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CREW MEMBERS BREAK THE COMMISSIONING PENNANT ABOARD
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NORTH CAROLINA (SSN 777).



Kevin Carpentier, ATI
Director

Bob Schaffran, Schaffran Inc.
Technical Director

Dale Orren, ATI
Deputy Director

Larry Karns, ATI
Business Manager

Natalie Corella, ATI
Director of Contracting

Scott Leasure, ATI
Project Manager

Melissa Clements, ATI
Project Manager

Connie Taylor, ATI
Program Administrator

The **Center for Naval Shipbuilding Technology** is Navy ManTech's Center of Excellence for shipbuilding and ship repair manufacturing technologies. Our mission is to identify, develop and deploy in U.S. shipyards, advanced manufacturing technologies that will reduce the cost and time to build and repair Navy ships.

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Page 3: VIRGINIA-Class outfitting photos courtesy of Electric Boat.

Page 4: USS North Carolina (SSN 777) construction photo courtesy of Northrop Grumman Shipbuilding - Newport News.

Page 4: Composite cross-section photo courtesy of Northrop Grumman Shipbuilding - Gulf Coast.

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LASER IMAGE PROJECTION

Laser Image Projection Technology Shows Big Savings for VCS Program

Electric Boat (EB) has successfully piloted a new laser imaging system that enables EB's Quonset Point facility to automate the layout of attachments during early outfitting stages of

VIRGINIA-Class Submarine (VCS) construction. The EB project team used an innovative laser image projection system to locate and attach over 4,800 electrical and ventilation hangers, installing approximately 8,860 studs in 21 VCS hull segments. A savings of 7,700 man-hours per ship is expected – reducing labor by 85% compared to the traditional method.

The previous process for locating attachments and penetrations onboard a VCS hull was labor-intensive and lacked automation. However, new layout technologies and the availability of 3D ship design data provided by the OneStop database presented opportunities for considerable reduction in labor hours and cycle time.

The EB team discovered that image projection technology could automate layout processes, thus significantly reducing the labor hours and span times and eliminating the use of antiquated paper templates and string measurements. Ultimately, the automation was successful and enabled production workers direct access to the CAD model information needed to locate and mark points of attachment.



Image Projection hardware, including Marquis Billboard (upper left), projectors (#2 and #3) and personal computer.

Much of this project's success can be attributed to its ability to utilize the OneStop CAD Database that was produced under another CNST-funded effort, EB's Product Centric project. This tool enables the extraction of positional data from EB's product model to determine the quantity and specific location information of various attachments.

This project ended in June 2008 but the EB project team continues to evaluate additional uses of this technology. The cylindrical shape of the submarine's hull is ideally suited for this technology, but other naval platforms are also being considered and could result in additional cost savings for the Navy. One technology that was considered by the EB Team during this project, Indoor Global Positioning System (iGPS), was proposed as a follow-on project, Automating the Install of Studs. This EB and CNST project is scheduled to begin in November 2008.

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VCS MATERIAL MANAGEMENT

Improving Material Logistics for VIRGINIA-Class Submarines

This project is already showing great success with 22 of 47 subprojects being fully implemented. In total, a savings of \$4.5 million per hull is estimated for all implemented and working projects. The Electric Boat (EB) team is diligently working to quickly transform those estimated savings into realized savings.

Shipyard material flow management challenges directly contribute to higher cycle times, excess inventory, low material availability rates, and re-manufacture/re-procurement costs due to rejected, damaged or lost parts. This project evaluates the performance of the material flow process from requirement identification to delivery to the trades for consumption.

A two-phase approach is being used to establish a world-class material flow system. In the first phase, Value Stream Analysis methodology was used to develop a Current State Value Stream Map. Computer simulation modeling performed by ManTech's Institute for Manufacturing and Sustainment Technologies (iMAST) at Pennsylvania State University's Applied Research Laboratory was an essential element of this effort, as it provided a means to visualize the flow of material. The EB team identified best-in-class companies, benchmarking material management systems to identify process excellence in material flow techniques. Finally, a list of prioritized projects was formalized in an improvement plan to develop a world class material flow system. The second phase incorporates those best-in-class projects into existing shipyard processes.

Once implemented, this technology could save an estimated \$3M annually in labor costs, and avoid an additional \$150K of lost or damaged materials for each VCS hull constructed. Findings from this effort could be applied across the shipbuilding industry as well as other material-centric activities.



VCS construction at Electric Boat.

OUTFITTING PROCESS IMPROVEMENT

Helping Achieve VCS Aggressive Construction and Cost Reduction Goals

The CNST team is expecting significant results from this General Dynamics Electric Boat-led project. The project began in June of 2007 upon recognizing that the outfitting area presents one of the best opportunities for continued reduction of costs and span times in VIRGINIA-Class Submarine (VCS) construction. The outfitting phase accounts for over 30% of the total labor hours for a typical VCS hull, and there are significant opportunities for savings in this segment of the overall construction process.

This project analyzes the major processes employed during the outfitting stage of construction, prioritizing and targeting areas for improvement and recommending solutions. The project also investigates the latest advancements in equipment and information technology to determine if implementing these technologies could significantly reduce the costs and span times for unit outfitting and final shipboard installation and outfitting.

The first phase of this project was recently completed, the goal of which was to identify, analyze and document the cost impact for each of the major outfitting processes. The investigation also included analysis of foremen work-distribution time commitments, current scheduling methods and techniques, and the various transfers of work, information, and material. A key result of this phase was the identification of the major cost drivers in outfitting and potential solutions to reduce those costs. The next phase of this project will execute and prototype pilot projects in support of developing a world class outfitting process for VCS construction efforts.

Outfitting process improvements resulting from successful completion of this project are expected to reduce labor costs by \$15M per hull and decrease early outfitting time by approximately 30%. Implementation activities could begin as early February 2009 with complete implementation of all new processes and tools by June 2009.



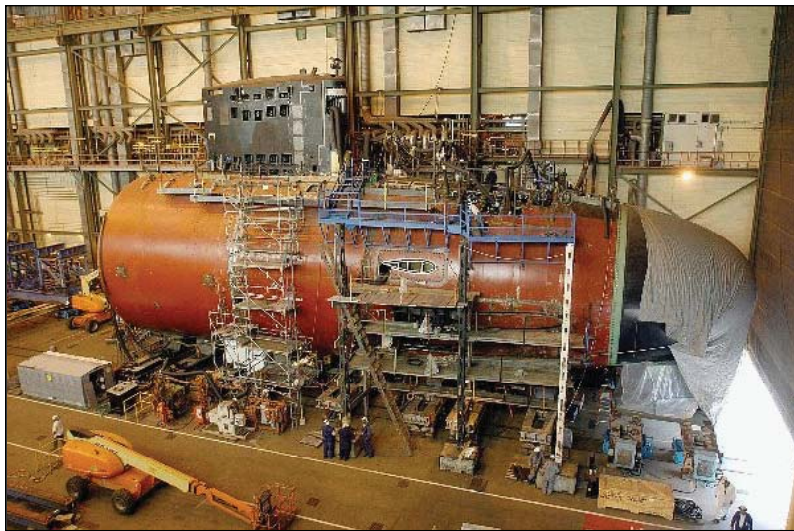
VCS cylinder outfitting during construction at Electric Boat.

SMALL WELDMENTS OPTIMIZED CELL

Project Set to Begin Tests

This Navy ManTech project will optimize the process for assembling small weldments from component-level parts at the Northrop Grumman Shipbuilding - Newport News (NGSB-NN) shipyard.

Computer simulations conducted earlier this summer predicted touch labor reductions of up to 25% in the small weldments process by optimizing cell configuration, tooling, equipment, material flow, and work sequences. With over 1,800 small weldments assembled per VIRGINIA-Class Submarine (VCS), these improvements would yield estimated per-hull savings of \$2.4M for the



The forward section and sail unit of the SSN 777, under construction at Northrop Grumman Shipbuilding - Newport News shipyard.

VCS program and over \$12M for the FORD-Class aircraft carriers. Additionally, modernizing the small weldments facility will alleviate one potential bottleneck during simultaneous construction of two VCS hulls and one aircraft carrier per year.

Simulation results specify state-of-the-art tooling and equipment in each ‘optimized’ cell, including fixturing tables and tool kits, weld positioners, and lifting devices. As such, test cells have been erected in the NGSB-NN small weldments fabrication shop – populated with the specified equipment – to validate computer predictions. Controlled tests began in November 2008 on production assemblies. Labor hours charged for each work package will be compared with historical expenditures to determine the cost savings.

Provided pilot tests generate favorable results, NGSB-NN plans to submit a capital expenditure request to each platform’s program office and begin implementation activities as early as March 2009.

SMART MANUFACTURING METHODS

Improved Resin Infusion Process for Large Composite Ship Structures

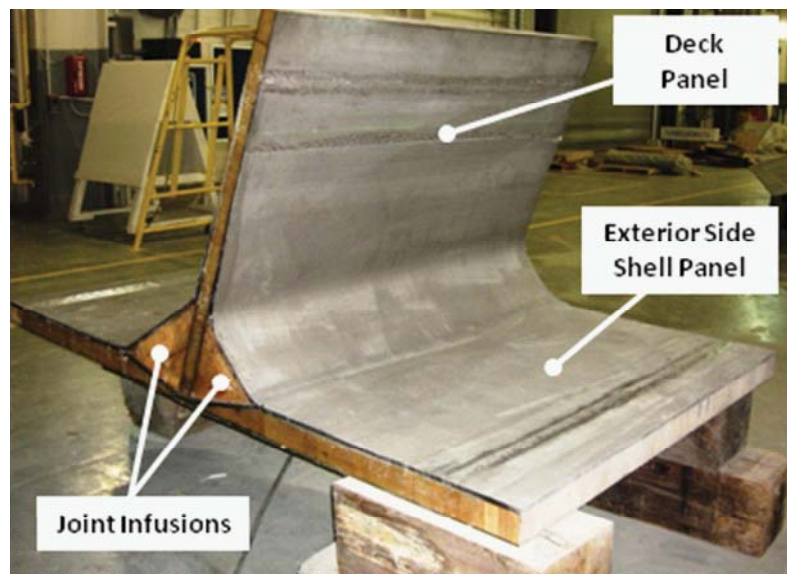
Northrop Grumman Shipbuilding - Gulf Coast (NGSB-GC) designs, constructs, and outfits vessels for the U.S. Navy that include components constructed of composite materials. These structures are required design features, but the infusion process for first-time production is quite variable and frequently results in excess material/labor costs and schedule interruptions. This issue will be critically important during construction of the

ZUMWALT-Class destroyer (DDG-1000), whose entire deckhouse will be made from composite materials.

Advances in computer technology have led to commercially available software packages that can assist engineers and planners in developing instructions for the set-up and infusion process that will generate high quality parts while minimizing rework and wasted material. This project sought to develop resin infusion processes for Carbon/Vinyl Ester resin composite joints that are predictable, repeatable, and reduce the defect rate experienced with current assembly approaches.

The NGSB-GC Project Team successfully used resin flow modeling and simulation software, predicting resin flow behavior and determining optimal production parameters. They developed computer models of each infusion, provided engineering and design services for panel production, instrumented panels with “smart molding” sensors, and fabricated/tested panels to U.S. Navy acceptance criteria. A series of common and complex composite DDG-1000 deckhouse panel-to-panel joints were produced and analyzed. Pilot results indicate that joints fabricated using this technology will significantly improve fabrication quality over historical rework rates, reducing them by over 40%.

The technology successes were immediately implemented in NGSB-GC production processes to support the ongoing DDG-1000 program. They are already providing engineers greater control over resin distribution, tooling and handling, and injection port location. With an estimated key rework reduction of approximately 5,788 hours, a 75% reduction in rework labor for this composite fabrication process is expected. It is also expected that the requirement for 100% inspection of these fabricated composite joints will be eliminated.



Composite cross-section of a typical, two-dimensional “deck-to-side shell.”