# LESSONS LEARNED FROM THE HANFORD MISSION PLANNING PROGRAM

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## ABSTRACT

The Hanford Mission Planning Program was begun in 1991 to proide decisionmakers t the Hanford Site with the capability to evaluate options for clean up of Hanford Site problems in the context of an overall strategy for the Site. The approach was designed to allow creation of a balance between conflicting objectives (e.g., land release versus cost) and conflicting stakeholder perspectives in an integrated fashion across Site programs. The program is now entering its third year and this paper discusses the lessons learned, both in terms of management and organizational issues and the technical aspects of the program, that my help others who attempt a similar effort.

## BACKGROUND

The Hanford Site (depicted in Fig. 1) constitutes approximately 560 square miles in the southeast corner of Washington State. Nuclear materials production has been conducted on the site since 1943, originally as a part of the Manhattan Project, and later as a part of the cold ware weapons production mission of the Atomic Energy Commission and its successor agencies. The primary component of this mission, plutonium production took place in three basic steps that were conducted in three different areas of the site: uranium was made into fuel slugs in the southern part of the site, nuclear reactors in the northern part of the site along the Columbia River used this fuel source to product small amounts of plutonium, and that plutonium was extracted and concentrated through chemical processing near the center of the site.

These processing steps and their collateral support activities, as well as other activities on the site, led to the production of substantial volumes of hazardous and other wastes on the site. In general, these wastes were handled appropriately, given the technology available and scientific understanding at the time. Unfortunately, in some cases, due to a lack of understanding of the materials and/or the environmental processes involved, waste materials were simply dumped into the river or soil. The majority of the waste was placed in interim storage facilities until satisfactory long-term/permanent disposal options could be developed. Over time, these facilities deteriorated, allowing the waste to contaminate the environment.

With the end of the *production mission* at Hanford in the mid 80's the primary focus of the site became the cleanup mission, which includes not only the wastes produced but also the production facilities, which themselves had become contaminated. The different types of wastes and facilities to be managed and disposed of is shown in Fig. 2. The five main mission areas are: nuclear materials, tank waste, solid waste, environmental contamination, and retired facilities.

Initially, the cleanup mission was managed like the production mission, i.e., individual programs responsible for discrete steps in the production process. Increasingly, however, it was realized that the cleanup mission required a horizontally integrated site management and decision making approach. In early 1991, strategic and technology planners for Westinghouse Hanford Company and Pacific Northwest Laboratory, in conjunction with the Department of Energy, Richland Operations Office, began development of such an integrated approach for establishing a technical basis for managing the site and making decisions about the cleanup. The effort was further designed to develop a technical understanding of the strategic options for site cleanup and the evaluative characteristic of those options and to integrate the technical basis into the decision process used at the site. This concept, called the Hanford Integrated Planning Process (HIPP), was to be implemented over three years, 1991-1994, to provide the basis for future negotiations of the Hanford Federal Facilities Agreement (known as the Tri Party Agreement or TPA), as well as provide inputs to key headquarters decisions regarding Hanford.

The goal of the HIPP was to articulate the relationships and create a balance between several key, competing forces affection site cleanup decisions. First, there was the competition between existing, proven cleanup technology and a desire to lower the cost or otherwise improve the performance of the cleanup effort through the advent or design of new approaches and technologies. Second, a balance was necessary between approaches that are "technically correct" from an engineering perspective and approaches that are acceptable to the full range of stakeholders in the Hanford cleanup. Third was a balance between, once again, "technical correctness" and various regulatory requirements and agreements to which the cleanup is subject. Another balance was between cost and the return of various parts of the site to uses other than on a restricted basis. Finally, the intention was to gain an understanding of the relationship between cost and the reduction in health and ecological risk associated with that investment.

The key technical component of the HIPP is Hanford Mission Planning (HMP), a set of modeling and analysis tools that allow description and comparison of key strategic options. Exercise of these models and tools, which contain site-wide systems analyses, issues, science and technology needs, risk and cost comparisons, regulatory analyses, stakeholder participation plans and activities, and other decision-making information, was to lead to annual production of the Hanford Mission Plan for DOE-HQ, DOE-RL, WHC and PNL managers. Each main mission area of the Site was addressed and

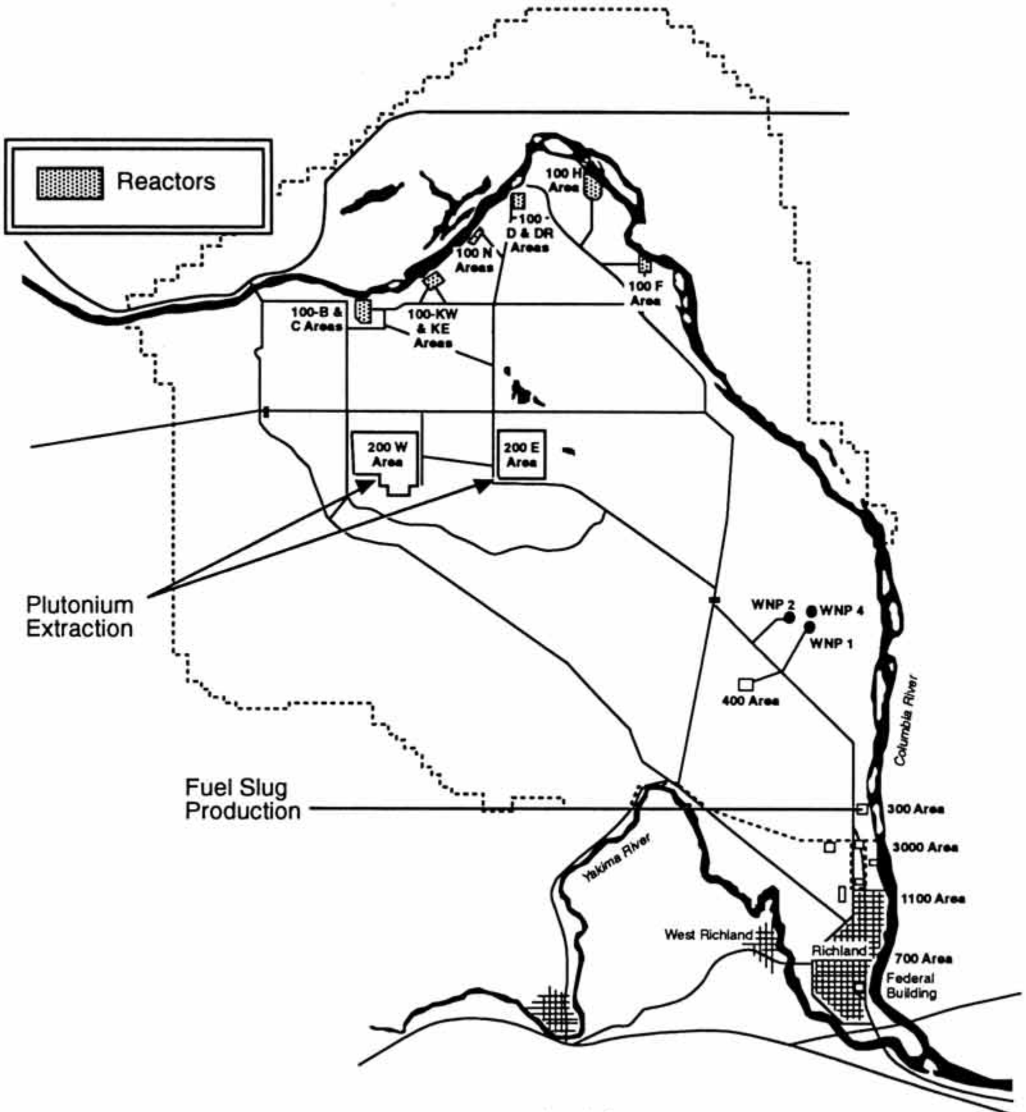


Fig. 1. Hanford site map.

# Summary of Hanford Strategic Analysis Study Material Inventory Groups

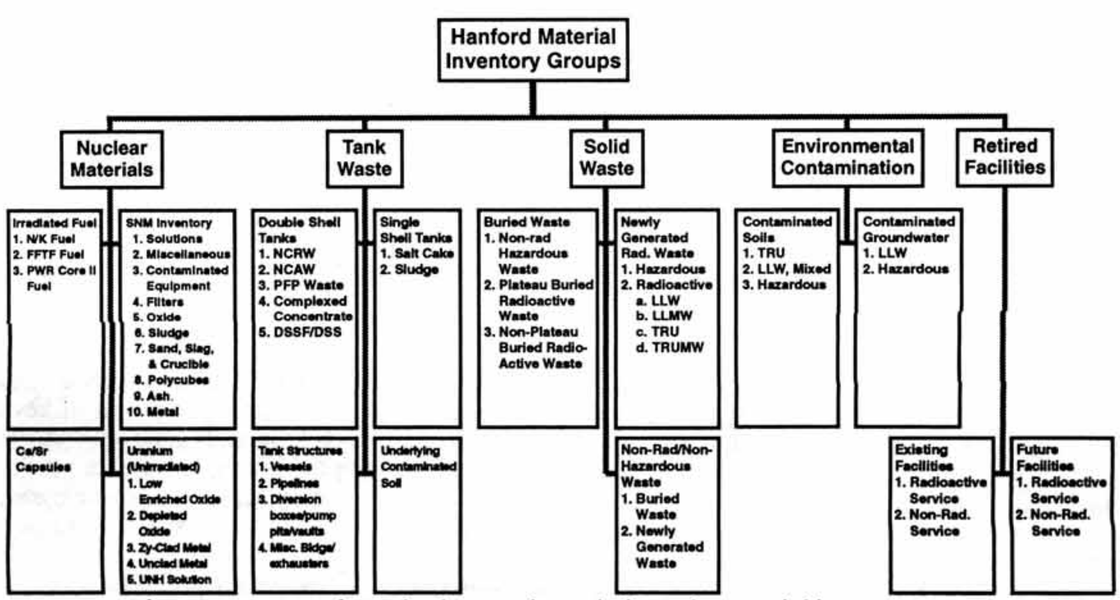


Fig. 2. Summary of Hanford strategic analysis study material inventory groups.

a "reference technical option" identified and described, based upon the best information available at the time of the production of the annual plan.

The Hanford Mission Planning activities have received considerable interest from the Washington Department of Ecology and throughout the DOE complex (e.g., Headquarters, Savannah River, Rocky Flats). Several other sites are now implementing, under guidance from HQ, mission planning activities.

**HMP Program Approach and Structure**

Initially, we had to define for ourselves what "cleanup" meant and then communicate its meaning to a wide variety of Stakeholders. Technical staff must have carefully defined objectives to which they can design, farmers must understand the impacts of cleanup on the soil and water supply, politicians need to be able to describe progress, housewives need to understand what "cleanup" means, and regulators need to regulate and discuss with their constituencies what they have accomplished, as well.

By working with an endstate definition driven by land use and bounded by "exclusive and "unrestricted" extremes, we constructed a framework that allows us to develop technical options and have the impact of those options understood by a variety of stakeholders. We have created a window that interested lay people can visualize, from which regulators can promulgate regulations, (and adjust them as information becomes available), for which technical staff can develop alternatives, and upon which politicians can claim progress.

Conceptually, the HMP program is structured around the application of a set of decision criteria to set of technical options or approaches to specific cleanup activities. As illustrated in Fig. 3, each option is measured, as much as possible, relative to each decision criteria. Each option is essentially a "portfolio" of the activities and decisions made with regard to individual problems or mission areas and must be defined not only in terms of the elements of the mission area, but also in terms of the relationships among mission areas. This, in order to evaluate an option for the entire site, mission planning takes into consideration geographic and other relationships among programs that could potentially affect the evaluation of a strategic option at a Site level. For example, it would be inconsistent to clean up one problem to a pristine condition, when a nearby problem is to be left "in situ," with the potential to recontaminate the cleaned area.

Other decision criteria could be evaluated differently when examined from a "total-Site" perspective. Two key decision criteria that could have different decision implications when viewed this way are cost, which is inevitably constrained for the Site, and boundary radiation levels, which are constrained under regulatory guidelines and must be allocated across programs.

Additional areas needing integration across programs include facility requirements, both in terms of duplication of capabilities (with associated duplication of budgets) and gaps in needed capability, and key differences in planning assumptions. Through our integration activities thus far, we have identified several instances of these duplications, gaps, and inconsistencies in planning assumptions. For example, both the Environmental Restoration and Solid Waste missions were planning to build a low-level, mixed-waste treatment facility; each with a line item in its budget. Alternatively, there was a need at the site for disposing of transuranic materials, yet no program had a TRU remote-handling facility in its budget. Each of the related programs assumed the need would be taken care of elsewhere. A striking example of inconsistencies in planning assumptions is that the tank waste mission area is striving for "unrestricted" use of the 200 area of the Site, while the environmental restoration mission area assumption is that the 200 area will be used for "disposal," a term yet to be defined.

The core of mission planning is the systems analysis modeling capability. In order to define the system, and thereby options, we started with a set of "material balances" for each mission area (as depicted on the left of Fig. 4). These material balances describe the problems as they currently exist (at least

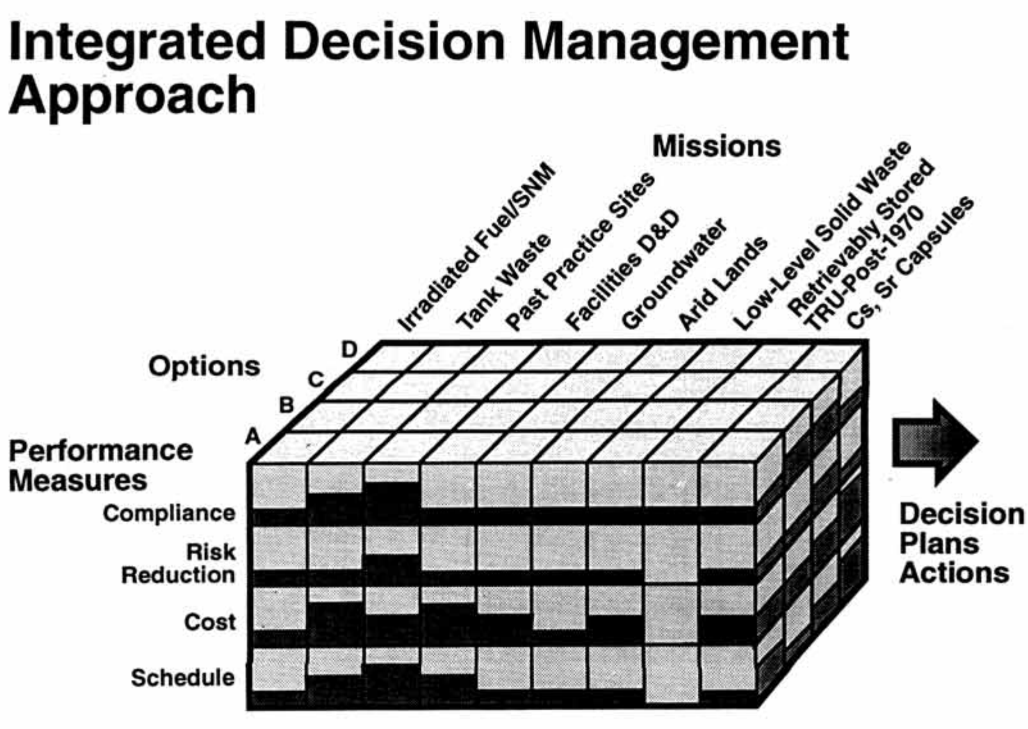


Fig. 3. Hanford mission planning.

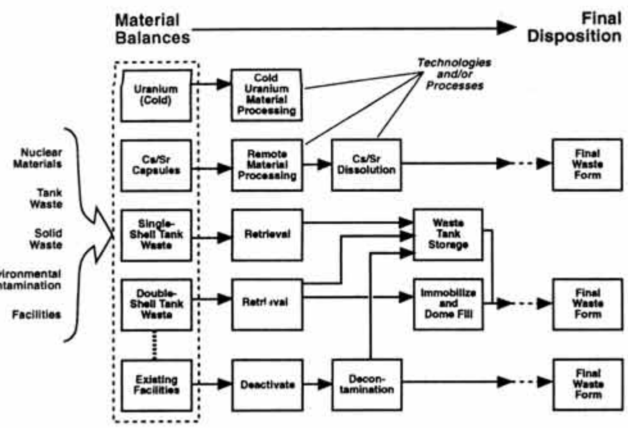


Fig. 4. Systems analysis model of cleanup process.

with regard to what is currently known) in terms of the amount of material to be dealt with and the levels of contamination of the primary hazardous and radioactive constituents.

Derivation of these material balances was an iterative process, initially focusing on a level of definition required for chemical process engineers to be able to define (at a fairly coarse level of detail) the process steps available for dealing with that material balance. Our definitions evolved as the needs of other technical disciplines created additional requirements. For example, process engineers focused primarily on the large volume materials. Later, as the risk assessment team examined the material balance processing steps, they identified some potentially high risk materials that, because they existed in relative low volumes on Site or were not central to the planning of the processing steps, were not included in the original material balance identifications.

For each of the material balances, the process engineers defined, in a set of systems diagrams, alternative steps that change the state of the materials (moving from the left to the right of Fig. 4), finally leading to some "end state" for that material balance (either storage, destruction, or shipment), as depicted on the far right of Fig. 4. They also identified corollary waste streams created in some process steps that then entered other process streams. For example, a number of chemical separation processes (e.g., for tank waste) will create substantial volumes of liquid effluent that will then enter the liquid effluent process stream.

We sought to define site level options (combinations of the process steps foe all Site problems) to cover a range of Site-level future use scenarios from "unrestricted use" (essentially a pristine site according to regulatory definitions) to "exclusive use" (a state very much like the limited access state that currently exists). It should be noted that the exclusive use endstate still requires substantial cleanup activity, for example, to limit the migration of certain materials off-site.

There were two reasons for defining such a broad set of strategies. The first is that there are many groups and individuals with interests and concerns about Hanford Site decisions. Creating a broad range of end-state-based options maximizes the chance that the full set of stakeholders will be able to find their "preferred" option among the analyzed set. The second reason is to explore the relationships among key decision criteria (for example, cost and risk) across the full range of possible options. This provides the opportunity to examine tradeoffs among these criteria for example, the amount of Site area returned to various levels of use for a given investment.

The next step in the systems analysis identifies technologies and/or processes that accomplish the process steps described in the systems diagrams. Inserting a technology into a process step allows description of the performance of that technology against the material balance to be dealt with in that process step and definition of the material balances that result from the application of the technology. These material balances then serve as the input to the next process step. The resulting system model allows manipulation of flows of material balances in order to determine the impacts on the entire system of changes to specific combinations of technologies.

The systems analysis model serves as the integrating mechanism for the information about decision criteria. Material balances are used, in conjunction with other information about population, etc., to determine the public and worker health risk associated with the materials as they exist today, during the clean up activities, and in their final endstate. The material balance process steps and associated application of technology also provide the basis for estimates of the cost for each step and a method for aggregating those costs under a given Site-wide strategy.

## Lessons Learned

We are now almost 2 years into the HMP effort. Substantial progress has been made in that time, both in terms of methodology development and actual decision data. Fourteen site-wide options have been fully modeled, including all material balances, flows, and final material dispositions. Progress has also been made in establishing the risk (most notably in terms of the public health risks of leaving materials as they are) and cost bases on which to compare site-wide options and regulatory concerns and issues with regard to options within each mission area. The team has also developed and begun implementation of a stakeholder participation plan for the Site.

At the beginning of FY93, HMP program entered a critical phase. We are near the point for full implementation of HMP and its umbrella integrated planning process, HIPP. For this implementation to be successful, progress is necessary in tow areas: 1) further development to technical information (primarily in the areas of cost, risk, schedule, and the relationship between current program plans and HMP guidance) for evaluation and comparison of site-wide cleanup options, and 2) full development of the HIPP, with specification of information and decision flows and organizational responsibilities as dictated by HMP mission definitions. It is appropriate to examine the last 2 years effort and to reflect on the lessons learned during that time and their implication for successful implementation this year.

The lessons learned from the HMP effort to date fall into two categories. The first is technical, i.e., lessons learned about the development of the models, tools, and data upon which the HMP approach is based. The second category involves lessons learned and issues about the managerial and organizational context in which mission planning is to be implemented and the implication of that context for the success of HMP and HIPP.

## Technical Lessons

**Methodological flexibility.** In order to serve successfully as an integrating mechanism for the Site, a planning capability of this type must have a structure that is adaptable to a broad range of users and uses, focusing both "out," to meet headquarters' needs, and internally to the site in order to be useful to programs. It must be able to utilize alternative data sources and levels of detail and provide information and reports with data aggregated in different ways. We sought as "robust" an integrating structure as possible, leading to the selection of generalized "options and decision criteria". Each axis of the decision matrix (as shown in Fig. 3) can be evaluated at different levels of detail, according to the use. At the most detailed level, the options mesh with the highest level planning elements within programs through the systems model elements. In this way, while the mission planning approach focuses on site-level options and decisions, it maintains the link to program options and decisions.

**Team building and integrating technical requirements across multiple disciplines.** The management and technical teams developing and implementing such a capability must come from many different disciplines. HMP required expert chemical engineers, systems analysts, risk analysts, decision analysts, regulatory analysts, management scientists, statisticians, computer scientists, and other disciplines. A substantial part of the challenge is getting them to be able to communicate and to "step outside" existing methods and approaches with which they are comfortable and focus on the approaches, tools, and languages required by integration. Innovation was required in each task area, while we still needed to produce useful products in a consensus approach.

This presented several management challenges. Part of the team worked on day-to-day connections to the problem owners (program managers and staff), while the rest focused on building the capability to solve the problems. New issues and considerations were constantly surfacing. At the same time, the management team must protect the technical staff from the day-to-day perturbations of the site, with the multiple influences from regulators, DOE management (local and Headquarters), and the full range of other stakeholders. The technical team must trust management to perform, i.e., to pass along the necessary information, while screening much of what is not relevant.

**Integrate health risk, cost modeling, and technology experts into the system analysis modeling activity from the start.** In particular with regard to health risk, it is critical that the rusk modeling experts be involved in establishing the systems modeling approach and data. Material balance information is the core of the systems analysis approach and also serves as a key input to risk and, to a lesser extent, cost calculations. However, process engineers focus on the larger volume materials, since those present the primary challenge in creating a process for their clean up. This is not always the case for risk. Some of the materials with smaller volumes constitute a larger relative rusk, and it is therefore critical that they be included in the material balance flow.

**Focus on "baseline health risk" first, then endstate health risk, and finally health risks for the cleanup activities.** Ideally, for decision making purposes, you would need to develop information about the health risk associated with the materials as they exist today (and in the future if they are left as they are i.e., "baseline risk"), the health risks that come about from the cleanup activities, and risks associated with the remaining material balances that will exist after cleanup activities are completed. But, decisions are being made now that would benefit from risk-based information. Given that we can't have all the information we would like immediately, the question becomes, "What information do we develop first?"

Some decisions can be made simply by establishing the baseline risk of the materials as they currently exist and as they are likely to move in the foreseeable future. This information will allow us to examine the current expenditures and reallocate funding from problems areas where their is little or no current or near-term risk. Thus, establishing the baseline risk should come first.

Next, by establishing risk associated with the endstate material balances and linking them to the risks from the materials before they were subjected to the cleanup activity, we can look at the value, in terms of risk reduction, of investing in the cleanup itself. If these do not differ greatly, independent of the initial risk, it would suggest that the investment in that activity should be curtailed. If there is a substantial risk associated with that material balance, their lack of change in the risk would also indicate that a new approach, possibly a new technology, is needed for this problem.

Finally, for those cases where there is an initial high risk level and substantial reduction of risk comes about from the cleanup activities, the health risks for the cleanup activities need to be investigated to determine whether the reduction in rusk from cleaning up the problem is greater or less than the risk from the cleanup activities themselves (for example, from worker accidents or additional public health risk when some materials are exposed that are now buried or otherwise isolated).

**Prioritizing needs for science and technology (S&T) for site cleanup.** There is widespread agreement that new technologies and new scientific research are needed to clean up the Hanford Site. It appears successfully there are many problems for which there currently are no solutions, which emphasizes the need for technology development. However, there is insufficient funding to develop every technology that is identified or to undertake every scientific research project that is proposed. Thus, DOE must focus its resources on S&T that will have the most significant impacts on the overall cleanup effort. Hanford has recognized the importance of identifying and prioritizing its most critical problems and the most promising S&T solutions to them.

A related issue for site cleanup was whether technology existed to address all site cleanup problems and would perform adequately (in terms of both cost and cleanup level). Cleanup of the Hanford Site will require numerous decisions about technology development and implementation, which will be complicated because there are substantial uncertainties about the risks and the costs of new technologies. Further, the choice of a given technology for a specific application must be evaluated with respect to multiple (and often conflicting) objectives (e.g., risk reduction, increasing effectiveness, cost reduction, increasing public acceptability, regulatory compliance).

A methodology was developed to combine technical judgments of Site experts with value judgements of Hanford stakeholders into a rigorous decision process that would prioritize technology needs for the Hanford problems. Program managers, engineers, and scientists identified and prioritized 1) Hanford problems, 2) functional needs that must be addressed to solve the highest-priority problems, and 3) candidate technologies to accomplish the highest-priority functional needs. In addition, Hanford stakeholders were asked to provide the values (criteria) they would use to make judgement regarding the severity of one Hanford problem versus another. Similarly, the stakeholders provided criteria to prioritize functional needs and candidate technologies.

There were three main lessons learned regarding the process used for this S&T needs assessment activity. First, the prioritization process that we tested is doable but complex and time-consuming. Second, the process will identify the most important technology candidates (i.e., those that address high-priority problems and functional needs), but it may miss smaller opportunities for improving cost-effectiveness in areas of lesser importance. Third, many improvements of the process are possible, both in structuring and in the actual assessments.

**Computer Support.** We learned that a large amount of data is necessary to perform technically defensible analyses. Our data manipulation requirements grew as the capability grew, overwhelming the capacity of our initial data manipulation tools. Investment in a relatively unconstrained data tool at the outset would have greatly increased the efficiency with which we were able to create and examine options and would have led to a much more efficient use of analyst time.

## Management/Organizational Lessons

**Cleanup decisions will be made at the regional level based on regulatory and cost/risk benefit determinations.** DOE's centralized management of programs at HQ reinforces the separate program structure at the Site and discourages Site integration. The Site manager has both planning and implementation responsibility and authority and supports an integrated mission planning approach, success is more likely.

**Requirements for change in the organizational culture.** Integration of an organization is difficult at best, and in the case of DOE sites where security dictated decentralization, change is more difficult still. However, the cleanup mission requires integrated management. Decisions must be made that serve a broader set of objectives that will not always be clear from within an individual program. A change in the culture of decentralized management is necessary at DOE Sites for integration to be successfully implemented.

**Development of an effective change management strategy.** The implementation of an integrated planning process constitutes a large-scale organizational change which will have operational, psychological, and social effects on a large number of people. Efforts to implement an integrated planning process at hanford would have proceeded much ore quickly had we developed a process with a greater appreciation for the full range of impacts brought about by these factors. We needed to understand that all of the necessary changes could not be mandated from the top down, and that while senior management can espouse the new approach as a high priority, it will not necessarily be understood or implemented. It was not recognized that the then-existing culture of bottom up planning was not working. Key components of the needed change management strategy are: early involvement of program management staff in the process of development of the integrated planning capability (including early development and communication of the site level objective of cleanup activities) and continuous support from senior and middle management for integrated decision making.

**Acceptance of and commitment to integrated planning by DOE-RL and WHC managers at all levels.** Managers at all levels must be given responsibility to implement the recommendations developed by the integrated planning functions or, alternatively, demonstrate compelling logic to support the alternative underlying their own integrated decision making. As the HMP and HIPP move towards implementation, it will become critical that all levels of management understand the mission definition within which their program is operation and the role of their activity in successfully fulfilling that mission. While it is difficult to know at what point in the development of a HMP/HIPP capability that a critical mass of knowledge and understanding has been developed in order to begin the integration of the Site, it is clear that the authority for integration needs to be transferred to the integrated planning team fairly early in the process, possibly in the first year of activity.

This commitment also implies budgetary commitment to the integrated approach. Development of the capability takes time and impact is not made immediately. A stable resource base is necessary to maintain the integration team. The management team needs to be committed to developing the capability and allowing it to proceed to implementation.

**Decision processes must be clearly defined if the HIPP/HMP is to be successfully implemented.** HIPP is a process developed to aid decision makers at all levels in the organization in developing cleanup plans that consider the site as an integrated whole. In order for it to be effective, it must be applied as part of a structured decision process that identifies the key decisions to be made, the decision makers, and the sequence in which the decisions are made.

Mission planning does not replace decision making, nor does it take decision making authority out of the hands of the responsible individuals. Mission planning enables the responsible individuals to make better decisions by clearly articulating the tradeoffs among a set of key decision criteria (cost, risk, regulatory requirements, stakeholder values, etc.).

**Consolidation of planning functions under single DOE site and contractor organizations.** All Site planning functions, from higher level, strategic planning activities to fiscal year work plans and cost and schedule detail, need to be linked and become natural, smoothly flowing process. Consolidation of responsibility for each of these functions into a single management unit will facilitate the necessary consistency of approaches and data and will promote better communications among the different planning functions.

**Linkages between the programs and the HMP must facilitate the flow of technical information.** Technical information must flow freely in both directions between the programs and the HMP. As the programs produce better data about the feasibility of achieving planned program objectives, this information must be fed into the Site-wide analyses. As Site-wide decisions are made (such as land use priorities, risk allocation, etc.), the information must be fed down via the mission planning through the mission areas to the programs for implementation.

**Value of a single, comprehensive date source.** As HMP matured in terms of the quality and quantity of data developed and was linked to the systems analysis model, we found that, more and more, we were able to respond to request for information to support decision making at a variety of levels and for different purposes. By having a single, strategy-driven data source (in the systems model and its associated data and models), we were able quickly to evaluate new initiatives, respond to inquires for summary data, and provide justification for existing actions. This included rapid responses to a range of data requests, including manpower projections, facility needs, planning assumptions, and key site-wide and programmatic issues. Each of these request would, before HMP, have required a separate data development effort for a much more costly nature.

Finally, a new, more effective approach to stakeholder involvement in decision making must be developed. Decision environment is extremely complex and not well understood. Recognitions of this new decision environment requires the implementation of a stakeholder involvement process that enhances communication and begins to provide a framework which can serve to integrate various disjointed processes. Even small efforts in this area will yield substantial results.

In summary, Hanford Strategic planners and decision makers have made substantial progress in formalizing the planning and decision-making process. While much remains to be done we are positioned to take advantage of the lessons learned from two years effort in mission planning.