In the Summer 2008 issue of the Canadian Naval Review (Volume 4, No. 2), my article, "Obsolescence Challenges and the Canadian Navy," identified that the Canadian Navy is facing a number of obsolescence challenges. Two of the major challenge areas I identified were the rate that defence technology is evolving (and how this will affect Canada’s ability to react to new threats and interact with its allies), and the failing logic behind the boom-bust approach traditionally employed by the Canadian Navy to replace and/or update its systems. In this article I would like to introduce the concept of technology insertion to the broader naval community.

In 2005, a navy team completed a three-year study that looked at technology challenges in the navy. This Maritime Technology Insertion Working Group (MTIWG) also examined the challenges facing the United States and the United Kingdom, as well as investigating the initiatives that were being undertaken in these countries to combat these challenges. The study identified that Canada and its naval allies are all facing significant challenges trying to maintain operational currency. It further identified that the United States and the UK have been successfully utilizing a concept called technology insertion to address the challenges. The MTIWG concluded that adopting the TI concept could provide significant benefits to the Canadian Navy.

To begin it is necessary to review the MTIWG definitions for the key concepts of technology management (TM) and technology insertion (TI).

**Technology Management and Technology Insertion**

Technology management (TM) refers to the overall process of identifying and incorporating technology into military capability from concept development through design, acquisition, life-cycle support and disposal. Figure 1 shows the major components of the process.

Within the TM process there are a number of options for how a given capability is provided, based in part on considerations of cost, expected availability of parts and projections of how the technologies and military requirements will change over time. These considerations lead to the choice of through-life support strategy, as well as system design and acquisition routes that facilitate this choice.

For equipment such as a ship's main gearbox, where neither technology nor military requirement is expected to change significantly with time, the most appropriate life-cycle support strategy likely will be based solely on maintaining the gearbox over the course of its service life without upgrade. When technology or requirement change is expected, equipment such as a gun system may be designed, acquired and supported based on a strategy of maintaining that capability to a certain point and then looking to take advantage of external improvements in the gun design. This may result in the system being replaced with an upgraded or new model perhaps once during the 30-year life-cycle of a ship, a point referred to as the ship's mid-life refit. When an upgraded version becomes available, a new project is stood up to obtain approval and funding to buy and install the replacement.

Technology insertion is a subset of technology management. It refers to the implementation of capabilities that are designed to be, and actually are, upgraded routinely over their serviceable lives. Equipment meant for technology insertion is designed in a modular fashion with open architecture specifications. The philosophy is that modules – whether hardware or software – can be replaced or added easily without redesign of the whole system. Long-term equipment sustainment is by replacement of components shortly after their commercial end.
of life. New capability can also be added by component replacement. Such a combined sustainment and upgrade process allows systems to evolve over time, with a smooth and largely predictable spending profile. In general, only certain systems/equipments (primarily information technology-based) lend themselves to this application of the TI philosophy. Figure 2 shows the relationship between TM and TI.

With these terms defined, it now is possible to review how the United States and Britain are utilizing the TI concept.

**United States of America**

In 2002, the US Naval Research Advisory Committee published a study entitled “Life Cycle Technology Insertion.”1 The Assistant Secretary of the Navy for Research, Development and Acquisition commissioned this study to review the US Navy’s processes for technology exploitation, to identify any problem areas and to provide recommendations for improvement.

In the best practices section of this report, the committee identified the submarine Acoustic Rapid Commercial Off-the-Shelf Insertion (A-RCI) Program as an example of how to apply these best practices. This program was started by the US Navy in 1996 to deal with what it considered to be a crisis in its ability to field submarine sonar systems capable of dealing with a new generation of quiet threat submarines.2

The old sonar systems needed to be replaced; however, the forecast $1.5 billion development cost and the $90 million ship-set cost for a new military specification system was considered unaffordable.3 The concept then for the A-RCI sonar was to design the system using commercial off-the-shelf (COTS) hardware and software components to provide the most up-to-date and powerful computer processing capability possible and then to establish a process to identify, undertake and manage regularly planned upgrades to the COTS hardware and software. This successful A-RCI Program led to the development of the AN/SQQ-10 submarine sonar system, the standard sonar throughout the US submarine fleet.4

The USN use of technology insertion provides for a continuously evolving baseline. The impact of TI in this instance is that every boat equipped with this sonar system receives improved capability from one deployment to the next. In general this results in a software upgrade being developed every year and a hardware upgrade every three years. It is then a matter of scheduling the submarines for their upgrades as part of their routine maintenance cycle.

Not only has the A-RCI process resulted in the development of a sonar flexible enough to meet the sonar needs throughout the submarine fleet, but the TI methodology has also proven to be significantly cheaper than more traditional development methods. Figures 3 and 4 illustrate some of the benefits reported by the United States.

**Figure 2. Technology Insertion within Technology Management**


**Figure 3. Reported USN Technology Insertion Benefits – Performance**

**Towed Array Processing Performance Improvement Trend**

<table>
<thead>
<tr>
<th></th>
<th>Legacy</th>
<th>A-RCI / APB-98</th>
<th>A-RCI / APB-00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Operator Detection Success Rate</td>
<td>23%</td>
<td>49%</td>
<td>87%</td>
</tr>
<tr>
<td>Improved by a Factor of ~ 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Number of False Alarms Per Run</td>
<td>1.0</td>
<td>0.92</td>
<td>0.58</td>
</tr>
<tr>
<td>False Alarms Reduced by 40%</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mean Initial Detection and Classification Time (When Detection Occurred)</td>
<td>Baseline</td>
<td>9 Min Earlier</td>
<td>27 Min Earlier</td>
</tr>
<tr>
<td>Improved by 27 Minutes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Contact Holding Time* (When Detection Occurred)</td>
<td>Baseline</td>
<td>10 Min Longer</td>
<td>25 Min Longer</td>
</tr>
<tr>
<td>Improved by 25 Minutes*</td>
<td></td>
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</table>

* Measured holding time limited by the length of recorded tape.

United Kingdom

In the UK, the Ministry of Defence (MOD) has identified as its main obsolescence challenge the ability of its acquisition system to respond to the rapid development of commercial technology worldwide. To address this challenge, the MOD established a Major Program Area (MPA) study. The objective of this study is to identify and overcome the barriers to inserting new technology into existing platforms, systems and equipment. This is being done to cut time and cost of upgrading equipment, to mitigate obsolescence and to reduce whole-life cost.

In addition to the MPA study, the Royal Navy (RN) is also utilizing TI concepts in a number of areas. One such area is the Delivering Rapid Sonar COTS Insertion (DeRSCI) Project. This project was started as the RN faced problems, similar to the USN, in trying to keep capability up and costs down for its submarine sonar. This project uses open systems design and COTS technology to enable rapid capability upgrades through incremental acquisition and to reduce the impact of obsolescence.

Another area where the RN is utilizing the TI concept is in its Future Aircraft Carrier (CVF) Project. With technology developments increasingly being driven by the priorities of commercial markets and an ever-increasing uptake of COTS technology in defence programs, the RN has realized that defence programs have less and less control over the direction and pace of development of the technologies on which they are dependent. For the CVF Project, the RN decided it must deal with this reality at an early stage. As Martin Evans and Graham Stott note, “During the CVF assessment phase, a technology insertion strategy was developed to address the challenges of cost-effective technology
exploitation, for managing risk, sustaining capability, and achieving thru-life cost reduction.7

From this quick review of the American and British situations, it is apparent that both countries are experiencing obsolescence challenges similar to those being experienced by the Canadian Navy. In each country, operational and technology obsolescence, rapid technological change and budget limitations seem to have driven the defence departments to seek alternative solutions. Chief among these solutions is the adoption of the TI concepts.

The USN appears to have the most mature TI methodology. Its TI process began with the A-RCI Program and the philosophy is now being adopted by every sector of the fleet. In the UK, the MOD is currently investing significantly in studies of how best to use TI in its everyday business practices and it is utilizing TI concepts in the DeRSCI and Future Carrier Design Programs.

The experience of the United States and UK indicates that technology insertion could provide the Canadian Navy with an extremely effective model for addressing changing operational requirements, countering obsolescence and reducing through-life costs of ownership. The next section will now look further at these potential benefits.

**Benefits for the Canadian Navy of Adopting Technology Insertion**

As mentioned in the introduction, two of the major obsolescence challenges facing the Canadian Navy are:

- the difficulties faced in improving the navy's operational capability to meet rapidly changing operational requirements in regards to both new threats and interoperability with Canada's naval allies; and
- the boom-and-bust cycle of government investment.

The US and UK experiences indicate that the following benefits might accrue to the Canadian Navy if it were to adopt TI. First, technology insertion improves operational capability. TI solves this problem through design specifications that make optimum use of COTS equipment and open architecture software that makes ship systems amenable to upgrades and easy replacement. As well, the associated acquisition contracting process facilitates technology upgrades on a regular basis. Thus the system remains current in both hardware and software resulting in increasing operational effectiveness over its life.

Second, technology insertion reduces the effect of the boom-and-bust investment cycle. The issue of cost management for naval capability is clearly a prime factor in the navy's development planning. Through-life costs are now gaining more visibility when accounting for the total
same lifespans as encountered during the Cold War. The article also noted that the boom-bust approach to planning and acquisition must be dropped in favour of a new paradigm focused on flexibility, modularity and growth space. This article has pointed out that Canada’s major naval allies are facing the same challenges and they are adapting to these challenges through the use of the innovative technology insertion concept. Adoption by the Canadian Navy of the TI concept offers the potential to address its major obsolescence challenges. Prime among these is that it will allow the navy to maintain its operational currency at a much-improved level over the current life-cycle support philosophy. TI also offers great flexibility for planners to tailor system upgrades to changing operational requirements. As well, the TI concept takes full advantage of design modularity and planned growth space in systems. Finally the predictable nature of the spending offers much greater stability to navy planners over the current boom-bust process. These advantages make a very strong case for the Canadian Navy to adopt the TI concept.

Notes
2. Richard A. Udicious and Michael E. Feeley, “Acoustic Rapid COTS Insertion (A-RCI): An Acquisition Model for Future Military Systems,” US Naval Institute Proceedings, Vol. 130 (January 2004), pp. 72-75. Although this was written by two retired Navy Captains, they were both working for Lockheed Martin at the time.
4. The AN/SQQ-10(V) is installed in SSN 688, SSN 688I, SSN 21, SSGN and SSBN 726-class submarines. The AN/SQQ-10(V4) system is also installed on the SSN 774-class submarines.
5. The MPA study is a UK process that engages the scientific, engineering and operational communities in a defence enterprise study. United Kingdom, Ministry of Defence/DSTL, “Technology Insertion, Major Programme Area: Definition Study,” 17 October 2003, available at www.timpa.co.uk.

Figure 6. The Technology Insertion Approach