Proceedings of the 1996 Winter Simulation Conference
ed. J. M. Charnes, D. J. Morrice, D. T. Brunner, and J. J. Swain

SIMULATION IN POLICY ANALYSIS: THE TRANSFER OF FACILITIES WITHIN THE DEPARTMENT OF ENERGY'S ENVIRONMENTAL MANAGEMENT PROGRAM

Samuel M. Hart

Project Performance Corporation
46030 Manekin Plaza, Suite 180
Sterling, Virginia 20166, U.S.A.

ABSTRACT

This paper explains how process simulation can be applied as a policy analysis tool. While many simulations are used to evaluate and improve specific processes, few are currently used as a policy analysis or decision-making tool. For the purpose of choosing from several potential policy choices, a simulation model can describe the probable outcomes under each alternative in a concise and easily understood manner. Such a model can combine the work of several more traditional policy analysis tools into a single analysis that, once designed, can be performed in a fraction of the time. The specific case presented in this paper is the transfer of deactivated facilities from one organization (the Office of Nuclear Material and Facility Stabilization) to another (the Office of Environmental Restoration) within the Department of Energy's Environmental Management program. The model was developed using VENSIM, an off-the-shelf modeling software package. With the completed model, several potential policy choices regarding the rate of facility transfer were assessed to identify funding and scheduling problems with each policy.

1 INTRODUCTION

Computer simulation has become an established tool for analyzing and improving processes in the manufacturing industry as well as other production-oriented industries such as the chemical industry. Directors at DuPont and Dow Chemical believe that simulation modeling is essential to the progress of their companies (Krieger 1995). More recently, simulation models have been entering the arena of business management. James Krieger (1995) indicated:

"Companies in the [chemical] industry are at the beginning of a major transformation in how they operate: how they focus their research and engineering design activities, how they run their plants, how they decide which products to market, and how they make tactical and strategic business decisions."

Simulating how to best manufacture a product, as well as simulating its performance, are important to the success of that product (Dvorak 1994). However, what about considering the importance of modeling in areas other than production? Businesses have been making the transition from using models strictly as a production tool to employing them as a decision tool as well. Models are now used as business tools focusing primarily on cost estimating, scheduling, and logistics.

Evaluating the costs of new products and market acceptance of those products is important to business for obvious reasons. The ability to predict the success or failure of a product helps companies capitalize on a success or avoid costly failures. A strict cost evaluation; however, could be completed without simulation. The value of a simulation in cost estimating stems from the fact that non-economic factors can play an important role in the way costs behave in reality. As Max Weber stated (Breiner 1995):

"The explanation of everything by economic causes alone is never exhaustive in any sense whatsoever, in any sphere of cultural phenomena, not even in the economic sphere itself."

Using simulations for scheduling and logistics enables businesses and manufacturing plants to operate more efficiently. As James Trainham, director of engineering research and development at DuPont, declared (Krieger 1995):

"Outstanding supply-chain management cannot make a second-rate manufacturing process world-class, but second-rate supply-chain management can make a best-in-the-industry manufacturing plant perform no better than a mediocre one."

If the private sector can use simulation tools for such a wide array of applications, why shouldn't the federal government use simulation tools in a similar manner? Some organizations within the government, such as the military, are already using simulation models for a wide array of uses. As Major General Joseph J. Redden (1995) explained:

"Simulation has been extensively and successfully applied to a wide range of military problems including

- *operations of weapons*
- *establishing requirements*
- *acquisition*
- *logistics*
- *communications*
- *war-gaming"*

One such model used by the Department of Defense is the Cost Analysis Strategy Assessment model. The model serves as a Life Cycle Cost model to be used as a decision tool (Manary 1995). Some government organizations are now beginning to use simulation models on a large scale. Within the Department of Energy's Office of Environmental Management (EM), a simulation tool is used to provide a life-cycle cost and scheduling estimate for the entire program. However, few models are used on a smaller scale to evaluate specific problems in EM. In 1995, Idaho National Engineering Laboratory designed a simulation to analyze different scenarios of storing high-level nuclear waste (Kristofferson 1995). The model evaluated five scenarios varying the availability of a waste repository facility. It provided a useful scheduling policy analysis tool for the transfer of high-level waste, although the different scenarios were assumed outcomes with varying funding levels, and cost data was not directly integrated into the model.

The objective of the model described in this paper is to develop a policy analysis model that integrates budgetary and scheduling concerns. The process chosen was the transfer of facilities from the Office of Nuclear Material and Facility Stabilization to the Office of Environmental Restoration. This simulation is also unique to other policy analysis models in that the transfer that is modeled is a "paper" transfer. In other words, it is not a physical transfer of materials, but rather an administrative transfer.

An additional goal of this simulation was to use an off-the-shelf software program to design the model. The software chosen was VENSIM, a discrete event, system simulation program.

2 THE MODEL

The model shown in Figure 1 simulates the process that a facility scheduled to be decommissioned follows through the Office of Nuclear Material and Facility Stabilization (EM-60) and the Office of Environmental Restoration (EM-40). The majority of facilities will go through five phases in EM-60 and two phases in EM-40. The EM-60 phases include Pre-Stabilization Surveillance and Maintenance, Stabilization, Post-Stabilization Surveillance and Maintenance, Deactivation, and Post-Deactivation Surveillance and Maintenance. The EM-40 phases are Decontamination and Decommissioning. Two additional phases in the EM-40 program that are not included above are: 1) a general Surveillance and Maintenance phase, shown as Transfer Holding in the model flowchart, and 2) Long Term Surveillance and Maintenance. The Transfer Holding is identical to EM-60's Post-Deactivation Surveillance and Maintenance with the exception that facilities in this phase are under EM-40 management instead of EM-60. The Long Term Surveillance and Maintenance phase includes facilities that have been decommissioned but are still owned by EM-40 and must be maintained. Surveillance and Maintenance includes basic operations and costs necessary to maintain the facility such as security, power, etc.

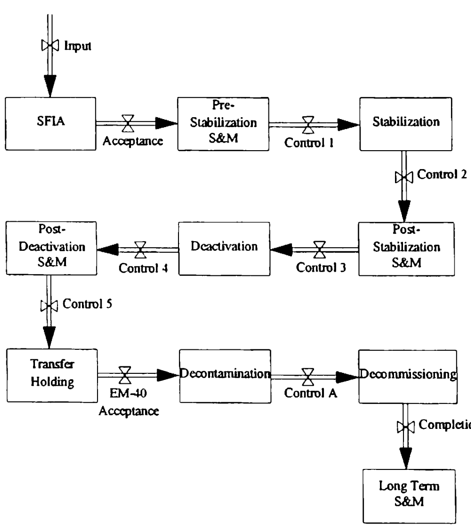

Figure 1: Facility Transfer Model Flowchart

It is possible for additional facilities to enter the process at a later date. Most of these facilities are logged in the Surplus Facilities Inventory Assessment (SFIA) database. It is also possible; however, that some facilities not currently in the SFIA database will be added. Therefore, the model was designed to include both SFIA additions as well as any other additions to the current SFIA database.

A facility spends a given amount of time in each phase and then moves on to the next phase in the process; however, the rate at which facilities proceed is also somewhat determined by the costs of processing those facilities and the budget allocated to the program. Therefore, cost information as well as program budget information were included (for each phase) in the model.

The facilities follow a linear flow from one phase to the next until completion. The facilities included range from a large production reactor to storage tanks to retention basins. Obviously, the costs and time to complete these different types of facilities may vary. As organized by the Office of Environmental Management, there are 22 possible facility types. They are based on the type of building, the size of the building, and waste type. Therefore, the model was subscripted to include different cost and time duration information of each phase and each facility type. Since the program is already several years old, those facilities already into the process were included in the phases where they are currently located.

The model was also designed to remain as flexible as possible. It is likely that the amount of time required to complete a phase may vary over the course of the several decades required to complete all facilities. Therefore, the model includes a time dilation factor. This variable will increase the time required to complete each stage by a certain percentage each year. While this variable is not required, it is helpful for evaluating different scenarios. Similarly, a cost inflation rate is factored into the model. Finally, it must also be remembered that budgets will fluctuate from year to year. The VENSIM software allows a step function to be used that increases or decreases the budget figures at specified years. It is even possible to set the model to automatically pause during the simulation run to adjust the budget.

3 MODEL ASSUMPTIONS

Three basic assumptions had to be made in the model. First, those facilities already in the process could not start in the middle of a given phase. Therefore, facilities were placed at the beginning of their current phase if less than half way to completion of that phase, or at the beginning of the next phase if more than half way through the phase. This rule does not apply to facilities in SFIA or Transfer Holding since there is no time constraint on those phases.

The second assumption applies to determining the method in which facilities are accepted from SFIA into EM-60 and from Transfer Holding to the Decontamination phase of EM-40. There is not a standard program-wide policy on the method of selecting facilities into the process. Therefore, a system was devised that would calculate a proportionate number of each facility type to be accepted into the next phase (Pre-Stabilization Surveillance and Maintenance or Decontamination) based on the number of facilities of that type remaining and the cost of accepting each facility. This is explicitly stated by the following equations:

$$F_tP = F_t/F$$

$$B_t = B * F_tP$$

$$F_{t0} = B_t/C_t$$

where F_t is the number of facilities of type t remaining in SFIA or Transfer Holding, F is the total number of facilities, F_tP is the percentage of facilities of type t remaining, B is the total budget for accepting new facilities, B_t is the budget for accepting facilities of type t, C_t is the cost of facilities of type t in the next phase, and F_{t0} is the number of facilities of type t accepted into the next phase. While this is not the method that EM-40 and EM-60 necessarily follow in accepting facilities into the process, it is the best standard method available at this time.

Finally, the model assumes that EM-60 will receive a minimum funding level equal to that which is necessary to process the facilities that have already been accepted into the program.

4 OPERATING THE MODEL

While the model is designed to simulate the entire program, it can also be used on a site specific basis. Here the model was run using test data for a single site in the Environmental Management program. The site includes eight facility types out of the possible 22. Three different policy scenarios were examined: increased funding for EM-60 to complete facilities in the minimum amount of time with constrained EM-40 funding at 50% of EM-60 funding, equal funding for both EM-60 and EM-40 with 50 percent more facilities being added from SFIA, and equal funding for both EM-60 and EM-40 as the control scenario. The model runs from fiscal year 1995 through fiscal year 2070.

5 RESULTS

In the first scenario, EM-60 completes all the facilities in the minimum time allowed; however, a bottleneck forms in the transfer holding phase since EM-40 does not have the funding to process all the facilities when they are received. As seen in Figure 2, the low EM-40 funding causes a delay and the last facility is not accepted into the Decontamination phase until 2045.

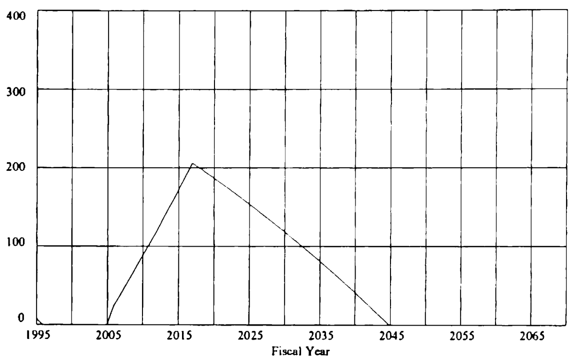

Figure 2: Total Facilities in Transfer Holding Phase

In the second scenario, EM-60 has only enough funding to process the facilities already in the program. Therefore, as seen in Figure 3, the additional facilities from SFIA do not enter the Pre-Stabilization Surveillance and Maintenance phase until 2007. This

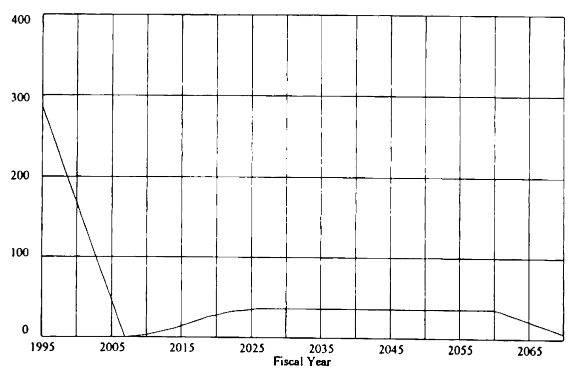

Figure 3: Total Facilities in Pre-Stabilization Surveillance and Maintenance Phase

influx of facilities at such a late date makes it impossible to complete the facilities by 2070. In fact, as shown in Figure 4, some facilities are still in the Transfer Holding phase in 2070.

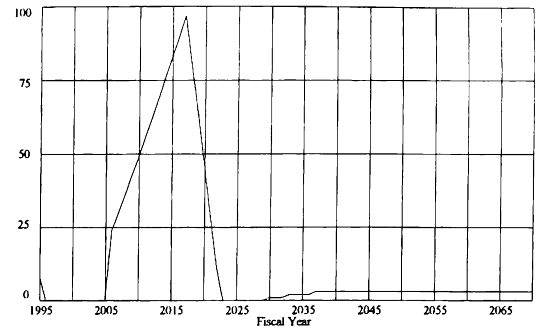

Figure 4: Total Facilities in Transfer Holding Phase

In the control scenario, EM-40 is able to accept facilities almost as quickly as EM-60 completes them as illustrated in Figure 5. The backlog in the first scenario is avoided, and instead of a peak of over 200 facilities, the Transfer Holding phase never reaches 100. Furthermore, all facilities have been absorbed into EM-40 by 2025 instead of 2045 in the first scenario or later than 2070 as in the second scenario.

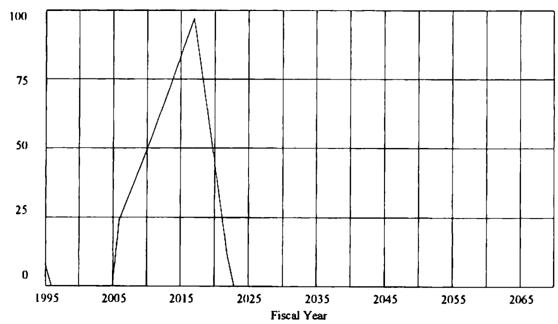

Figure 5: Total Facilities in Transfer Holding Phase

6 FUTURE REVISIONS

In future revisions of the model, additional variables will be added to aid in analysis of the best methods by which to accept facilities into the process. Such methods will include relative risk and difficulty level. Relative risk refers to the risk posed by a facility to the workers, the public, and the environment. Risk levels will be assigned to each facility type. This variable will enable the policy of completing high risk facilities to be evaluated. For the difficulty level, assigning such a score could show whether it would be cost effective to process the most difficult facilities first or last.

7 CONCLUDING REMARKS

This model has shown that simulation models can be successfully used as policy analysis tools for specific processes. Once the model was designed, the results for several different scenarios were obtained in a fraction of the time it would take to obtain them from more traditional means. The model was able to combine cost and schedule analyses in evaluating several policy alternatives. Furthermore, the model shows that non-physical transfer processes can be simulated as well as physical processes. Finally, the model successfully used an off-the-shelf software package for a unique government process.

ACKNOWLEDGMENTS

The author would like to thank Dr. Rick Shangraw for his guidance and support.

REFERENCES

Manary, Joel M. 1995. A Useful and Popular DoD Life Cycle Cost Model. *Estimator*. Fall: 23-45.

Krieger, James H. 1995. Process Simulation Seen As Pivotal in Corporate Information Flow. *Chemical and Engineering News*. 3/27: 50-61.

Breiner, Peter. 1995. The Political Logic of Economics and the Economic Logic of Modernity in Max Weber. *Political Theory*. 2: 25-47.

Dvorak, Paul. 1994. Yielding to Analysis. *Industry Week*. 7/18: 325-363.

Redden, Joeseph J. 1995. Military Keynote Address and Panel Discussion: Military Simulation and Modeling - Today - Tomorrow. *Proceedings of the 1995 Winter Simulation Conference*, ed. C. Alexopoulos, K. Kang, W.R. Lilegdon, and D. Goldsman, 1133.

Kristofferson, K., T.P. Oholleran, R.H. Powell, and E.C. Thiel. 1995. *National High-Level Waste Systems Analysis Plan*. Idaho National Engineering Laboratory.

AUTHOR BIOGRAPHY

SAMUEL M. HART is currently a consultant in the field of environmental management with Project Performance Corporation. He received his B.A. in Physics and Political Science from Ripon College in 1994 and his M.P.A. in Technology and Information Policy from Syracuse University in 1995. His areas of interest include simulation, process improvement, database design, and technology development.