Final Report

Prototype Implementation of a Visualization System for 3D Models of CPC Parts

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1 INTRODUCTION

1.1 Project Overview

The Common Parts Catalog is a real-time, searchable inter-shipyard parts catalog in production at GD Electric Boat, Bath Iron Works and HII–Ingalls. While using this system, the shipyards have identified the need for and the potential benefits from visualization of CPC parts.

As part of the recently completed CPC Enhancements Project, a study was done which determined that implementation of a visualization capability was feasible. This project embarked on the next logical step to actually develop the tools necessary to implement that capability and prototype its use at each of the participating shipyards.

1.2 Objectives

The shipyards using the Common Parts Catalog (CPC) have identified significant benefits that could be obtained by having the capability to view the 3D model of a part before having to decide whether to include it in a new design.

The goal of this project was to develop and demonstrate a viewing capability within CPC, so that a CPC user at any participating shipyard is able to display a 3D model of the procured part.

The model viewing tool selected will be widely available at all shipyards, and not proprietary to one CAD vendor. It must read the common neutral file and display it to the screen within the context of a web browser. The tool for viewing the 3D model must have extensive display capabilities including:

- Dimensioning
- Annotation
- Rotation of the part
- Zoom and pan features

This projects objective was to make the availability of these capabilities a reality by selecting the appropriate neutral file format, resolving all implementation issues, and developing the software tools needed to add these features to CPC.

The goal was to develop and install prototype implementations at all participating shipyards using the Common Parts Catalog.

1.3 Participants

The participants in this task represent the three major shipyards currently using the Common Parts Catalog (Bath Iron Works, Electric Boat, and HII–Ingalls) plus the software companies supporting the Common Parts Catalog; JDA Software Group and Computer Sciences Corp.(CSC)

Each entity performed the specific tasks as assigned, contributing to the overall success of the project. Electric Boat was the Team Lead. The CPC participating shipyards completed the following tasks;

- Participated in selection of the neutral file format to be used for visualization
- Developed the requirements for our lightweight visualization system
- Determined where files would be stored and who would be permitted access
- Generated the neutral files for CPC parts and stored them in a repository on the CPC servers
- Tested and demonstrated the process for lightweight visualization of CPC parts and assemblies

The software needed to implement this capability was developed by personnel from Computer Sciences Corporation (CSC) and JDA Software Group, Inc. Their specific tasks were;

Computer Sciences Corporation

- Served as the system technology integrator and provided technical support
- Set up the structure on the participating shipyards CPC servers to store the visualization neutral files in the selected neutral format for CPC parts
- Ensured that each shipyard's client/server network supported the project's requirements
- Supported the testing and demonstration of these features at the participating shipyards and the NSRP All Panel meeting

JDA Software Group

- Created a "View Part Model" button within the CPC user interface
- Developed an automated process and supporting software where clicking of the "View Part Model" button would automatically go to the local CPC server, retrieve the neutral file and opened a new page displaying the corresponding model on the screen
- Assisted the Shipyard Team with requirements development, COTS and custom programming with guidance in relation to solutions, software, hardware, and system integration
- Supported the testing and demonstration of these features at the participating shipyards and the NSRP All Panel meeting

2 NOMENCLATURE

2.1 Acronyms and Abbreviations

ASE: Advanced Shipbuilding Enterprise program of the NSRP

BIW: Bath Iron Works

CAD: Computer-Aided Design

CCCG: Central Configuration Control Group

CGR: CATIA Graphical Representation is the triangulated format used by CATIA V5

CPC: Common Parts Catalog

EB: Electric Boat

GD: General Dynamics; Parent company of both BIW and EB

HII–Ingalls: Huntington Ingalls Industries – Ingalls Shipbuilding Division

HII-NNS: Huntington Ingalls Industries – Newport News Shipbuilding

IGES: Initial Graphics Exchange Specification is a file format which defines a vendor neutral data format that allows the digital exchange of information among CAD systems

ISE: Integrated Shipbuilding Environment is a series of NSRP Projects that developed and prototyped standards for shipbuilding product model exchange

ISO: International Organization for Standardization

JDA: JDA Software Group is a software development company that has supported the development of the Common Parts Catalog for the U.S. shipbuilding industry

JT: 3D data format developed by Siemens PLM Software that is used for product visualization, collaboration, and CAD data exchange. ISO has officially accepted the JT specification for publication as an ISO Publicly Available Specification (PAS)

JT2Go: Viewing application that supports JT provided by Siemens PLM

NSRP: National Shipbuilding Research Program

PAS: Publicly Available Specification of the International Organization for Standardization (ISO)

PDF: Portable Document Format is an open standard for document exchange. This file format created by Adobe Systems in 1993 is used for representing documents in a manner independent of application software, hardware, and operating systems. Each PDF file encapsulates a complete description of a fixed-layout flat document, including the text, fonts, graphics, and other information needed to display it

PDM: Product Data Management

PLM: Product Lifecycle Management

SDMT: Ship Design Material Technology

STEP: Standard for the Exchange of Product Model Data is a comprehensive ISO standard (ISO 10303) that describes how to represent and exchange digital product information

TIA: Technology Investment Agreement

URL: Uniform Resource Locator

VFI: Vendor Furnished Information

VRML:	Virtual Reality Modeling Language is a standard file format for representing three dimensional (3D) interactive vector graphics
XML:	Extensible Markup Language
2D:	Two dimensional
3D	Three dimensional
3D PDF:	3D data format developed by Adobe Systems that differs from other lightweight formats in that it focuses on bringing CAD visualization capabilities into a ubiquitous PDF document to combine CAD and business or workflow data into a single document, as opposed to a standalone representation of the geometry
3D XML:	a lightweight XML-based format developed by Dassault Systemes for the sharing of 3D data

3 TECHNICAL STATUS

The objectives for this project were for the team to deliver the capability for the CPC users to view the 2D/3D Model of the corresponding part in a prototype environment. To support this, the following requirements were established and met.

Each CAD/PDM system was required to output an agreed on common neutral model for each released CAD model design. The common neutral model must be stored within a file system that was accessible by the Viewing tool component.

A 2D/3D Model Viewing tool component had to be deployed which would read the common neutral model and display it to the screen within the context of a web browser. Users had to be able to rotate, zoom in and out, and perform other operations depending on the functionality provided by the selected Viewing tool component.

An integration between CPC and the Model Viewing tool component had to be provided. The integration provided a new View Part Model button within the CPC user interface, which opened a new page displaying the corresponding Model on the screen.

This was a prototype task, and thus made evaluations and recommendations. It did not include the installation of any of these capabilities in production at this time.

3.1 Viewing vs. Exchanging

There were two potential uses identified by the participating shipyards CCCG for the 3D models of the parts in the Common Parts Catalog.

The first of these involved Visualization of the model, while the second involved the actual Exchange of the model for the catalogued part.

This project focused solely on the Visualization of the model. This capability is the logical next step in the quest to formally exchange and reuse the 3D solid model of the part. Various neutral file formats are available that support lightweight visualization. Previously, under the CPC Enhancements Task, the participating shipyards reviewed the possible neutral formats available for each scenario, and then did detailed testing of the ones deemed to have the most potential.

3.2 Neutral Format Selected

The experts representing the participating shipyards have extensive experience in using various neutral file formats for model visualization or for exchange between the different CAD systems. For part visualization, numerous potential candidates were considered for evaluation (including CGR, IGES, JT, STEP, VRML, 3D PDF, and 3D XML). At the completion of the CPC Enhancement Project the team had narrowed their choice to JT and 3D PDF. These were the two primary neutral file formats considered for visualization. They were selected based on the identified visualization neutral file format requirements. These two formats are well established industry standards, have efficient file size, can be generated by a broad number of CAD applications, and have no cost viewing applications that provide the features required.

This prototype task required a selection. Both JT and 3D PDF formats were found to meet the model viewing requirements. JT was chosen as it was readily available at all shipyards and required no investment. The JT Data Format is also accepted as the World's First ISO International Standard for Viewing and Sharing Lightweight 3D Product Information. It was also acknowledged that in the event of an eventual production deployment, the decision could be revisited.

3.3 Viewing Capabilities

A viewing capability was required so that a CPC user at any participating shipyard is able to display a 3D model of the procured part.

The JT model viewing tool was widely available at all shipyards, and not proprietary to one CAD vendor. It read the common neutral file and displayed it to the screen within the context of a web browser. The tool for viewing the 3D model had display capabilities including:

- Dimensioning
- Annotation
- Rotation of the part
- Zoom and pan features

Each participating shipyard was able to generate an agreed to common neutral file for each CAD model design in the prototype. The CPC user did not need to know where a model was developed in order to display that model with the viewing tool.

The tool for viewing the procured parts was integrated into the current CPC environment. The CPC user was able to click on a "View Model Part" button within the CPC user interface, which opened a new page displaying the corresponding model on the screen.

3.4 Storage of Neutral Files in a Repository Available to All Participating Shipyards

The neutral files for visualization were not created on demand, but instead were created and stored in a repository when the part was added to the Common Parts Catalog. An option was considered to create a separate repository independent of the ones at the shipyards to just maintain the neutral file for visualization. It was determined that such a solution would create security and performance issues, so the decision was made to store the visualization files in a repository on each shipyard's CPC server. Since, in general, the visualization files require significantly less storage space than the actual models; it was felt that this method would not pose a burden to the CPC servers. The CPC models viewing capability used a direct URL address to access and launch the viewing tool application. Based on using a URL integration solution and maintaining security, the visualization neutral files were stored within each shipyard's CPC server. This avoided potential security and performance issues caused by accessing the visualization neutral file from a remote location.

The neutral files for visualization were stored in a repository on each of the shipyard's CPC servers. Since GD and Ingalls have separate CPC servers, each CPC server had a copy of the visualization neutral files. This was required to support the CPC viewing tool integration solution. Each shipyard had a manual process to generate the visualization neutral file and transferred it to each of the CPC servers, where it was stored. It is desired for the process that generates the visualization neutral file to be automated. During an

implementation phase of the model viewing solution, the specific process and feasibility of an automated process will be determined.

3.5 Benefits

Today, CPC contains only the textual technical definition of a Standard Part. Adding visualization capability will enable users to choose the correct part which will increase Engineering and Design efficiency. Reduction in man-hours will be achieved by further streamlining parts search in CPC and eliminating duplications and introduction of unique parts. When designing a system, each nonstandard part added can cost an average of $27,000 over the life of the program. Engineering and design of the new part is nearly one-half of the total cost. The six specific drivers for which parts management provides cost benefits are; engineering and design (46%), testing (3%), manufacturing (9%), purchasing (19%), inventory (4%), and logistics support(19%).

Following the live demonstration that was provided as a Ship Design and Materials Technology (SDMT) panel technical track presentation at the NSRP All Panel meeting on April 24, 2013, the team went back to their shipyards and solicited input from a wider distribution of the pilot to their user communities. The feedback on "usability" and enhanced visualization capability was positive. In summary;

Engineers and Designers who actively use CPC to search parts said Models in CPC would benefit their jobs greatly. It would save them multiple steps since their primary part searching is done in CPC they would instantly be able to identify if a model exists against the part. They could then filter on those parts with models and view specific attribute information against each part to make educated decisions on part choosing for their design. Currently, Designers search in CPC, find a list of parts, and refer back to their Modeling tool to try and locate models against each part.

Engineers and Designers who utilize CPC to preform very specific searches associated to certain specs, and parts consider the Models as another key contribution that will help them to complete their jobs more efficiently. They also expressed technical concerns showing they understood the scope this capability. For example, some wanted to know how the Models would be kept in sync. I.E. if the Model was detailed from Rev B to Rev C, when and how would the Model update be displayed in CPC?

There was a small group of individuals who seem to "know" their parts and rarely use the tools to perform part searching had no comment on the subject.

Two additional benefits were identified;

- Lightweight visualization capability could be an incentive for an additional shipyards to use CPC
- Visualization of CPC Parts has been reviewed and endorsed by NSRP Information Technologies Panel as well as Ship Design and Material Technology Panel.

3.6 Issues

Security and intellectual property concerns must be addressed before a Visualization capability is placed in production. As far as developing a capability to view the models of the CPC parts, the security requirements should be no different than the rules for accessing the catalog in general. Restrictions are currently in place as to which parts are loaded into CPC and who has the right and ability to access the catalog. These same rules and restrictions should apply to the ability to display and view the 3D models. If a user is authorized to retrieve a part from CPC and display its properties, he should also be able to view the 3D model. If, in an occasional instance, a shipyard chooses to restrict access to the viewing of the 3D model, then it would not load the neutral visualization file into the repository. If a neutral visualization file is loaded into the repository, it will be available to all users who have access to that particular part or assembly. The team will investigate the viability of non-disclosure agreements in the event they pursue implementation.

This project focused on the requirements for the creation of a neutral file for viewing the model, a step in the process of exchanging the actual 3D model. The requirements and issues involved in actual model exchange are very different and more complicated. To get maximum benefit out of a model exchange in CPC, the receiving shipyard would require that it could use the model in a design as if the model was created at its own shipyard. In order for the shipyards to achieve the benefits hoped for in an exchange of 3D solid models of the catalogued parts, the yards would have to follow a uniform set of standard modeling techniques. This would require that all the CPC participating shipyards model parts to the same level of detail, place attributes in the same locations, use the same layering designations, and agree on a uniform way to pass information on construction history and fixed parameters in the model. There is question as to whether or not an agreement should be reached prior to pursuing a visualization capability.

Another issue is that there are many parts already loaded into CPC that are not modeled and existing models would not meet a set of comprehensive standard modeling procedures. It would be too costly to create models or remodel the existing parts to meet the new requirements, so their exchange would attain limited benefits.

4 SCHEDULE

This project completed all activities in accordance with the contract requirements.

5 BUSINESS

There were no problems or issues regarding project funding, invoicing, subcontracting issues or changes to the level of participation by the project team members. This can be attributed to the fact that all participants have developed a close working relationship through their collective efforts in CPC participation.

6 NEAR TERM PLANS

In order to implement the ability for visualization, an implementation plan must be developed which will specify how this capability will be implemented and provide a schedule based on the accomplishments of this project. The key issue to be resolved is that is visualization the logical next step for 3D model sharing and exchange. And if the requirements for a productive exchange cannot be achieved, is the cost versus the benefits of implementing only visualization justified. In particular, an analysis must be done of the feasibility of implementing uniform modeling standards at all participating shipyards.

Another factor the shipyards are considering involves a current effort initiated by an SCRA Applied R&D Task Order for participation of EB, BIW, HII-Ingalls, HII-NNS, NASSCO, Bollinger Shipyards, NAVSEA Commonality Director, and NAVSEA NSRP Program Office in a Commonality Focus Group. The Statement of Work asks for this cross functional group to identify the top 5 tangible ways to reduce cost of commodities and complex components based on shipyard experience and shipyard and government supplier input. Upon identification of the top 5 items, the group is to recommend a phased approach for the Navy and NSRP to address the reduction of costs for the top 5 items identified above.

A survey of twelve enhancements was distributed to the Working Group members for ranking as potential barriers to commonality. Each organization completed the survey and the results were tallied and submitted to the team for review. Currently, the visualization and sharing of 2D/3D Models ranked number 10. The team has developed an informational brief for DASN ships, SEA05, etc., which describes the challenges to commonality (highlighting the top 5), the clear value that would result from commonality, and the tool set required to manage common parts across industry and the Navy. Additionally, RDML Kearney, NAVSEA Vice Commander, is an active participant in the Navy Commonality efforts. SCRA and the Navy NSRP Program Manager are arranging a date and time for the Admiral to discuss commonality and provide the NAVSEA perspective to our NSRP Commonality Group. Our plan is to integrate the timing of any implementation plans with the efforts and plans of the Commonality Working Group.

7 SUMMARY

This project was awarded to develop a prototype capability to view the 3D model of a part as an aide in the selection of parts. It has been identified that significant benefits could be obtained by having this capability. This was confirmed by each shipyard as they conducted a wide area review of the live prototype capability with the user community. The deliverable of this project was to develop and provide a live demonstration of the initial capability as a prototype implementation of the viewing capability within CPC, so that a CPC user is able to display a 3D model of the part. The demonstration was provided as a SDMT panel technical track presentation at the NSRP All Panel meeting. The presentation was well received.

For visualization of the 3D models of the CPC parts, the team recommends that adding this feature is both feasible and beneficial. However, as the CPC participating shipyards are involved in the NSRP Commonality Working Group and that group has identified nine other enhancements that would rank ahead of this capability, the decision is to integrate the timing of any implementation plans with the efforts and plans for the Commonality working group.