Lessons in Innovation: The SSBN Tactical Control System Upgrade

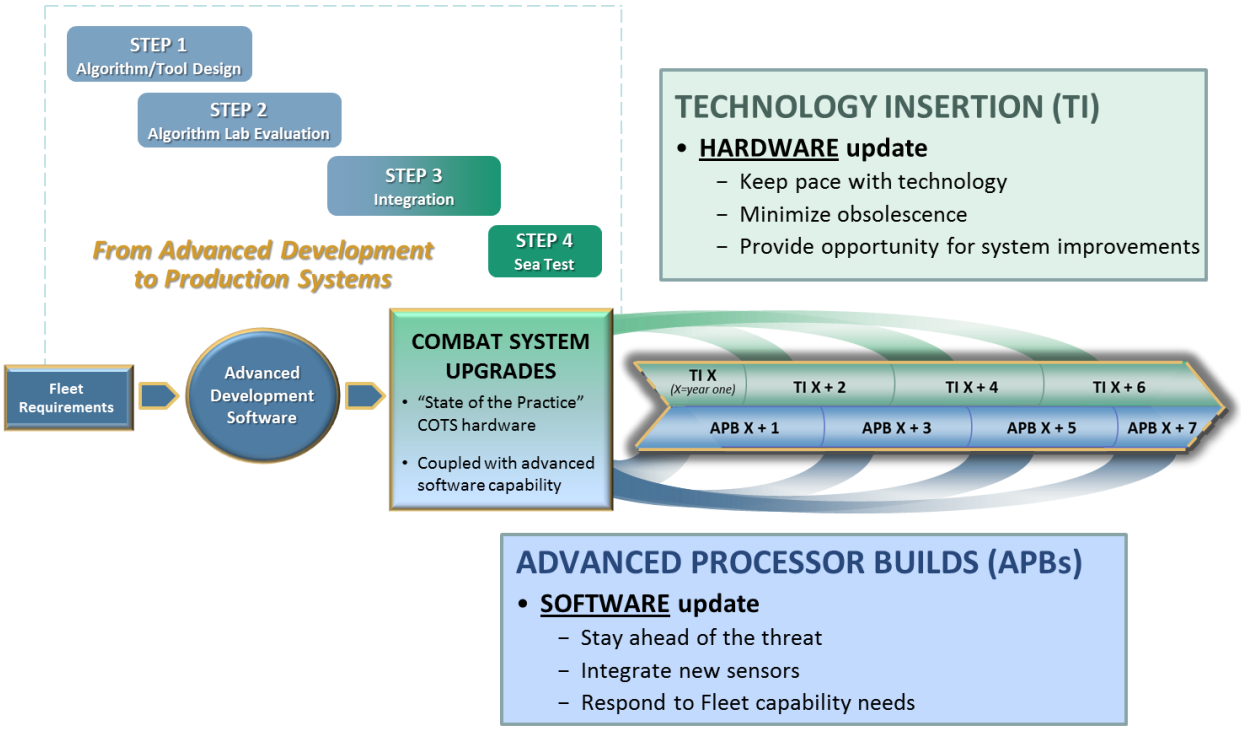
By Captain John Zimmerman **

In late 2013, the Submarine Force decided to modernize the 1990's combat systems on OHIO-Class submarines. In early 2014, as the Submarine Combat and Weapon Control Systems (PMS 425) Program Manager, I realized that due to the process we use for developing software and hardware, it would take until 2022 to modernize all SSBN combat systems. Based on this lengthy timeline, I challenged my team - "How might we bring as much submarine combat system capability to the entire SSBN Fleet, for as little money as possible, in one year's time?" With no program dollars set aside for this initiative, any resources required would have to come from other organizations or from savings within our program. The one-year target meant we would have to bring capability faster than had ever been done before. However, the most important part of the question was the first three words – "How might we…"

> *Innovation is about learning what works. "How might we…" put this initiative on a problem solving and learning course that influenced the entire effort.*

If It Ain't Broke… Make It Fifty Times Better

The Submarine Force has an excellent tradition of bringing modern commercial hardware and combat system software to the fleet. The Rapid COTS (Commercial Off-The-Shelf) Insertion (RCI) process is the means by which new commercial hardware and combat system software are developed for SSNs and SSGNs. RCI is composed of the Technology Insertion (TI) process, which provides new computer hardware, and the Advanced Processing Build (APB) process, which develops new combat system software. These processes run on a two-year development cycle, that are offset by a year so that engineers can develop software on hardware that is in the final stages of production and vice versa.



The Advanced Processor Builds and Technology Insertion Process (Figure 1)

The PMS425 program office vision is "Any Submarine Combat System Capability on Any Hardware at a Reasonable Cost". This vision sought to improve upon the standard of excellence established by the TI/APB process. The key to this improvement was developing software that could run on many hardware baselines, not just the most current computer hardware. If we achieved this goal, then as soon as new software was developed it could be installed via fast and inexpensive software upgrades instead of the slower and significantly more expensive hardware modernizations. It was this vision, plus the challenge from Admiral Greenert, the Chief of Naval Operations, to "Get Faster," that inspired the development of this initiative.

> *Innovation requires challenging the way you do business. Even when things are going well, innovation can still achieve dramatic improvements in cost, schedule, and performance.*

Find Value and Eliminate Costs

The Submarine Combat System is comprised of two subsystems: the Tactical Control System (TCS) and the Weapon Control System (WCS). The TCS generates an operational picture using ship sensors (SONAR, radar, etc.). Operators use the WCS to place ordnance (either torpedoes or tactical missiles) on target. Because WCS changes require extensive testing, we decided this effort would focus only on upgrading the TCS.

To keep costs down and reduce development and installation timelines, our team concentrated on how to reuse current TCS software and the SSBN legacy combat system hardware. Over the years, more than one hundred million dollars have been spent developing TCS capabilities. Besides the current TCS software, our team identified a new mission planning application being developed by the Office of Naval Research (ONR) in advance of the submarine modernization process fielding this on SSN platforms.

The team planned to utilize as much of the legacy combat system hardware as possible. Initially, laptops were considered since they were inexpensive and easy to install. However, Fleet feedback was not positive. The laptops had limited processing power, and they crowded the limited space in the SSBN control room. Based on this feedback, the team converged on the idea of integrating one new computer server with the legacy SSBN combat system to run the latest TCS software on the installed SSBN workstations. This solution provided a tremendous increase in processing power, while eliminating the need for new combat system workstations. What remained was to determine if the new server could be integrated into the legacy combat system and provide enough computing power for all the new software applications.

> *Achieve innovation by finding value in previously-developed products and by eliminating processes that drive cost and schedule.*

Simple Prototypes – Provide Speed and Savings

With little money and little time, the team used simple prototypes to determine what might be achieved. Within one month of the project start, the interface was developed to prove the concept was viable. Based on this progress, the team held a Concept of Operations Experiment (COOPEX) for Fleet representatives at the Naval Undersea Warfare Center (NUWC) in Newport RI. The COOPEX demonstrated the software being run by the new server integrated into the SSBN combat system. In this early configuration, not all capabilities could be supported, and of greater concern, there were still many technical issues that needed to be resolved. In fact, at the time of the demonstration the latency of the integrated system was so bad that there was a five to ten second delay between the time an operator initiated an action and the action actually occurring. Regardless, Fleet participants made it clear that if the latency issue could be resolved, the initiative would be a tremendous improvement over current SSBN TCS capabilities.

> *Simple prototypes help to determine quickly what innovative approaches work.*

Only Promise To Do Your Best

At the end of the COOPEX, participants provided feedback. Overall, they were pleased but as the list of priorities was developed, some participants started identifying certain priorities as "deal breakers". "If this can't be done, then we won't use the system." It was tempting in the moment to make promises and guarantees about what would be achieved. Part of what made this an innovative effort was that we were moving so fast we could not be certain what would or would not be achieved. In that moment, we promised only to do our best to achieve what the Fleet felt was important. We also asked the Fleet participants to help us think about how this system could best serve the Fleet, instead of focusing on what the system could not do. Everyone was reminded that the Fleet would make the final decision whether to install the system onboard SSBNs.

Innovation means accepting the final outcome is unknown.

For Bold Innovation - Risk Taking is a Team Sport

With Fleet buy-in established, but still numerous technical, operational, and schedule hurdles to overcome, the PMS425 team quickly implemented the contract modifications required to purchase the necessary hardware and to begin integrating the new server into the SSBN combat system. PMS425 purchased the hardware without any assurance that the system would ever be installed. Our team accepted this risk based on initial Fleet support for the initiative and the engineering assessment that the technical issues that remained could be solved.

While there was significant support, many Fleet representatives still were concerned by the risks required to bring this concept to fruition. Submarine Development Squadron Twelve would have to develop employment guidance. The Submarine Learning Center would need to develop new training curricula. The Trident Training Facilities would need to schedule the required training in facilities that were already fully booked. Most importantly, the Submarine Squadrons and submarine crews would have to accept the risk of committing to, and training on, a system that had not yet been fully certified or tested at sea, in order to ensure their crews were ready to employ it once final testing and certifications were complete.

Our team solved many technical and performance problems, and within twelve months of concept initiation, the system was successfully installed in three training facilities in Bangor, Washington and Kings Bay, Georgia. Due to Fleet willingness to take risks, the required employment guidance and training products were also ready.

Innovation across many organizations requires everyone to assume risk.

Expect Setbacks and Respond Accordingly

The installation of the TCS Upgrade in the training facilities offered a number of opportunities: to get the system into the hands of the Fleet operators, to demonstrate the system could be quickly installed, and also to prove the reliability of the system through many hours of Fleet use. With these opportunities also came risks.

While the system had been tested extensively, there were still technical issues that needed to be fixed. The system was deemed "good enough" for installation into the trainers. Our goal was to deliver these capabilities to the Fleet as soon as possible, without providing a product with so many issues that it could result in a loss of Fleet support.

Unfortunately setbacks occurred. The initial installation did affect the performance of the legacy combat system. With the TCS upgrade system in operation, operators had to enter a solution twice before the system fully accepted a solution. While this may seem minor, and the SSBN crews quickly adjusted to this annoyance, the real issue was that the TCS upgrade was having an impact on the legacy combat system at all. Additionally, due to another technical issue, at certain times all the contacts in the system would "clump" to the same default solution. For a system whose primary purpose is to paint an accurate operational picture, this was a very significant problem.

> *Innovation is also about learning what doesn't work. Setbacks help to understand what isn't working. They're part of the innovation process.*

Many Small Risks Can Achieve Big Rewards

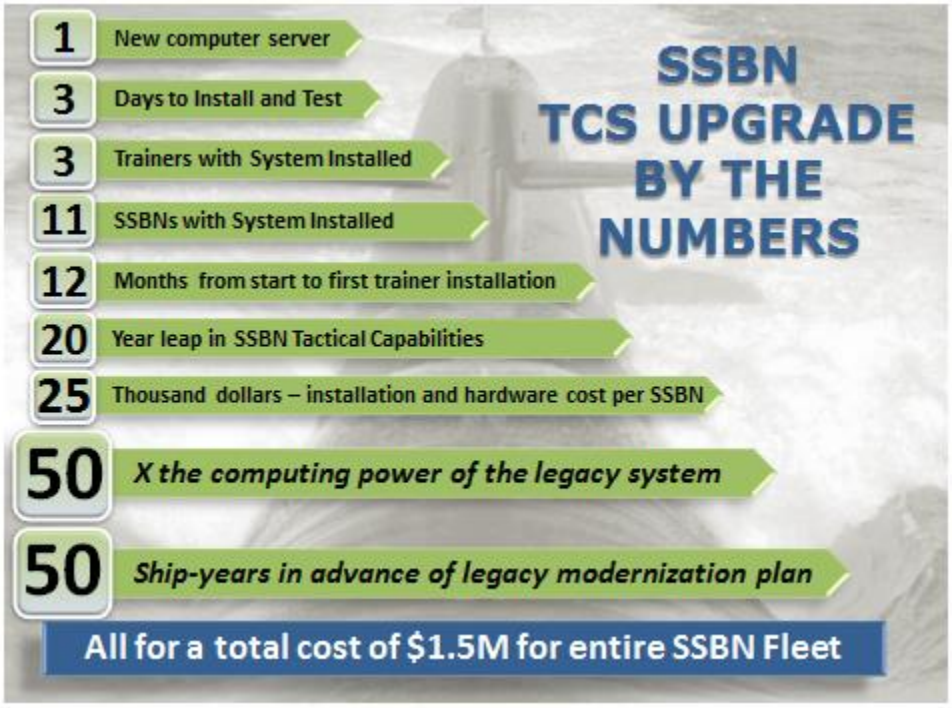
Fortunately, the submarine crews continued to train with the system while technical issues were being worked. CDR Ken Curtin, captain of USS WYOMING (SSBN742)(Gold), was an excellent example of this willingness to accept risk. After seeing the system in operation, CDR Curtin eliminated all planned legacy combat system training and fully committed to training his officers and crew on the TCS Upgrade system.

CDR Curtin's instincts turned out to be correct. Our team eventually resolved both technical issues, completed all testing and certifications, and on 24 July the Tactical Control System upgrade was successfully installed on USS WYOMING (SSBN742) (Gold), the first US Navy Fleet Ballistic Missile submarine to receive the Tactical Control System Upgrade.

The fact that many organizations were willing to take small risks enabled this success, and achieved very significant rewards for the Fleet. In less than two years this effort journeyed from concept to reality. Each new server brings with it more than fifty times the computer processing power than the legacy SSBN Combat System, the latest tactical control system capabilities, and the most modern mission planning capabilities available in the Submarine Force today. Just one operator can now perform the functions previously performed by three operators on the legacy system. Previously, officers and fire controlmen on SSBNs had a significant training burden when they transferred to a SSN or SSGN. This upgrade put them on par or ahead of all the SSNs

and SSGNs in the Submarine Force, providing operators that are better trained, and more easily transferred to different submarines throughout the Submarine Force. Due to the extremely small size and ease of installation and testing, the upgrade has already been installed in three Fleet trainers and eleven SSBNs. This effort represents the fastest, least expensive, and most significant improvement in tactical control system capabilities in the history of the US Navy Submarine Force.

He who is willing to risk and innovate can win big.



** = This article was written in December 2015 by United States Navy Captain John Zimmerman while serving as the Major Program Manager for Submarine Combat and Weapon Systems, PMS425. Since that time this capability has reached Full Operational Capability and is installed and in use on 13 Ohio Class submarine platforms and at the Trident Training Facilities. An earlier description of this project was published in the March 2016 United States Naval Institute Proceedings magazine.