Nuclear Aircraft Carrier Inactivation – Execution of Waste Management Initiatives – 15565

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ABSTRACT

After 6 years of planning efforts, in June 2013, Newport News Shipbuilding (NNS) began the execution phase of the inactivation of the USS Enterprise. The USS Enterprise decommissioning involves implementation of a new approach to defueling aircraft carriers, utilizing new processes for defueling and shipment of spent nuclear fuel and waste. During planning for this complex endeavor, NNS developed several process improvement initiatives including streamlining waste management processes and technology insertion using modeling & simulation (M&S) capabilities. One of the new approaches involves the establishment of a Waste Packaging Area (WPA) onboard the ship. The process assists with maximizing waste loading and shipments directly from the ship. Another waste management initiative includes the NNS/ Waste Vendor teaming effort to facilitate more efficient loading and shipment of inactivation waste. With execution underway, these initiatives are being put to the test to see if they can withstand the rigors of day-to-day production.

NNS has implemented the use of the Modeling and Simulation (M&S) technology. During the planning phase, the M&S 3D Spatial Arrangement Tool was utilized to determine the optimal equipment layout within the new M-290 facility used for spent fuel packaging and shipout and to determine the appropriate shipping container placement on the ship to maximize waste loading. The M&S technology proved to be a beneficial application resulting in continued utilization through the execution phase of the carrier inactivation. NNS is currently expanding the M-290 Facility Model to provide a visual representation of the facility, its processes, resources, and variable parameters that can be utilized as a decision support tool through simulation of the spent fuel packaging and shipout process through the facility's lifecycle.

NNS is also expanding the application of the waste management model to effectively predict waste forecast. The simulation model is linked with the defueling schedule which captures the operational elements of the waste flow process. The model extrapolates the data to provide waste generation output to assess the most efficient and cost effective path for radiological waste shipments offsite. The ability to conduct waste forecasting allows streamlining of the waste management process in support of complex defueling operations.

INTRODUCTION

The defueling and decommissioning of the USS Enterprise represents a new approach to the defueling of aircraft carriers, and presents unique challenges to the process. In advance of the work to decommission the Enterprise Newport News Shipbuilding (NNS) initiated the creation of a set of modeling and simulation (M&S) tools to support the planning and execution of this new process. During planning the tools supported the creation of work plans which resulted in reduced risk and higher likelihoods of success. Now that the process is underway these tools

continue to support, on a daily basis, the defueling and decommissioning operations. The tools support the handling of waste on this ship, identifying optimal operational areas, forecasting equipment needs, and forecasting waste streams.

Off the ship the tools support the operation of a fuel handling facility. The M290 facility is operating for the first time since its creation, and as such is continually assessing the operational plans to ensure they remain viable. The tool supports these processes by providing visual representations of the facility, allowing the production teams to identify potential space constraints. Concurrently the simulation tool allows the teams to test strategies to set operational times, equipment needs and crew sizes to the most efficient levels possible.

DESCRIPTION

The use of M&S to support deactivation and defueling of the USS Enterprise is resulting in actionable decision support information because of the construct of the tools involved. Utilizing principles of discrete event simulation (DES), the latest visualization technology and point cloud data these tools are accurately modeling the operations occurring in support of this effort. The detailed information within the models, pertaining to operations both aboard the ship and within the M-290 facility allow the team to execute DES supported model runs, accurately capturing the likely outcomes of these operations. Employing a DES toolset developed within NNS the teams are able to build flexible models that can change at the same pace as the work being performed. At the same time, the coupling of the DES tools with accurate physical information about the environments where the work occurs adds another layer of fidelity to the tools. Accurately capturing the dimensions of the M-290 facility or the travel paths waste takes on the USS Enterprise ensures the DES models accurately capture all aspects of the work occurring during these operations. As this work continues these tools will continue to grow and support the execution of the deactivation process, as well as supporting plans for future deactivations.

Inactivation

The M&S model is also being used to support waste management operations during the deactivation of the USS Enterprise. Due to the anticipated large quantity of radiological waste generated, the standard process for managing radioactive waste is not feasible. Implementation of a specialized waste management plan was necessary to mitigate the competing needs of other concurrent contracts for shipyard resources. Waste processing efficiencies were evaluated to effectively showcase the most efficient waste process flow for moving waste containers onboard the ship. The simulation component of the M&S model captures the operational elements of the waste management plan such as container placement, appropriate personnel and equipment, material durations and routing. These features allow the user the flexibility to evaluate a variety of options to determine the best plan of action. As part of the execution phase of the inactivation, experimental use of the M&S model is currently being conducted to expand the model's capabilities to perform future waste forecasting.

Modeling Facility Utilization

The M-290 facility is a new facility which is being employed for the first time during this deactivation process. During the planning efforts for this work a team of NNS modeling and simulation professionals developed a DES tool capable of capturing the planned process, spatial

constraints, and manning requirements within the M-290. The tool supports this through two components.

The first is a DES facility model which captures the operations performed within the M-290 during defueling. The facility model covers operations associated with the transfer of empty casks into the facility, the operations to load the casks with the fuel from the ship and the operations to close the casks and remove them from the facility. In addition, the tool examines the operations occurring directly outside the facility where the casks initially arrive and eventually depart. To ensure these operations are accurate the model captures process times for each step, required personnel and any equipment needs. Employing NNS proprietary Common Simulation Framework (CSF) the model ensures a flexible structure which lends itself to rapid modification by non-technical users.

To ensure this capability the models employ a set of outside input sheets which dictate everything from process steps and time distributions to manning levels and equipment needs. By placing the majority of the model logic and operational information in external locations, the model is accessible to non-technical users who do not need a detailed understanding of how to write computer code to make modifications to the process. The external sheets allow anyone familiar with the process to make changes to the order of operations, add or remove steps, modify manning or equipment levels and modify or experiment with the logic of step constraints within the model. All of this is possible over a short period of time, greatly increasing the usefulness of the model when compared to traditional tools which potentially require hours of modifications to change similar components.

The models also employ an actuals input sheet which captures information about processes performed to date. Factoring this information into the model ensures that each time the system runs it starts from the most recent point in time and moves forward. The actuals data also forms a basis for analysis and provides input for future planning of deactivation operations. By implementing the flexible nature of CSF the team can capture the operational steps with a high level of detail, while ensuring constant accuracy to actual process steps and the creation of a dynamic experimental platform for rapidly assessing new plans.

The models logic pertaining to spatial limitations and equipment utilization also ensures that the production team can accurately assess areas where their plans may encounter delays. An example of this occurred during the planning phase when the team was able to identify that operating only one of two cranes inside the facility when a cask was being loaded resulted in significant time delays. They were able to modify this plan well in advance of execution and further assess the new operations to ensure they did not create danger for the personnel within the facility.

The second component of the facility model is the Spatial Arraignment Tool (SAT). The SAT is a visual representation of the facility and its equipment, built to exact dimensions. To ensure the dimensions were completely accurate NNS performed laser scans of the facility to generate point cloud data. Point cloud data allows the software employed to determine the exact dimensions, locations and sizes of the facility and its equipment. Using the data from the point cloud scans the model is able to accurately reflect spatial constraints with incredible fidelity.

Using the point cloud data within the SAT the production team is able to move objects around the environment and observe how they fit within the allowable space. The equipment of the greatest concern are racks for holding cask components, equipment required to work on the cask and personnel. Employing a drag and drop functionality the SAT allows the user to place the objects in the facility, and highlights or dis-allows overlapping equipment (the user may choose whether to allow overlaps or not). Taking this technology beyond just spatial visualizations the tool allows the user to plan where to place equipment and to model the current facility layouts. The SAT also serves as a front end for the facility model, allowing a user to move equipment around the SAT to reflect the exact facility layout on any given day and run the facility model with that setup. Utilizing this level of fidelity for current facility layouts increases the accuracy of the model data and helps the production team better identify constraints and limitations.

Waste Forecasting

Waste volume projections for the USS Enterprise deactivation is significantly greater than a Refueling Complex Overhaul (RCOH) project. In an effort to ensure efficient waste loading and shipments, the M&S model has been expanded to provide a look ahead schedule known as Waste Forecasting. The model includes baseline parameters which are based on the Defueling Operation Schedule (DOS) and waste volumes from previous availabilities. Additional parameters inputted into the model include container weight capacity, paperwork processing time, and shipment schedule. Based on these variables, the model outputs the monthly container flow to the WPA to effectively schedule shipments. The model also provides the capability to showcase different scenarios and the impact on waste flow using the baseline parameters discussed below.

Full Container Accumulation

The model forecasts the maximum number of full containers that are sitting idle waiting for paperwork to be processed in each month. The model output is based on two scenarios which are the baseline and extended parameters for container paperwork processing. The baseline container paperwork processing time is set at 4 days minimum, 10 days maximum and 7 days most common. The extended container paperwork processing time is set at 28 days minimum, 35 days maximum and 31.5 days most common. The model shows that the two scenarios produce significantly different results as shown below.

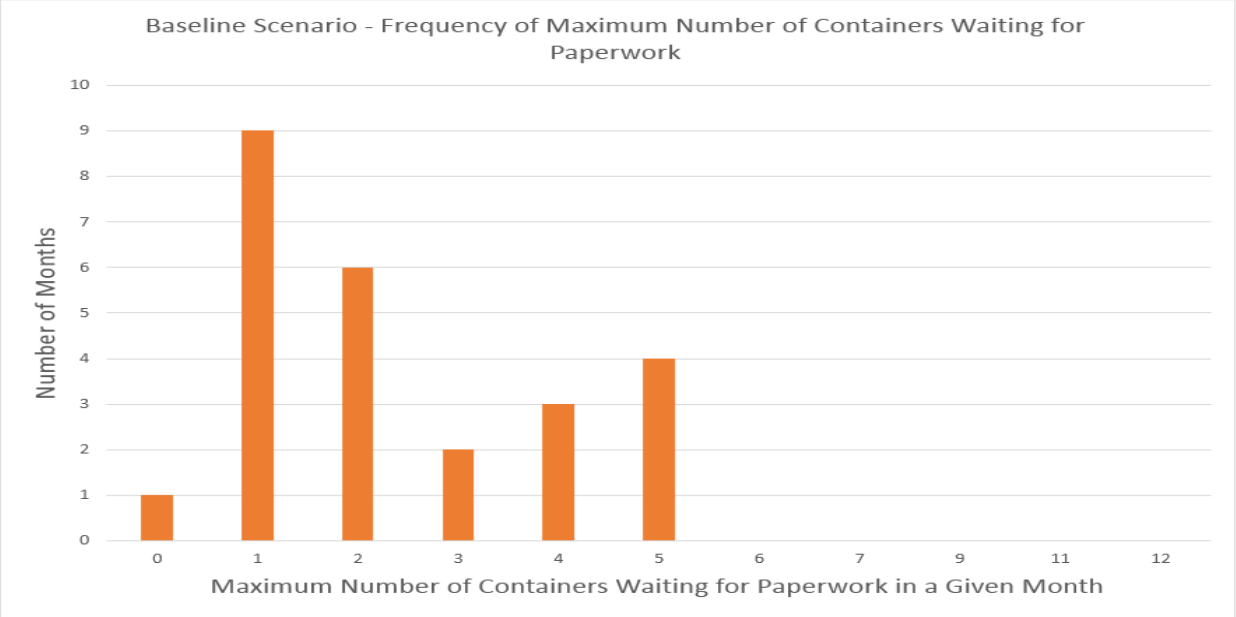

Fig. 1. Baseline – the absolute maximum number of containers waiting for paperwork in any given month is five.

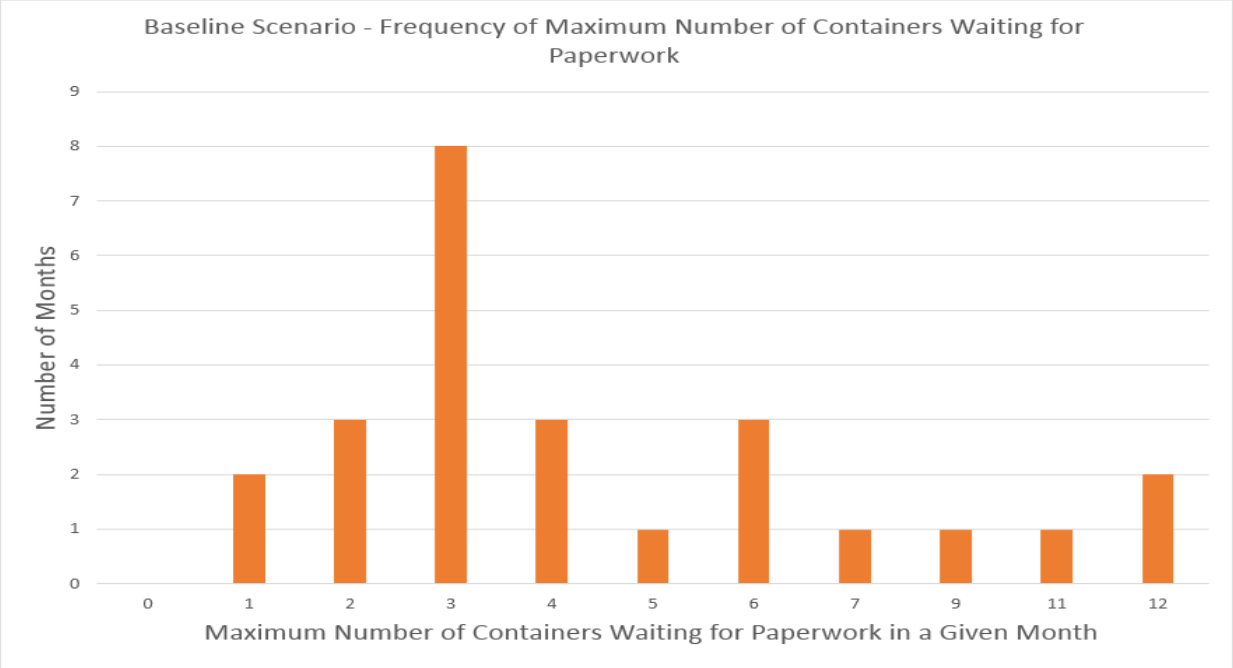

Fig. 2. Extended – the absolute maximum number of containers waiting for paperwork in any given month is twelve.

The two graphs shown in figures 1 and 2 above demonstrate how often the monthly maximums occur. For example, in the extended paperwork scenario, a maximum of 12 containers waiting

for paperwork occurs in two months, while a maximum of 3 containers waiting for paperwork occurs in eight different months. The amount of time it takes to process shipping paperwork does have a significant impact on the number of containers forecasted to be shipped. In the baseline scenario verses the extended scenario, almost double the number of containers can be shipped offsite.

The changing variables expected during the deactivation has limited the use of the waste forecasting feature during the early stages of the execution phase. The goal is to expand the model's features by inputting actuals to better forecast waste volumes and shipments. It has in turn provided the opportunity to evaluate use of the model and forecasting capabilities for future deactivations.

DISCUSSION

The M&S suite developed for the USS Enterprise's deactivation is currently in use and supporting multiple facets of the process. The tools cover waste handling and packaging on the ship during defueling and deactivation as well as operations at the M-290 facility, where defueling operations operate adjacent to the ship. During the execution phase of this effort these M&S tools continue to support execution of the work and have resulted in documented cost savings and risk avoidance.

Within the M-290 facility the model supports daily operations and the spatial arrangement component allows the production team to continually assess spatial constraints and identify potential future constraints well in advance of their occurrence. Using this tool, combined with the facility model, the team is constantly generating potential recovery paths to alleviate any delays that arise. The re-planning of work and development of mitigation strategies prior to a delay occurrence is resulting in reductions in risk to the overall program schedule.

Benefits

During the defueling process at NNS, the M-290 facility serves as the transfer point of materials leaving the USS Enterprise to storage and transfer casks. The facility being brand new, the current activities represent the first work ever performed within the M-290. As such, all of the operations and equipment usage patterns were pre-planned prior to observing how feasible they would be in the real facility. During planning for M-290's initial operations NNS developed a model to reduce the likelihood of risk associated with these new operations. Now that the facility is in active use the model continues to support operational work, as well as ensuring operations developed during initial planning are still feasible.

During the initial training and worker familiarization at the facility the M-290 model supported several studies to examine ideal crew sizes, optimum equipment positioning and the optimum equipment totals. The 3-D component of the M-290 model supported initial training operations by allowing workers to visualize how operations would occur within the facility. The ability to visualize the operations prior to filling the facility with equipment and running operations the first time helped the workers understand spatial limits and identify ideal locations to position themselves during operations. The 3-D component also allowed the planning teams to visualize the best location for equipment within the facility prior to moving materials inside.

As the facility began to prepare to receive the first shipments of material the model identified potential risks to the initial planned schedule. Because of the nature of the operations and equipment required to move materials from the USS Enterprise to the M-290 there was risk to schedules related to total times required to load casks. The initial schedule did not fully account for these potential risks, but through the use of the model the production team was able to demonstrate that making use of "off" days already built into the schedule they could meet the overall timeline. The identification that the timeline planned was only feasible by modifying cycles for cask loading prior to execution fully commencing allowed the team to pre-plan to meet the longer timelines and avoid risk to the overall schedule.

A major concern within the M290 facility is available space for operations. Due to the size of casks, cask movement equipment, and other equipment related to cask loading the floor space within the M-290 is at a premium. One proposal the production team developed to alleviate some of the risk associated with a lack of floor space was the removal of a set of racks used to store cask equipment. The initial plan called for the facility to operate with three sets of racks on hand and inside the facility at all times. However, the team suggested that loading one rack with equipment from the first cask, and then removing it and holding it at an adjacent facility for the duration of the operations would result in significant space savings. However, by removing the equipment the team would not be able to quickly use it to load a cask, should they require it. Using the model the team validated that, despite not having the equipment on hand throughout operation, the impacts to the schedule were negligible, remaining well within the planned work cycle for the entire operation. As a result the team decided to remove one set of racks as planned and proceed with only two on hand, returning the third set to close the final cask.

The Spatial Arrangement Tool (SAT) component of the facility model is also in continual use. Beyond its initial use during planning to find optimal material and equipment laydown areas, the tool currently allows the production team to update the location of equipment, on a daily basis, and observe potential spatial conflicts and bottlenecks well in advance of their occurrence. The tool allows the team to plan for these potential delays in advance and in the instances where they do occur the team is able to implement an existing plan, developed with the tool. This results in quicker response times to problems, reductions in lost time due to delays and reduced risk to the overall schedule.

Future Planning

While these tools support the current operations, they are also serving the role of data capture tools. The models run with updated information provided via the "actuals input sheets", accumulating as the work progresses. By creating a database of these historical progressions the models will support planning for future deactivations. The tools will allow the users to go back and observe specific periods during the deactivation, using actual information from that period in the process. The visual components of the model will then allow planners to observe how work progressed during these periods. Any delays which arose will also be apparent. As the planning team moves to preparing for the next deactivation they can utilize this information to refine plans. They will also be able to use the models to assess different deactivation strategies and assess their likelihood of success. Coupling this capability with traditional scheduling techniques will result in better schedules and reduced risks.

CONCLUSIONS

The waste handling and M-290 models are supporting the deactivation of the USS Enterprise, generating cost savings and reducing risk. The tools initial use during the planning phase ensure that the current operations are viable and have high likelihoods of success. As work commenced and continues the models are identifying risk reduction techniques and highlighting potential roadblocks and bottlenecks well in advance of their occurrence. The visual components of the model also allow the production teams to continually assess modifications to strategies to adhere to the planned schedule and develop mitigation strategies ahead of time. The data capture component of these models is ensuring that future deactivations will be able to use the models to plan and execute the work more efficiently.