

Planning Tool for Strategic Evaluation of Facility Plans – 13570

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ABSTRACT

Savannah River National Laboratory (SRNL) has developed a strategic planning tool for the evaluation of the utilization of its unique resources for processing and research and development of nuclear materials. The Planning Tool is a strategic level tool for assessing multiple missions that could be conducted utilizing the SRNL facilities and showcasing the plan. Traditional approaches using standard scheduling tools and laying out a strategy on paper tended to be labor intensive and offered either a limited or cluttered view for visualizing and communicating results. A tool that can assess the process throughput, duration, and utilization of the facility was needed.

SRNL teamed with Newport News Shipbuilding (NNS), a division of Huntington Ingalls Industries, to create the next generation Planning Tool. The goal of this collaboration was to create a simulation based tool that allows for quick evaluation of strategies with respect to new or changing missions, and clearly communicates results to the decision makers. This tool has been built upon a mature modeling and simulation software previously developed by NNS. The Planning Tool provides a forum for capturing dependencies, constraints, activity flows, and variable factors. It is also a platform for quickly evaluating multiple mission scenarios, dynamically adding/updating scenarios, generating multiple views for evaluating/communicating results, and understanding where there are areas of risks and opportunities with respect to capacity.

The Planning Tool that has been developed is useful in that it presents a clear visual plan for the missions at the Savannah River Site (SRS). It not only assists in communicating the plans to SRS corporate management, but also allows the area stakeholders a visual look at the future plans for SRS. The design of this tool makes it easily deployable to other facility and mission planning endeavors.

INTRODUCTION

The Savannah River National Laboratory (SRNL) is the United States Department of Energy's (DOE) lead laboratory for environmental management (EM). The laboratory applies state-of-the-art science to provide practical, high-value, cost-effective solutions to complex technical problems. With experience spanning six decades (and counting) as well as expertise spanning all radiological and chemical disciplines, SRNL has an extensive record of defining and developing applied technologies for deployment to solve national and international challenges.

SRNL set out to create a planning tool to assist in meeting its goals to use the SRS assets, both facilities and personnel knowledge, to reduce the environmental legacy of nuclear materials and radioactive waste, to provide innovative solutions for nuclear nonproliferation and detection, and to assist in accelerating the deployment of nuclear energy. In order to develop and analyze plans for these missions and to communicate the results of these plans, SRNL needed an effective and efficient tool or tool set. SRNL collaborated with Newport News Shipbuilding (NNS) to develop this next generation planning tool.

NNS, a division of Huntington Ingalls Industries, is the birthplace of the U.S. Navy's nuclear fleet. NNS continues a long heritage of shipbuilding and providing fleet services for naval ships, and has recently expanded its nuclear and manufacturing expertise into DOE and alternative energy business ventures. As part of its missions, NNS has been working in the area of modeling and simulation for over 15 years. The NNS team has matured a capability for developing simulation based tools that builds on the modeling and simulation industry best practices, supplemented with guidance from software engineering, operations research and systems engineering fields. This capability includes a focus on architecture that promotes interoperability, reuse, robustness, foresight and potential for growth.

PLANNING TOOL IMPROVEMENT NEEDS

The SRS Planning Tool is a strategic level tool for assessing multiple missions utilizing various Savannah River Site (SRS) facilities. The original version of the Planning Tool was built by utilizing multiple scheduling tools and manually plotting the resulting mission duration in the appropriate section of the Gantt charts. The effort to maintain and update this tool was challenging and time consuming. It allowed only a limited number of scenarios to be evaluated in a short time frame. Expanding the outputs to include additional missions and facilities, or isolating a specific facility, could not be done quickly. It was also difficult to deduce how the plan would be impacted by uncertainties within each mission and mission interactions. In addition, SRNL needed the ability to evaluate when and where the facilities could support additional missions.

DEVELOPMENT OF A SOLUTION

To address current limitations SRNL teamed with NNS to create the next generation of the Planning Tool. The goal of this collaboration was to create a tool that would not only support automation of overview plan construction and updating activities, but would also facilitate in depth analysis of the proposed missions within SRS processing and storage facilities. For automation purposes, the tool needed to provide a forum for capturing the necessary dependencies, constraints, activity flows, and variable factors. This knowledge capture would ensure that data could be easily accessed and utilized, minimizing data entry errors and maintaining data integrity. For analysis purposes, the tool needed to serve as an experimentation frame for quickly evaluating multiple mission scenarios. This includes assessing the process throughput, duration and utilization of the facilities, as well as understanding where there are areas of risks and opportunities with respect to capacity. Flexibility was an important requirement for this tool. As a strategic decision making aid, the Planning Tool needed to allow the user to rapidly update and adapt scenarios to new information. The user needed to be able to

dynamically add/update scenarios, create multiple views for evaluating/communicating results, and easily execute the application. The overall objective was to create a simulation based tool that allows for quick evaluation of strategies with respect to new or changing missions, and clearly communicates results to the decision makers.

Common Simulation Framework

NNS applies modeling and simulation from a total lifecycle perspective. Instead of developing single purpose models, the focus is on building reusable and expandable decision support tools that advance as the needs evolve. To fulfill the requirements of the next generation Planning Tool, the SRNL/NNS team decided to build the tool using a simulation framework developed at NNS. NNS has created an open architecture software framework for development of modeling and simulation based tools for decision makers, called the Common Simulation Framework (CSF)¹. CSF is a component based framework written in Java language, giving it maximum flexibility and ability to interface with a variety of applications. The framework has been used to create a number of simulation based decision support tools, many of which have stochastic discrete event simulations as their foundation. CSF uses a layered approach to provide functionality to the modeler and allows maximum flexibility for creating user friendly applications that include interfaces, analytics, visualization and other features. The foundation is the simulation engine. The Application Programming Interface provided by the CSF is then used to create libraries of components that are compiled into simulations (see Figure 1). Unlike commercial off-the-shelf simulation tools, CSF is designed to create tools that apply simulation at its core but are not necessarily intended to be used by modeling and simulation professionals. In this manner, the tool offers the flexibility of a programming language to create custom applications, while providing libraries of components for constructing simulations.

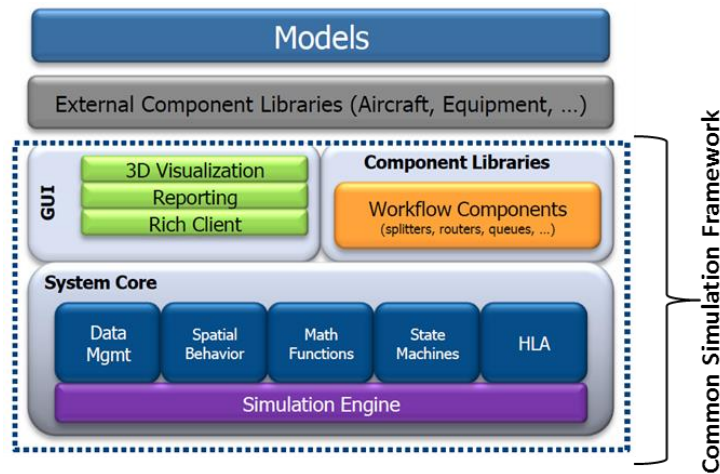


Figure 1 Common Simulation Framework architecture

The process framework employed by the team draws on the Agile Software Development principles (www.agilemanifesto.org) of iterative development, focused on consistently

¹ The Common Simulation Framework (CSF) is copyright protected in the United States by the Huntington Ingalls Industries.

connecting model development with the problem statement and analysis needs, ensuring development of valid and useful tools and utilizing sound statistical techniques. To begin the process, the team developed a set of high level user requirements. These user requirements were broken down into simulation software features used to develop the initial product backlog of activities. The development process consisted of four week development cycles called Sprints, which began with prioritization of the product backlog and planning, and concluded with review of completed work. Each sprint resulted in an executable part of a solution building up to a complete working tool.

FEATURES OF NEXT GENERATION PLANNING TOOL

The SRNL/NNS team worked iteratively to create the next generation Planning Tool. The resulting tool is an application that delivers scenario analysis capability at the decision maker's fingertips. This application can be deployed on any standard computer, encapsulates all the necessary utilities and will run on multiple platforms. It does not require installation of non-standard software, extraordinary memory needs or any other specialized requirements.

The data entry is performed via interface windows some of which are shown in Figure 2. The user is guided through a series of windows to enter information about missions, activities, facilities and equipment. This data allows the user to capture the activity flows and system constraints to thoroughly analyze how they impact the plan execution. For activity level data the user may enter processing rates, materials available and storage options. Once the data is entered, it is stored within a scenario and can be used in any number of alternative scenarios. This drastically reduces the amount of time needed to update a scenario or to create a new one. The user can simply load an existing scenario with all of the missions, facilities and other components already defined and change as needed.

Some features not yet developed include configuration management to be maintained through permissions, as the number of users increase. With this feature, any user would be able to create and experiment with scenarios, but only the designated users would have the authority to maintain the official baseline scenario.

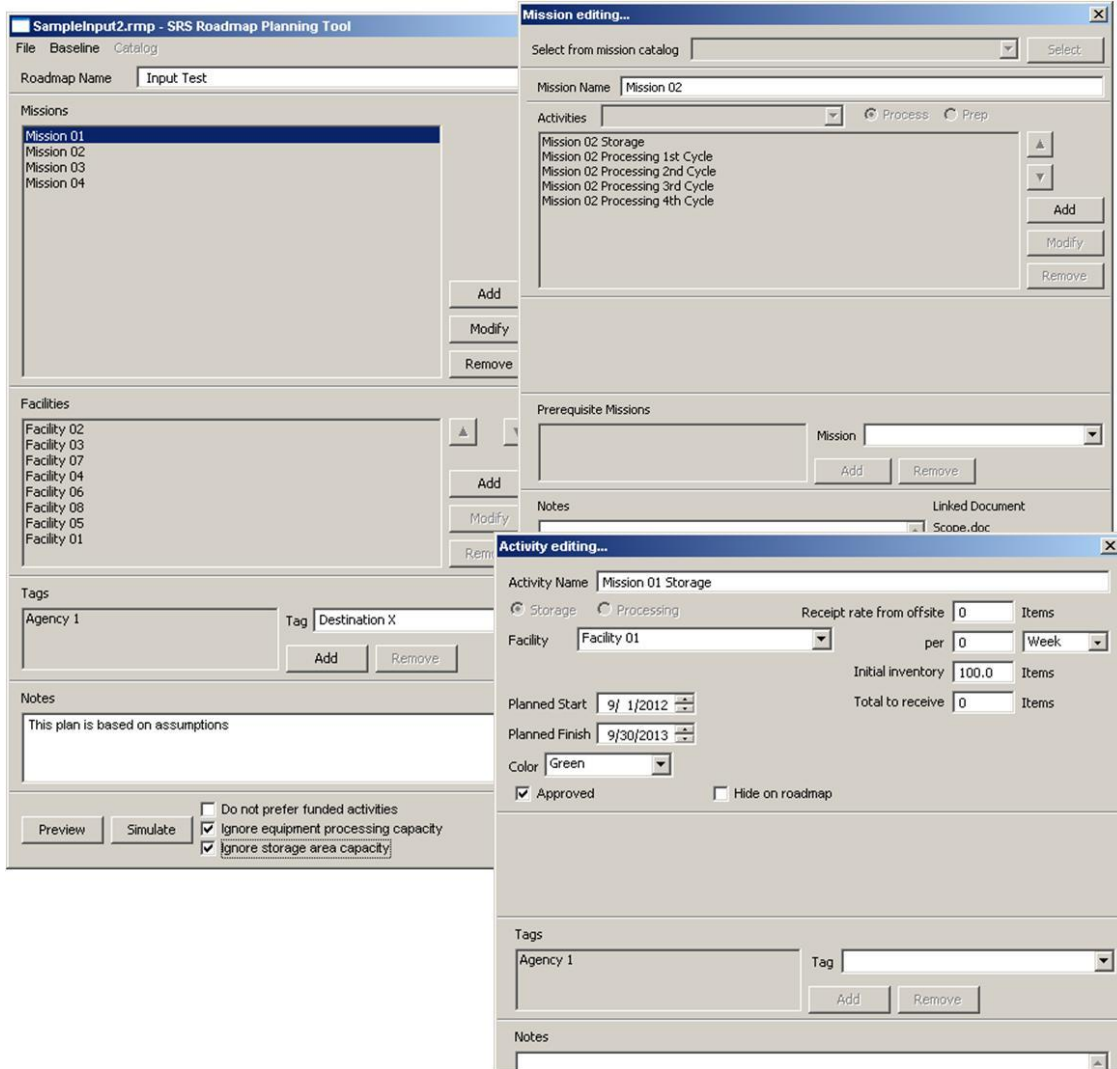


Figure 2 Planning Tool data entry windows

Once the scenario is created, the user can preview the planning chart. Figure 3 is the preview visualization of the planning chart. Like the original tool, the next generation visualization depicts a Gantt chart with blocks for mission activities within the designated facility, and the duration shown on a horizontal timeline. A major difference in the next generation tool is that the user can collapse or expand the timeline to view a timescale at a year, quarter or month fidelity. Similarly, the user may hide the facilities from the view. This allows the user to have control over the view and the ability to zoom in on areas of interest.

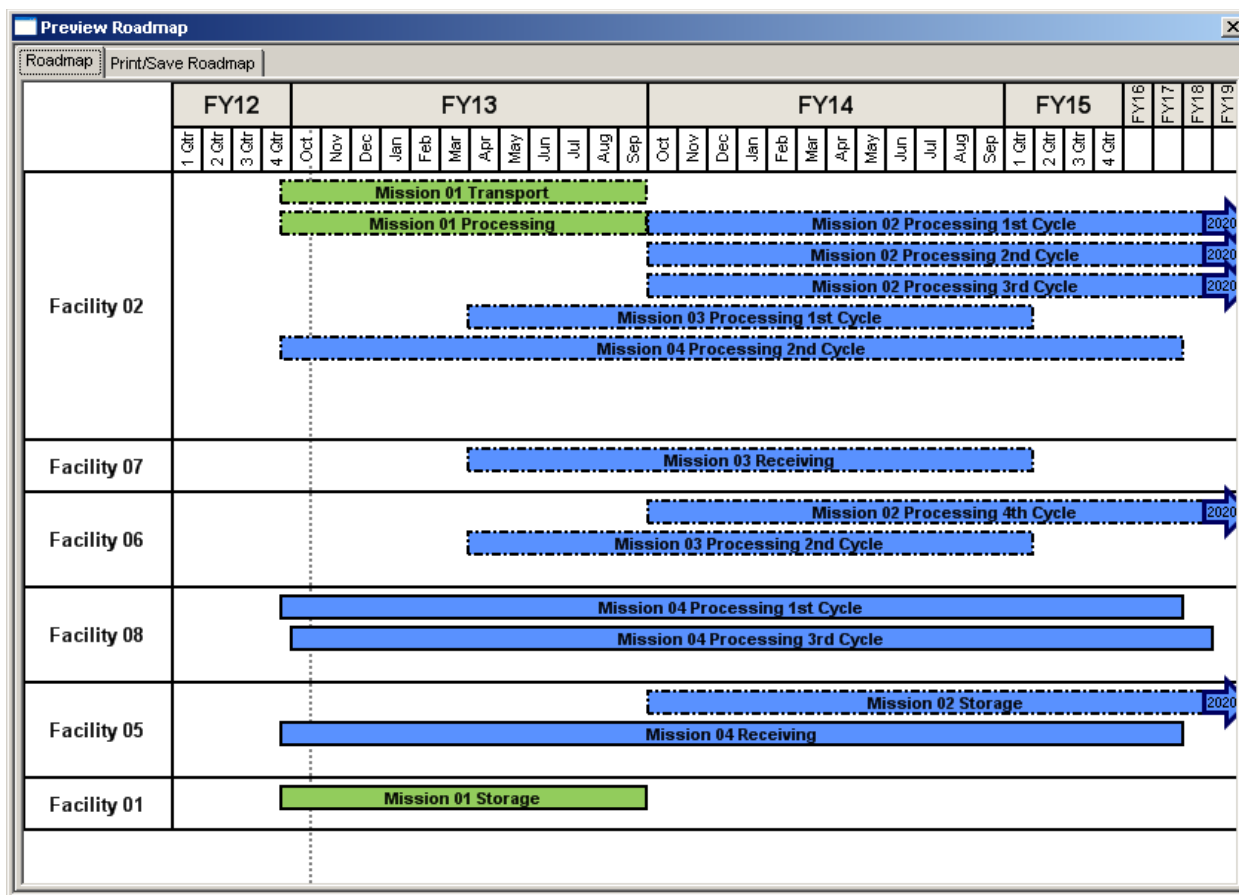


Figure 3 Planning Tool preview visualization

The next step in the assessment of the plan is to determine changes given the system constraints. To do this the user “simulates” the plan. The plan preview depicts the user’s anticipated result. The simulation then executes the requirements within the constraints and generates the resulting mission durations. The plan’s simulated view shows how the simulation performed as compared to expected completions. This feature allows the user to predict and eliminate any unforeseen issues associated with the plan, such as bottlenecks or shortages in capacity. When creating a plan, it may be difficult to anticipate what may result from multiple activities competing for the same resources. The simulation component offers that insight.

The tool offers several analytics to further evaluate the performance of the plan. The analysis material ranges from raw output data from the simulation run to various charts. The raw output data traces the activities throughout the simulation run. This data can be used by an analyst to conduct in-depth analysis of the material flow and mission performance. The charts are a quick way to obtain similar information. The pre-defined charts trace utilization of equipment, amount of material processed at each location, storage capacity utilized and others. Figure 4 is an example of an output that shows the percent of the scenario run time that equipment was busy. These charts are useful in pointing out opportunities in the system, such as where equipment is being underutilized or extra capacity is available.

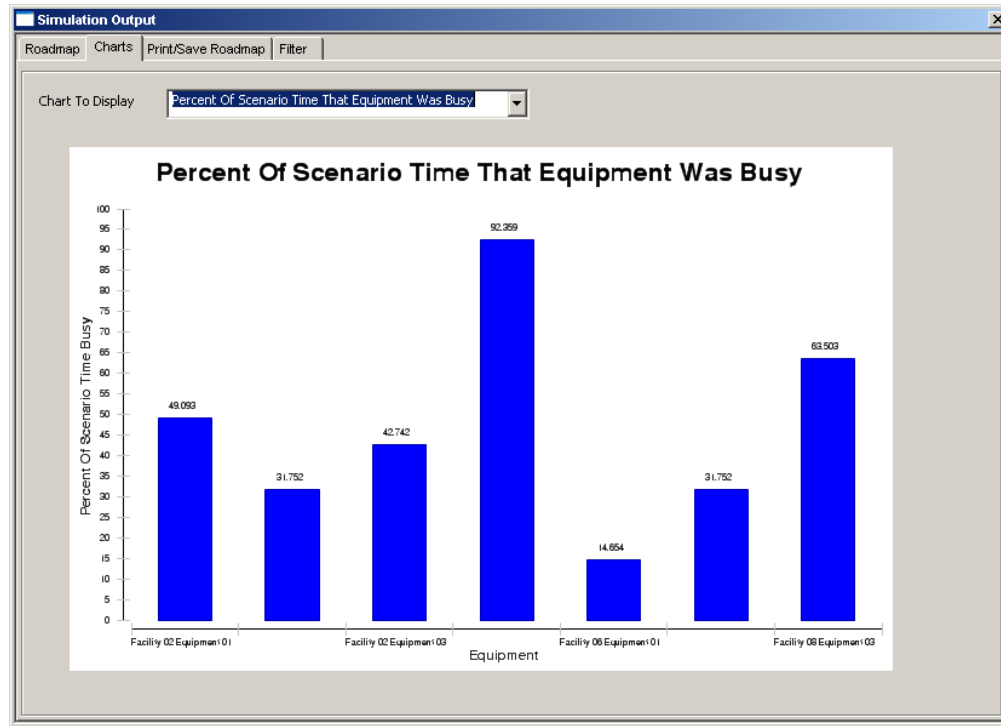


Figure 4 Sample analysis chart

This next generation Planning Tool also offers many other features to aid the user. Both the preview and the simulated views can be saved and printed in a number of formats.

The user is given various simulation parameters to help in the plan analysis. One of the parameters the user may specify is running with unlimited capacity. When the Ignore Capacity boxes are checked (see Figure 2), the simulation will ignore user inputs on storage locations and/or equipment capacities and will assume it is unlimited. Although it is not a realistic depiction of planned activities, it provides insight into the threshold of the system capability. This analysis helps determine the optimal capacity needs and find opportunities when capacity restrictions are alleviated. Another analytical feature is a Temp Buffer. When this box is clicked the simulation will create a virtual queue, where material can stack up if there is bottleneck at a processing location. Although this buffer does not correspond to a physical location, it helps pin point where the bottleneck is as opposed to potentially discovering its impacts downstream of the mission.

The user may assign tags throughout the data to be used for looking at specific aspects of the plan and the output. The left side of Figure 2 shows the window where tags can be created and managed. These tags can be assigned to an activity to allow the user to filter the information. Figure 5 shows how this is done. The user can assign a tag to an activity, then, using the Filter menu display those activities and facilities on the preview that are associated with the specified tag.

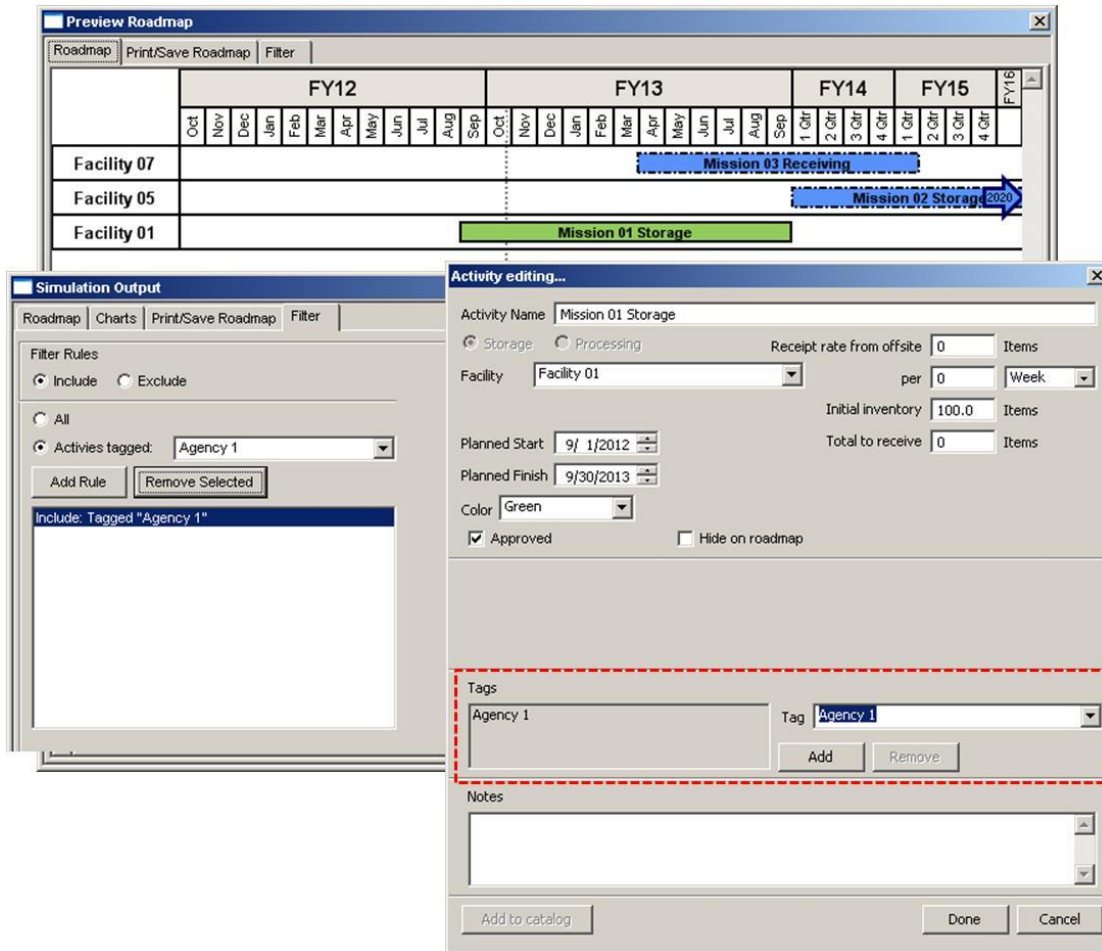


Figure 5 Using tags to filter information

To help capture any other relevant information, the user may enter notes throughout the scenario to any aspect of the plan: missions, activities, facilities, equipment, etc. The tool also allows the user to attach files to missions. These files are then available for access by clicking directly on the mission on the plan as pictured in Figure 6.

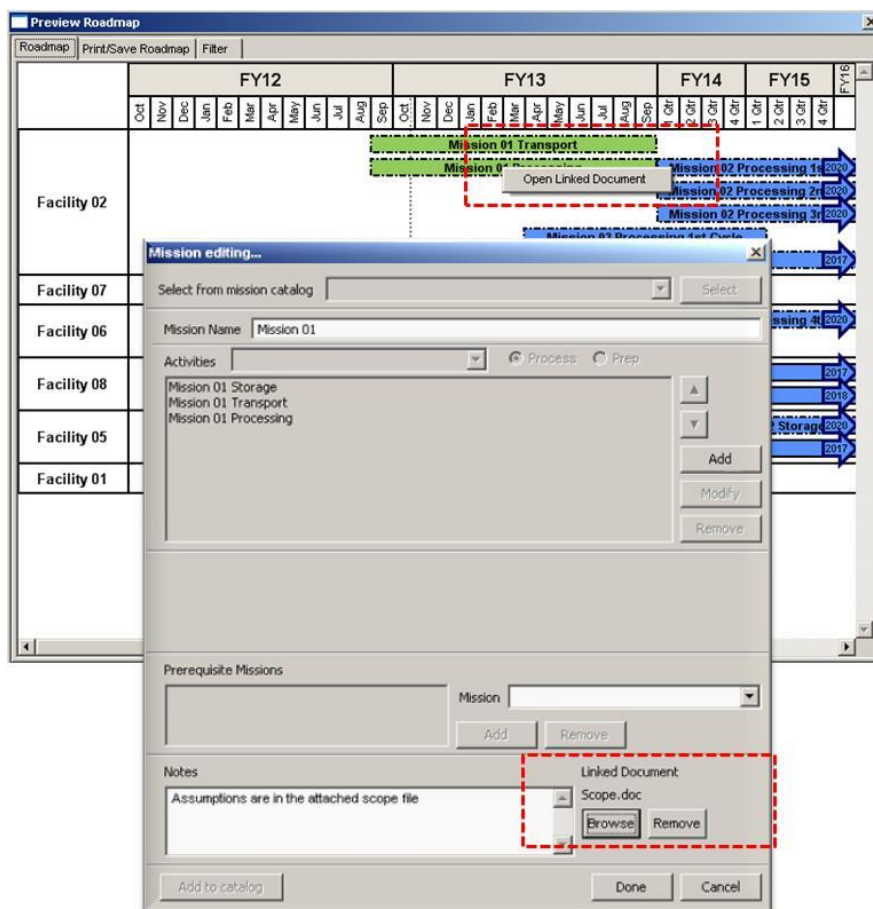


Figure 6 Linking file to a mission

CONCLUSION

The Planning Tool developed by the SRNL/NNS team is a simulation based application that supports efficient and well informed mission planning. The tool presents a clear visual plan for the missions at SRS. It has the ability to analyze mission plans to determine the SRS capability to add new missions or to show if additional equipment would result in a faster throughput. This version of the Planning Tool will assist the SRNL Management Team in communicating the vision for utilizing SRS processing and storage facilities and its vast knowledge base to support national security, environmental and energy mission areas. It not only assists in communicating the plans to SRS corporate management, but also allows the area stakeholders a visual look at the future plans for SRS and shows where SRNL continues to play a major role in solving national and international challenges.

This tool has been developed such that it can also be used for strategic evaluations of missions at any set of facilities. The tool is not constructed around specific facilities or process systems. The tool's approach of the rate of movement of material from initial storage locations, through processing steps, and then to a final location can be tailored to support the strategic analysis of many different missions. This design makes the tool very easily extensible to support of variety of other decision making efforts.