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- *NSAM Teams with Lockheed Martin to 'Drill Down' F-35 Cost Saving Through Advanced Drilling Electronic Parameter Transfer Project*
- *NSAM, NNS, and Vendors Collaborate to Strengthen Digital Supply Base*
- *NSAM Teams with GDBIW to leverage use of "Intelligent" 2D Diagrams as DDG-51 Class Cost Saver*
- *NSAM Teams with Northrop Grumman to Incorporate Predictive Analytics into F-35 Production Automation*

# REDUCING THE COST AND TIME TO BUILD & REPAIR **NAVY** PLATFORMS

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## PHOTO CREDITS:

***Cover***

*Fully assembled F-35 departing Lockheed Martin's mile-long production line to adjacent paint facility*
**Photo Courtesy of Joint Strike Fighter Program Office**

# NSAM Teams with Lockheed Martin to 'Drill Down' F-35 Cost Saving Through *Advanced Drilling Electronic Parameter Transfer* Project

In order to fulfill their mission requirements, fifth generation aircraft such as Lockheed Martin's F-35 fighter use a combination of materials intended to minimize weight while maximizing performance. Assembling these structures of diverse materials presents many unique challenges; particularly in the case of the drilling process. Parameters that are optimal for one material often prove detrimental to others. In order for the F-35 to maintain its superior performance, a method to optimally drill holes in all material combinations must be achieved.

Currently, the conventional power-feed motors used at Lockheed Martin cannot optimize drilling parameters when drilling through multiple materials. This forces the motor to use the drilling parameters defined by the harder material. Using non-optimized drilling parameters forces the motor to use a much slower penetration rate, has undesirable effects on the cutting tool and the other materials in the stack, and greatly increases cycle times. Other issues arise when using non-optimized drilling parameters such as the possibility of excess lubricant being used, galling, smearing, and possible re-cutting of chips, which all can cause costly rework to be required. Having a motor to sense and adjust the drilling parameters based on the material will reduce the time it takes to drill holes on the aircraft, minimize any galling or smearing that may occur, and improves cutting tool life and hole quality.

Through the *Advanced Drilling with Electronic Parameter Transfer (ADEPT)* project, Lockheed Martin is currently refining and validating a comprehensive portable drilling system which will enable the optimization of all drilling parameters for each material in a stack and each hole in a tooling fixture. The project team plans to use a Commercial Off The Shelf (COTS) solution and modify the equipment to meet the unique needs of the defense manufacturing industry. The ADEPT system will enable electronic data transfer of location specific requirements to load the proper and optimized cutting parameters for each material. This robust drilling system will improve process control while reducing operator dependence and will enable Full Rate Production (FRP) on the F-35 Program.

Following full implementation anticipated in Q3 FY22, this project is expected to result in a F-35 Program savings over $6M and a 5-year Return on Investment (ROI) of 2.85.

# NSAM, NNS, and Vendors Collaborate to Strengthen Digital Supply Base

Newport News Shipbuilding (NNS) is embracing digital data like never before in building aircraft carriers. From eliminating paper drawings and work instructions to using product model data to plan wireways, digital data is finding its way into every process at the shipyard—and is credited with saving money on aircraft carrier (CVN) construction. After decades of using two-dimensional paper drawings, the shipyard has set its sights on a "drawingless" future, where work instructions are packaged and delivered electronically, and the digital supply chain provides the millions of parts required to deliver a CVN to the fleet and keep the ship sustainable for its expected 50-year life-cycle. One approach that NNS has undertaken is the Navy ManTech Digital Thread Shipbuilding – Supplier Interface project, one that incorporates NNS's supply base into the company's digital shipbuilding strategy by connecting the 'digital thread' from design through production/fabrication, assembly, test, inspection, integration, and installation/operation—a daunting challenge to team with the more than 2,000 suppliers from 46 states that are supporting NNS construction efforts.

*Focusing on enhancing data capture and establishing a knowledge base for processing and storage of growth work disclosures* **- Photo Courtesy of Newport News Shipbuilding**

NNS is focusing on improving supplier first-time quality, cycle-times, schedule performance, and readiness which will lead to realized cost savings. Providing suppliers with clear and concise technical requirements that are specific to the material being purchased reduces the time required by suppliers to estimate, plan, manufacture, and inspect. This will also lead to improved first-time quality of items, components, and assemblies being purchased, as providing suppliers with 3D design disclosures will help NNS better convey design intent, thus reducing the number of supplier inquiries requiring technical resolution (i.e. Vendor Information Requests (VIRs) and Vendor Quotes (VQs)), ultimately reducing cost and construction delays. A key benefit to the supplier base is the elimination of suppliers having to develop their own 3D component models to produce parts using Computer Numerically Controlled

(CNC) machines; this also leads to shorter cycle times and better quality. NNS established a secure exchange medium, enabling the two-way transfer of data with suppliers---this increases speed and efficiency, and also establishes the framework for more effective collaboration between NNS and suppliers moving forward.

As the *Digital Thread Shipbuilding – Supplier Interface* project moves into completion, the NNS team met several objectives, each part of the overall cost saving assumptions. One of the 'pilot' activities led to simplified Technical Data Packages (TDP); a 127-page TDP shrank to just 16 pages, critical to providing suppliers with clear and concise requirements that are specific to the material being purchased. A second objective was to 'standardize' 3D design disclosures that clearly convey design intent, essential for vendor use to support today's CNC machining processes. NNS expects to reduce the number of VIRs received; these typically identify design errors or request clarification—delaying part delivery. A significant benefit is that suppliers will no longer have to develop their own 3D component models to produce parts; this could help grow the Department of Defense (DoD) vendor base. A third objective was to build and integrate a 'Secure Exchange Medium,' a digital corridor to enable efficient two-way transfer of data with suppliers, establishing the framework for more effective collaboration between NNS and suppliers, and the various Government entities.

As acknowledged across the DoD Enterprise, supplier quality and schedule performance are not challenges specific to NNS and this project presented an opportunity to significantly improve the material procurement process by extending the digital thread to the shipbuilding supply base. Other platforms, shipyards, and Government agencies could benefit from the results of this Navy ManTech project that will eliminate labor hours from a CVN new construction contract by addressing current material delinquencies, and lead to over $4.5M saved for each new CVN hull.

## NSAM Teams with GDBIW to leverage use of "Intelligent" 2D Diagrams as DDG-51 Class Cost Saver

The DDG-51 Program initiated in the late 1970s, with the first DDG-51 procured in 1985, is one of the longest-running shipbuilding programs in Navy history, and the DDG-51 class, in terms of number of hulls, is one of the Navy's largest classes of ships since World War II. As platform capability and complexity increase, costs for the ships have also increased as expectations and requirements for the program have grown. The DDG-51 Program Office has directed a reduction in construction costs with the DDG-51 co-build shipyards. General Dynamics Bath Iron Works (GDBIW) sees cost savings potential in how it designs, plans and installs nearly 320 miles of electrical cable on each ARLEIGH BURKE Class destroyer through the development of "intelligent" 2D electrical drawing products, where drawing components are attributed, and include engineering, design, and planning details within the components description. Many of the opportunities for process improvements applicable to electrical diagram products will also be applicable to certain mechanical diagram products.

*USS John Finn (DDG 113), the first Arleigh Burke restart ship, conducts Alpha Trials in the Gulf of Mexico.* **- U.S. Navy photo, Courtesy of Huntington Ingalls Industries**

At GDBIW, diagram development and maintenance is done manually through the use of AutoCAD 2D drawings. The diagram drawing components lack attributes associated with them and there is no specific intelligence or links built into the drawing. Tabular data stored in parts tables or other generated lists are not linked to the objects on the drawings, requiring manual intervention of data sets each time there is a change. The information contained in the drawings (bill of material items, equipment characteristics, cable types, connectors, valves, pipe, etc.) ultimately resides in multiple places, including other design and engineering drawings/reports, databases for design, engineering, planning, and production, and it is handled multiple times during the design and construction process. A significant amount of manual effort is spent maintaining diagrams driven by design changes due to either design development or government-driven changes. In addition, there are many other processes and products that are impacted when diagrams are revised, which also require manual revision.

To address the overarching legacy issue, GDBIW is developing a standardized and integrated data architecture to store drawing information. This effort builds from this architecture to create intelligent, linked, attributed, and standard products. Ultimately, GDBIW users will manage the processing of the data, rather than the visual presentation of the functional requirements. The envisioned data architecture tools can be used to add automation in the creation and maintenance of "intelligent" 2D electrical and mechanical drawing products, ensuring standardization, reducing labor hours, and improving quality. The GDBIW 'toolsets' will consistently process data and present data in the formats required; in this case, functional diagrams verified, directly managed, and consistently used by other users throughout the organization. Once diagram objects, such as circuit breakers, power panels, or valves are created and attributed, a library of attributed objects will result, representing a repository of smart drawing objects. The data characterizing the objects will be managed, not the depictions shown on a drawing sheet today -- the lines, blocks and text shown on the drawing sheet will be automatically generated from software tools that draw information from data repositories. It will become routine for users to easily access the data, understand its relevance to products that are delivered and its impact to diagrams and other downstream products. The concepts and applications developed for electrical system diagrams will be extended to mechanical system diagrams such as piping system drawings and HVAC system drawings.

Once completed, an anticipated project outcome is a roadmap that will be shared with the relevant shipbuilding industry, indicating how to institute similar methods, tools and data management initiatives. The GDBIW team estimates the use of 'intelligent' 2D drawings can save as much as $924K per DDG-51 Class hull.


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# NSAM Teams with Northrop Grumman to Incorporate Predictive Analytics into F-35 Production Automation

*Northrop Grumman is leveraging predictive analytics to drive improvements in manufacturing capacity, performance, and reliability.* **- Photo Courtesy of Northrop Grumman**

Northrop Grumman Aerospace Systems fabricates F-35 components on its highly automated aircraft assembly line, which includes several robotic assembly systems to support various manufacturing activities. Key pieces of automation assets are required to operate on a repeatable basis to realize committed production schedules and cost targets. Incorporation of a predictive failure capability on critical automation assets is necessary to enable proactive management of these systems in order to guarantee their capacity and performance in manufacturing quality parts within the program production intervals.

Currently, maintenance operations are driven by the suggested recurring preventative maintenance schedules set forth by the Original Equipment Manufacturer (OEM). However, when unanticipated issues arise with critical equipment the team turns to a "reactive" mode of stopping, analyzing the issue, and working with a cross-functional team to determine the appropriate disposition. This reactive break-fix approach inevitably causes delays to the production line that are costly and jeopardize delivery schedules, part quality, and best-fit assembly. With program ramp-up and product delivery rate increasing every year, these schedule delays, inefficiencies, and quality compromises are exponentially costly and impactful in effective program execution. The current reactive approach does not support an efficient use of the personnel and equipment resources.

Through the *Rapid Automation Technology Evaluation (RATE)* project, NGAS is currently developing a solution system that utilizes a combination of Commercial of the Shelf (COTS) products and internally developed models and applications to predict high-impact failures or issues leading to downtime. The RATE solution will involve establishing a real-time connection to the automation equipment on a large-scale assembly line through the incorporation of hardware and sensoring devices to reach a quality of data that is informative and actionable for maintenance and equipment operations. Additionally, the RATE effort will investigate part quality implications of unplanned automation events and utilize CBM to optimize part quality and best-fit assembly. Corrective actions are expected to be applied with prescriptive models that take from a combination of knowledge based, physics based and/or data driven modeling.

Following full implementation expected in Q2 FY21, this project is expected to result in a per-aircraft savings of $12K and an F-35 Program savings of $23M.

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***To date, NSAM project efforts have led to over $700M in total savings, measured as "per hull" cost reductions across several U.S. Navy platforms.***