The industry partner hires top-of-their-class ex-military instructors with the required subject matter expertise and military ethos to deliver the training. Enhancing simulated training in a synthetic environment will free up people and reduce the demand on operational units.

Industry will become a risk-sharing partner with its measure of success dependent upon the effectiveness of its elements of the training programme. Industry will guarantee availability of training and address potential obsolescence issues that may arise.

An experienced Training Supplier will manage the entire industry team and have access to a global network of suppliers and partners. This obviates the need for the Navy to devote extra resources to managing multiple contracts. Engaging with a single industry partner maximises commonality across the training systems in areas such as management information, synthetic environment, databases and courseware. It also helps make the overall training system more scalable for the inevitable changes and evolving requirements that will arise over the long life of a training system.

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List of Acronyms and Abbreviations

Acronym	Definition
CBT	Computer Based Training
CDB	Common Database
CGF	Computer Generated Forces
CIC	Combat Information Centre
DMO	Distributed Mission Organization
ILE	Integrated Learning Environment
LMS	Learning Management System
LVC	Live Virtual Constructive
MCR	Machinery control Room
MPA	Maritime Patrol Aircraft
OEM	Original Equipment Manufacturer
ROV	Remotely Operated Vehicle
SAT	Systems Approach to Training
TCC	Tactical Control Centre
TMT	Tactical Mission Trainer
TNA	Training Needs Analysis
TSI	Training Systems Integration (-or)
UAV	Unmanned Aerial Vehicle

1 The Training Challenge

Upgrading existing naval fleets with complex ships, aircraft and weapon systems brings with it the challenge of providing realistic cost-effective training, while at the same time maximizing the availability of personnel for frontline service. Added pressures arise from the increasingly complex and uncertain nature of the operating environment.

Modern warships are technically complex. Some are highly specialized for a designated warfare role but may also have modular components to assist preparation for multi faceted missions. Highly automated onboard systems are also leading to smaller ships' crews. These factors mean onboard routines are changing whilst operational cycles have reduced the time available for training onboard. This is especially critical for perishable skills.

Many new warships are designed to deploy for long periods and the practice of exchanging crews in theatre rather than rotating ships has increased. This operating model implies that modern sailors will spend their career with a fixed and balanced period of sea and shore time. Under this operating pattern, naval training needs to provide readily available and flexible shore and ship based training media to enable effective training and keep the crew prepared for current and upcoming missions.

1.1 Operational constraints

Most Navies today are very busy, and often have to operate in high risk areas. At the same time the availability of ships and personnel has reduced as has the budget for both operations and training.

Traditionally, Navies have used live assets to train a ship whose crew will invariably include several individuals straight from initial training. A large crew can make it easier to compensate for the lack of experience in new team members. Today, and increasingly so in the future, crews are smaller. Also, on-board training systems are not always fully exploited and face restrictions in terms of available bandwidth and fidelity. Furthermore, peacetime EMCON and cyber restrictions may prevent the partial or even full use of emitters for training purposes. Training at sea often involves pre-set scenarios which are limited by the availability of assets; such scenarios are becoming increasingly unrepresentative and may not test modern sensors and weapon systems. Preparing ships for operations in this way is therefore costly and not always fully effective.

1.2 Training challenge

A modern, mission ready naval force can only be delivered if its operational capability is underpinned by effective and affordable naval training. Most navies currently use a combination of live sea training and basic simulation for separate components (i.e. Combat Information Center (CIC), Bridge) as well as shore based classroom training to educate their crews in preparation for sea duty. To provide optimum value and maximum benefit, an integrated training solution is needed that delivers training for individuals and for teams - ranging from ship-based sub-units to combined task groups with multiple ships and aircraft. This should be flexible, modular, and capable of being integrated into networks spanning different military bases and facilities. Including warships in harbour and at sea within a live, virtual and constructive training architecture will provide an advanced training solution to prepare a ship to fulfil its assigned missions.

2 Concept – Training Systems Integration

Sophisticated simulators are often the high-profile centerpiece of a training system, but they are only one part of a seamless solution for delivering a fully trained and operationally-ready ship's crew. Producing a world-class training system requires a comprehensive understanding of every facet of training and the expertise to integrate all those components to work together flawlessly.

A training systems integrator (TSI) acts as a partner throughout the training lifecycle, beginning with requirements definition and an analysis of alternative training approaches through to design and delivery of a training solution to meet the navy's operational requirements.

2.1 Training Systems Integrator

A TSI is an independent and experienced Industry partner able to provide:

Innovation

Engineering excellence, constantly innovating in training device design, visual and sensor systems, common synthetic environments and databases, weapons platform performance fidelity, cross-platform interoperability and networking, distance learning alternatives, and much more; every element of naval training will benefit from the TSI's deep training knowledge base.

Training Systems Design

The TSI is there to deal with multiple "make or buy" decisions for the various components of the overall training system. It will ensure that every decision supports the optimum training solution for the customer's requirements, including best-in-class Industry and academia partners where appropriate.

Training Systems Expertise

The TSI must have operational domain expertise, technical expertise and extensive training systems expertise. A partner with these levels of expertise and ongoing experience in multiple industry training domains can enhance training optimization through sharing this broader specialized capability for both learning methodologies and learning technologies.

Independence

Original equipment manufacturers (OEMs) are understandably focused principally on the weapons platform they are developing. Training is only one element of a myriad of programme details and unlikely to be the OEM's primary concern. A TSI is platform-agnostic. Its core business and total focus is training with the key objective being to deliver the most effective training enterprise to meet the customer's operational needs.

2.2 Training Systems Integration

Training Systems Integration aims to provide state of the art and cost-effective training, maximizing synthetic training elements and, when desired, doing so in a Live-Virtual-Constructive (LVC) environment. By exploiting synthetic training, demand on operational units and uniformed training staff can be reduced, improving operational availability and lowering training costs. These benefits are best realized by pursuing a complete training solution that is delivered by training experts and combines courseware, classroom-based training, part task training systems and team training systems, all within an integrated learning environment. By using simulation-based technology and shifting shore-based training system accountability to an industry partner, a Navy will be able to focus more on its operational demands and requirements. Such an arrangement, however, will require an industry partner that can look beyond simply meeting specifications and instead act as a stakeholder in creating and then maintaining effectiveness in those elements of the overall training solution that have been entrusted to the industry partner. Given the many interrelated aspects in creating a comprehensive integrated training solution it is important to partner with an industry provider with proven experience and comprehensive expertise as a TSI.

2.3 System of Systems

Following a thorough analysis and design phase with customer engagement, and subject to the customer's requirements, the TSI will propose a system of systems to support a complete training solution, which is likely to include some or all of the following components:

- Training Devices
 - Computer Based Trainers
 - Part Task Trainers
 - Skills Procedural Trainers
 - Full Mission Simulators
- Integration of live assets (ships, helicopters, UAVs, ROVs)
- Synthetic environment and Common Database
- Facilities for students and instructors
- Networked communications
- Project management
- Instructors
- Courseware
- Course design
- Training infrastructure management
- Distributed Mission Organization (DMO) Network

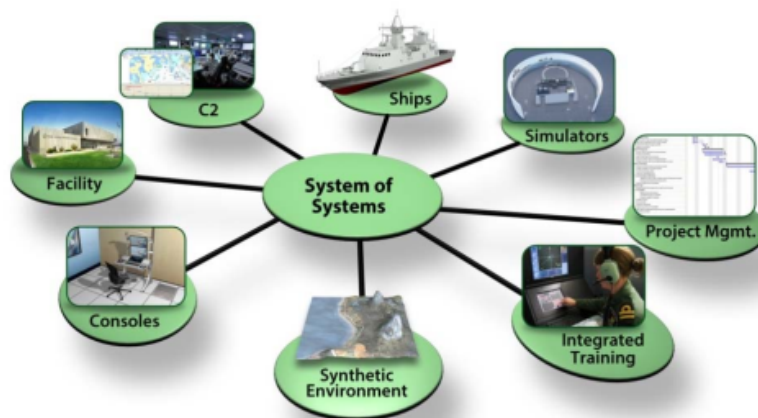


Figure 1: System of Systems

3 Naval Training System

3.1 Requirements for Naval Training Systems

A modern Navy needs an integrated, flexible and scalable training solution which provides credible, consistent and repeatable training. Major benefits will arise if the training solution also has a high degree of commonality amongst individual training systems, all operating in a networked environment.

The recommended characteristics of an integrated naval training system are:

Modular

A modular reconfigurable training console-based solution increases efficiency by using the same devices for many different levels of training (individual, sub-team, whole ship etc) and to train different personnel for different tasks. This offers real value for money.

Networked

A networked training solution allows instructors to assign training teams to support individual, team, whole-ship, and task group training. It will integrate training facilities, as well as ships in harbour and at sea, and is upgradable to include other training centres and live platforms. This efficient training solution maximises realism while minimising cost. Operating all networked training systems in an LVC environment will greatly enhance mission training, enabling mission rehearsal when live training may be limited by safety and/or security considerations.

Reconfigurable

Teams can train together in a setting that represents their work stations aboard a live ship. The reconfigurable training devices can be moved and adjusted to reflect the layout of the team's vessel, while the touch-screen human-machine interface representations will be customised according to the specific system being trained.

Systems Approach to Training (SAT)

Ensuring the Naval Training Systems are optimized through the application, SAT is a key component and ensures continuous improvement and achieves the right blend of instructional strategies for both individual and team/collective training at all times for both efficiency and effectiveness. This will also facilitate easier integration or collaboration with other services (air forces, marines, armies) training and allied nations training and operational systems.

Integrated Learning Environment (ILE)

The ILE allows for the efficient tracking of individuals, content and resources. Users can quickly reallocate training resources as needed and efficiently assemble fully trained qualified teams.

Realistic Fidelity

This flexible solution uses physics-based simulation models, high-fidelity representations of human-machine interfaces, and reconfigurable training device networks to provide highly realistic training. This approach will help a Navy to integrate newly-trained personnel quickly and easily into active duty.

Brief/Debrief

The solution will facilitate and reinforce learning through integral brief/debrief features, including recording and playback capabilities to support After Action Review.

Not being an original equipment manufacturer, a TSI is free to engage the most appropriate supplier for any of the systems within the training solution that best meets the needs of the Navy. The solution, composition and structure of such a TSI partnering arrangement should therefore result in complete alignment with the interests of the Navy.

This approach ensures the Navy gets the best possible value for its money. In developing and implementing the training solution, the TSI will work closely with representatives from the Navy through a series of reviews and testing phases interspersed within the solution development process, and through regular review meetings as the training system is made ready for training. If so desired, the TSI can engage with local industrial partners and transfer specialized knowledge, thus providing long term benefits to the nation's industrial capability.

3.2 The Naval Training Concept

An experienced TSI brings expertise in training analysis, design, development and delivery which will enable a comprehensive and accurate training needs analysis (TNA). By combining naval and systems engineering knowledge, a TSI will capture detailed information relating to the jobs and tasks undertaken by naval personnel, along with training and operational doctrine and documentation, equipment, and ship's systems data. Using this information, the TSI will undertake a scoping study to generate an *operational task analysis*, a *training gap analysis*, a *training options analysis*, and a *final report*.

Accurate completion of this process is crucial to the delivery of an integrated training solution that meets the Navy's operational requirements for the lowest cost.



Figure 2: Training Needs Analysis (TNA)

Based on the TNA results, it will be possible to create a complete training delivery solution combining courseware, classroom-based training, reconfigurable training consoles, part task training systems and team training systems including simulators, and an integrated learning environment. This will provide a fully integrated naval training system.

3.3 The Naval Training Architecture

Using the information gathered through the TNA, the TSI will develop a *system of systems* to deliver individual, team, whole-crew and task group training. This training system can include:

- Reconfigurable training device to emulate various operator consoles
- Computer-based classroom trainers
- Several simulators (MCR, CIC, Bridge, Damage Control, Firefighting, helicopter control, gunnery simulation etc.)
- Courseware
- Central gaming control (including Common Database)
- Facilities
- Project management
- Simulation controllers
- Long-term in-service support.
- Local and wide area networking
- Synthetic training environment
- An integrated learning environment (ILE), including a learning management system (LMS)
- Web based learning and mobile learning / performance support
- Recording and assessment capabilities that will help improve the quality of individual and team training
- Training centre management
- Integration of operational assets (ships, aircraft, ROVs, UAVs)

The advantage of taking a modular approach to training design is that a Navy can decide which elements best suit its training needs without having to acquire an entire training solution. Furthermore, the training solution can be custom designed to meet its specific training needs.

3.4 Naval Training Design

The design and operation of a naval training system is based on a partnership between the naval customer and an industry partner, as indicated in Figure 4 below. Within this partnership, the naval customer will define operational requirements and set the schedule to operate the training system. The industry partner who has the experience and the relationship with existing OEMs will deliver the technical solution, maintain and operate the training system. Responsibility for establishing the Training Concept, Exercise Design and delivering After Action Reviews may be shared between the customer and its industry partner.

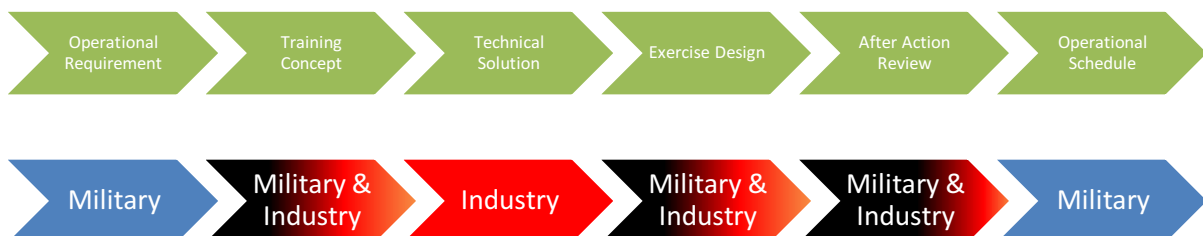


Figure 3: Naval Training Design – Military Led – Industry Enabled

3.5 LVC Technologies

LVC – Live, Virtual and Constructive Training aims to optimise the training environment through networking the real and virtual world while also adding a gaming dimension.

Live Training	The domain where participants operate live systems and platforms (including their full range of mobility) in the physical environment. In this case, real people using real equipment on real terrain are required to conduct training with and against notional forces. The realism of such training can be enhanced through the use of embedded simulation and by connecting to a constructive simulation environment in real time.
Virtual Simulation	The domain where live participants operate an operational system, such as a radar, or weapons platform in a synthetic environment, including distributed mission operations. In this case, real people interact with simulations and computer-generated forces.
Constructive Simulation	The domain where virtual forces operate virtual systems. Those forces can be controlled by live participants, typically command and staff trainees, or have their own artificial intelligence and behaviour. The trainees provide stimulus to simulated forces at all levels and act upon consequences generated by the simulation.

Table 1: Definition LVC

The LVC construct makes use of the following technologies:

- Embedded simulation.
- Datalinks – ship-to- ship, ship-to-aircraft, aircraft-to-aircraft, aircraft-to-surface.
- Wide area networks to allow communication between air and surface assets.
- Common database (CDB) protocols. The CDB is an open, standard database that defines a single synthetic representation of the world. It is now the simulation industry's recognised standard database and allows for a common correlated real/synthetic environment within and across each of the LVC domains. CDB allows for the correlation of multiple databases in varying formats in real-time. This includes out-the-window visual scenes in a simulator, plus all other systems in simulators, such as sensors, Computer Generated Forces (CGF) and navigation systems.
- Synthetic environment databases built to the CDB specification allow multiple synthetic training devices to draw from a single central database, ensuring correlation and enabling quick database modifications when required. The CDB promotes interoperable training and mission rehearsal while reducing database development, configuration control and publication time and cost.
- Ground mission coordination, record and playback briefing centre.
- Instrumented training ranges with time and space positioning information to allow the monitoring of flight and ship operations and the gathering/recording of flight data.

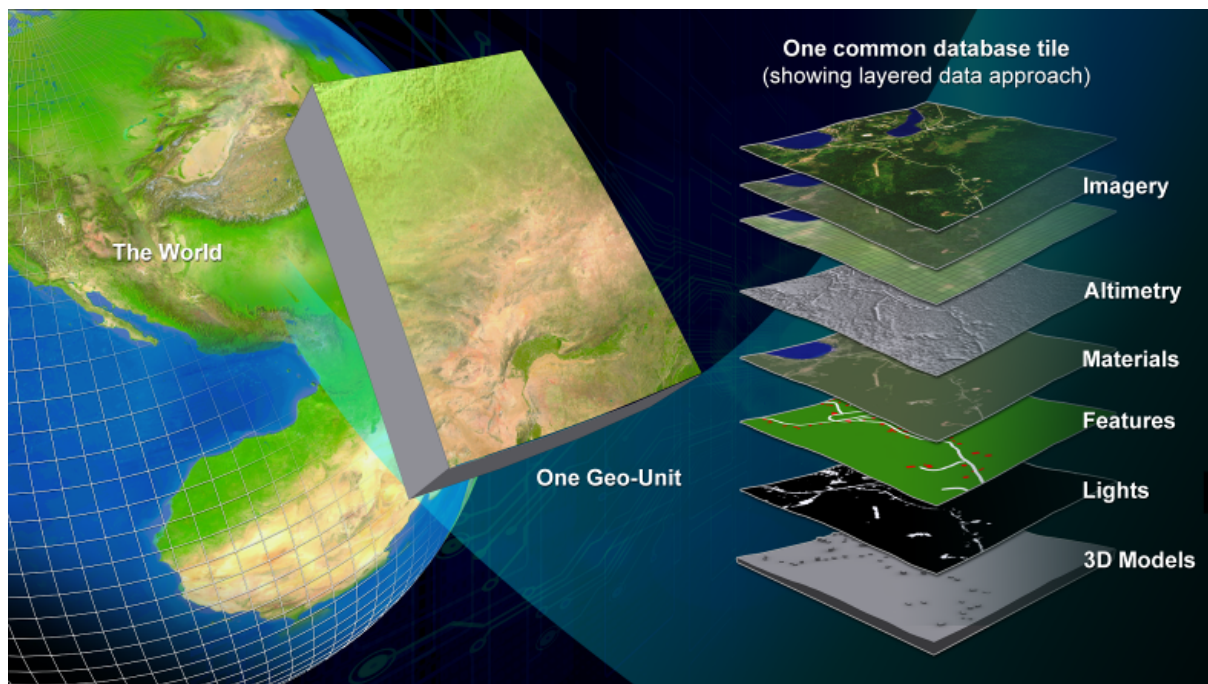


Figure 4: Layered Data Creates the Most Realistic Surface Possible

4 TSI Business Models

A TSI can deliver training services to a naval customer in a variety of ways. These can range from:

- Traditional government customer-owned and run facilities, with industry contractors in support. This gives the naval customer full control over all elements of training. However, it limits flexibility, in that any changes require further capital investment by the customer and many militaries lack capital to invest in training facilities.

to

- A system where Industry makes the capital investment, builds all infrastructure, installs equipment, and runs the shore training facility, while the naval customer simply pays for services received. Industry capital investment frees up government capital for front line equipment programmes. It also sees Industry running and resourcing training, releasing naval manpower out of the training organisation back to front line. Flexibility is written into the overarching contract and the naval customer uses its annual operational budget to pay for services received. This represents a true TSI service, where the naval customers sets the tone and standards, but the industrial partner takes on the full running and delivery of training services.

The table below gives examples of business models that Industry can offer to help the naval customer receive tailor made services that fit both the requirement and budget.

RESPONSIBILITY	BUSINESS MODEL					
	Government Owned, Industry Support Contracts		Government Owned, Industry Supported		Naval-Industry Partnership	
	Govt/Navy	Industry	Govt/Navy	Industry	Govt/Navy	Industry
Capital Investment	X		X			X
Facilities Ownership (on Balance Sheet)	X		X			X
Setting Standards	X		X		X	
Monitoring Standards	X		X		X	
Training Centre Build	X			X		X
Equipment Installation		X		X		X
Facilities Management	X		X			X
Facilities Maintenance		X		X		X
Training Centre Security/Access	X		X			X
VIP/Visitor Control	X		X			X
Equipment Maintenance		X		X		X
Equipment Modification	X	(X)	X			X
Classroom Instruction	X		X	(X)		X
Simulator Instruction	X		X	(X)		X
Simulator Control	X		X	(X)		X
Course Design	X		X			X

Courseware Production and Update	X		X	(X)		X
Exercise Coordination	X		X		(X)	X
Training Resource Management	X		X	(X)		X
Programme Direction/Management	X		X		(X)	X
Student/Crew Training Progress Management	X		X		(X)	X
Distributed Mission Operations	X		X	(X)		X
After Action Review	X		X		X	(X)
X – denotes primary responsibility (X) – denotes supporting role						

Table 2: TSI Business Models

5 Advantages of a TSI solution

A military led and Industry enabled approach to Training Systems Integration leads to many advantages.

5.1 Frees up Military Personnel and Operational Assets

The industry partner manages all training tasks except those that cannot be delegated, freeing Navy personnel for operational assignments. The industry partner hires top-of-their-class ex-military instructors with the required subject matter expertise and military ethos to deliver the training. Enhancing simulated training in a synthetic environment may also free up operational assets dedicated to supporting training.

5.2 Transfer of Risk

The industry partner will remain committed to meeting the naval training requirement. Industry will become a risk-sharing partner with its measure of success dependent upon the effectiveness of its elements of the training programme. Industry will guarantee availability of training and address potential obsolescence issues that may arise.

5.3 Continuity

In contrast to military personnel who move in and out of the training system, industry personnel accumulate a corporate memory and provide standardisation and continuity to the programme management and instruction cadre.

5.4 Access to a Wealth of Expertise

The training solution will capitalize on specialisation in the training process and applicable technologies and skill sets.

5.5 A single Point of Contact

An experienced Training Supplier will manage the entire industry team as the TSI Lead and have access to a global network of suppliers and partners. This greatly reduces the need for the Navy to devote resources to managing multiple contracts. As training objectives evolve, the TSI Lead has the means to align the industry team effort.

5.6 Agility and Training Quality

A sophisticated training system including continuous improvement through an adaptive, disciplined application of Systems Approach to Training provided by a TSI will lead to a more agile solution that can be adjusted to accommodate unforeseen missions. Additionally, by exploiting the capabilities of an industry partner and combining these with mission experience of the Navy, the overall training quality will be further enhanced.

5.7 Commonality and Scalability

Maximising commonality across the training systems in areas such as management information systems, synthetic environment, databases and courseware delivers a range of benefits. It also helps make the overall training system more scalable for the inevitable changes and evolving requirements that will arise over the long life of a training system.

Annex - 1

CAE – Experienced Naval Training System Integrator

CAE – Global Leader in Training

CAE is a global leader in the delivery of training for the defence and security, civil aviation and healthcare markets. We design and integrate the industry's most comprehensive training solutions, anchored by the knowledge and expertise of our 8,000 employees, our world-leading simulation technologies and a record of service and technology innovation spanning seven decades. Our global presence is the broadest in the industry, with 160 sites and training locations in 35 countries, including our joint venture operations, and the world's largest installed base of flight simulators. Each year, we train more than 120,000 defence and civil aircrew and thousands of healthcare professionals.

CAE's business is diversified, ranging from the sale of simulation products to providing comprehensive services such as training and aviation services, integrated enterprise solutions, in-service support and crew sourcing. The company applies simulation expertise and operational experience to help customers enhance safety, improve efficiency and maintain readiness.

CAE is the leader in simulation-based training for military personnel, and has more than a 25% market share. CAE serves more than 50 national defence forces and is a globally-recognized training systems integrator with expertise in providing training centres, training services and simulation products across maritime, land, air and critical infrastructure domains. Defence Training and Services CAE provides its military customers with turnkey training solutions as well as comprehensive training support services and integrated enterprise solutions at more than 80 locations worldwide. CAE's service offerings include training needs analysis, instructional systems design, learning management information systems, curriculum and courseware development, classroom and simulator instruction, airborne instruction, and maintenance and logistics support. In addition, the company provides systems integration, systems engineering and in-service support for operational platforms.

State-of-the-Art Naval Training Centre in the United Arab Emirates

CAE is delivering an advanced Naval Training and Mission Rehearsal System for the UAE Navy providing Individual, Team, Collective and Joint Training. The program includes the design, building and operation of a comprehensive Naval Training System to increase fleet operational readiness for ships in service but also future naval vessels and operational assets, like UAVs, ROVs, MPAs and helicopters. The training centre includes:

- Main training centre
- 5 distributed sites
- Network to ships alongside & at sea
- Reconfigurable Simulators for
 - 17 Ship types – Combatants, Minor Combatants, Auxiliaries
 - 2 Helicopter types – Sensor System Stations
 - MPA – Combat System Stations
 - UAV
 - Land System – Naval Gunfire Support.

This program will deliver training for all ships in the UAE fleet as well as MPA and helicopters. For this the following training devices will be delivered and operated in a networked LVC environment:

- Several OEM specific Combat Management System (CMS) GUIs to be emulated (Saab 9LV, Selex, Thales, Patria)
- Integration of full bridge simulators
- Integration of machinery control system simulators
- Distributed around 6 sites in the country with the ability to train together
- 170+ student stations, 50+ IOS and role player stations
- Task group control office
- Tactical Floor.



Figure 5: UAE – Naval Training Centre

Swedish Naval Warfare Training System

CAE has delivered a Naval Warfare Training system to the Swedish Navy. This system is installed at the Naval Warfare Training Centre in Karlskrona and comprises of a total of 65 consoles that can be configured for several training tasks like:

- Communication training
- ASW training
- Navigation training
- C4 training
- Sonar operations.

CAE's Naval TMT is a major element of the overall solution consisting of 65 Naval TMT workstations in addition to synthetic environment and computer-generated forces software.

This modular training system offers flexible configuration to train for any combination of missions the system is capable to handle as well as to network with other existing training devices not forming part of the CAE delivered systems.

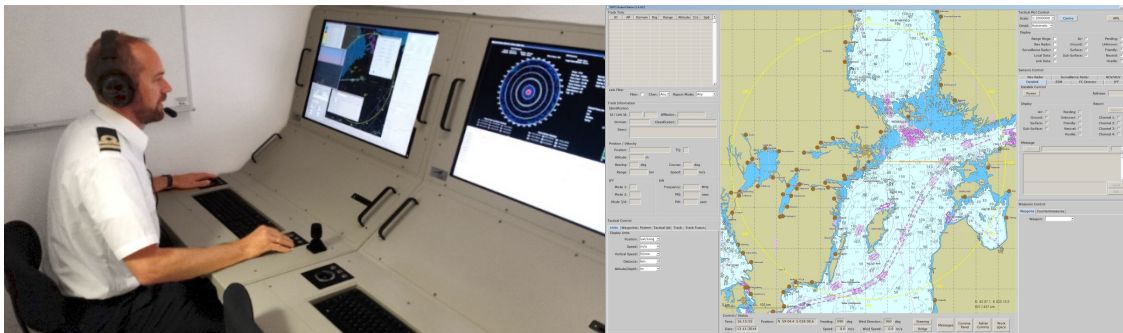


Figure 6: Naval Warfare Training Centre

Naval Mission Training for Airborne Sensor Operators

CAE has many years of experience providing training for the rear seat crews of maritime patrol aircraft and maritime helicopters operating in anti-submarine, anti-surface warfare, and search and rescue roles.

Our customers include the United States (Lockheed Martin P 3 and Boeing P 8 maritime patrol aircraft), Canada (Lockheed Martin CP-140 maritime patrol aircraft), Italy (AgustaWestland EH101 helicopters) and the United Kingdom (AgustaWestland and Lockheed Martin Merlin and Westland Lynx helicopters).

CAE's rear crew training solutions range from initial systems instruction in the classroom to fully integrated mission rehearsal in linked flight simulators, where all crews share the same virtual environment. One stand-out example of CAE's capability is the procedures crew trainer and software that runs the operational mission simulator for Canada's CP-140 Aurora maritime patrol aircraft. The procedures crew trainer and operational mission simulator are used to train both new crew members just starting out on the Aurora and also to provide continuation training for experienced operational crews. The procedures crew trainer is a reconfigurable training device that spans individual part-task training to part-crew training to full-crew training, while the operational mission simulator is a high fidelity training device used for full-crew training.