Argonne NATIONAL LABORATORY

Decision Support and Risk Management

Restore©: Modeling Interdependent Repair/Restoration Processes

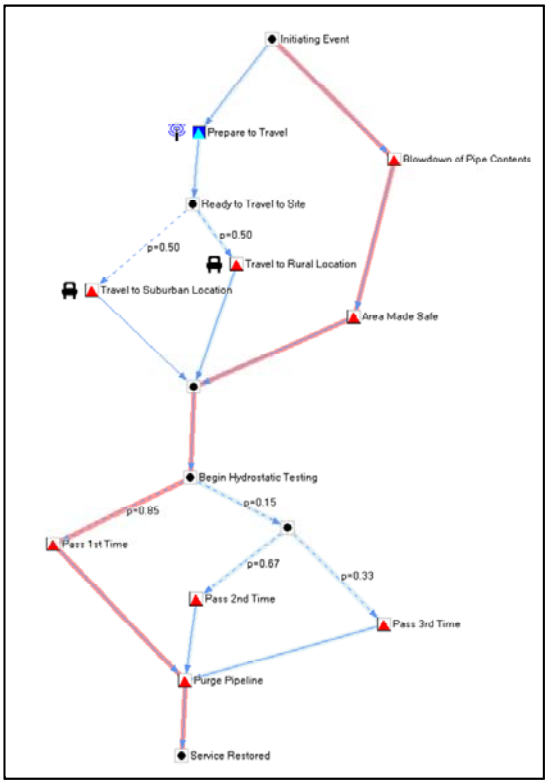
Modeling Complex Systems

Restore, developed by Argonne National Laboratory, models complex sets of steps required to accomplish a goal, such as repairing a ruptured natural gas pipeline, when the time required to complete a step may be uncertain. For example, external conditions (i.e., the time of day, weather, availability of crew) may affect one or more of the steps required to accomplish a goal. Therefore, "nature" can influence which steps are taken and the time needed to complete each step. Restore© enables a user to model the costs, which also may be uncertain, for each step.

Restore allows a user to estimate the time and cost (which may also be uncertain) needed to achieve an intermediate stage of completion, as well as overall completion. Restore can also model workarounds and a simultaneous complete repair to obtain a distribution for the earliest time until service (either temporary via the workaround or normal via complete repair, which ever comes first) can be restored.

The tool also identifies the "most active path" through the network of tasks. This is extremely important information that helps gain insight into the most effective ways to speed up (or slow down) progress.

Finally, unlike other project planning and risk analysis tools, Restore provides an intuitive, graphical, and object-oriented environment for structuring a model, setting its parameters, and viewing results.

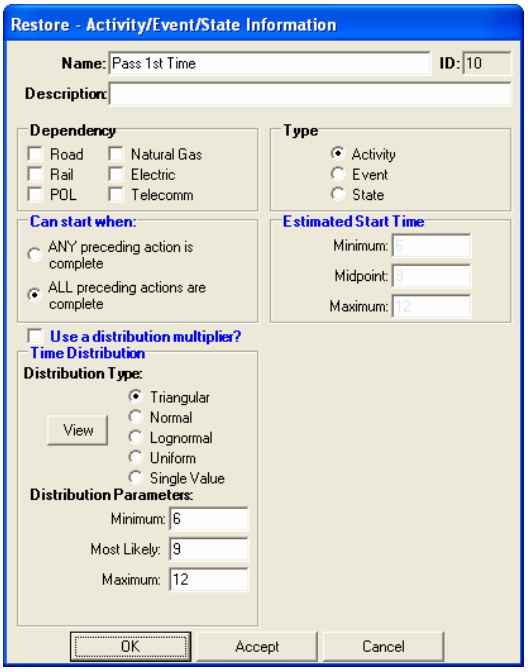


Simple example of a Restore© transition diagram – a graphical representation of a restoration model – for the repair of a ruptured natural gas pipeline. The nodes represent events (dots) and activities (squares) pertinent to the repair. Branches (arrows) indicate the relationships among the activities and events. Branches connect a predecessor node to a successor node. The icons beside some activities indicate dependencies on other infrastructures (e.g., telecommunications, transportation). Nodes and branches are added to a model through simple point-and-click mouse operations. The most active path (which is not the longest path) is highlighted in red.

Using Restore

Argonne staff has used Restore to analyze many failure scenarios over the past 5 years. Restore's data library of applications was developed in collaboration with subject matter experts on natural gas, water, electricity, and telecommunications infrastructures.

A new user with as little as 4–6 hours of training can use the tool to modify an existing data file in the library to better represent an ongoing failure condition. With experience and in collaboration with subject matter experts, users can build new data files for new failure scenarios.



Typical Restore© dialog box for specifying an activity. A user specifies a rule for starting the activity and a probability distribution for the completion time.

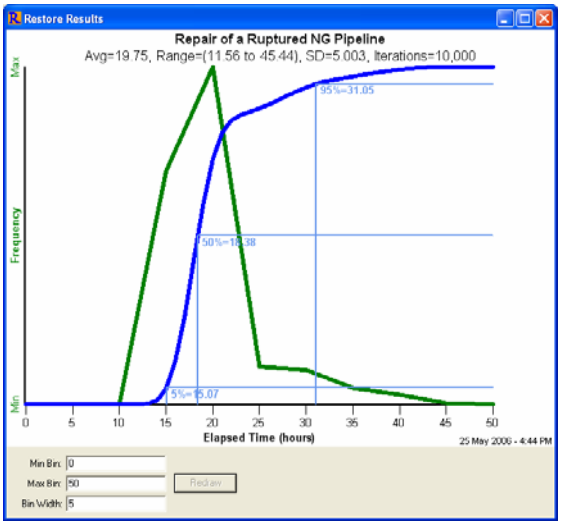
Applications of Restore

The Department of Homeland Security has used Restore to estimate times needed to re-establish service after disruptions to natural gas supplies due to transmission pipeline ruptures, compressor station failures, city gate failures, and gas-water separators at underground storage facilities.

Work is also being performed for the US Environmental Protection Agency to estimate service restoration times following damage to drinking water distribution systems.

Using Restore is simple. The challenge is to identify required activities and specify their completion time distributions. Argonne staff always relies on the experience of infrastructure professionals to answer this challenge. Argonne staff is uniquely skilled and experienced in obtaining the "right" information.

Restore runs in a few seconds or less, even when restoration processes comprise many activities and complex relationships. Output graphs summarize probability distributions for overall and intermediate completion times. A wide variety of sensitivity analysis features help the analyst develop insights into the restoration process and how to improve it.



Sample output from Restore© showing a completion time distribution and its corresponding cumulative probability function, simulation statistics, and input areas for controlling the appearance of the graph.

Learn more about Restore© and other Argonne-developed models at:
http://www.dis.anl.gov/

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