Newport News Shipbuilding, a Division of Huntington Ingalls Incorporated (NNS)

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NSRP | National Shipbuilding Research Program

Project Close-out Final Report (Milestone 25)

"Enterprise-Wide Accuracy Control in a Digital Environment"

Task Order Agreement (TOA) TBD Control No. 23-01

Lead: HII-Newport News Shipbuilding (NNS)
Team Members: Applied Research Laboratories-Penn State University (ARL-PSU)
HII-Ingalls Shipbuilding (Ingalls)
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1.0 Scope

1.1 Problem Statement

Inconsistent part quality is negatively impacting Carrier New Construction (CVN) cost and schedule performance in the unit assembly, joining, and dock erection phases of construction. Part inaccuracies are causing poor fit-up that drives over-welding, rework, weld distortion and 3D geometric inaccuracies. Material is strategically added to offset the dimensional impacts, but must be removed as part of the assembly process. Less accurate parts require more expertise to assemble. Given the decreasing experience levels of our work force, our ability to process inaccurate parts is diminished. Manual and digital checks are performed in the various work centers but their data is disconnected and not readily integrated, making root cause and corrective action (RCCA) and continuous improvement efforts difficult and less effective.

1.2 Goals and Objectives

This project will provide a software solution that connects accuracy control data across work centers. This will enhance problem solving and process improvement, increase part accuracy and fit-up quality, and drive down over-welding and rework. It will enable predictive analytic capabilities that will improve our ability to pre-cut jobs to size. It will ultimately enable future ability to "neat build" to design dimensions. This will reduce our dependence on craftsman experience and increase the less seasoned employee's ability to assemble our product with high first time quality.

This software will be the foundation of a centralized accuracy control program that connects inputs from the myriad input checks, supports statistical process control, enables real-time analysis and decision making, and offers predictive capabilities to detect and prevent errors more frequently and reliably. This will ensure a most accurate and least-cost end product. Accomplishing this objective would:

- Enable full value stream connectivity and the ability to recognize and predict the impact of individual process variation on downstream operations
- Support statistical process control (SPC) in key operations
- Provide user-friendly reporting and metrics that are meaningful to both the operator and the decision maker
- Enable consistent and sustainable first time quality at all phases of construction
- Reduce the cost and schedule impacts of rework required to address in-process geometric variation
- Preserve alignment on critical components and systems such as shafting, elevators and catapults
- Enable future process evolution to neat build as well as extension to other programs, platforms and shipyards
- Provide a low cost means of sustaining an accuracy control program and form the foundation for a documented, disciplined and effective approach to shipbuilding accuracy control
- Deploy an application that supports real-time inputs and generates reports

1.3 Project Overview

This project will assess internal processes, outputs from successfully completed National Shipbuilding Research Program (NSRP) and ManTech projects, and Commercial Off the Shelf (COTS) offerings to identify and reconfigure existing software solutions as necessary to provide the functionality required to support project objectives. We will engage project partners Applied Research Labs/Penn State University and Huntington Ingalls Industries - Ingalls Shipbuilding, whose depth of experience will enhance performance while minimizing project risk.
The project will be executed in two (2) phases for a total duration of 16 months as shown in Figure #1:

Phase	Lead	Support	Duration (months)	Deliverable
1 - Conduct AC program maturity level assessment; evaluate DACMS and other COTS software	NNS	PSU	12	Action plan to close maturity gaps; suitable software and data management system to capture and process data from any work center
2 - Customize accuracy control software; develop user interface application	NNS	PSU	4	Software and AC system solution that is fully sustainable with quantifiable results

2.0 Statement of Work

2.1 Task 1: Project Kickoff

NNS will kick off the project and clarify the deliverables, schedule, roles, levels of participation, tasks and gate reviews. NNS will review all current data collection methods and processes currently being used at NNS in the design, fabrication production and assembly of steel hull units for CVN construction.

- 2.1 Task 1a: collect all current inspections forms and document the reporting and analysis being done for each data stream, (NNS – primary, BIW – secondary, PSU-ARL and Ingalls – observer)
- 2.1 Task 1b: conduct a gap analysis to determine areas of immediate need and implement quality checks, (NNS – primary, BIW, PSU-ARL and Ingalls – no action)
- 2.1 Task 1c: develop a current and future state map, (NNS – primary, BIW – secondary, PSU-ARL and Ingalls – observer)

2.2 Task 2: Evaluate Previous Accuracy Control Project

Review current accuracy control guide book that was developed under a previous NSRP project (Subcontract @2001-338) and declare extent of use, purpose, applicability and areas of focus for this project, (NNS – primary, BIW – secondary, PSU-ARL and Ingalls – observer)

- 2.2 Task 2a: review all NNS documents, procedures and process that intently request the collection of data in respect to dimensional values of steel structure, (NNS – primary, BIW, PSU-ARL and Ingalls – no action)
- 2.2 Task 2b: compare and contrast best practices for data collection as established by NNS and BIW, (NNS and BIW – primary, PSU-ARL and Ingalls – observer)
- 2.2 Task 2c: compare and contrast current databases to other industries that utilize SPC, QC and other methods to control their processes, (NNS – primary, PSU-ARL and vendors – observer)

2.3 Task 3: Define Database Requirements

Define the specifications and requirements for vendors that would meet the NNS future state needs. These requirements must include specific elements of data collecting, data correlating, data processing, data reporting and data archiving, (NNS – primary, BIW and PSU-ARL – observer, Ingalls – no action)

- 2.3 Task 3a: identify and select vendors that have experience and user ready database software that can be adapted to the requirements defined in Task 3, (NNS – primary, vendors – secondary, BIW and PSU-ARL – no action)
- 2.3 Task 3b: write acceptance details for vendors and define what BETA testing would be comprised of, (NNS – primary, vendors – secondary, PSU-ARL and BIW – observer)
- 2.3 Task 3c: validate software algorithms, software limitations, software add on ability, software ease of use, software cost, and software ease of updating, (NNS – primary)
- 2.3 Task 3d: define deliverables that are associated with the reporting functions of the software and ensure that the reports are usable, understandable and meaningful to all levels of production, (NNS – primary, BIW and vendors – secondary, PSU-ARL – observer)
- 2.3 Task 3e: define areas of growth and next steps of the accuracy control process and determine if the software is adaptable to those future state needs, by program and process type, (NNS – primary, BIW – secondary, PSU-ARL – observer)

2.4 Task 4: Conduct Beta Testing

Conduct beta testing of vendor databases and include future state assessment criteria (NNS and vendors – primary)

- 2.4 Task 4a: document beta testing results, (NNS and vendors – primary, Ingalls, BIW and PSU-ARL – no action)
- 2.4 Task 4b: compare and contrast, as allowable, the vendors database and Digital Accuracy Control Management System (DACMS), (NNS and BIW – primary)
- 2.4 Task 4c: determine cost effectiveness, user friendliness and adaptability to other shipyards, (NNS – primary)
- 2.4 Task 4d: determine expandability of the software for other accuracy control products and materials such as machinery, piping, outfitting and high aspect ratio parts (NNS – primary, BIW – secondary, PSU-ARL – no action)

2.5 Task 5: Select Database

Select database to be used at NNS and adaptable for other yards and sub-contractors, (NNS – primary)

- 2.5 Task 5a: preview project findings, deliverables and demonstrate the database and the accuracy control process with key stakeholders, (NNS – primary)
- 2.5 Task 5b: present deliverables to NSRP, (NNS – primary)

3.0 Project Deliverables

The primary deliverable for the “Enterprise-Wide Accuracy Control in a Digital Environment” project is a downselect and criteria assessment and review of potential database and SPC softwares, with a singular recommendation and lessons learned applying it to a shipbuilding environment.

Based on our research, shipyard conditions, and lessons learned, Qualis from Datalyzer International is a viable tool for shipyards to use. Major concerns are the variability in parts produced, which can be addressed with Performance to Tolerance assessment.

4.0 Phase Recaps

4.1 Phase 1 Recap

Phase 1 consisted of an evaluation of existing data sources and available COTS software, in addition to DACMS, then creating a data capture mechanism and merging existing data with new data. The evaluation of existing data found a myriad of sources for qualitative data of various kinds, but no significant source for numeric dimensional data required for the project. The project proceeded with new data only. Several attempts were made at developing initial data capture tools before revised and improved check sheets were used. This served as a temporary hold until a final software selection could provide an integrated data capture tool. The software assessment covered 6 different COTS software options as well as the results of Navy ManTech project #S2844, Digital Accuracy Control Management System.

DACMS was found in implementation to be more focused on file organization and transmission between disparate groups rather than data capture and processing. DACMS possessed no SPC capabilities at the time and deck plate data recording was not operational. Meanwhile, the COTS software review highlighted fundamental challenges for data operations in a Navy contractor shipyard.

First, many COTS options operate in their own selection of a Cloud Service, many of which do not have the data certifications necessary to house NOFORN data. Only a few offered local network operations.

Next, many COTS options assumed that all parts from a particular process would be identical, and large numbers would be produced in regular frequency. This is not a Naval shipbuilding norm. Only a few offered Performance to Tolerance assessments, where data is assessed on a 'how far from 0 deviation' basis. This allows different parts that are being produced by the same process to be assessed together, as long as the same tolerance is required of them.

Other major concerns were found to be standards in the industry, including automatic SPC assessment, charting, live data updates, and notifications in case of problems. A full whitepaper and the below graphic were produced as part of the rating process:

	Cloud / Local Install	Compatability with other systems	Short Run / Deviation from Tolerance	Flexibility to Process Changes	Predictive Analytics	Chart Live Update	Alert Live Update	Need Total	RCA Capabilities	2D or 3D Drawing Display	View Data Across Processes	Map Production Line	Meta-Analytics	Flexibility to Data Analytics	Want Total	Total Requirement
Name	Need	Need	Need	Need	Need	Need	Need		Want	Want	Want	Want	Want	Want		
Predisys Analytical Suite	1	1	1	1	1	1	1	7	1	0	1	0	1	1	4	11
DataLyzer Qualis 4.0 SPC	1	1	1	1	0.5	1	1	6.5	1	1	1	0	1	1	5	11.5
SafetyChain SPC	0.5	1	0.5	0.5	0.5	0.5	1	4.5	0.5	1	0.5	0	0	0.5	2.5	7
ZonTec Synergy 2000	1	0.5	0.5	1	0	1	1	5	0.5	1	0	0	0	0	1.5	6.5
QAD EQMS	0.5	1	0.5	1	0	1	1	5	0	0	0	0	0	1	1	6
Hexagon Q-Das	1	0.5	1	0	0	1	1	4.5	0.5	0	0	0	0	0	0.5	5
DACMS	1	0.5	0	1	0	0	0.5	3	0.5	1	0	0	0	0.5	2	5

Figure 1 – Comparative Software Assessment

As a result of the evaluation, Qualis was selected, as it provided a back-end that NNS IT was endorsed. The runner up, Predisys Analytical Suite, presented comparable capabilities, but didn't fit NNS IT architecture as well.

An in-house system was developed using Excel and SharePoint, as an exploration of SPC reporting capabilities, an introduction of SPC to the workforce, and as a base-lining of what improvements the COTS tool could bring above and beyond what we could do ourselves.

This Excel and SharePoint system had basic functionality but was highly manual, prone to error, and time intensive for several stages.

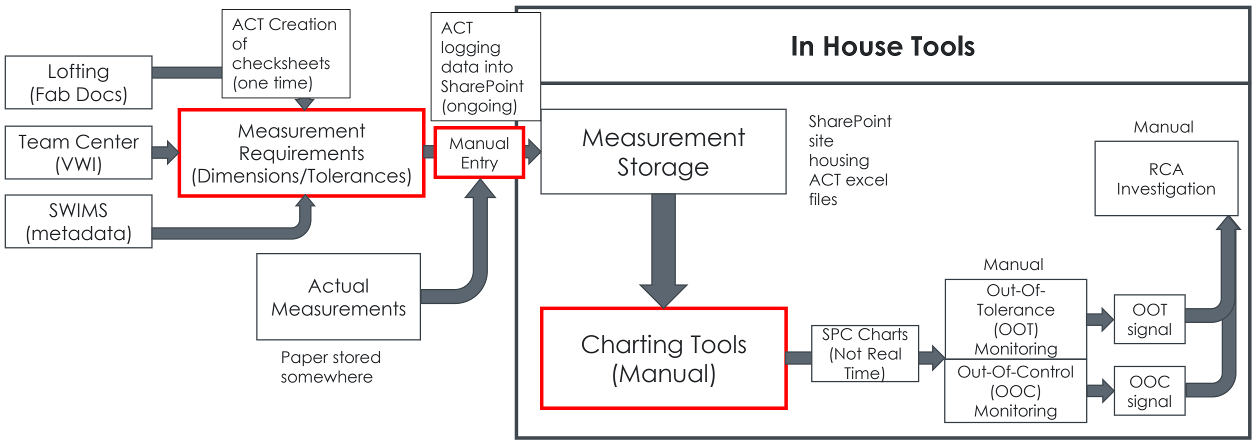

Figure 2 – Current State of In-House Process Map

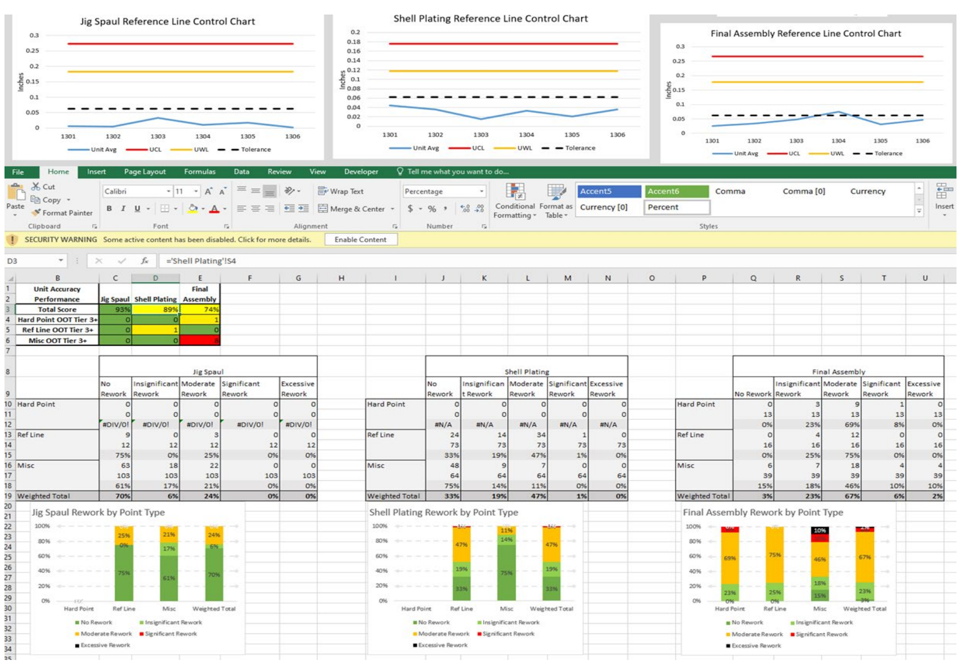

Figure 3 – Excel-based reporting using SharePoint

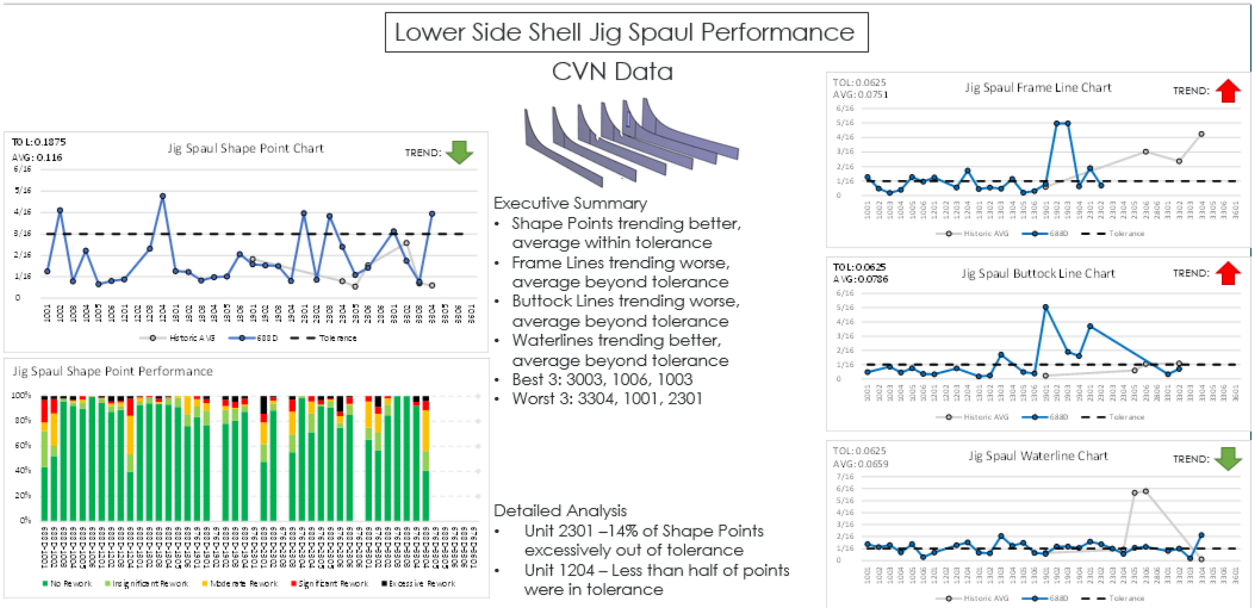

Figure 4 – Excel-based reporting on 3D points

4.2 Phase 2 Recap

Phase 2 consisted of the configuration and testing of the Qualis software. As this is a commercial software, we will not include instructions on its use. However, the software included capabilities to calculate fields from data entry fields, allowing us to input X, Y, Z coordinates and calculation deviation from ship design parameters.

Testing consisted of entering a pre-determined set of data developed to mimic data harvested from a variety of processes throughout the steel value stream. This data was entered and charting was assessed, ensuring meaningful data on process performance was communicated.

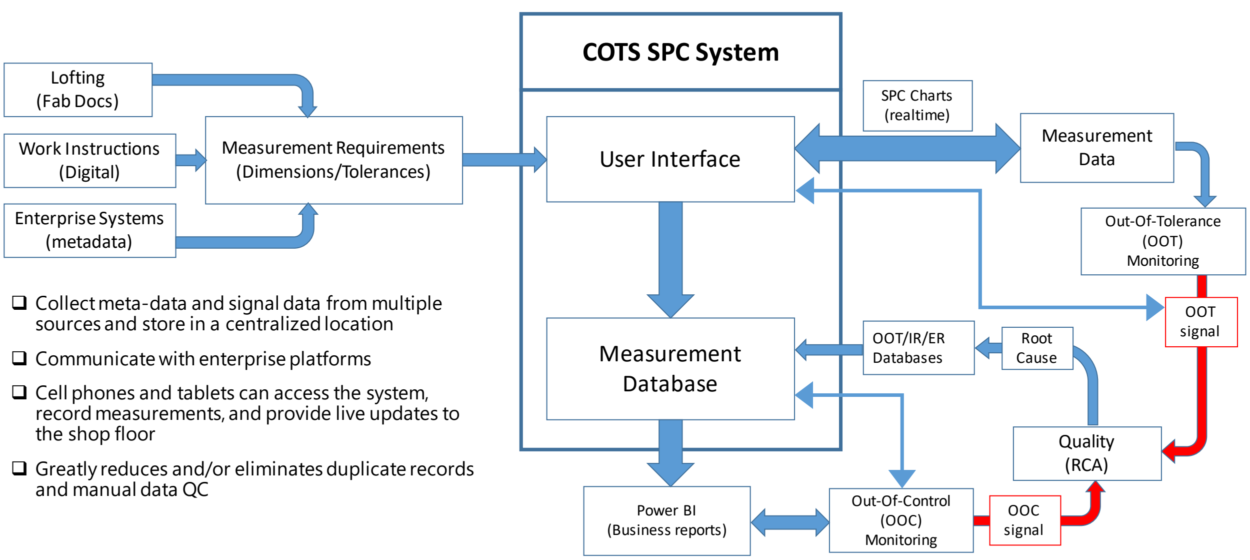

Figure 5 – COTS Process Map

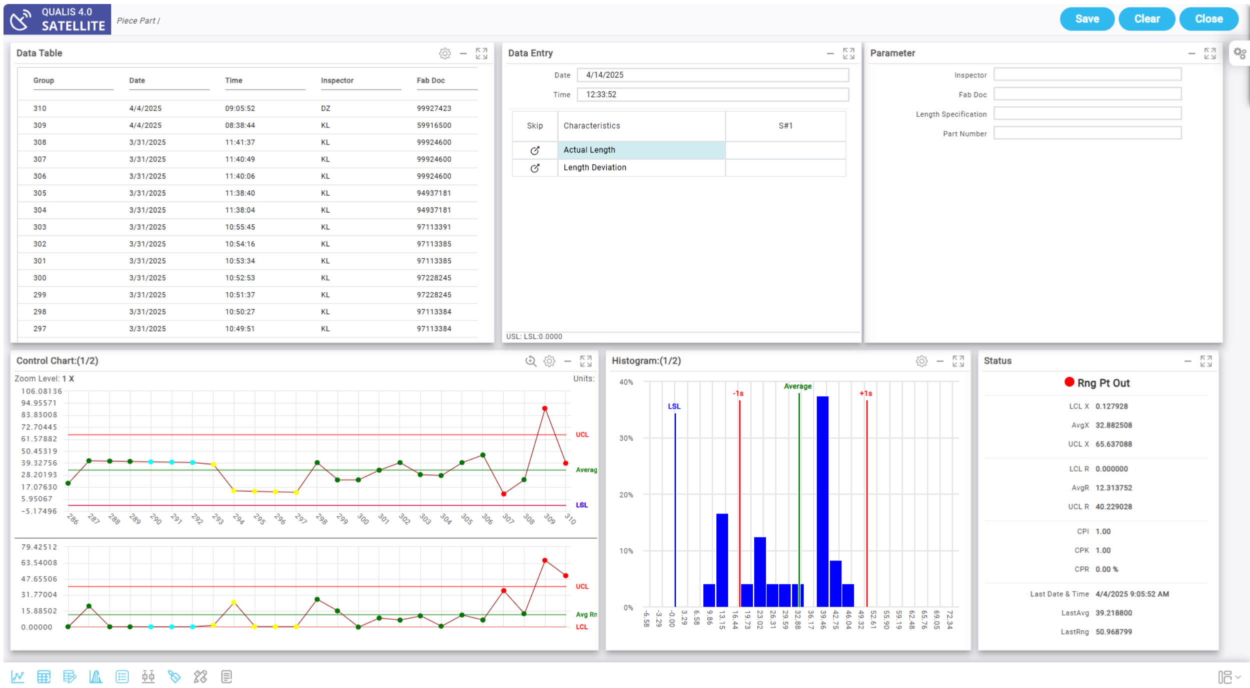

Figure 6 - Datalyzer Data Entry Screenshot

The testing consisted of loading 200 fabricated data records into the system for each of 3 different stages of construction: 1D part measurements, 2D part measurements, and 3D part measurements. The system was capable of recording all of them and performing calculations to automatically calculate deviation, including from 3D point coordinates. Charts were then created, demonstrating the reporting capabilities of the software.

Figure 7 - Datalyzer Reporting Screenshot

The capabilities of customizing charts and reporting were assessed. The ability to review preserved records, both of original data and of calculated results was confirmed. The ability to import mass records from Excel was not found, however a tool is being developed by ARL-PSU to do so.

5.0 Technology Gaps and Future Considerations

NNS wasn't able to connect enterprise resources before the end of the project due to time constraints, but the fact that Qualis uses SQL as the back-end database promises easy connection.

A notification tool through email and text was also not able to be installed before the completion of the project. It is available as a Qualis add-on and will be installed in the future at NNS.

An import tool to load mass data into Qualis from excel records wasn't available before the completion of the project. This tool is in development by ARL-PSU.

The follow-on ManTech planned to start in July 2025 will develop an advanced analytics tool to use the data housed in Qualis. It will perform far more advanced analytics, including cross-process analytics and part tracking between processes. The intent is to determine causes of problems associated with metadata to be identified and loaded.

Although Qualis includes in-house reporting tools, it is likely that we will link the database to PowerBI for more fluid reporting at NNS. PowerBI is a recognized and mature tool at NNS.

6.0 Conclusion

A variety of COTS tools were assessed, as well as DACMS. They were rated and compared, and one software was selected: Datalyzer Qualis. At the same time, an in-house system using Excel and SharePoint was created as a baseline, and a way to explore SPC reporting options.

Once Datalyzer was purchased, the software was installed, set up, configured, and tested for functionality. A new, smoother workflow diagram was developed to utilize the software.

Due to the long-term build-up nature of the work, ROI could not be confirmed in the test period and the evidence does not indicate any change to projected ROI.

NNS and BIW seek to significantly reduce acquisition program cost by improving dimensional accuracy throughout the structural production cycle – from fabrication, to structural assembly, to unit joining, and finally erection. NNS and BIW anticipate substantial savings and acknowledge that the desired gains will require additional support in the form of added inspection, analysis, and reporting by shipwright linesmen and metrology technicians, which have been accounted for in the ROI. For NNS, project savings assume:

- 50-80% Reduction in Structural Rework at the Base A and Superlift Construction Phase
- Reduction in Weld Distortion Migration
- Reduction of Welding Volume and Welding Resources due to Root Gap Issues
- Reduction of Outfitting Issues due to Structural Location Issues
- Reduction in Service and Support (i.e. Stage Building, Flame Straightening, JLG Service, Burner and Chipper Hours)
- Schedule Savings / Risk Reduction
- Unit Assembly – 20% of units require rework that impacts delivery by more than one week
- Superlifts – 5% reduction in OOT and alignment rework could conservatively be realized
- Shipboard – 5% reduction in OOT and alignment rework could be realized plus a positive impact on outfitting activities
- Cost Validation
- Reduction in Out of Tolerance Conditions reported by the Metrology and Quality Inspection
- Reduction in Engineering Resolution (ERs) for Systemic and Overall out of Tolerance Conditions
- Compare Accuracy Rating of Component Units to SL Fit/Weld Costs – determine if correlation exists
- Direct Reporting of Structural Misalignment Rework Costs via Rework Management System
- Correlate Unit Geometry to Downstream Fit and Weld Costs WRT Budget
- Compare Weld Metal Usage to Previous Hull. Opportunity exists to Reduce Weld Metal by as much as 20% Yielding in a Material Savings of approx. 2.5M

For BIW, project savings assume:

- 5% - 10% reduction in man-hours and schedule required major unit joins (included in ROI)
- Additional savings associated with sub-unit assembly
- Ability to identify potential tolerance stack issues early in the construction process, thus avoiding rework and alignment issues
- Process optimization lessons learned that can be rolled into future build plans.

Additional savings include reduced service and support work such as stage building, deck and bulkhead handling, welding engineering memos, and engineering discrepancy resolution; consistent data stream that forms foundation for industrial engineering and process owner's improvement initiatives; enables progression towards "Neat Build" format (precisely sized for product joins instead of added material "stock" to allow for uncertain fit-up during assembly process).

- Reduction in Pre-cut Activities by 30 to 50%. Currently, it takes 4EM; 5 to 8 days to prep a pre-cut unit.
- Reduction in cycle time in high demand work centers
- Reduction in Support Trades Activities such as Inspections

Digital Accuracy Control provides the means, the ways, and discipline to self-inspect the work. The methodology and data analytics are adaptable to other shipyards and likely result in similar savings (not included in the ROI).

For Ingalls, project savings are based on a 5% reduction in man-hours required for major unit joins (threshold value; included in ROI) with an objective value of 10% reduction in man-hours. There will also be additional savings which are not included in the ROI at this time, stemming from the ability to identify potential tolerance stack issues early in the construction process (reducing rework, root cause of alignment issues, and material loss).

- Project: Enterprise-Wide Accuracy Control in a Digital Environment – reduced rework for major and minor unit erection joins and reduced rework and material costs at all stages of construction.
- Period of Performance: August 2024 – October 2026
- ManTech Investment: $4.484M

- Implementation Assumptions:
  - First Year of Implementation – FY26
  - Final Year of Implementation –
- Will implement at Newport News Shipbuilding on CVN
  - Number of craft built during implementation period – 1.4
- Will also implement at Bath Iron Works on DDG-51
  - Number of craft built during implementation period – 8
- Will also implement at Ingalls Shipbuilding on DDG-51
  - Number of craft built during implementation period – 6

- Investment Assumptions:
  - ManTech Investment – $4.484M
    - NSAM Subcontractors – $3.284M
    - iMAST – $1.2M
  - Program Office Investment – N/A
- Newport News Shipbuilding Investment:
  - NNS Project Cost / ManTech Investment – $1,760,000
  - NNS Implementation Cost – $500,000
  - NNS Total Cost – $2,260,000
- Bath Iron Works:
  - BIW Project Cost / ManTech Investment – $849,320
  - BIW Implementation Cost – $267,700

    - BIW Total Cost – $1,117,020
- Ingalls Shipbuilding:
    - Ingalls Project Cost / ManTech Investment: $675,000
    - Ingalls Implementation Cost: $60,000
    - Ingalls Total Cost - $735,000

- Return (Savings) Assumptions:
    - Savings for CVN – $9,300,000/CVN hull; $13,020,000 total
        - Basis for Assumption: See paragraph above
    - Savings for DDG-51 (BIW) – $380,000/DDG hull; $3,040,000 total
        - Basis for Assumption: See paragraph above
    - Savings for DDG-51 (Ingalls) – $380,000/DDG hull; $2,280,000 total
        - Basis for Assumption: See paragraph above

- ROI Calculation

$$\mathrm{ROI} = \frac{\mathrm{RETURN} - \mathrm{INVESTMENT}}{\mathrm{INVESTMENT}}$$

$$\mathrm{ROI} = \frac{(\text{NNS savings} + \text{BIW savings} + \text{Ingalls savings}) - (\$\text{iMAST} + \$\text{NNS} + \$\text{BIW} + \$\text{Ingalls})}{(\$\text{iMAST} + \$\text{NNS} + \$\text{BIW} + \$\text{Ingalls})}$$

$$\mathrm{ROI} = \frac{(\$13{,}020\mathrm{K} + \$3{,}040\mathrm{K} + \$2{,}280\mathrm{K}) - (\$8501200\mathrm{K} + \$2{,}260\mathrm{K} + \$1{,}117\mathrm{K} + \$735\mathrm{K})}{(\$850\mathrm{K} + \$2{,}260\mathrm{K} + \$1{,}117\mathrm{K} + \$735\mathrm{K})}$$

$$\mathrm{ROI} = \frac{(\$18{,}340\mathrm{K}) - (\$4{,}9625{,}312\mathrm{K})}{(\$5{,}3124{,}962\mathrm{K})}$$

- ROI
- CVN and DDG-51: 2.7045
- CVN only: 3.192.76
- DDG-51 only: 0.7497

Figure 8 – Original Projected ROI Calculations

Sources Page

Graphic Location	Source	Copyright Permission
Figure 1 – Page 6	NNS Internal	N/A
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Figure 3 – Page 7	NNS Internal	N/A
Figure 4 – Page 8	NNS Internal	N/A
Figure 5 – Page 8	NNS Internal	N/A
Figure 6 – Page 9	Software on NNS Internal Server	N/A
Figure 7 – Page 10	Software on NNS Internal Server	N/A