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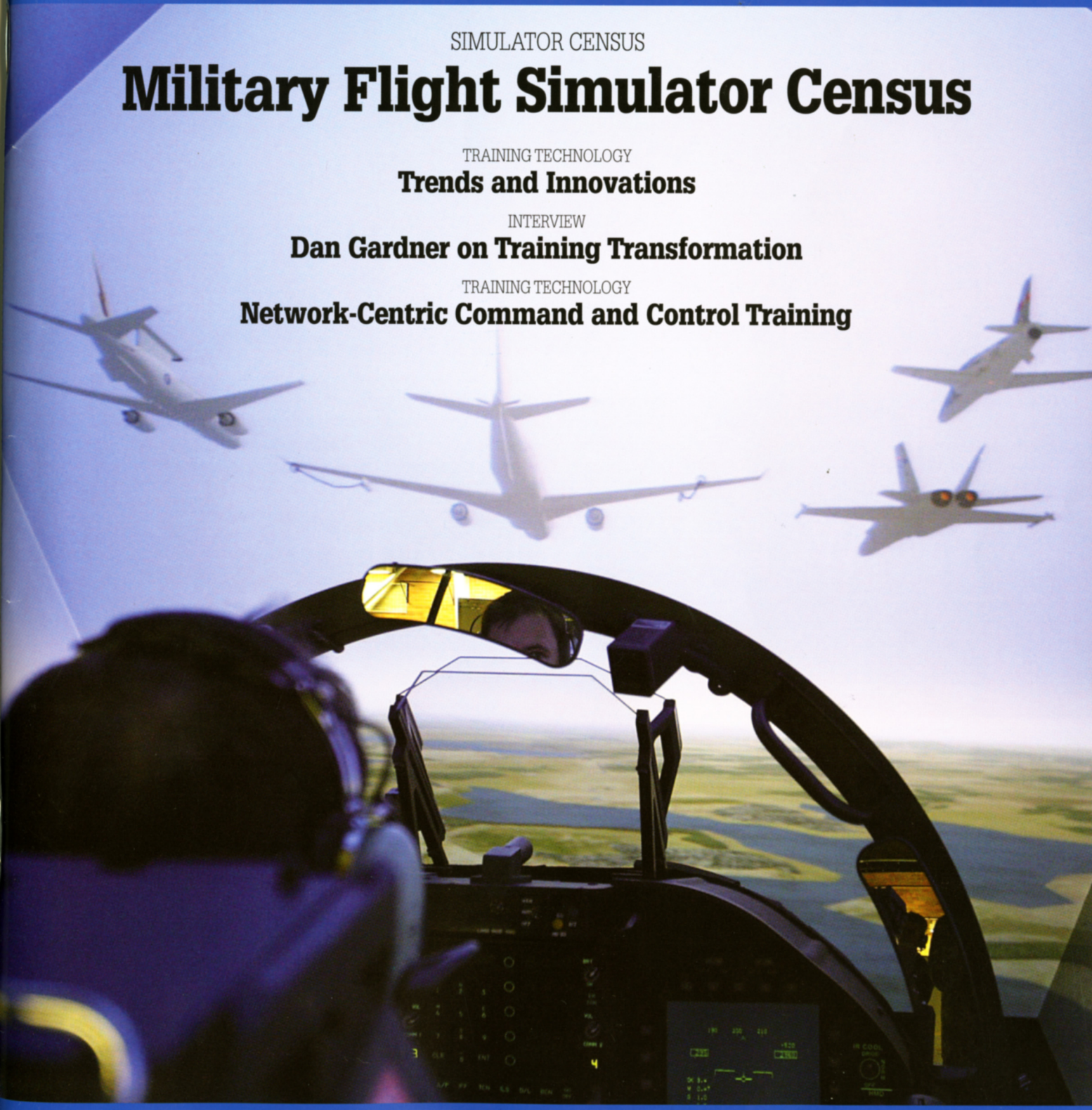

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Left
USCGC Mackinaw.
Image credit: USCG.

One-of-a-Kind

The US Coast Guard chooses a maritime simulator-based solution for the unique Great Lakes Icebreaker – USCGC Mackinaw. **Glenda Feldt** and **Keith Bills** tell the story.

One of the eight major missions of the U.S. Coast Guard is domestic icebreaking; another is providing aids to navigation marking the nation's waterways. When the 63 year old Great Lakes icebreaker USCGC MACKINAW (WAGB 83) was to be replaced, the decision was to construct a new one-of-a-kind ship that could perform both major missions, as well as, support law enforcement, environmental and lifesaving missions. Thus, the new MACKINAW (WLBB 30) is unique, equipped with state-of-the-art technologies not found on any other CG ship. The systems onboard are complex and ship operation carries a high consequence of error. The MACKINAW's sophisticated electronics and fully-integrated control and monitoring systems, dynamic positioning system, her unique Azipod® propulsion system and optimal manning presented steep training challenges. The nature of MACKINAW's electric pod propulsion system – 2 x 3.35 MW pods - affords the operator with maneuvering capabilities well beyond that seen on conventional vessels equipped with rudders used for steering and maneuvering. But, there is no ship's wheel! Just pod and throttle positions.

There is potential for loss of life and property if the MACKINAW operators make errors in ship handling or navigation whether in manual or dynamic positioning modes. The leveraged value of newly trained (and competent) personnel using the new equipment is high and impacts safety of the crew, commercial and recreational boaters and the public along the US Great Lakes; accurate and thorough crew preparation is essential. Clearly, innovative interventions were needed to prepare crew members to operate the ship.

Simulation and Simulators

Simulator and simulation decisions were under pinned by a "total ship training" philosophy. From initial acquisition planning, the philosophy was that USCGC MACKINAW's training system would center on the ship as the focal point for the management of crew competencies, development, and training. The total ship training philosophy aimed to:

- Migrate traditional shore-based training and technical support to the ship using training courses, embedded training, interactive courseware, on-the-job training, training with simulators, qualification workbooks, job aids and built-in electronic performance support systems for maintenance and operator training, and limit resident training at remote sites to existing programs; and.
- Integrate training into everyday operations and maximize the use of embedded training aids and other performance support interventions to minimize formal resident training requirements.

Performance analysts worked closely with the ship's sponsor and acquisition program during the construction of the MACKINAW to determine the best methods to prepare crewmembers to navigate and handle the icebreaker. Since there was to be only one ship like this, traditional training methods of setting up classroom instruction off site were deemed not practical. Analysts looked at the psychomotor skills, perception, decision making and action needed by operators of the MACKINAW. Operators needed an opportunity to practice navigation and handling tasks to proficiency with hands-on activities. Individual learning is important but some interaction with others on the bridge was also needed. Analysis determined that it was not practical to train on the live equipment due to severe consequences caused by inadequate performance and safety hazards inherent with improper performance. The selected solution? Place navigation and dynamic positioning simulators in a training room on the ship, and provide ready access to individuals and teams for training and practice. To be effective, a high level of realism was needed.

MACKINAW is equipped with a shipboard Kongsberg Polaris desktop simulator. This visual simulator integrates controls and information screens with a Kongsberg Databridge Radar, Kongsberg SeaMap ECDIS, and Kongsberg Simrad dynamic positioning into an integrated

bridge console designed to train new conning officers. Various simulation scenarios have been developed to afford a consequence driven, no-risk training environment. These scenarios also provide a measurement tool to assist seniors in determining the level of proficiency a trainee has achieved. In addition to required performances that must be successfully demonstrated on the bridge by a break-in Officer of the Deck, several simulated performances must also be successfully demonstrated in order to complete MACKINAW's Deck Watch Officer Watch Qualification Standards. The simulators provide a safe environment to visually demonstrate the maneuvering characteristics of MACKINAW and the opportunity to learn from mistakes without any consequences. A civilian (retired USCG Cdr) on-board training specialist provides support

An embedded simulation of the machinery plant control and monitoring system was installed to allow operators to train in plant operation while alongside. The simulator models what operators can expect to see when the system is operating underway, under varying conditions.

Above
Simulators on board USCGC MACKINAW. Image credit: USCG.

Unexpected Benefit

An unexpected benefit of the shipboard simulators is the capability to manage maneuver risk. MACKINAW's simulator is an excellent risk management tool. The ship is home ported in a narrow, shallow channel that creates significant bank suction and shallow water effect, requiring entry and exit at speeds limited to 3 or 4 knots. The lack of horizontal stability when reducing speed also complicates this mooring. Prior to transiting this port, existing wind and current conditions can be entered into the simulator as part of an evolution simulation scenario. By running this simulation, operators gain information on the actions that will be needed for the evolution. What was originally considered a marginal risk evolution could prove to be high risk but this is determined and planned for as a result of the operator's practice on the simulator. The MACKINAW has incorporated use of the ship simulator into shipboard

risk assessment procedures whenever possible. The simulator helps reduce the risk of human error by allowing repeated practice of performance to mitigate the steep learning curve and the challenges associated with frequent transfer of deck watch officers.

Lessons Learned

The commercial off-the-shelf visual simulator was integrated with the Dynamic Positioning simulator, but the MACKINAW ship's model had to be updated to reflect actual ship performance and configuration. For example, a 10 per cent Azipod thrust moved the model at 10 knots, the bow thruster simulation was fully effective even at 15 knots, the dynamic positioning simulator contained no "Remote Control" feature, no DP "Lever Active" feature and no DP "ECDIS Import" feature. Besides considering the initial cost of purchasing shipboard simulators, it is important to budget for modification of the simulator's software to reflect the specific ship's capabilities. This cost for commercial-off-the-shelf proprietary software simulators can be significant.

In this case, the software is customized for one vessel type only—MACKINAW. The system simulates bank effect (suction and cushion), draft resistance, ice resistance, tug and mooring line effects, anchor resistance and weather and lighting conditions. Wind direction and force, effects of weather, tidal strengths and currents are built into the simulations. Multi-vessel traffic encounters in actual ports within the cutters area of responsibility are part of the simulation. The look and feel of the simulation is authentic. Actual mission area models had to be built, including the port at Cheboygan, MI, the Straits of Mackinac, and the St Mary's River.

When determining what types and vendors of shipboard simulators to purchase, it is important to consult with other organizations already involved in use of maritime simulation. For the MACKINAW's decision making, analysts reviewed commercial maritime simulators at: Memorial University, St. Johns, Newfoundland; Canadian Naval Simulator, Halifax, Nova Scotia; and Kongsberg desktop simulators at Coast Guard Innovation Expo, Savannah, GA, STAR Center, Ft Lauderdale, FL and commercial cruise ships, Port Miami, FL.

When creation of traditional training is not cost-effective for one-of-a-kind vessels, the embedded and onboard simulation will provide the training supports and practice the crew needs. In addition, simulation software can enable operators to simulate actual sailing and mission conditions so that the simulator can function as a risk management tool. For risk management, the crew can rehearse the entry or exit of a difficult port in specific weather conditions, such as high wind or fog, before attempting the operation from the bridge. **ms&t**

About the Authors

- *Dr. Glenda Feldt*, of USCG's Performance Technology Center. holds a doctorate in Educational Leadership and a Master's of Public Administration in Human Resources Management. Her work employs HPT processes and methodologies and encompasses all ADDIE model phases for major systems acquisitions. Dr. Feldt was lead performance consultant for the USCGC MACKINAW project.
- *Mr. Keith Bills* is a retired USCG Commander with extensive command cadre experience in shipboard operations. He serves as MACKINAW's knowledge manager, and is the on-board Performance and Training Specialist.