Alternative D&D Planning Tool – 12466

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ABSTRACT

On August 1, 2011, URS | CH2M Oak Ridge LLC (UCOR) began cleanup of the East Tennessee Technology Park (ETTP). UCOR's $2.2 billion contract has an initial five-year term and a four-year option period for completing the cleanup of ETTP and performing surveillance and maintenance and waste management operations at both the Oak Ridge National Laboratory and the Y-12 National Security Complex. ETTP D&D work includes disposition of large, complex, contaminated, Manhattan Project-era facilities such as the K-25 and K-27 uranium enrichment facilities.

At ETTP, UCOR views the D&D process as a “Waste Factory” with waste production lines from the point-of-generation to the point-of-disposal. Safely transforming vertically-standing buildings into horizontally-lying waste in a disposal facility is the primary cleanup objective. Whereas a factory produces widgets, D&D produces waste—lots of waste. In support of the Waste Factory view, UCOR is developing a systems planning tool to help better plan how to effect cleanup by improving waste planning, uniting waste generator with waste dispositioner, and represent the “waste factory” in a computer model that allows the D&D and waste management teams to better understand available disposal paths, waste uncertainties and potential consequences, driving variables, and sensitivity to changes.

INTRODUCTION

On April 29, 2011, the United States Department of Energy (DOE) awarded a multi-year $2.2 billion cleanup contract for Oak Ridge’s East Tennessee Technology Park (ETTP) to URS | CH2M Oak Ridge LLC (UCOR), a partnership between URS and CH2M HILL. The purpose of UCOR’s contract is to Decontaminate and Demolish (D&D) the major facilities at ETTP— (see Fig. 1) including K-25, K-27, K-1037, and other facilities; remediate associated media; and continue Environmental Management (EM) activities currently ongoing at the Oak Ridge National Laboratory (ORNL) and Y-12.

At the ETTP, UCOR is developing a computer model concept for D&D that identifies and documents the major waste production steps from the point-of-generation through the point-of-disposal for priority waste streams. The project team (waste generators and waste disposition team members) must plan the available, practical and compliant options for each waste stream from characterization/waste determination, generation, containerization, transportation, through final disposal and assess how their plan may be impacted by change. The Waste Factory Model is envisioned to help improve understanding of a given project's waste implications; help reveal and suggest the important few variables out of the trivial many; reveal likely process bottlenecks, and help focus risk mitigation and assumption management efforts to better manage the total cleanup costs.

Fig. 1. East Tennessee Technology Park cleanup activities.

The Waste Factory Model represents an important, emerging innovation. UCOR views the ETTP D&D work as a large "Waste Factory," the purpose of which is to transform and transport vertically-standing buildings into horizontally-lying waste in disposal facilities. This framework recognizes that cleanup actions will produce various quantities of various waste types in various time periods with various disposal paths to achieve project delivery. This "waste production machine" has manufacturing facility analogies; however, instead of transforming raw materials into saleable products, the waste factory generates, transforms, and transports EM waste from its point-of-origin to its point-of-ultimate-disposal. The Waste Factory Model is envisioned to be a computer representation of the waste streams resulting from the ETTP System Plan. The System Plan documents the overall, integrated technical plan that is responsive to the contract vision, strategy, and requirements and thus underpins the Performance Measurement Baseline (PMB).

After the Waste Factory Model is developed and deployed, UCOR will be better able to describe how the ETTP EM mission could be achieved given an alternative set of assumptions (scenario) and convey the potential mission impacts of key issues and uncertainties; and identify areas that might require decisions or benefit from resolution of issues and uncertainties to further improve risk mitigation strategies. As a scenario evaluation and planning tool, by changing key model inputs, alternate technical plans can be evaluated and thus direct future PMB updates.

BACKGROUND

The following provides background information and describes the general development method being employed for the Waste Factory Model concept.

Key bottom-line D&D technical questions are:

- "How are we going to execute the pre-demolition work?;
- "How are we going to execute the demolition work?";
- "How much and what waste types will we generate?"; and
- "How will we get rid of that waste?

A technical plan that reflects an understanding of the underlying issues and answers these questions is key to safe execution and a credible critical path schedule and credible total estimated cost. The technical plan gets quantified, and scheduled, and priced using a combination of known and assumed waste characterization results, quantities, types, generation/production rates, processing and treatment, container and packaging types and quantities, transportation, and disposal destinations. A key result is the PMB. Typically, there are alternate pre-demolition and demolition approaches, waste paths, container options, transportation options, and ultimate disposal paths which complicate decisions and planning. But ultimately, the PMB must reflect a single set of choices because after all the PMB is the sole plan by which cleanup progress is measured.

UCOR is developing a D&D planning tool based on the recognition that D&D projects can be thought of and planned like a Waste Factory with standardized waste stream production lines from the point-of-generation through the point-of-disposal. Safely transforming vertically-standing buildings into horizontally-lying waste in a disposal facility is the primary D&D objective. Instead of "widget" production lines, the D&D Waste Factory production lines are designed waste streams. Table 1 lists functional analogies between a manufacturing factory and a D&D Project, organized by major attributes such as planning; inputs, processes; outputs, and transportation.

> "The primary D&D objective is safely transforming vertically-standing buildings into horizontally-lying waste in a disposal facility."

Table 1. Manufacturing and Waste Factory Analogy.

Attribute	Manufacturing Factory	D&D Project – Waste Factory
Planning	Product technical design – product and cost data	Project technical plan and cost data
	Production approach-flexibility, time, optimization, time-to-market	Waste production approach-flexibility (including MOA), time-to-completion
	Production and distribution schedule (how to get finished goods to customers)	Waste production schedule (how to get disposable waste disposed)
Inputs	Raw materials and purchased inputs (e.g., subassemblies) Labor and equipment	Waste types and quantities and purchased containers Labor and equipment
Processes	Production lines where value is added incrementally with each manufacturing step (value increases as Work in Process advances)	Process steps where value is added incrementally as waste is generated and converted (as needed) into disposable entities
	Throughput considerations (unit rates)	Throughput considerations (unit rates)
Outputs	Products for customer purchase (Finished Goods)	Waste suitable for transportation and disposal
Transportation	Customers buying products	Waste “packages” transported to disposal outlets (e.g., local disposal facility, NNSS) and disposed.

The Waste Factory analogy offers a different planning perspective. The question “What waste *should* we produce?” is relevant. At first glance it may appear as if D&D has no choice in what waste is generated, e.g., what is in the building is in the building. However, D&D execution decisions deserve special care, particularly for complex nuclear facilities that are contaminated with hazardous materials (e.g., Tc-99, mercury, various oils), because both the pre-demolition and demolition approach can alter the physical waste forms and contaminant distributions as well as the unknown assumptions. These execution decisions can prevent unintended consequences that otherwise would increase the work, time, and cost to comply with requirements associated with handling, packaging, containerization, treatment, and ultimate disposal. A simple example would be the decision to manually remove from a building the sources of highly dispersible Tc-99 contamination to reduce the risk of cross contamination during machine demolition thus minimizing the quantity of Tc-99 waste which requires expensive transportation and disposal.

The waste forms and types are vital because they carry with them important cost and time considerations. Waste management is a knowledge-intensive, highly-regulated business. Copious Environmental, Safety, and Health (ES&H)-related requirements, transportation regulations, and disposal facility constraints can create a planning maze. But unlike a maze where you can retrace your steps when needed, once certain waste streams are generated or commingled, undoing it isn't possible and the result can be a waste that now is excessively costly to dispose, or worse, a waste with no legal disposal path. With contract performance incentives it is important to avoid mistakes, inefficiencies, and delays that quickly can produce expensive, and even unrecoverable, lessons-learned that can alter the PMB and hinder achieving the project's goals.

The following section provides an overview of UCOR's concept for an initial Waste Factory Model that can be used to both model waste scenarios and, in the future, improve waste planning by helping to lay out a standardized and improved execution approach.

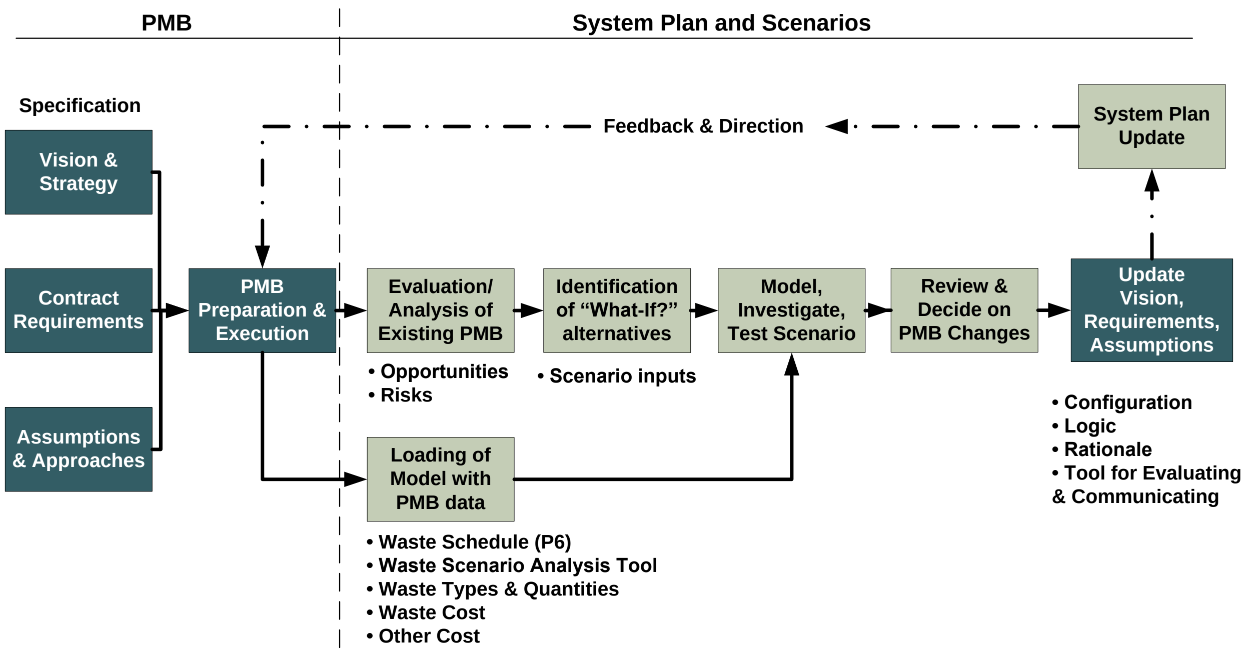

Fig 2. Waste Factory−Conceptual Model.

Waste Factory Conceptual Model Description

P6 Waste Schedule

Shown in Fig. 2 is a conceptual model for the waste factory. It begins with preparation of the PMB which reflects the overall contract vision and strategy, requirements, and assumptions and approaches. Analysis of the PMB will reveal additional opportunities and risks that will prompt a listing of scenarios (alternative PMBs) that warrant investigation using the Waste Factory Model.

To evaluate these scenarios, Fig. 2 reflects a Waste Factory Model. A key Model component will be a Waste Schedule (in P6) that is loaded from and reflects the initial PMB which serves as a reference point of comparison. This summary schedule will contain the project activities that generate waste (e.g., key pre-demolition and demolition steps) with their respective durations and logic ties. This schedule is also envisioned to have ties to key Hotel load/base operations (e.g., Security) step down events (see Fig. 3). Identifying and managing these Hotel-related logic ties is important for understanding how changes in waste disposition timing can affect the Hotel load cost (e.g., delay a step down and thus increase the overall project cost). Numerous Hotel loads are likely linked to waste disposition. For example, a Security ProForce step down may be linked to the disposal of Highly Enriched Uranium (HEU). The last disposal activity for HEU may be represented in the P6 waste schedule as Act 2 in Fig. 3. If Act 2 were delayed, the related Hotel step down for ProForce would be delayed, thus possibly resulting in an overall increase to project cost.

For many sites, the Hotel load can be significant and consume a double-digit percentage of available funding, so understanding how work sequencing impacts the Hotel load can be important. The linkages between project activities and the Hotel load need to be identified, understood, incorporated in the Waste Factory Model, and socialized with others to ensure common understanding. Without looking at the bigger, overall System-level picture, it is possible to optimize a system component (one of many projects in a contract) at the expense of the whole system. With tight and sometimes declining budgets, including Hotel load implications in scenarios and analyses and decisions is important. The Hotel load is a key part of managing what some refer to as the cost critical path (analogous to the common critical path schedule).

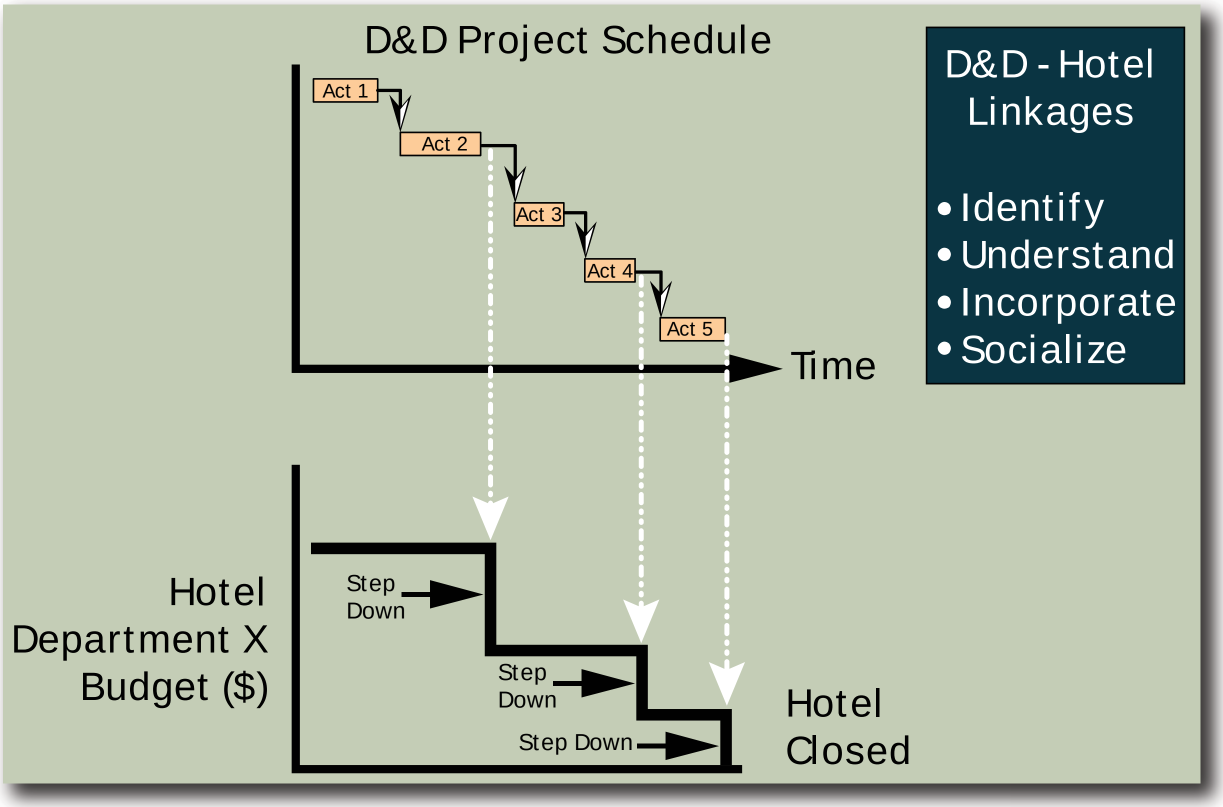

Fig. 3. Schedule ties to "Hotel Load" step down events.

Following the P6 Waste Factory schedule's development and confirmation, a copy will be made and adjusted to reflect key scenario assumptions and related inputs. Schedule-related scenarios will be formulated following an analysis of the original PMB. This analysis will focus on the identification of improvement opportunities. Scenarios may include evaluating the time impact of assuming a waste stream requires a different disposal facility, an additional demolition front, accelerating the start date of one or more projects, altering durations, or adding or deleting waste generation/processing activities or logic.

Management review of the scenario results will result in a clear path for the next PMB update – including changes to vision, requirements, and assumptions. Documentation of this direction will be reflected in an update to the System Plan which will then drive the PMB update.

Waste Stream Standard Rates

Shown below the "Waste Schedule (P6)" in Fig. 2 is a Waste Scenario Analysis Tool. This is envisioned to be a database to house the results of an effort by a collaborative team of subject matter experts from D&D, waste management, and transportation who will identify the waste streams necessary and appropriate for modeling (e.g., the significant few waste streams the ETTP Waste Factory will produce) such as structural debris and certain types of equipment. Additional thought will be given to whether waste stream subgroups are needed, such as Tc-99 (technetium-99) contaminated structural debris or classified (security) equipment.

Next this team will itemize the required standardized steps required to take each identified waste stream from point-of-origin to ultimate destination and capture those requirements. Typically, those standardized steps may include characterization, generation, size reduction, loading, packaging and containerization, transportation, and disposal. Numerous factors determine the applicability of standardized steps. For example, for typical structural debris being disposed at EMWMF (Environmental Management Waste Management Facility—the local Oak Ridge CERCLA disposal facility), containerization, treatment, and disposal cost likely would not apply, but if the waste destination were commercial, containerization and disposal costs likely would apply.

After the teams identify the waste streams and steps, cost estimators can compute the normalized, or standardized costs for the steps required for addressing a single M^3 of the waste stream. These data will be captured to provide documented ties and integration links among waste streams, steps, requirements, and cost. Documenting requirements is particularly important as discussed below.

Shown in Fig. 4 is the Waste Scenario Analysis Tool concept reflecting the beginning of a listing of ultimate waste destinations (e.g., EMWMF, NNSS), a listing of respective waste resources, and an abbreviated waste code. The second column, “Waste Resource Title,” will contain specific waste streams, such as Structure/Debris disposed at EMWMF. The fourth column, FY 12 Unit Cost/M^3, will be the total cost per M^3 for taking that particular waste stream from generation to disposal. Columns to the right of this column identify the individual Waste Factory process steps required to take each waste stream from characterization through disposal and the respective cost per M^3 for each step.

Behind and linked to the standardized steps will be the documented primary requirements that are associated with the particular waste stream and step. Among other reasons, the documented requirements can be used to identify and eliminate any gold-plated or defective compliance and also help enable evaluation of the impact of requirement changes (e.g., requirements management). The far right column, Notes/Bases, will be used to specify important estimating or assumption info (e.g., specific equipment involved, container names, and reference documents).

Resource Group Title	Waste Resource Title	Waste Resource Code	FY 12 Unit Cost/ M^3(?)	Charact. per M^3	Sort/ Seg per M^3	Contain. per M^3	Loading per M^3	Transport per M^3	Treat per M^3	Dispose per M^3	Other per M^3	Notes/Bases
EMWMF	EMWMF-Structure/Debris	EMSTRUC	$63	$1	$12	$0	$25	$25	$0	$0	$0	Basis for each cost…

Fig. 4. Waste Scenario Analysis Tool Concept.

Ideally the unit cost-related columns (e.g., Charact. Per M^3, Sort/Seg per M^3) can be standardized. In those instances where a given process step is not applicable (e.g., containerizing typical structural debris headed for EMWMF), the unit cost for this step will reflect $0. To standardize certain data elements in terms of cost per M^3−technically defensible conversion assumptions will be required to translate cost per kilogram or pound into cost per M^3. For example, some vendor's treatment or disposal costs may be quoted in terms of cost per pound−not cost per M^3.

Understandably, the finished Waste Scenario Analysis Tool's standard rates may prove to be an exceptionally difficult table to prepare. However, once developed, in addition to helping with scenarios, this table alone could be sorted in descending order by cost per M^3 to reveal the highest-cost waste streams and the specific steps driving the high unit cost (e.g., is it loading? containers?) to help improvement teams better focus their efforts.

Resultant Waste Scenario Analysis Tool unit cost information will be maintained under change control in P6 so that waste streams' "origin-to-destination" standard cost for 1 M^3 can be multiplied by the respective waste quantity on each applicable activity in order to compute relative cost and quantity totals by month.

Waste Input Template

To help with modeling, a standardized, automated waste data input template (a concept is shown in Fig. 5), with drop-down pick lists, will link Waste Generation Forecast information from the PMB to the Waste Factory summary schedule activities to allow the user to specify, for a given schedule activity, the standardized waste stream resources (e.g., process equipment type ABC planned for disposal at EMWMF) and waste quantities (in terms of M^3) that the activity will "produce." Items in green will be populated automatically via the pick list once a given activity is selected. Initially the template will be loaded to match the PMB. Subsequent scenarios will alter it to reflect scenario input assumptions.

The waste input template is envisioned to be flexible and "granular" enough to allow:

- multiple schedule activities;
- multiple waste streams per activity; and
- ability to add new waste streams.

Line	Waste Factory WBS	Bill of Material Description	Activity Description	Summary Schedule Activity ID	Early Start	Early Finish	Dur.	Waste Resource Code	Waste Stream/Destination Combo	Quantity (M^3)
1	50.01.04.12	Building ABC	Demo/Load/Haul Unit ABC	WFA0990	7-Dec-11	29-Dec-11	15	EMSTRUC	EMWMF-Structure/Debris	4,000
2	50.01.04.12	Building ABC	Demo/Load/Haul Unit ABC	WFA0990	7-Dec-11	29-Dec-11	15	EMCONVT	EMWMF-Converters	175
3	50.01.04.12	Building ABC	Demo/Load/Haul Unit ABC	WFA0990	7-Dec-11	29-Dec-11	15	EMCOMPR	EMWMF-Compressors	150
4	50.01.04.12	Building ABC	Demo/Load/Haul Unit DEF	WFA1000	3-Oct-11	21-Oct-11	15	EMTRANS	EMWMF-Transite	25

Fig. 5. Waste Input Template Concept (excerpt).

The scenario team populating the waste input template will be sensitive to the inherent uncertainty in their selection of what waste streams will be produced by a given activity, e.g., when they select structural debris that qualifies for disposal at EMWMF, is this based on completed characterization or is it just a planning assumption? Noting such distinctions is important to interpreting the model output and in feeding risk modeling efforts.

Process Flow Modeling

As shown in Figure 6, key D&D operations, such as the K-25 Segmentation Shop, may avail themselves to process flow modeling where the segmentation operations process is modeled using discrete simulation. Often used to “operate” a manufacturing facility before it’s built to improve the design, discrete simulation’s use on certain crucial D&D operations can help evaluate operations performance, bottlenecks, equipment breakdown consequences, opportunities, and sensitivity to changes.

The simulation results might indicate that by making certain process changes (e.g., install new equipment, altered layout or process flow or staffing) the related activities’ duration in the P6 schedule can be reduced by “x” days. These new durations could then be a feed back into the overall P6 “Waste” Schedule (see Figure 2) for scenarios.

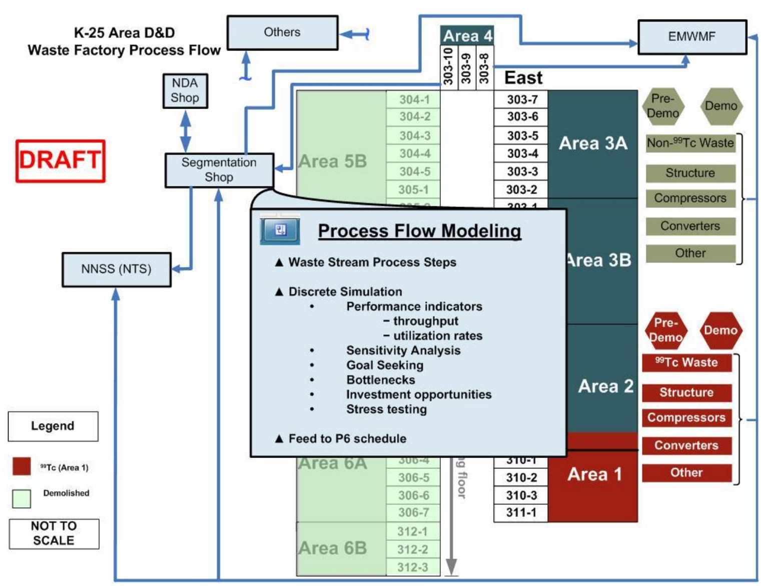

Fig. 6. Waste Factory Summary concept (simplified for K-25 Area D&D).

Scenarios

For scenarios, after needed adjustments are made to the P6 Waste Schedule and needed input changes are made to the Waste Input Templates, the resultant waste resources (waste quantities and waste stream resource codes) can be loaded onto the respective Waste Factory summary schedule activities. This typically highly-laborintensive step will be automated to reduce the required time and lessen the possibility of data entry errors. The P6 schedule will integrate the waste quantity, unit cost, and timing information and perform needed cost computations.

Scenario output reports will be the end result. Envisioned are reports that show the planned waste quantity of a given waste stream code (or all waste streams) applicable to a given waste destination (e.g., monthly M^3 quantity distribution of structural debris from one or combinations of projects destined for EMWMF). Companion cost curves will also result-not just for the waste, but also for the hotel loads in order to see the bigger contract picture.

Together these reports, and important assumptions (e.g., waste stream types selected in the waste input template prior to having solid characterization data) will quantify and help communicate the relative (not absolute) cost and schedule impacts of making changes to the Waste Factory identified in the scenario for comparison to the current PMB.

Examples of typical scenarios might include:

- Would it pay to reduce the overall critical path duration by "X" months by choosing a different, higher unit cost disposal approach (e.g., shortened Hotel load)?
- How would the critical path schedule be impacted by improving a key operation's waste throughput by X%?
- What would be the incremental impact of changing a particular waste stream's required disposal location from NNSS to EMWMF or vice versa?
- What would be the incremental impacts if numerous or all waste streams in a set of activities were changed from NNSS to EMWMF or vice versa?
- What if the standardize unit cost of a given waste stream were reduced by 25% (e.g., better deal from a subcontractor)?

RESULTS

Initial Waste Factory Model development began in the late fall of 2011. The effort's ambitious nature demands careful planning to help ensure that the right Waste Factory Model is built and that it is built right. To this end, some standard systems development techniques will be employed to force needed discipline and rigor.

Note that even if the Waste Factory Model's expectations prove too ambitious, more certain benefits, such as thoroughly evaluating and capturing the Hotel Load step down linkages, will be captured. And any planning efforts that thoroughly captures and reflects these key linkages represents a clear and important advance that is likely within reach of every site.

SUMMARY

Any model of reality represents a compromise. Part of the Waste Factory Model's value may be in providing standardization and relative direction for assisting decision making as opposed to absolute cost or schedule answers. From that relative direction, management can commission detailed planning and estimating. Also, the model's output credibility is tied directly to its input quality. That is why, as discussed above, the Waste Factory Model's key informational component will be the standardized waste streams (e.g., Structure/Debris disposed at EMWMF) and associated standardized unit costs. The model development process generally, and the development team's collaboration, specifically, is most important. Building-in this integrity up-front, transparently, will help ensure that the model outputs are known, understood, and credible (no mysterious "black-box" components).

The Waste Factory Model is envisioned to help improve understanding of a given project's waste implications; help reveal and suggest the important few variables out of the trivial many; reveal likely process bottlenecks, and help focus risk mitigation and assumption management efforts to better manage the projected total cost.

In the long term, the UCOR team's goal is to incorporate an information feedback loop to help improve the accuracy of key model attributes, such as the standardized cost information. This way, by design, the model output should improve over time and thus help the model mature into both a credible scenario tool and a standardized project planning resource. The initial model capabilities may be narrow, but with time and effort it may prove to be a timely and cost-effective tool.

Key Point: employing a collaborative, cross-functional model development process helps ensure credible model outputs.

REFERENCES

1. DOE-ORO, 2011, Contract No. DE-SC-0004645, “East Tennessee Technology Park Project,” U.S. Department of Energy Oak Ridge Operations, April 29, 2011.

2. 42 USC § 6901 et seq., 1976, “Resource Conservation and Recovery Act (Solid Waste Disposal Act),” *United States Code*, October 21, 1976.

3. 42 USC § 9601 et seq., 1980, “Comprehensive Environmental Response, Compensation, and Liability Act of 1980,” *United States Code*, December 11, 1980.

4. DOE O 413.3A, 2006, “Program and Project Management for the Acquisition of Capital Assets,” U.S. Department of Energy, July 28, 2006.

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