

EVALUATING SCIENCE AND TECHNOLOGY FOR MANAGING DOE WASTES

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ABSTRACT

The mission of the Department of Energy's (DOE's) Office of Waste Management (OWM) is to protect people and the environment from the hazards of chemical and radioactive waste by providing an effective and efficient system that minimizes, treats, stores, and disposes of such waste as soon as possible. Radioactive waste presents the greatest challenge for OWM. The strategic objectives of OWM include a continuous reduction in the environmental risk and in the cost of operations for responsible management and disposal of DOE waste.

New technologies to improve waste management operations are essential if OWM is to realize its strategic objectives in any significant way. Some useful new and alternative technologies may be obtained from the private sector. For those technical requirements that cannot be met by the private sector, DOE has established the Office of Science and Technology (OST) to fulfill the technical needs of the DOE Waste Management, Environmental Restoration, and Nuclear Materials and Facility Stabilization Programs.

Planning and evaluation of science and technology development projects to support waste management operations requires the participation of "target waste management programs if efficient deployment of the resulting technology is to be achieved." In large measure this approach defines the basic measure for evaluating directed science and technology projects, namely, "is the technology "customer" or end-user satisfied with the progress being made in meeting an expressed technical need and with the projected cost savings?"

This paper will describe the strategy being promoted and employed by the OWM in partnership with the OST to maximize the deployment of beneficial new and alternative technologies for managing DOE waste. This strategy is based on an optimization of investments by OWM and OST in the development of technologies for near-term and long-term deployment.

INTRODUCTION

The DOE's OWM's mission is to protect people and the environment from the hazards of chemical and radioactive waste by providing an effective and efficient system that minimizes, treats, stores, and disposes of these wastes as soon as possible.

To accomplish this, the Environmental Management (EM) OWM continues to be fully committed to technology development and deployment.

Historically speaking, OWM is the daughter organization of previous waste management organizations under the DOE Defense and Nuclear Energy Programs, and predecessor organizations: the Energy Research and Development Administration and the Atomic Energy Commission. Accordingly, many of OWM's current waste management operations are in fact based on the technology development conducted by predecessor organizations. For example, the high-level waste vitrification technology used in the Defense Waste Processing Facility and the West Valley Demonstration Project is the result of technology development efforts started during the 1970's.

Over the past several years, OWM's support for deployment of new technologies is illustrated by an analysis of EM total new technology deployments. For example, the overall EM deployment of new innovative technologies from 1989 to 1997 shows 28 deployments out of 129 for OWM, or approximately 22 percent of the total for all end-users. As the Office of Science and Technology (OST) has developed new initiatives to promote deployments, OWM has supported them through both the Technology Deployment Initiative and the Accelerated Site Technology Deployment programs. Specific examples of waste management deployments include the Atomic Energy Agency's Fluidic Sampler at the Savannah River Site; Improved Sludge Retrieval, Modular Evaporator, and Ion Exchange Systems at the Oak Ridge Reservation; and Decontamination and Volume Reduction system at Los Alamos National Laboratory. In addition, waste management tank cleanup at the West Valley Demonstration Project was accelerated by deployment of TARZAN, a robotic system to clean out the tank heel. This was a cooperative venture between OST and OWM, and was funded by OWM and OST's Industry Programs and the Tank Focus Area.

So, why does the OWM support science, technology development, and deployment? The answer is simple: Enlightened self-interest. Supporting science, technology development, and deployment is in the best interest of OWM. This paper reviews the reasons for supporting innovative technologies, and discusses how the implementation of these technologies can promote the development and application of meaningful performance measures.

OWM STUDY ON TECHNOLOGICAL INNOVATION, ORGANIZATIONAL CHANGE AND RENEWAL

Consistent with the OWM mission, the Accelerating Cleanup: Path to Closure (ACPC) Plan provides EM's blueprint for future cleanup. Using the ACPC framework, EM plans to clean up and close out many sites by the year 2006.

OWM's part of this mission is to store, treat, and dispose of wastes such as high-level waste (HLW), transuranic waste (TRU), low level waste (LLW), mixed low-level waste (MLLW), hazardous waste (HW), and sanitary waste. OWM has addressed some of these wastes using present-day technologies resulting in successful treatment, storage, and disposal.

But OWM recognizes that continued application of current technologies to the large volumes of waste still in storage, or anticipated to be generated over the life of the EM program, will result in significant costs to the program. Specifically, the ACPC forecasts that a \$61 billion life cycle cost

will result just from addressing HLW and TRU waste during the years 1997-2070. This is out of a total program cost of \$147 billion for all of EM's activities during this time period.

OWM has both the opportunity and obligation to reduce these costs as much as possible. To achieve these reductions, OWM must work proactively with OST and the field offices to develop and implement technological innovations that will improve clean up performance, accelerate cleanup schedules, and save money.

To assess the current status and allow for planning for future improvements, over the past several years OWM conducted several reviews and studies on technology development and deployment. In addition, an analysis of various management approaches for success in a technological organization was conducted. As a result of this analysis, OWM prepared a paper (1) for use by OWM management and staff to improve OWM's ability to successfully apply science and technology to the OWM program.

Based on past experience in waste management and work by several management writers such as M. L. Tushman and C. A. O'Reilly III (2) and others, the paper attempted to identify some of the barriers to technological innovation and articulate an answer on strategic choices, objectives, and organizational leadership and renewal using lessons learned from industry.

The paper used the semi-conductor industry from 1955-1995 as a "base case." In the mid 1950's, vacuum tubes was the state-of-the-art technology and represented a market of approximately \$700 million. The evolution of companies within this industry is illustrated in Table I. Specifically, the table shows RCA Corporation as the industry leader in vacuum tube manufacturing in 1955. However, RCA lost its position of leadership during the transition to semi-conductor technology, primarily because it could not cope with the technological change from vacuum tubes to transistors to integrated circuits to submicron technology. The present leader in the semiconductor industry, Intel, did not even exist in 1955.

Table I – Semiconductor Industry, 1955 – 1995

1995 (Vacuum Tubes)	1955 (Transistors)	1965 (Semiconductors)	1975 (Integrated Circuits)	1982 (VLSI)	1995 (Submicrons)
RCA	Hughes	TI	TI	Motorola	Intel
Sylvania	Transitron	Fairchild	Fairchild	TI	NEC
General Electric	Philco	Motorola	National	NEC	Toshiba
Raytheon	Sylvania	GI	Intel	Hitachi	Hitachi
Westinghouse	Texas Instruments	GE	Motorola	National	Motorola
Amperex	GE	RCA	Rockwell	Toshiba	Samsung
National Video	RCA	Sprague	GI	Intel	TI
Rawland	Westinghouse	Philco	RCA	Philips	Fujitsu
Eimac	Motorola	Transitron	Philips	Fujitsu	Mitsubishi
Landsdale	Clevite	Raytheon	AMD	Fairchild	Philips

Business literature shows many other once-successful firms that lost their position of leadership or did not survive when they failed to cope with technological changes in their fields. This ultimately left them vulnerable to competition. It should be noted that though these lessons are from industry, they apply as well for OWM, as Government operations tend to follow industry's lead with a little bit of lag time.

The most successful firms are able to proactively move from today's strength to tomorrow's strength through technological innovation. The paper advocated that OWM use the lessons learned from industry to make a strategic choice to be an "Ambidextrous Organization" which means that OWM would both thrive on present success but also continually strive for improvements, plan for future leadership, and ensure continued survival through technological innovation. Ambidextrous organizations recognize that change is inevitable, accordingly they embrace both evolutionary and revolutionary technological changes.

A successful ambidextrous organization will cope with change not only in its organization but also in its *culture*. Organizational culture can promote or hinder future success or survival. Therefore, the paper argues, a successful OWM strategy should include a strategic choice to pursue OWM activities using present-day available technologies, and should also deliberately pursue and fund evolutionary change by promoting short-term technology development and revolutionary or long-term R&D scientific and technological breakthroughs. These revolutionary breakthroughs would address some high cost, large volume wastes such as HLW and TRU. Both the evolutionary and revolutionary breakthroughs would be accomplished in cooperation with OST.

The paper advocated an OWM vision that includes "Excelling at present, and excelling and thriving in the future." The OWM strategy, as an ambidextrous organization, would include the following objectives:

1. Short-term Objective: Continue OWM activities using first-generation technologies, and promote efficiency and cost savings through short-term evolutionary technology development funded by OWM which targets operational improvements and process optimization.
2. Long-term Objective: Work closely with OST to promote scientific breakthroughs for second generation technologies to address longer term OWM challenges such as HLW and TRU waste.

The OWM has been working with field counterparts, especially the Waste Management Steering Committee, to promote support for the above-mentioned objectives. This approach to build support, essentially a marketing approach rather than a hierarchical management approach, has been used by OWM to foster the dissemination of information and use of innovative technologies of benefit for waste management operations. In summary, OWM supports science and technology development and deployment because they provide organizational renewal, improvements in short-term operations, and the opportunity for mortgage reduction for the long term.

PERFORMANCE MEASURES

The EM organization is a part of DOE's Environmental Quality (EQ) unit. The DOE Strategic Plan states that the strategic goal of the EQ unit is to *"Aggressively clean up the environmental legacy of nuclear weapons and civilian nuclear research and development programs, minimize future waste generation, safely manage nuclear materials, and permanently dispose of the Nations's radioactive wastes."* The EQ unit articulates seven objectives:

- 1) reduce risk;
- 2) accelerate cleanup of as many sites as possible;
- 3) expedite safe disposal of wastes and make defense HLW disposal ready;
- 4) prevent future pollution;
- 5) Dispose of HLW and spent fuel in accordance with the Nuclear Waste Policy Act;
- 6) reduce life cycle costs; and
- 7) maximize beneficial reuse of land.

Tiering off of the EQ strategic objectives, the OWM performance measures are based on unit wastes management in specific ways. For example:

	1998 Actual	1999 Planned
Number of HLW Canisters Produced	331	215
Volume of TRU Waste Treated cubic meters	90	358

The OWM succeeds in its mission by using present-day technologies to treat HLW and TRU waste. (The HLW vitrification technology was developed in the 1970's.) The EM Research and Development Program Plan cites four major objectives for success indicators/metrics:

- 1) Meeting high-priority end-user needs;
- 2) Reducing the cost of EM major efforts;
- 3) Reducing technical risk; and
- 4) Accelerating deployment of new technologies.

Clearly, technological innovations are a key component to achieving the EQ strategic objectives.

As stated above, OWM believes that technology development is needed both in the short term to improve waste management operations and in the long term to provide the opportunities for technology breakthroughs to reduce long-term mortgage costs (especially those associated with HLW and TRU).

The ACPC forecasts that about \$57 billion will be spent to clean up at most of the EM sites through 2006. An estimated additional \$90 billion is expected to be spent from 2007 through 2070. Out of the total \$147 billion for EM, \$61 billion is associated with the management of HLW and TRU, or

41.5 percent of the total EM mortgage. This, then, is the “window of opportunity” for technology development and deployment.

The EM science program and cross-cutting areas are responsible for providing long-term technological solutions or improvements. They have been working on HLW technologies for several years. However, currently, TRU waste does not yet have the same level of attention or support as HLW. Therefore, OWM has been working closely with OST to focus additional OST efforts on future TRU waste management needs.

Accordingly, a Performance Measure to Reduce Life Cycle Cost is an important one for OWM. However, it is important to recognize the difference between the value of annual savings achieved (especially those associated with the first year of operation) and the potential of the technology to generate cost savings over the entire life cycle of its application to numerous waste streams or at a number of sites. In general, the first year, or startup phase of a new technology may not provide any savings at all. In fact, it may result in increased costs as situation-specific modifications are made to optimize the application. It is usually after the startup phase, process optimization, and operational fine tuning, that these savings are realized.

So what other performance measures might be appropriate for technological improvements within OWM?

An obvious option is the use of numerical targets for deployment. However, OWM does not support this performance measure because it trivializes both the program and the intelligence of the measurer. Specifically, OWM believes that the number of technologies deployed is not as important as the value of the technology both in performance enhancement and in cost and risk reduction.

Clearly the deployment of several technologies that contribute small savings is of less value to DOE than the application of a single technology that contributes major savings by itself.

OWM believes that short-term technology improvements are associated with a Total Quality Management effort for operations, and should be funded directly by the line organizations (such as OWM). Those technology improvements that are longer term should be funded by OST in coordination (or partnership) with the line organizations (such as OWM).

Furthermore, OWM believes that the use of numerical targets for deployment could inadvertently discourage the deployment of useful technologies. There are two fundamental concerns related to numerical targets for deployment:

- 1) A technology deployment may be delayed because a program wants to avoid the near-term costs associated with the initial deployment.
- 2) Acceleration of technology deployment could cause a technology failure because the emphasis on deployment caused implementation before the technology was ready.

In addition, OWM believes that it is a legitimate function of OST to develop alternative technologies for high-risk program activities. If OST allocates funds to an alternative technology, and the originally planned technology ends up functioning as needed, then OST will be accused of “wasting” that funding. But unless OST is able to pursue alternative technologies, EM will inevitably end up unable to achieve some future program goal because of the risk associated with EM’s one of a kind activities.

Another important program area that should be emphasized in performance measures is Pollution Prevention and Waste Minimization.

Over the past few years, OWM worked closely with the Office of Environmental Restoration to formulate and promote two policies for the recycling and reuse of radioactively contaminated metal (3) and the use of standardized containers for LLW disposal (4). These policies, if implemented throughout the DOE complex, would reduce the volume of wastes requiring disposal, and result in lower life cycle costs to the EM program. Yet, this initiative would result in increased costs to EM, especially waste generating programs, at least initially. As a result of being unable to demonstrate near-term cost savings from this initiative, it has only been implemented in a few special cases. OWM believes this is an example where using cost savings as a performance measure results in the wrong programmatic decision being made, because it is not possible to identify specific cost savings associated with the reduced environmental result associated with disposing of less waste. A recent Executive Order 13101 “Greening of the Government Through Waste Prevention, Recycling, and Federal Acquisition” encourages Government agencies to incorporate the executive order goals in their Government Performance Results Act annual performance starting Fiscal Year 2001. This in our view will enhance the use of waste minimization as a performance measure.

CONCLUSION

The OWM continues to support technological innovations, both in the short-term and long-term. OWM will continue to look for opportunities to partner with OST to deploy technologies that will improve OWM’s ability to achieve its programmatic mission for less cost, with less risk, or with less environmental impact.

We owe this to our taxpayers, and to our planet.

References :

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