Consortium for Risk Evaluation with Stakeholder Participation III

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"Best in Class" and Root Causes:

A CRESP Perspective on DOE-EM's Programs

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Figure 1. In a Class by Itself. (Arman, *Pieza Unica*, n.d. Bronze, 134 x 44 x 44cm. Fundacio Fran Daurel Colleccio d'Art Contemporani, Barcelona, Spain. Permission to reproduce image requested 11-07.)

Introduction

The Office of Environmental Management currently seeks to become "best in class". In fact, the Office is in a class by itself – and is, therefore, by definition both the best and the worst in that class. Accordingly, EM's leaders and others often rightly describe the Office's work as being unique for several reasons: (i) the nature, quantity and diversity of the wastes to which its remediation program is devoted, (ii) the complexity of the tasks EM faces, (iii) where some wastes are found and problems (risks) involved in their handling and (iv) the fact that its remediation program's requires first-of-a-kind projects involving processes and construction projects that are simply found nowhere else. In reality, the EM program faces several distinct forms of challenges: (i) radioactive waste processing, (ii) remediation of contaminated geologic media (e.g., soil, sediments) and water from land surface to deep subsurface, (iii) decommissioning, including decontamination and demolition, of complex contaminated structures and, (iv) establishment, operation and closure of near surface disposal and deep geologic repositories. In this paper we seek to relate "best in class" concepts to earlier CRESP work on roots causes of EM problems. We look back to see how EM has or has not been able to use prior advice as a guide to what kind of effort is needed to make an initiative on "best in class" effective. We then propose a four-part approach to a comprehensive EM effort to drive for the quality and qualities that will make it "best in class".

What does it mean to be "best in class"?

To be meaningful as "best in class,", given EM's distinctive challenges, EM must achieve outstanding performance in a variety of "classes" made up of other institutions and processes that engage in analogous activity and/or face analogous challenges to those faced by EM. Furthermore, EM must define the key attributes (e.g., treatment process efficacy, schedule, safety, cost control, regulatory milestones, etc.) and associated metrics and targets that, when achieved, will facilitate meaningful evaluation of "best in class" performance by the organization.

The focus on becoming best in class is in stark contrast with most of the approaches taken in the past to address the fact that EM has for at least a dozen years been perceived – by nearly all observers and participants (stakeholder, regulators and EM's own leaders and employees) to have fallen short of expectations. These have been expectations (i) independently set by others, (ii) those which EM has agreed it should meet in negotiations with other stakeholders, and (iii) those EM set for itself. Most often, prior expectations were set as goals in the context of sparse knowledge and high levels of uncertainty, but regarded as definitive milestones, setting the stage for inevitable shortfalls in performance independent of whether or not true progress is efficiently achieved. For example, EM's remediation performance is routinely censured; perhaps no governmental program has received more advice – typically couched in the context of strenuous criticism. And there has been no tougher critique than that offered by the Office itself in its 2002 Top-to-Bottom Review.

Recent efforts to adopt better project management techniques, and particularly efforts to develop project baselines that can be validated, are widely seen to be indicators of important improvement. EM has achieved important successes in completing remediation projects at several key sites. However, some observers are reserving judgment. But as they do so, they explain their continuing concern by noting that the list of sites not yet complete is long; the list of the largest sites where risk reduction is lagging remains basically static; the struggle continues across the complex to achieve timely completion of regulatory milestones; and, the problems of missing both cost forecasts and projecting completion dates and then revising them continues -- in almost all cases by delaying completion and increasing the cost estimates. The Office has sought to learn from its success sites – particularly Rocky Flats and Fernald. EM has recently quite boldly had its executives examine in tough seminar contexts a set of examples where its performance has gone awry to seek to understand why. EM has redirected the technological focus, and where it only recently suggested that it had the technology it needed, reversed itself on the evidence (after a series of problems in attempting to apply technologies EM thought were ready but weren't), and determined that technology and engineering development and research should be ramped back up. Tellingly, after having four years ago pulled most of its completion dates forward by decades – EM is now yielding the time back at its major sites in response to recognition of the reality that those agreements and promises for acceleration were unrealistic. In sum, the program has been under review, reorganization and contract reform and life-cycle forecasting improvement for at least a decade. It is important to remember that it is in this charged and complex context that the effort to achieve "best in class" is now being pursued.

Evaluation of the Root Causes for Why EM Projects Often Fail to Meet Expectations

In 2007, the United States Department of Energy (DOE) requested that the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) identify root causes that contribute to DOE projects that have failed adequately to meet expectations - and then offer implementable recommendations to address or mitigate these root causes.

CRESP found there were common elements that when combined lead to persistent disappointment in EM project performance:

1. EM projects so often do not adequately achieve their stated objectives. (For example, a project developed to remove waste from a lagoon, separate, treat, and convert it to an inert form left residuals in the lagoon bottom that did not meet regulatory requirements);

2. They do not regularly reduce risk as much as needed and intended. (For example, the residual now poses an ongoing risk to conservation managers, possibly a risk higher than existed before the project began);

3. They so frequently do not meet project schedules and adversely affect other work. (For example, the delay caused by having to return to the lagoon led to a cascading set of disruptions in related projects that depended upon timely performance);

4. They have habitually overrun cost schedules with adverse effects on total site costs and the credibility of EM cost estimation. (For example, the lagoon costs led to deficits in other site programs and were cited in congressional language as a reason for reducing EM funding).

The first CRESP report (Greenberg, Powers, Mayer and Kosson, 2007) defined five root causes of these common elements, and noted two pervasive DOE-EM specific conditions that exacerbate the negative effect of these five root causes:

1. Complex science, engineering and technology. The DOE-EM scientific and engineering challenges are perhaps unprecedented. Waste compositions and processing conditions (chemistry, thermodynamics, kinetics, unit operations) are often either inadequately defined or not previously demonstrated. Accurate waste characterization frequently is a serious challenge and impediment. Problems with insufficient characterization are exacerbated by the limited quantities or complete absence of waste samples available for process development and demonstration. First of its kind technology often is required for safely removing wastes from current storage facilities, and then separating and/or treating these wastes before transfer to interim and/or permanent storage. Incomplete specification of required results (process output specification for compatibility with downstream requirements) is common. Too often the final disposition pathway and associated waste acceptance criteria are not yet defined. Finally, required integration of multiple disciplines (especially nuclear and chemical engineering) focused on process performance is an ongoing challenge. Bad decisions regarding any of these underlying factors work together to put in motion the four "elements" (consequences) of performance challenged projects.

2. Ambiguous economics. The complex technological requirements and unusually long project horizons for DOE's largest projects make it difficult to reasonably estimate project and long-term life-cycle costs. This leads to an inherent challenge to efficient planning and management of long-term construction projects – projects whose efficient execution also simply depend on stable funding. We have noted the challenges (frequently not met by EM) to set project life-cycle boundaries that are appropriately delineated to capture all programmatic costs and full-life cycle costs (currently too much focus on near-term steps and site/contractor boundaries without overall context). These, we believe, are exacerbated by incomplete data leading to

errors in complex science decisions; reliance on outdated costing systems and thought processes about funding; insufficient in-house expertise to evaluate cost and schedule estimates of outside contractors; limited internal project management; and the effects of Congressional and internal funding decisions.

3. Project planning and contractor management shortcomings. DOE relies on private contractors to design, cost, build and operate all major projects. The contractors often know much more about the sites and specific projects than does DOE. And this dependence becomes particularly obvious when contractor contract transfers result in significant project instability. Hence, contract rebidding (generally important to contract attentiveness) results in changeovers prior to project completion. EM continues to struggle with the important issue of selecting the right contract structures and contract length. But the twin issues of adequate project planning and the capacity to achieve contractor accountability are the fundamental questions here. The Department lacks sufficient internal project management and technical staff at the sites and headquarters to examine and question project estimates and decisions in depth. Project management and technical expertise at both sites and DOE headquarters simply are insufficient. An additional critical shortcoming in project management is the Department's persistent failure to characterize, track and communicate uncertainty in terms of technical efficacy, schedule and cost, thus creating the perception of unwarranted precision in these estimates and providing the basis for unrealistic expectations.

4. Political processes and EM's own credibility problems together inhibit EM's ability to define, design and/or implement large projects. Congressional budgets uncertainties, marks, instructions, and appropriations discontinuities make it difficult to plan and implement complex long-term projects. Regulatory authority interventions (Tri-Party Agreements provisions, milestones, DFNSB) constrain the Department's options, often forcing EM to prematurely and inefficiently commit resources. DOE's sites have a substantial local and regional political base of strength and when this political strength is exercised may result in decisions that are not necessarily the best for the DOE and its EM mission. Lastly, local or regional interventions to maintain local expenditures in host regions have complicated DOE's efforts to shift resources to the highest priority projects.

5. Organizational history and culture. The AEC and now DOE have relied on private contractors to design, cost, build and operate all major projects. Reputedly this reliance is greater than any other federal contractor (though NASA would be close). Historically, DOE's own internal project management personnel (their numbers, skill-base, managerial experience and authority) are, as we have seen, too limited to oversee, examine and question contractor estimates and decisions. Changes in Assistant Secretary and many senior staff every 18-24 months has sometimes led to a tendency to draw attention to organizational structure rather than programmatic substance and badly impairs needed institutional memory among senior decision-makers. Relatedly, the EM's culture's near schizophrenia about the exercise of managerial authority leads its staff to vacillate between extremes. For example, the Department's original need to protect national security still sometimes shapes habits of secrecy and leads to "decide and defend" approaches

rather than effective collaboration; but these patterns at times alternate with almost obsequious acceptance of all stakeholder views, irrespective of their technical validity.

The five “root causes” CRESP identified were neither really unexpected, nor revealing of corruption or bad intentions. They were causes or factors that others, too, had individually identified. But what is surprising in what we found was how completely interdependent the root causes are. That is, they were found to be “at work” together and if not always, then regularly, in so many types of EM activity and project work. And it was their interdependence that created predictable behavior when “put into motion” together. It is important to view the root causes as five (often “hidden”) factors at work on EM projects and functioning both as project drivers and as themselves “driven” by the EM projects to which they are related. Hence the biological images (roots, trunk branches tree) gave way to a mechanical one (EM projects as gears intersected by causes at work on the project itself.) (see Figure 2)

Root Causes of Failing Project Problems

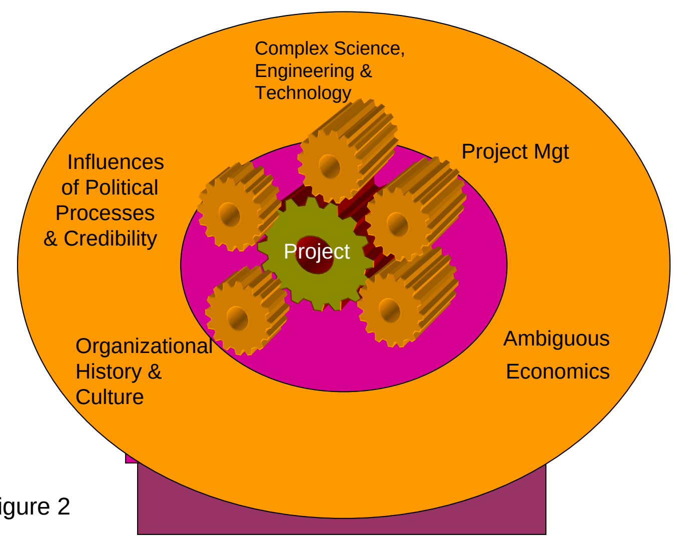

Figure 2

All of these root causes are, in the EM case, made more difficult to address by two additional factors that we believe are characteristics of the very matrix within which the five EM root causes exist. The first factor is the difficulty EM faces in attempting to identify where and how some of its major EM projects “begin” or “end” since the work on most of the projects which pose current problems has been going on for extended periods and in some cases almost the entire life of EM (17 years), and will continue for a decade or longer. The poorly defined and lengthy project time lines make individual and contractor accountability particularly challenging. The second factor is the absence or incomplete definition of final disposition pathways for many waste streams, resulting in incremental approaches rather than integrated solutions. In addition, lack of clarity about the final disposition pathways and other project interfaces results in unclear or insufficient definition of project objectives and requirements at the project outset. Often, EM does not control the final disposition pathway or its plans are foiled because they involve the participation of multiple sites with different stakeholder expectations and requirements.

DOE remediation projects tasks and technologies and processes are themselves interdependent and "project borders" are exceedingly difficult to define (See Appendix 2). The low hanging fruit has for the most part been picked since many of the small and slightly contaminated sites have been entirely or largely remediated. In much of what remains, the crisp terms applicable to a system developed to "make an acquisition" are immediately mired in the history of all that has gone before. Many of the key projects which EM now seeks to get under management control are massive sites with multiple contaminated areas which require major treatment facilities and are deeply controversial, mired in regulatory ambiguity and have experienced multiple stops and starts. They are stuck in the middle. Hence the designation of these problems as "projects" (something that has a "discrete start, middle and end"), and whose movement from one stage of activity to another based on rigorous criteria, while essential for effective project management, is radically inconsistent with their history and the level of frustration and confusion associated with them. The term "project recovery" - the explicit programmatic recognition that the key work to be done is to find the lost elements or create the bridging elements that would constitute a viable project - has been applied to only the most seriously delayed and daunting construction/remediation project ever undertaken by DOE – the Waste Treatment Plant at Hanford. But project recovery is a better description of the essential task at many EM sites.

Many of the stalled projects are not only long standing and difficult to "begin again", but they often are ones where the actual end of the project is poorly defined ("where is this stuff going and in what form"), and where their managers have for most of the past decade, or more, been expecting (told to expect) <u>that imminent decisions would provide clarity about the location and final disposition characteristics (WAC's) of the waste materials</u>.

In reality, where the actual success or completion of an EM task is defined as involving the successful and safe final disposition of a many types of waste materials, the absence of complete and well defined disposition pathways and promise that they would soon open have been paralyzing. This is surely true of the waste bound for Yucca – and it is also clear that the uncertainties that attend when and how the HLW and SNF would be leaving has severely impaired the willingness of state authorities and other regulators to work out final agreements about what to do with on-site wastes and affected negotiations about the movement of specific waste types and forms among the DOE sites. The target disposition date is incorporated in many milestones and drives many of the complex events that are to have led to having the materials ready to enter the disposition path. On the other hand, the fact that the actual disposition path and timetables are delayed not only creates distortions in project timelines and expense flows but literally means that implementation consistently recedes. The central dynamic here is not simply that the actual final disposition place and forms remain uncertain. Rather, it is the fact that the expectation that that final disposition is imminent freezes all of the parties and focuses their attention on a result that seems forever to be delayed - does not arrive – and lies beyond their control. Disposition pathway uncertainty is a major factor in the fabric of EM work.[1]

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[1] An additional point here: the remainder of this document focuses on issues that we believe EM can itself address. This issue of having a disposition path for EM's most heralded wastes is not an issue of this type. This issue seeps like a mobile toxin into the entire fabric of the EM program. If the final disposition path is not going to be resolved

Prior Advice to EM: Why has it not succeeded?

The purpose of identifying root causes of why there are shortfalls is to be able to identify what would remedy the situation. As noted, EM has had a host of advisors. Some were of EM's own choosing (its Environmental Management Advisory Board or its Site Specific Advisory Boards), and some are major national centers of science and administration (NAS and NAPA). Some are investigative teams from elsewhere in the Department or the executive branch or report to Congress. But already in September 1993, two years after EM was created, its EM-1 leader described the Department's situation as dire indeed. Assistant Secretary Thomas Grumbly (1993-97) said that DOE-EM "has been beset by public and Congressional concern over priorities, the pace of cleanup, and the total costs of the program. One of my highest priorities is to conduct a fundamental re-evaluation of the program". And with that as the base, he asked the NAS to advise him on how to make risk evaluation an effective agent of change, of "program recovery". Since then the Department has gotten thousands of pages of advice. We think that advice can actually be summarized as falling into six categories:

> **It is noteworthy that the success of the Rocky Flats cleanup was importantly contingent on the fact that the approvals for the movement of various key materials to be taken off-site were achieved "just in time", particularly at the Waste Isolation Plant (WIPP) and SRS, for the project teams at Rocky Flat to integrate the transport offsite with the other aspects of the cleanup. Both destination sites were ones over which EM itself had authority to achieve regulatory agreement and EM did not have to depend on other DOE offices to clear the way. It has no such freedom with respect to HLW and some mixed wastes.**

1. Advice that proposes ways that the managerial systems, algorithms or criteria governing the program either be developed, or changed or – most often – better integrated. The source of those systems have been borrowed from other sectors, other federal agencies (most notably DOD) and/or created de novo from the work of the advisors themselves (e.g., NAS on risk assessment-risk management). Currently EM is working to make its 1) project management systems (and its newer relationship to both 413 and to the older PBS system), and their programmatic risk evaluations work in relation to 2) a new algorithm for deciding when technologies it is considering are sufficiently mature (the Technology Readiness Assessment tool), and how both relate to the 3) ISMS program designed to assure safety.[2]

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in the next decade (and that fact should be known within the next 18 months), then the waste forms and disposition paths for them for foreseeable future (for example, the next 100 years) need to be clarified and codified. We encourage EM to work more actively to clarify to all of those with whom it works, both in and outside the Department, the importance of achieving disposition clarity.

[2] And this advice began coming quite early. See especially, Committee on Remediation of Buried and Tank Wastes, Board on Radioactive Waste Management, National Research Council, *Barriers to Science: Technical Management of the Department of Energy Environmental Remediation Program*. 1996, Washington, DC: National Academies Press.

2. Advice that focuses on improved/changed contracting procedures and contract structures (including incentives) and propose various ways for tracking the success of those innovations. Much of this advice pivots from our third "root cause" and sees changes in procurement preparation, definition, evaluation and oversight as key.

3. Advice that focuses on better defining the inputs into whatever management approach is used, focuses on the how poorly the interfaces among project and programmatic elements are understood and does draw attention to how little control EM has been able to establish over disposition pathways at those places where its work is stymied. The common theme in this body of advice is that the Department has not yet gotten conceptual control of the sequencing and operationalization of its tasks and sees improved information flows and some organizational changes as the solution.

4. Advice that focuses on the skills base and training of the Department and its ability and or freedom to manage/oversee the work of the contractor components. This advice typically stresses the need for interdisciplinary technological and project management capability, particularly the skills to integrate chemical, nuclear engineering and managerial elements.

5. Advice that the Department needs better, earlier, more frequent and better targeted independent reviews of its projects as they move into particularly challenging phases and or as they move from one to another level of complexity or implementation. Of particular concern to these advisers is the fact that the Department persistently commits resources to full-scale implementation (often involving major construction commitments) before its designs have been validated, or tested at the pilot level. Advice focusing on what constitutes both independent and expert review suggests that early identification of where the "root causes" are infecting EM work could put EM work back on track before the consequences of mistakes undermine success.

6. Advice that the Department's work become more transparent and that its managers more effectively listen to the views of the diverse stakeholders concerned with EM work.

It is noteworthy that this body of advice has been consistently made by very diverse types of advisors for more than a dozen years. In discussions with those who have been involved with this "advice-giving" over the years, we find an intriguing conclusion. These advisers are most concerned about how little their advice has actually shaped subsequent developments in EM. Some believe that the Department is actually so inundated with a constant flow of advice that it cannot effectively distinguish what to pursue and, in order to be seen to be responsive, follows much of the advice for brief periods until the next wave of advice pours in – and the early reforms are remolded to meet the next set of advice. We found, however, that others are far more impressed with the fact that "plus ca change, plus c'est la meme chose" – the fact that EM has not been able either significantly or consistently to address the issues raised for it – either the analysis or the remedies. And many observers with whom we have discussed these issues believe that the EM mission cannot successfully be achieved within DOE or at least within the EM office.

We think we understand where this cynicism comes from. What is it that makes EM so impervious to the kinds of reforms or changes that would make it a more effective organization, better able to pursue its admittedly difficult and unusual challenges more efficiently and well? It is quite clear to us that an answer, perhaps the most important answer, lies in the fact that the five root causes are, in fact, interdependent and effectively "lock in" the way EM functions including how it responds to advice. Temporary new concepts or slogans or reforms initiatives or metrics will miscarry when confronted with the way in which the several root causes work together to preserve the status quo. Our Figure 1 (page 2) shows the root causes as mechanical gears intersecting EM projects as though they are integral to it. We suspect this is an accurate image. Therefore any successful "remedies" must be as integrated and persistent and conceptually complete as is the nemesis they address. The remedies themselves must – like the challenge they confront – constitute a coherent, integrated set. To be "best in class", the Department needs a program for EM reform that allows its well-run projects literally to shape the way the other causes ("gears") intersect it – and reshape them, rather than being badly distorted by them.

From abstract concepts to EM management processes

EM has an evolving set of management processes and associated tools to achieve project objectives and improve project performance. Evolution of these tools is the foundation for achieving "best in class" performance. The most central are (i) the critical decision (CD) project management process, (ii) safety management systems, and (iii) technology development and implementation strategies (most recently embodied in Technology Readiness Assessments (TRAs), Technology Maturation Plans (TMPs) and the Science and Technology Development Roadmap (the Roadmap). However, critical elements within each of these management processes, and essential linkages amongst them lack adequate definition and associated, sufficiently clear implementation guidance. For example, what level of process testing and maturity, safety analysis, schedule and cost assessment is required on a comparable basis to achieve process down-selection at the point of CD 1? In addition, (i) the need for, (ii) the aspects where needed, (iii) the role of, and (iv) the mechanisms for obtaining constructive stakeholder involvement[3] as part of each of the management processes are not clearly defined. Furthermore, uncertainties and risks associated with technology efficacy, safety, schedule and costs need to be characterized, tracked and communicated effectively.

Additional factors that should be considered are listed below:

1. Clear and sufficiently detailed definition of project objectives and interfaces are essential to effective project management. For EM, this should include defining:

[3] Here, "stakeholders" are defined as the organizations, regulatory agencies, and public that either have prescribed roles, or impact or are impacted by the project goals and activities. "Stakeholder Involvement" is an on-going exchange intended to facilitate (i) stakeholder input at appropriate points and levels, (ii) improved stakeholder understanding, (iii) transparency, and (iv) improved program credibility.

a. The disposition pathway, interim state required to be achieved to allow the next process step, or final end-state to be achieved.

b. Required processing rates and/or measurable milestones.

c. Requirements for all process outputs (beyond the primary process objective), including air emissions, water discharges, and secondary solid wastes as a consequence of operating conditions, maintenance activities and final closure.

d. Regulatory interfaces and requirements.

2. The relationships and distribution of responsibilities between DOE-headquarters, DOE-sites, and contractors should be more clearly defined.

We suggest that that enterprise will require itself a "remedial design" for EM that is spatially as broad as the EM program itself and temporally initiates a process (a process of continuous improvement) that assesses quality across all the elements of the EM program on a continuing and coherent basis. They must be both robust and yet evolve to help achieve quality improvement as the organization itself evolves the capacity to achieve its goals and mission. We suggest that that design would have four overlapping efforts:

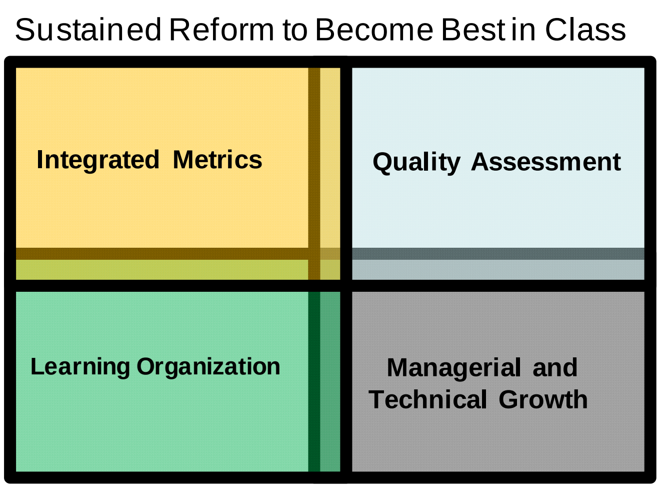

Figure 3.

1. the definition and continued application of improved metrics that address, in integrated, interdependent ways, the primary factors that are not yet under intellectual control (technology readiness assessment, integrated safety management systems and the evolution of the 413 CD process), so that EM both rigorously controls the steps to project implementation but also ensures that (irrespective of the pressures that impinge on the department) a project does not begin until the design elements are sufficiently mature as to link real technology availability, integrated safety, and the steps and costs of actual project execution.

2. the initiation and then institutionalization, of a program for the "assessment of quality" that first "maps" the relationships between EM's structure, process, and its outcomes and puts a broad range of issues, cases and projects under regular independent review. And once mapped, the program of "assessment of quality" should be given a continuing investigative role in persistently exploring in depth ways in which the EM structure, processes and the outcomes they achieve are evaluated in a consistent and thorough effort to become "best in class" in

relation to a broad and evolving set of parameters that are newly mapped periodically. (see Appendix 1)

3. a new commitment to create a continuous learning environment in a self-consciously "learning organization" that simultaneously explores – in depth - the ways in which EM has achieved its major successes, the ways in which it has failed to achieve its goals and missions in the most telling ways, and learns applicable best practices from other organizations. In our judgment the case studies demonstrating success should include thorough examination of the structures and processes that allowed EM to achieve closure at Rocky Flats and Fernald, the opening of WIPP, and its successful design and building of the DWPF at SRS. Case studies of what went wrong should include Pit 9 in Idaho, the ITP process at SRS, and the WTP at Hanford. Thorough examination of both the successful and failed case projects would be developed with the purpose of beginning to frame a new and authentic, historically-self-conscious culture and an evolved history to replace the current troubled one.

4. A sustained and publicly articulated managerial and technical expertise development program to add both numbers and skills to the current human resource capacities of EM. This broad scope HR program would chart long-term public service careers related to EM and to other nuclear waste challenges faced by the nation and integrate recruitment with well-funded technical and managerial training both for new and current staff. The curriculum of the program should build a quality evaluation of current training and career programs and evolve as the other three components of this reform program grow. [4]

Conclusion

The search for root causes and the commitment to become "best in class" can be mirror images of the same enterprise. Any "best in class" initiative that is substantive – one that is not another temporary fix or palliative – must be guided by a thorough understanding of the "root cause" issues we have discussed: complex science, engineering and technology, ambiguous economics, project planning and contractor management shortcomings, political processes, EM's own credibility, and EM's organizational history and culture. We placed these root causes in the context of the unique challenge to traditional project management processes that EM's chronic large project problems pose and the corrosive effect on all of EM of never getting clarity on disposition paths for key wastes. We suggested that 15 years of criticism, and the reform efforts they have generated, have by and large not been successful but suggested that their persistent ineffectiveness provides important insight about the key characteristics of any significant "best in class" initiative. Its program to carry out assessment of quality and the new pursuit of excellence implied by the "best in class" effort must be as broad and deep and long as are the problems they are addressing. We suggested that four self-consciously linked and interdependent initiatives (see Figure 3, p. 11) could be undertaken: 1<u>) integrating the metrics</u> of the CD (413) process with evolved technology readiness measures and integrated safety management; 2) a mapping effort to establish the basis for understanding and then continuously improving <u>quality assessment</u> that links

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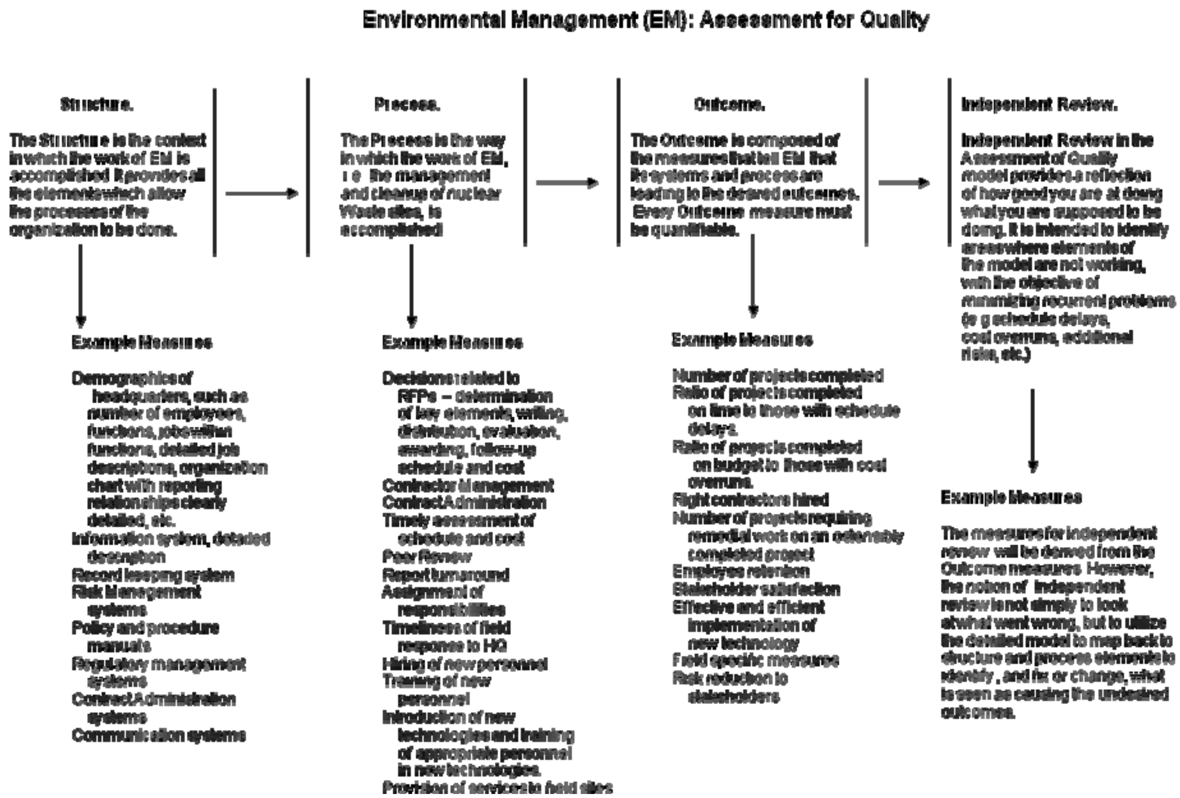
[4] CRESP researchers have developed, or in the process of developing, work on each of these four quadrants of a reform effort and can provide reports, presentations or articles from the peer reviewed literature to elaborate on each.

structure, processes and outcomes to independent review practices; 3) creating a learning environment where the key successful and troubled projects serve as rigorously examined case studies so that they together become the basis for a new institutional self-understanding – an evolved EM culture; and 4) managerial and technical expertise growth, comprehensively conceived, to include career paths and training in and respect for the relevant managerial and technical expertise of an increased number of EM managers. Were these initiatives pursued actively in a sustained way, the integrated drive for "best in class" we have described could, we believe, succeed.

Appendix 1



Methodology

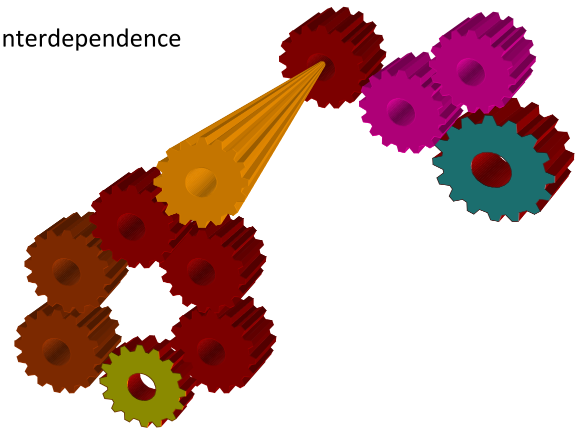
The data must be identified, gathered and analyzed.
An Assessment for Quality project cannot be done successfully solely by an outside researcher or researchers. The key to the Assessment's success is the involvement of a team of 6 or 7 EM people who everyday live within the structure And conduct the processes to achieve EM's goals.

- Teamwork -- In-house team to work with researchers:
- Process Involvement
- Problem-solving model
- Design of data collection and analyses
- Design of information flow
- Establish accountability
- Identify critical pathways
- Embed regulatory standards

Appendix 2

Large projects:

Interdependence



The projects are interdependent and complex and typically must **connect** with the waste stream source(s) in their current location and "matrix" to treatment processes using "ready" technology and to a clear path for consequent ultimate disposition.

Interdependent complex projects disintegrate – if their initial design is not adequate to the full scope of the project mission and if alterations are not continuously integrated in relation to the initial design.