Departmental Information Systems Engineering (DISE) Guidance

Volume 2
Managing DOE IT Projects

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The concepts and processes in this document are aligned with the DOE Information Management (IM) Strategic Plan Mission and Goals.

The IM Mission is:

To provide DOE employees and contractors with the capability to readily acquire, share, protect, disseminate, and store the information needed to successfully accomplish their jobs.

The IM Strategic Goals are:

1. Increase customers' trust by involving them in the information management process.
2. Improve understanding of DOE missions and processes in order to provide effective information management support.
3. Partner with our customers in planning and implementing corporate systems.
4. Develop, in concert with our customers, DOE-wide data administration to ensure data availability and access.
5. Provide customers with the technology to access and share information easily and seamlessly from any location.
6. Improve cooperation and collaboration of information management community to cost-effectively meet the information management needs of DOE.

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Preface

The purpose of the DISE series is to foster information systems engineering practices that will move the Department towards achieving higher levels of capability, maturity, and quality in information systems solutions and encourage the institutionalization of these practices.

This is the second volume in a series that was initiated as part of the continuing efforts of the Office of the Chief Information Officer (OCIO) to improve the architectural alignment, quality, performance, productivity, and maintainability of Departmental information systems. Many federal and contractor personnel were involved in the development of the document as contributors or reviewers.

DISE Volumes

Volume 1, Information Systems Engineering Life cycle – includes an overview of information systems engineering (ISE), project identification and strategic planning activities, resources, and quality management. It includes a discussion on drivers, roles, concerns, capital planning, acquisition, and Information Architecture as they relate to information systems projects.

Volume 2, Managing DOE IT Projects – includes guidance on project management practices such as Earned Value and performance measurement, and project life cycle processes such as project planning and control, tracking and oversight, estimating, and uses of project plans and work breakdown structures.

Volume 3, Process Management – includes adopted and/or recognized best practices for developing individual, team, and organizational processes; techniques for definition, mapping, analysis, and improvement of existing processes; guidance on definition and implementation of new processes.

Volume 4, Off-the-Shelf and In-House Programming – includes Departmental practices for COTS integration and quality assurance techniques for system development.

Volume 5, Metrics and Assessments – includes techniques and tools for metrics, assessing solution provider capability, and the benefits and techniques for Post-Implementation Reviews (PIRs) and Information Systems Reviews (ISRs).

1.0 Introduction

The DISE series will be reviewed on a regular basis and modified as needed to keep pace with the changing needs of the Departmental information systems engineering environment and the continuing technical advances in the information systems industry. Questions or comments should be referred to the document owner, listed on the title page.

While the DISE series does not intend to specifically exclude any information system or Program area from using the concepts and practices identified, additional security or other Program requirements may take precedence or dictate additional activities to the principles outlined in the DISE series.

1.1 Scope

The objective of the DISE Volume 2 is to provide guidance focusing on key elements of managing IT projects successfully within the DOE environment.

In support of its mission, the DOE designs, implements, and manages information systems, including the infrastructure within which these systems operate. There is an abundance of "generic" documentation on project management guidance both within the DOE and in industry.

Within industry, the Project Management Institute's (PMI) *A Guide to the Project Management Body of Knowledge* (PMBOK) is recognized as the de-facto standard. Within DOE, Order 413.3, *Program and Project Management for the Acquisition of Capital Assets* is the applicable guide for projects estimated at $2 million and above. DOE 413.3 provides excellent general project management guidance, valuable for projects of all sizes, regardless of threshold.

1.2 Applicability

The DISE series provides guidance for maturing DOE's capability in providing quality information technology (IT) solutions and, therefore, is applicable to all IT development and maintenance projects within the DOE.

Managing DOE IT Projects is intended to assist project managers (typically contractors) in overcoming the challenges posed by the ever-increasing complexities of these projects, and program managers (typically federal employees) who prepare and update programs and plans, and monitor adherence to those plans.

1.3 Purpose

DISE Volume 2 is intended to provide high-level guidance to foster more consistent and mature project management practices. Inconsistent project management practices within and across organizations limit the Department's capability to deliver quality information systems and

corporate systems applications in accordance with predictable costs and schedules. In addition, without well defined, repeatable processes to improve, it is impossible to systemically improve product delivery.

1.4 Document Overview

This volume consists of 5 chapters and 2 appendices, as follows.

Chapter 1, Introduction, provides an introduction, applicability and purpose for DISE Volume 2 and the applicability for the DISE series.

Chapter 2, Overview of Project Management, provides a definition of project management and elements of project management processes at the DOE.

Chapter 3, Initiating, identifies the processes for initiating projects at the DOE, including identifying, approval, start up, authorizing, and funding a project. The roles and responsibilities of the federal and contractor program and project managers are also identified.

Chapter 4, Planning and Executing, identifies practices such as determining project activities, estimating project effort, developing project schedules, managing decision points, and bringing projects to logical closure.

Chapter5, Controlling, identifies the practices for monitoring project and product performance and the reporting processes.

Appendix A, Resources, provides a list of the resources used in developing this guide.

Appendix B, Glossary and Acronyms, provides definitions for selected terms and defines acronyms.

1.5 Guidance Reference

References for additional information are documented throughout, as applicable to the section.

2.0 Overview of Project Management

Project management is the application of knowledge, skills, tools, techniques, and resources to project activities to meet or exceed stakeholder needs and expectations. It is the discipline associated with planning, managing and executing a project to ensure that the products or services are produced according to specifications, on time, and within budget.

Project management entails carrying out a project as effectively as possible with respect to these dimensions. All successful projects, regardless of size and complexity, share the following attributes:

- A project manager assigned, in charge, accountable and in control of the project budget.
- Clear definition of the work scope.
- An integrated schedule, including milestones.
- Supportive budget management that ensure funding availability within DOE.
- An overall plan (management or project) for performance.
- Project execution measured against the plan.
- Organizational commitment to successful project completion.
- Sufficient reporting to keep stakeholders aware of progress.
- Periodic management review to ascertain project status.

2.1 What is a Project?

A project is a series of goal-oriented processes to produce a specific *unique* product or service. A project includes the coordinated undertaking of interrelated activities. It is a *temporary* endeavor. *Temporary* means every project has a beginning and an end - the end being when the project's objectives have been achieved. The result or product may be ongoing, but the project has ended. *Unique* means that the product or service is different in some distinguishable way from all similar products or services - a product or service that has not been available before.

Projects have a scheduled beginning, intermediate, and ending date milestones, prescribed performance requirements, and costs. A project is subjected to planning, management, and control. It may stand alone, or be a basic building block in a program. It can be individually planned, approved and managed, or share activities and goals with related projects within a program.

2.2 Project Life cycle

A project life cycle is the methodology that is applied to a project to provide a method for performing the individual activities and tasks within an overall project framework. The stages and activities are designed to follow each other in an integrated fashion, whether the stages of development are accomplished sequentially, concurrently, or cyclically, etc. Generally, project teams have the flexibility to adapt the life cycle model to accommodate a particular development methodology (e.g., spiral development), software engineering technique (e.g., prototyping and rapid application development), or other project constraints.

The amount of project and system documentation required throughout the life cycle depends on the size and scope of the project. System documentation needs to be at a level that allows for full system operability, usability, and maintainability. Typically, projects that require at least one work-year of effort should have a full complement of documentation. For projects that require less than one work-year of effort, the project manager and system owner should determine the documentation requirements. In addition, the project's security and quality assurance criteria may require the performance of other activities and the generation of additional documentation.

2.2.1 Systems Engineering Methodology

The DOE Systems Engineering Methodology (SEM) integrates systems and software engineering, project management, and quality assurance processes into a life cycle that is controllable, predictable, and repeatable. The life cycle processes are divided into stages, activities, and tasks that can be combined or modified as necessary to fit the needs of various types and sizes of projects.

The life cycle processes are compatible with Departmental policy on software development and maintenance, and compliant with Level 2 key process areas in the Software Engineering Institute's Capability Maturity Model.

📖 To view the SEM: http://cio.doe.gov/ITReform/sqse/index.html

2.2.2 DOE O 413.1

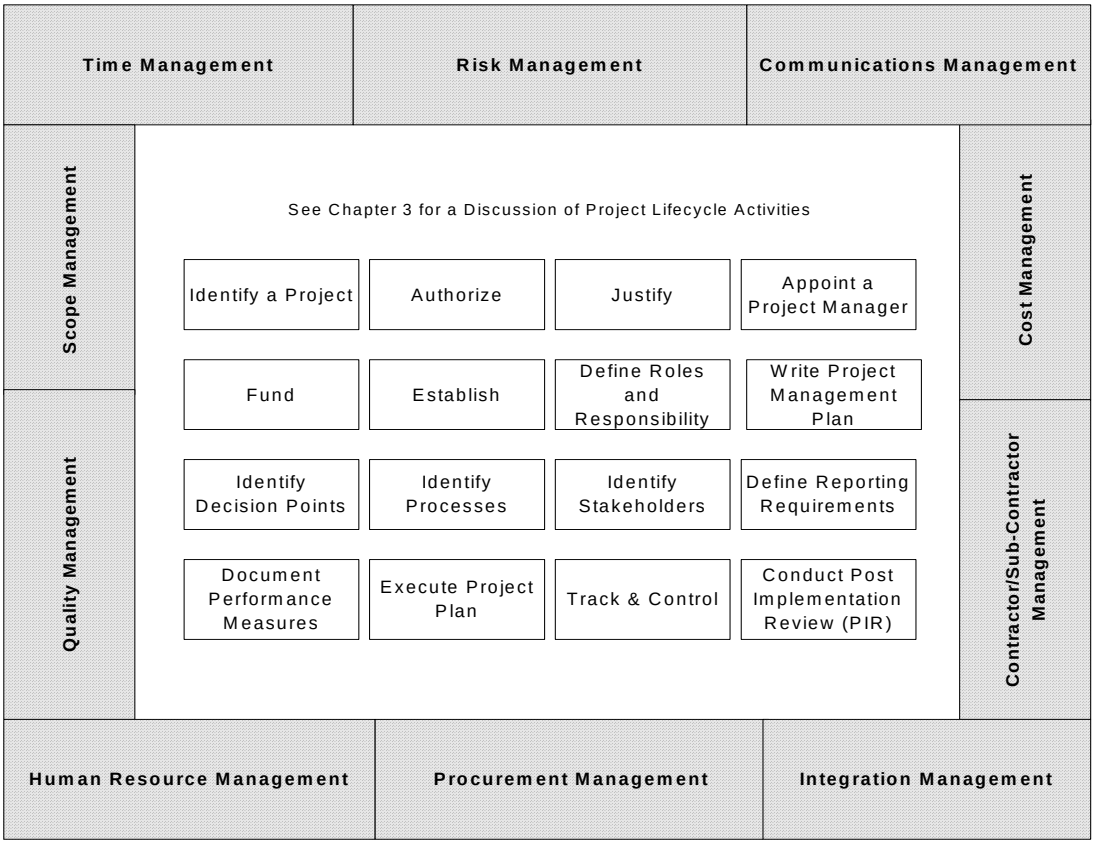
DOE O 413.1, Program and Project Management for the Acquisitions of capital Assets prescribes a life cycle process for DOE projects. The order provides a life cycle defined by its Critical Decisions points where a formal determination or decision is made at specific points in a project phase to allow the project to proceed to the next phase and commit resources. There are five Critical Decision points labeled CD 0 – 4 as follows:

- CD-0 - Approve Mission Need
- CD-1 - Approve Preliminary Baseline Range
- CD-2 - Approve Performance Baseline
- CD-3 - Approve Start of Construction, and
- CD-4 - Approve Start of Operations or Project Closeout

Specific project life cycle processes/methodologies may vary in detail due to different contractors or organizational requirements, however, they must be based on similar principles of a phased approach with pre-determined checkpoints and approval milestones, and meet, as a minimum, the requirements prescribed by DOE O 413.1.

📖 To view the 413: http://www.directives.doe.gov/pdfs/doe/doetext/neword/413/p4131.html

3.0 Elements of Project Management



The above diagram shows the generally accepted elements of project management. Complete definitions are contained in the Project Management Body of Knowledge (PMBOK)[1]. The size, complexity and environmental considerations of each project will dictate the extent to which they are incorporated into project plans. The project management team has overall responsibility for determining what is ultimately appropriate for any given project, which would be agreed to by the customer and stakeholders.

[1] Issued by The Project Management Institute: http://www.pmi.org

Elements	Project Stakeholders
- Project Integration Management - Project Time Management - Project Scope Management [2] - Project Communications Management - Project Cost Management - Project Quality Management - Project Human Resource Management - Project Risk Management - Project Procurement Management - Project Contractor/subcontractor Management	Customers, End-users, Owners of interfacing systems, Organizational management, LAN engineering, Operations support, Documentation engineers, Testing organizations

A project requires a wide range of skills and experiences. It may require teaming agreements with DOE organizations, contractors, or subcontracts with other companies. It is the project manager's responsibility to ensure that the teaming partners and contractor/subcontractors are held to uniform quality standards, especially in view of DOE guidance. Statements of work for the contractor/subcontractors must clearly state what quality assurance reviews are expected in their performance. The primary quality activities that the project management team will address with contractor/subcontractors are:

- Provide DOE quality requirements to the subcontractor.
- Establish acceptance criteria.
- Review and approve the contractor/subcontractor quality plan.
- Perform quality assessments of contractor/subcontractor performance.
- Monitor contractor/subcontractor assessments, and preventive and corrective action.

3.1 Integration Management

Project integration management involves the processes required to ensure that the diverse elements of project management are properly coordinated. This includes making tradeoffs among competing objectives and alternatives in order to meet or exceed customer needs and expectations. The work of the project must also be integrated with the ongoing operations of the organization conducting the project. Additionally, product and project scope must be integrated; i.e., the features and functions that are to be included in a product must flow with the work that must be done to deliver that product. This includes deliverables from, and required by different functional specialties. The elements of project integration are Project Plan Development, Project Plan Execution, and Change Control.

3.1.1 Project Plan Development

A Project Plan is developed for each new task/project. The Plan is the result of the project manager and project staff going through the process of planning project scope, specific project deliverable activities, staffing, activity sequencing, activity duration estimating, schedule

[2] Developing the work breakdown structure (WBS) subdivides major project deliverables into smaller, more manageable components. An example of a software project WBS may be viewed at: http://cio.doe.gov/ITReform/sqse/pm_wbs.htm

development, resource planning, cost estimating, and cost budgeting. The detailed Plan may be referred to as a **Project Management Plan** or **Project Plan**. They both serve the same purpose: they are the consistent, coherent, dynamic document that is used to guide both project execution and project control.

The Plan contains the project goals, objectives, scope and product overview. It is used to guide project execution, document project planning assumptions and decisions regarding alternatives chosen, facilitate communications among stakeholders, define key management reviews as to content, extent, and timing, and provide a baseline for progress measurement and project control. The Plan is reviewed and revised as needed, typically at the end of stages, phases or any logical checkpoint within a project. Critical project decisions can also result in the Plan being revised.

📖 To view a project plan template: http://cio.doe.gov/ITReform/sqse/template.htm
📖 To view project plan samples: http://cio.doe.gov/ITReform/sqse/pm_docs.htm
📖 To view a project plan example: http://cio.doe.gov/ITReform/sqse/pm_plan.htm

3.1.2 Plan Execution

Execution of the activities documented in the Project Plan and/or the WBS is where the majority of the project budget will be spent. Throughout this process, the project manager and the project management team must coordinate and direct the various technical and organizational interfaces that exist in the project.

3.1.3 Change Control

Once written, the Project Plan is placed under configuration management. Changes are managed in a manner that assures the integrity of the project baselines is maintained. All approved changes are reflected in a revised Plan. Changes to the products will be reflected in the revised definition of the project scope, and be approved by all project stakeholders or as per the approval process defined for a given project.

Change control is critical. When the scope of the project changes (typically as a result of requirements changing), costs may increase, benefits may decrease, and payback periods may increase. Project managers will use an integrated change control process (configuration, quality, time, and cost control), to manage changes when they occur, and to ensure changes are beneficial.

3.2 Time Management

Project time management includes the processes required to ensure timely completion of the project. The processes include activity definition, sequencing, duration estimating, schedule development, and schedule control. Also included in time management is the identification of resources, constraints, and assumptions that can impact scheduling.

3.3 Scope Management

Project scope management includes the development of a written statement about the parameters of the project, and the process required to ensure that the project includes all the work required for successful completion. Developing a written scope statement establishes the basis for future project decisions, and forms the basis for an agreement between the project team and the customer. It identifies the project objectives, project justification, a product description and a summary list of major project deliverables.

The major project deliverables are subdivided into smaller, more manageable components in a work breakdown structure (WBS) to improve accuracy of cost, time and resource estimates. The WBS also defines a baseline for performance measurement and control, and provides a graphic representation that completely defines the project by relating elements of work to each other and to the end product. The WBS shows the relationship of all elements (hardware, software, data, etc.) supporting the project, and provides a sound basis for cost and schedule control.

📖 An example of a software development WBS may be found at http://cio.doe.gov/ITReform/sqse/pm_plan.htm under Project Planning.

Scope verification is the process of formalizing acceptance of the project scope by stakeholders. It requires reviewing of work products and results to ensure that all were completed in a satisfactory manner. If the project is terminated, scope verification will establish and document the level and extent of completion.

3.4 Communications Management

Communications management involves methods for communicating and receiving information about the project to and from the customer, stakeholders, and all participants. The methods of dissemination can vary widely. The manner in which these needs are met can also vary widely.

One element of communications management required by DOE 1332.1A for all projects is the monthly Technical Status Report (TSR). Additional performance reporting requirements may include, but are not limited to, special project manager's progress reports, quarterly project reports, weekly/monthly status briefings to the stakeholders and management, and project status reviews and/or presentations.

More formal and frequent communications may be required for projects with critical importance to program objectives, large in size, complex, requiring a high degree of Federal oversight, and with high management visibility. All project communications requirements will be identified in the detailed Project Plan.

3.5 Cost Management

Project cost management is a process that ensures the project is completed within the approved funding. The cost management methodology must also consider the information needs of the stakeholders - different stakeholders may measure project costs in different ways and at different

times. The criteria for project cost management can be defined in the Project Plan or a Cost Plan.

3.5.1 Resource Planning

Resource planning is associated with determining the resources (people, equipment, materials) required for performing project activities. This can be accomplished by:

- Analyzing the WBS to identify project activities that will require resources.
- Reviewing historical information for the types of resources that were required for a similar project.
- Analyzing the scope statement containing the project justification and objectives.
- Analyzing the resource pool for staff, equipment, and materials that are relevant and potentially available to the project.

Any sponsoring organization policies regarding staffing and the rental or purchase of supplies and equipment must also be considered during resource planning.

3.5.2 Cost Estimating

Cost estimating is the process of developing an approximation or estimate (quantitative assessment of the likely costs) of the resources needed to complete the project. The estimates will be supported by documentation of the basis of the estimates, any assumptions made, and the range of what the item is expected to cost, i.e., between $n,nnn and $nn,nnn. Cost estimates should include all resources needed for a project such as labor, materials, supplies, management, and quality assurance. Projects should be estimated using a combination of the following methods so one method can be used to validate the results of another.

- Use the WBS to develop a *bottom-up* estimate of each task separately, then combining the results to produce an estimate for the entire project. Organizing the cost estimates in this manner helps to ensure that all identified work has been estimated.
- Analyze the resource requirements required for the project and resource rates for each resource unit (staff, supplies, etc.) to calculate project costs. If actual rates are unknown, the rates may have to be estimated.
- Analyze how activity duration estimates will affect overall cost estimates for projects that have an allowance for the cost of financing (i.e., interest charges).
- Use the *analogy method* by reviewing historical information from previous projects for similar categories of resources and extrapolating data to assist in estimating the cost of the proposed project. When the project manager and/or project management team from the previous project are available, their experience and understanding (*expert judgment)* of the proposed project can be used for formulating or validating estimates.
- Use computerized tools such as cost-estimating software, project management software, and spreadsheets.
- Analyze the organization's chart of accounts (DOE analogy is the B & R Code), to ensure project cost estimates are assigned to the correct accounting category.

3.5.3 Cost Budgeting

Cost budgeting is the allocation of the overall cost estimate to individual work items to establish a cost baseline for measuring project performance. The sources of cost budgeting include the cost estimates, the WBS, and the project schedule that contains the planned start and expected end dates for the project elements to which costs will be allocated. This information is needed to assign costs to the time period when the cost will be incurred.

3.5.4 Cost Control

Cost control is the control of the factors that effect change to the cost baseline, to ensure that changes are beneficial. Cost control for the project funding includes:

- Monitoring cost performance to detect variances from the plan.
- Ensuring that all appropriate changes are recorded accurately in the cost baseline.
- Preventing incorrect, inappropriate or unauthorized changes from being included in the cost baseline.
- Informing and/or obtaining mutual consensus from stakeholders on authorized changes and revising the cost baseline (estimates).

3.6 Quality Management

Project quality management involves the processes required to ensure that the project will meet or exceed customer requirements and expectations. It includes the process activities recommended by the Quality Program or function that determines the quality policy, objectives and responsibilities. The major processes are quality planning, quality assurance, quality control, and quality improvement.

Each of the quality processes or activities may involve one or more individuals or groups of individuals based on the needs of the project. The quality activities planned for the project should be documented either in the Project Plan or the project Quality Plan.

3.6.1 Quality Planning

Quality planning involves identifying the standards and quality activities that will apply to the project, and determining how to incorporate and satisfy them. Quality planning is performed regularly and in parallel with the other project planning processes. The performing organization's quality policy states the overall quality direction, and should be included in the Quality Plan (or Project Plan). If the organization conducting the project does not have a formal quality policy, then a decision should be made to have the project management team develop a quality policy based on the requirements of DOE Order 414.1A, *Quality Assurance.*

The customer will concur with the Plan and provide approval. The project management team is responsible for ensuring that stakeholders are aware of the quality policy. The scope statement is important to quality planning since it documents project objectives, project description, and major deliverables that serve to define important project requirements. The product description

will often contain details of technical issues and other concerns that may affect quality planning. Other considerations that affect quality planning are standards, regulations, and DOE policies.

A Quality Assurance Plan (QAP) will describe how the project management team will implement quality assurance on the project. The QAP will describe the organizational structure, responsibilities, procedures, processes, and resources needed to perform quality assurance. The QAP may be separate or contained within the Project Plan. It can contain a high or low level of detail based on the size and complexity of the project.

📖 DOE Notice, 10/02/2000, SO: DOE N 203.1
📖 DOE Order, 10/13/2000, CR: DOE O 413.3
📖 DOE Order, 07/12/2001, EH: DOE O 414.1A Chg 1
📖 DOE SEM, SQA Planning: http://cio.doe.gov/ITReform/sqse/download/v2c03-09.pdf

3.6.2 Quality Assurance

Quality assurance is the implementation of the planned and systematic activities contained in the QAP that will satisfy customer requirements and provide confidence that the project will satisfy the relevant quality standards. Some of the activities included in quality assurance are product audits and process audits, conducted by project staff and also independent parties.

3.6.3 Quality Control

Quality control involves measuring and monitoring specific project results to determine if they comply with project specifications and quality standards, and identify ways to eliminate causes of defects. Quality measurements and associated metrics should be specified in the Quality Plan (or Project Plan). The results of the quality measurements will be reviewed to gauge the quality of the project. Metrics may be identified through operational definitions, which will describe what something is and how it is measured.

For example, meeting the planned schedule date in itself is not a measure of quality. The project management team must indicate whether every activity must start on time, or only finish on time, whether individual activities will be measured or only certain deliverables, and if so, which ones. Checklists may be simple or complex (depending on the project) tools that can be used to verify that a set of required steps have been performed.

Project results include both *product* results (deliverables), and *management* results (cost and schedule performance). The project management team should have a working knowledge of statistical quality control, especially sampling and probability, to facilitate the evaluation of quality control outputs.

Comparisons of actual management and product results will be made with the planned and expected results identified in the Quality Plan or Project Plan. Assessment techniques can range from peer reviews to independent audits as a means to determine if the results conform to requirements. Variances will be analyzed for determination of causes and unidentified risks to the project. When variances exist, action must be taken to bring the project into compliance with requirements.

3.7 Human Resource Management

Project human resource management includes the processes required to make the most effective use of the staff involved with the project. It includes all project stakeholders, i.e., Federal program managers, customers, project manager, system owner, individual contributors and other staff described in the Project Plan. The key elements of human resource management are organizational planning, staff acquisition, team Development, and subcontractor management. These processes interact with each other and with the processes in the other project areas.

3.7.1 Organizational Planning

Organizational planning involves identifying, documenting, and assigning project roles and responsibilities, and establishing reporting relationships. On most projects, the majority of organizational planning is done early in the project and is reviewed regularly throughout the life of the project to ensure continued applicability.

All aspects of staffing should be addressed in a Staffing Plan (or in the Project Plan). Staffing requirements will define what skills are required from individuals or groups, and the time frames when those skills are required. The Staffing Plan will address these areas in detail and contain resource histograms of the project life cycle correlated with the project's resource usage of staff hours. Staffing requirements are a subset of the overall resource requirements identified during resource planning.

Some of the constraints that may limit the project team’s options are the organizational structure of the performing organization, collective bargaining agreements, preferences of the project management team, and expected staff assignments. Therefore, organizational planning is often closely linked with communications planning. The three project interfaces that need to be addressed in organizational planning are organizational interfaces, technical interfaces, and interpersonal interfaces. These interfaces, which often occur simultaneously, involve formal and informal reporting relationships and communications among organizational units, technical disciplines, and different individuals working on the project.

3.7.2 Staff Acquisition

Staff acquisition must take into account the potential available staff and previous experience, personal interests, personal characteristics, and availability. If the project sponsoring organization has policies governing staff assignments, those policies can act as a constraint on the staff acquisition process.

3.7.3 Team Development

In addition to the technical skills required to perform the project, the project manager and the project team are expected to have the necessary project management, general management, and team-building skills. Team building activities include management and individual actions taken

specifically and primarily to improve team performance. In addition, general management skills are important to team development. Many actions, such as involving non-management team members in the planning process, and/or establishing ground rules for surfacing and dealing with conflict, may enhance team performance as a secondary effort. Professional training is also desirable for team development and individual growth.

3.8 Project Risk Management

Project risk management is the process of identifying, analyzing and responding to project risks that could result in cost and schedule overruns, and/or project failure. Risk management begins with an assessment of the environmental, operational and technical risks prior to the establishment of a project.

Once the project has been approved and is initiated, risk management becomes an integral part of the project. Risk assessments will be conducted at logical checkpoints, or when key decisions are being made throughout the project. Risk assessments help assure that positive events are maximized and that adverse events are minimized, i.e., that the response to the risk assures that the risk is avoided, mitigated or accepted. The elements of risk management include identification, quantification, and response development and control.

3.8.1 Risk Identification

Risk identification consists of determining which risks, both internal and external, are likely to affect the project and documenting the characteristics of each risk. Products that involve proven technology will involve less risk and cause less cost and schedule impact than those which require innovation or invention. Projects that are mandated by law are less impacted by high-risk assessments because funding is generally made available and not likely to be eliminated. If a high level of risk is evident at a project's inception, and no tradeoff exists in the form of proven and affordable technology, a decision must be made as to whether the project is realistic or economically feasible.

Common influences for risk include changes in requirements, unrealistic requirements, changing technologies, unrealistic schedules, fluctuating or reduced budgets, ill defined or understood roles and responsibilities, inadequate estimates, insufficient skilled staff and low moral. The WBS, cost and duration estimates, staffing plan, and historical data will also be reviewed to identify possible risks.

3.8.2 Risk Quantification

Risk quantification is the process of evaluating risks and risk interactions to assess the range of possible project outcomes. It is primarily concerned with determining which risk events warrant a response. It is complicated by opportunities and threats that can interact in unanticipated ways (schedule delays), single risks that can cause multiple effects, and conflicting stakeholder opportunities, just to name a few.

3.8.3 Risk Response Development

Risk response development is the definition of methods or steps that can be taken to reduce or eliminate risk. One method is avoidance of a specific risk, which can be accomplished by eliminating the cause. For example, goods or services can be acquired from outside the immediate project organization, such as subcontracting to a firm that has the experience with a particular technology. Another way is to develop a contingency plan, which defines actions to be taken if an identified risk event should occur. A third way is to hold subcontractors to the same project specifications and quality assurance standards as the prime contractor.

Contingency plans can reduce (mitigate) the expected monetary value of risk by reducing the probability of occurrence. The consequences of risk can be accepted and alternative strategies for changing the planned approach can be developed. Proceeding with a project with high risk must be documented and agreed to by the customer and stakeholders.

3.8.4 Risk Response Control

Risk control involves executing the risk management plan to respond to risk events over the course of the project. When changes occur, the basic cycle of identifying, quantifying, and responding is repeated. Even the most thorough and comprehensive analysis cannot identify all risks and probabilities, therefore, control and iteration of the risk assessment process are required.

3.9 Procurement Management

Project procurement management relates to the process required to acquire products from outside the organization conducting the project to support the successful completion of the project. It requires project procurement planning to assure that project delays are avoided and project objectives are met. The procurement planning will take into account:

- Developing a procurement management plan.
- Preparing the statement of work.
- Preparing the product description.
- Developing the requirements and specifications document.
- Conducting market research.
- Performing contract administration.
- Coordinating procurement resources.
- Preparing the proposal/solicitation vehicle.
- Developing the evaluation criteria.
- Performing the source selection.

Procurements will be administered according to existing DOE and/or corporate procurement guidelines.

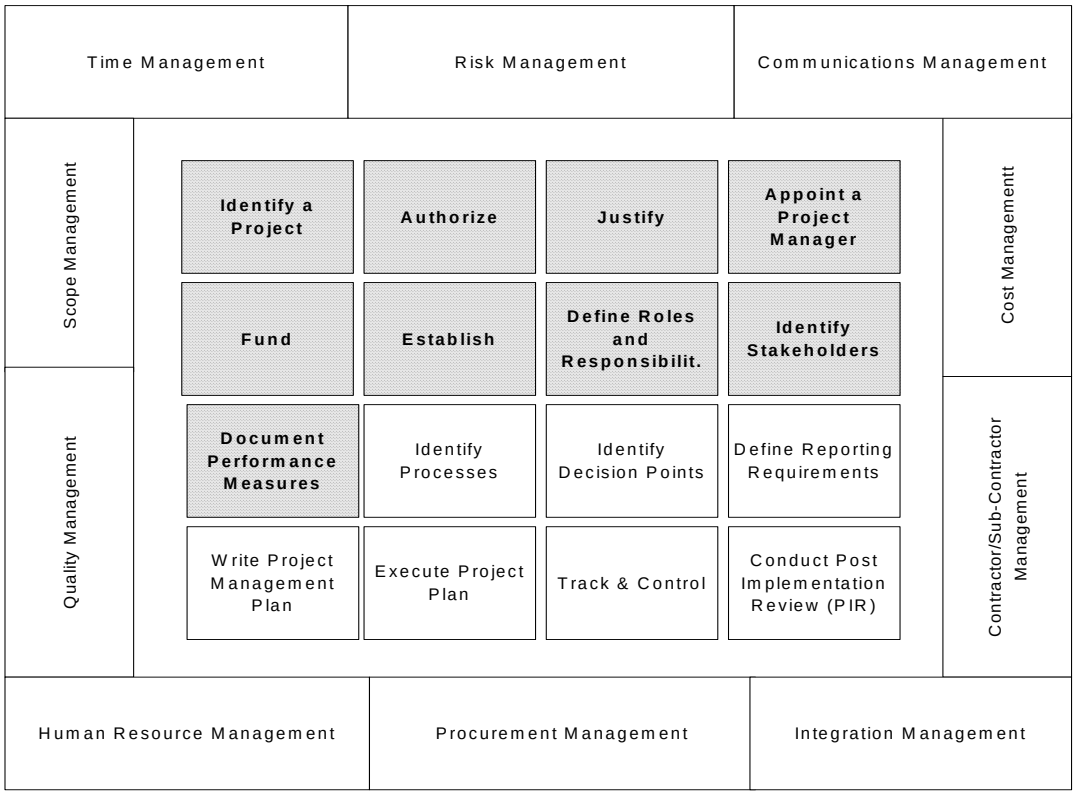
3.10 Contractor/subcontractor Management

When a project being managed by the primary contractor requires a wide range of skills and experience, it may require subcontracting with other companies. It is the prime contractor project manager's responsibility to ensure that the teaming partners and subcontractors are held to the same quality standards as the prime contractor as specified in the Project Plan, existing DOE guidance listed in the references section, and reporting requirements listed herein.

Statements of work for the subcontractors must clearly reflect the project requirements and state what activities and reviews are expected in their performance. Primary activities that the prime contractor will address with subcontractors include:

- Acceptance criteria.
- Subcontractor Project Plan, Quality Plan, Quality Assurance Plan.
- Quality assessments of subcontractor performance.
- Subcontractor assessments, audits, preventive and corrective action plans.

4.0 Initiating



4.1 Identifying a Project

Federal laws and regulations may mandate that a project be initiated to comply with their direction. A project may be identified in Departmental or IM Strategic Plans, and site working groups, such as the Headquarters Collaboration Group or the DOE IM Council. Projects may also be initiated by Federal program managers through mission analysis and internal assessments of their programs, where they identify need for improvement to existing capabilities or opportunities that will enhance the accomplishment of missions. Program managers are typically organizational heads, directors, or group leaders, and have the knowledge of organizational requirements and identify projects necessary to ensure organizational missions are accomplished.

4.1.1 Project Initiation

The Clinger-Cohen Act, also known as the Information Technology Management Reform Act, directs U.S. Government departments and agencies to better manage technology investments. As a result of this law and internal DOE process improvement objectives, the DOE has implemented processes for corporate project initiation to ensure the resulting IS solution meets business and mission needs, and is feasible both from a cost and technological standpoint. As described and illustrated in DISE Volume One, Chapter 2, internal and external Drivers are the source, or point of beginning, for most IT projects. All proposed projects participate in the process of forming

and evolving the Vision (target) DOE Information Architecture (IA). Projects must be strategically planned with capital planning such that they will be part of a harmonious migration from the current to the proposed DOE architecture, in line with the documented migration plans and objectives.

The Capital Planning Process, outlined later in this chapter, enables the migration process through cooperative planning efforts with the IA staff to develop both the technical strategies and budgets to achieve the Vision IA. The results of these planning efforts are potential projects that should undergo a feasibility analysis to determine if they should be funded.

Projects involving the development of corporate systems should be evaluated to determine if their participation in a full-blown business case and feasibility study set of activities, with alternatives and recommendations for systems and business process reengineering, is warranted. Evaluation of non-corporate systems is less intensive and may include a feasibility study and an analysis of benefits and costs (ABC).

4.1.2 Capital Planning

The implementation of an effective, efficient, and repeatable capital planning process is required by the Clinger-Cohen Act, and is essential to ensure sound IT investment decisions. DOE uses a documented and established approach to identify, prioritize, justify, fund, and manage corporate IT investment opportunities. The process describes the selection, control, and evaluation of the Department's corporate and infrastructure-related IT initiatives. The process includes guidelines for Program-level IT capital planning processes, as well as current Program models.

The Department's approach, Capital Planning and Investment Control (CPIC), is based on legislative requirements, direction provided by the Office of Management and Budget (OMB), recommendations of the General Accounting Office (GAO), Federal Chief Information Officer (CIO) Council, and best business practices

The DOE *Guide to IT Capital Planning and Investment* describes the approach DOE uses to identify, prioritize, justify, fund, and manage IT investment opportunities. The process applies to the selection, control, and evaluation of the Department’s business, administrative, and infrastructure-related IT initiatives. All projects, corporate and non-corporate, should participate in a capital planning process where they are funded, tracked, and analyzed to ensure sufficient resources are provided for successful completion.

📖 For additional information: http://cio.doe.gov/ITReform/Planning/index.htm

4.1.3 Enterprise Architecture

An Enterprise Architecture (EA) is the unified articulation of all the legislative mandates, the technical requirements as well as all policies, procedures, and standards necessary to ensure the optimum level of capability of all the various information technology investments of the enterprise.

An EA must contain a future (or target) architecture which is a complete inventory of all the information technology assets, legislative mandates, policies, procedures, and all technical requirements necessary to provide the information technology capabilities that the enterprise has agreed will be in place by a specified time.

The relationship of the CPIC process and the EA can be described as follows. The EA identifies the IT capabilities that an enterprise has agreed to acquire over a specified time, while the CPIC process is the comprehensive oversight mechanism to ensure that all IT assets acquired by the enterprise are the best of all available competing proposed asset purchases. The CPIC process also ensures that the asset selected for funding is in keeping with the IT goals outlined in the EA. In essence, the EA articulates the IT plan the enterprise agrees to pursue and the CPIC process is the process for ensuring that the plan is carried out properly.

4.1.4 Section 508 Law

In 1998, Congress amended the Rehabilitation Act to require Federal agencies to make their electronic and information technology accessible to people with disabilities. Under Section 508, agencies must give disabled employees and members of the public access to information that is comparable to the access available to others. Inaccessible technology interferes with an individual's ability to obtain and use information quickly and easily. Section 508 was enacted to eliminate barriers in information technology, to make available new opportunities for people with disabilities, and to encourage development of technologies that will help achieve these goals. The law applies to all Federal agencies when they develop, procure, maintain, or use electronic and information technology.

📖 For more information on Section 508: http://section508.gov

4.1.5 Business Case

When a corporate or major project is initially proposed, the project scope is established in order to limit the project size to a manageable cost target and implementation time frame. The high-level objectives and initial high-level requirements are identified based on the scope of the project and documented as part of the initial project planning. The high-level scope, objectives and requirements are often identified or affirmed when developing the business case for a corporate or major system.

A business case is a structured proposal for business improvement that functions as a decision package for organizational decision-makers and planners. A business case includes an analysis of business process performance and associated needs or problems, proposed alternative solutions, assumptions, constraints, and a risk-adjusted cost-benefit analysis

The business case should be reviewed and updated throughout the project life cycle to determine if it is still valid and the cost and benefit objectives are being realized.

4.1.6 PM for Corporate vs. Non-Corporate Systems

IT projects for efforts that are not identified as corporate (or major) systems still follow many of the same initiation processes as for corporate systems. They may be the result of the same drivers or result from a business process reengineering initiative; however, the processes are generally applied by individual Programs or organizations within DOE and are less structured than the corporate processes. In some cases, a non-corporate project is initiated by a bottoms-up request, where a business/mission need is identified based on individual input. Coordination with and alignment to the IA strategic plan and vision are required of all projects.

Both project management and oversight should be commensurate with the size and risk of the project. Projects involving corporate (and major) systems may be required by the DOE Chief Information Officer to be monitored via the CIO Quarterly Review Process. Non-corporate systems may be subject to similar scrutiny based on the requirements of individual programs or organizations within DOE and the requirements of site CIOs.

📖 CIO Quarterly Review Process guide: http://cio.doe.gov/ITReform/sqse/pm_trck.htm

4.2 Justifying a Project

Justifying and obtaining approval for a project is a prerequisite for requesting funds in the internal review budget cycle. Projects should have an Analysis of Benefits and Costs (ABC). Specifically, the business-need should be expressed in an ABC, which is generally a part of the business case for the project. The ABC justification will contain an analysis of the costs versus the benefits, and show a quantifiable return on investment (ROI). When the justification is realistic, accurate, and kept current, it will be easy to defend. An ABC is also effective as the basis for justifying prototyping or experimental projects for proof-of-concept (or choice of approach). Program managers should approve projects prior to the planning stages of the annual internal review budget cycle.

📖 More info. on ABCs: Volumes 1, *A Manager's Guide to Analysis of Benefits and Costs;* and 2, *An Analyst's Guide to Analysis of Benefits and* Costs:
http://cio.doe.gov/ITReform/sqse/pm_abc.htm and Section 3.7.5 of the (SEM):
http://cio.doe.gov/ITReform/sqse/sem_main.htm

4.2.1 Establishing Performance Measures

All IT projects should have clearly documented, and measurable performance objectives. For a complete discussion on this topic please see Section 5 of this document.

4.2.2 Establishing Project Measures

Project measures are used to track the health and status of a project. Project measures typically track the planned versus actual for the project schedule and budget. Further discussion of this topic is presented in Section 5 of this document.

4.3 Authorizing a Project

Projects, whether mandated by executive or legislative authority or identified through assessments or analysis of mission need, may be authorized by Federal program managers. In addition, a program manager undertaking new or additional program areas may authorize a project so new capabilities may be established. Some organizations authorize projects through an IM steering committee. Decisions may justify system acquisition approvals, projects, planning, and budget formulation.

4.3.1 Approval of Mission Need

The program manager must approve the identified mission need. It is the prerequisite for requesting conceptual design funding in the internal review budget cycle. Approval must occur prior to the planning stages of the annual internal review budget cycle and be accompanied by justifying documentation.

4.4 Approval of Project Startup

The approval for project startup is the prerequisite for requesting project line item funding in the internal review budget cycle. To receive approval, there will be an approved project description with initial project baselines and authorizing signatures that validates the commitment of how the project will be conducted. A change control process delineating specific responsibilities, authority, and accountability will be implemented to manage changes affecting the project baselines. These activities must occur prior to the release of funding.

4.5 Funding a Project

Program managers are responsible for budget formulation and execution of an approved budget for projects they have authorized. In almost all cases, legislative mandated projects will receive priority funding. Other projects may be funded by a Federal program manager to improve efficiency and effectiveness in the accomplishment of program missions.

Planning estimates must be developed for a project at the time of project identification to support project justification. These estimates are developed early in the project life cycle and are order of magnitude only. Cost estimates from the ABC must be documented in a statement of costs to be incurred to complete the project. This is the baseline against which cost comparisons are made during the life of a project.

📖 DOE Directives, Policies, Standards, etc.: http://www.directives.doe.gov/index.htm

4.5.1 Capitalization

Any internal use software project in the development or maintenance phase of its life cycle that meets the following criteria will need to satisfy capitalization requirements:

- Adds a new site or undertakes an enhancement or technology refresh or

- Reaches the cost threshold established by *The Statement of Federal Financial Accounting Standards (SFFAS) Number 10: Accounting for Internal Use Software*

Capitalization requires all Federal agencies to capitalize software acquired or developed for internal use if the expected service life of the software is two or more years and its cost meets or exceeds the agency's threshold for internal use software. The DOE threshold is currently set at $750,000.

The standard requires capitalization of direct and indirect costs, including employee salaries and benefits for both Federal and contractor employees who materially participate in the software project. DOE program managers are considered to be the source of cost information for internal use software projects. If capitalization data is collected for the project in the future, the project is expected to calculate and track its ROI.

4.5.2 Corporate Management Information Program (CMIP)

The CMIP was initiated by DOE in FY 1998 in recognition of the fact that corporate legacy systems that support administrative functions were nearing the end of their life cycles. An investment to replace and modernize severely outdated information technology (IT) systems would prove a much more efficient expenditure of scarce IT dollars than the continued enhancement, maintenance, and operation of the legacy systems. In implementing the CMIP, relevant sections of the Clinger-Cohen Act of 1996 have been addressed.

The CMIP provides a cost-effective way to modernize and improve software applications, hardware, and infrastructure, which support a wide range of Department-wide IT based business systems. The outcome of the CMIP initiatives will be a secure, contemporary, interoperable, and cost-effective corporate information management system for the Department

4.5.3 Working Capital Fund

The Working Capital Fund began operation in FY 1997 after OMB and congressional approval. The Fund is a financial tool for improving management of common administrative services including networking and desktop support. The objectives of the fund include:

- Fair allocation of administrative costs to mission programs.
- Choices on the amount, quality, and sources of administrative services.
- Expanded flexibility to permit service providers to respond to customer needs.

4.6 Establishing a Project

A project should be justified, authorized, and funded before it is established. If the project is to be conducted by a contractor service provider, a Federal project manager or Technical Monitor (TM) will be placed in charge. The TM will submit a task assignment through a Contracting Officer Representative (COTR), or establish a project via an existing task assignment. The contractor must respond to the task assignment with a Management Plan based upon contractual requirements. The Management Plan may summarily define the management approach for

performing the effort, the scope of activities, and provide information as to how the task will be managed to demonstrate to the customer that the contractor understands the request and objectives of the task.

This Management Plan may be all that is required for recurring (administrative) tasks. A more detailed Project Plan may be developed during the planning stage for new IT Products and Services projects. The size and complexity of the project are usually the determining factor in the level of detail provided.

4.7 Appointing a Project Manager

Project managers are appointed based on their overall skills and experience in project management. Federal program managers may assign overall project management duties to a Federal employee in cases where the project has DOE-wide impact, or there is a large mix of DOE and contractor project participants. In less complex projects, these duties may be delegated to a contractor project manager.

When project manager duties have been delegated to a contractor, the project may fall under the general direction of a TM who works within the program manager's organization. Although the contractor project manager generally has the authority and responsibility for planning, organizing, executing, directing, and controlling of all activities within the project, the carrying out of these duties should be performed with the full knowledge of the TM.

The project manager, whether Federal or contractor, is responsible for all aspects of the project including project planning, project tracking and oversight, quality assurance, configuration management, and sub-contractor management. The project manager will be the point-of-contact for the information flow to customers and stakeholders on the day-to-day project activities.

4.8 Identifying Project Stakeholders

Project stakeholders are individuals who will be actively involved in, or affected by the project. The project management team must identify the stakeholders, determine what their needs and expectations are, and then manage and influence those expectations to ensure a successful project. The project manager is responsible for identifying the key stakeholders during the planning process, if they have not already been identified, i.e., through the Business Case development process.

Typical stakeholders on a project include:

- Federal Program Manager. The person who identifies, authorizes, justifies, and manages funding for a project.
- Customer. The organization or individual(s) who will use the product or system. Customers may be (or may be represented by) a Program Manager, system owner, IM or user point-of-contact, or Technical Monitor. All customers must be identified to ensure all requirements related to the project are collected.
- System Owner. A person within the organization who may also have oversight

responsibility. The Program Manager can also be the system owner.
- Project Manager. Federal or contractor employee responsible for managing the project. Federal project managers may also be referred to as Technical Monitors.
- Project Team. The group of Federal and/or contractor employees responsible for developing the product.
- Quality Assurance. The person or group responsible for assuring the project meets customer specifications, project expectations, and quality standards.
- Functional Area Staff. Functional areas that at some point will be involved in completing the project, including, e.g., staff involved with infrastructure, security, operations, oversight, etc.

4.9 Roles and Responsibilities

There are many individuals involved throughout a project's life cycle. The key roles for the project management processes are the Federal program manager, the Federal TM and the project manager (typically a contractor but may be a Federal employee).

4.9.1 Federal Program Manager

This role is generally assigned to a Federal employee who is responsible for the oversight of a program that is supported by a team of people that may include, or be exclusively comprised of contractors. The program manager is the product sponsor and a key stakeholder. The program may include one or more systems engineering projects to develop new, or make changes to existing, information system(s). Program manager responsibilities include:

- Ensure justification of expenditures and investment in systems engineering activities.
- Coordinate activities to obtain funding.
- Review and approve project plans.
- Review and approve deliverables throughout the project life cycle.
- Ensure processes are applied that will foster delivery of quality products and services.
- Coordinate issue resolution and escalations to higher management.
- Ensure acceptance testing and acceptance by the customer or system owner.

The program manager should also ensure performance indicators are established, met, and an appropriate transition to operations and maintenance occurs.

4.9.2 Federal Technical Monitor

A Federal Technical Monitor (TM) is typically the Federal project manager who administers funded contractor task assignments. A TM must be involved in all DOE funded contractor projects. Following is a list of TM project-related responsibilities.

- Serve as the project manager for special, integrated, organizational and DOE-wide projects as assigned by a program manager.
- Develop a clear and definitive statement of work (SOW) for contractor task assignments and provide independent government estimates for manpower and funding resources.
- Ensure plans and reports for managing and monitoring the task or project are identified, and that they support effective management and satisfy technical and financial reporting

requirements. Review, analyze, evaluate and act on information provided through the plans and reports.
- Ensure coordination with all Federal and contractor project participants at project inception.
- Provide technical direction, planning, funding, and monitoring of contractor resources, including the approval of related travel and training.
- Closely monitor cost control, quality of technical performance, and timely milestone/schedule accomplishment through trend analysis and other means.
- Provide written evaluation of resource work plans, technical schedules, cost, and project management performance.
- Promptly review and approve management and project plans, and draft deliverables.
- Initiate written modifications to tasks upon change in scope or the period of performance.
- Advise customers on the appropriate telecommunications and computer technology and their capabilities and limitations.
- Periodically evaluate contractor performance and provide comments and grades.

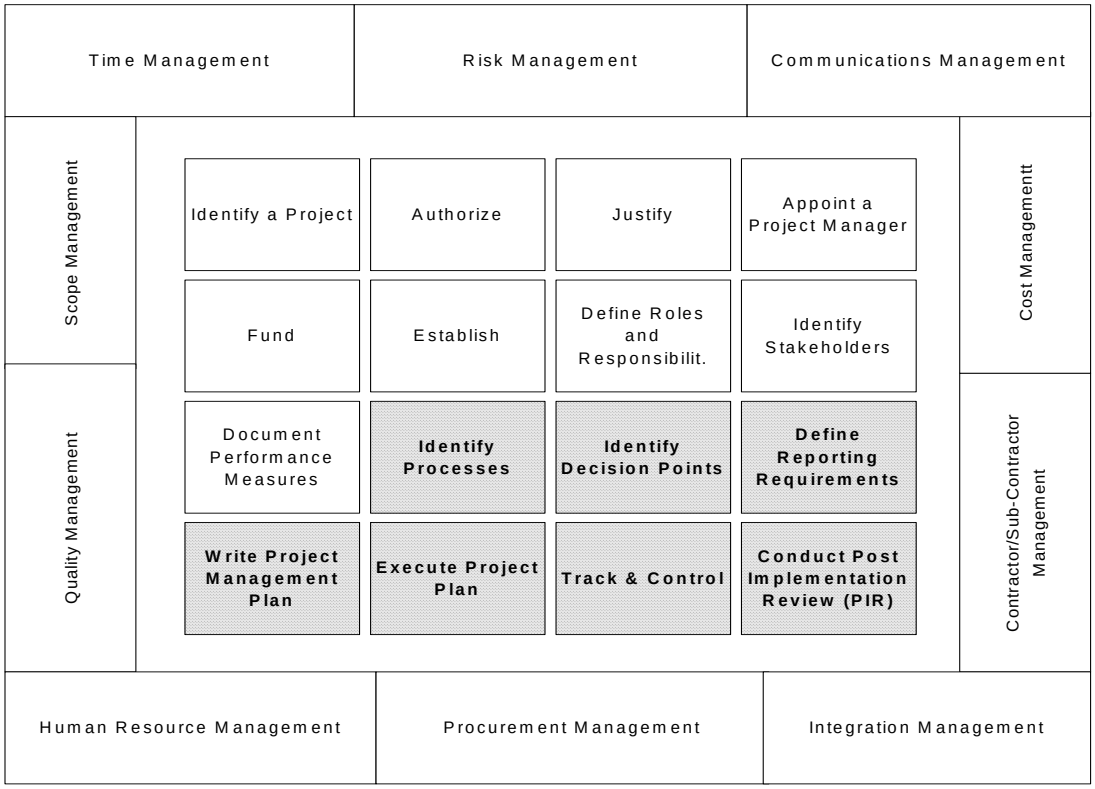
4.9.3 Federal or Contractor Project Manager

The project manager is the person responsible for daily planning, tracking, reporting, and coordinating of project activities. These activities include the performance or oversight of configuration management, requirements management, risk management, and quality management. The project manager is also typically responsible for personnel actions and issue resolution. Other common titles for the project manager's role include project coordinator, project leader, project officer, and systems integrator.

The project manager's role may be full or part-time. The project manager may be a Federal or contractor employee. It may be common for a contract project manager to report to a contractor manager from an organizational perspective, but receive functional direction from the Federal program manager and/or TM.

📖 DOE Software and Systems Engineering: http://cio.doe.gov/ITReform/sqse/index.html
📖 The Project Management Institute: http://www.pmi.org

5.0 Planning and Executing



5.1 Project Decision Points

Key decisions made throughout a project's life cycle. Several of those decisions are made prior to project initiation, and others at logical points during project execution.

5.1.1 Logical Checkpoints

Projects have logical checkpoints (e.g., stages or phases). These checkpoints are delineated in the project management plan. Project evaluations are conducted at these checkpoints. Stakeholders will take these opportunities to validate that the project is meeting requirements, that requirements are still worthwhile, if requirements have changed, and whether to continue with or terminate the project. Figure 2 provides a graphic depiction of this process.

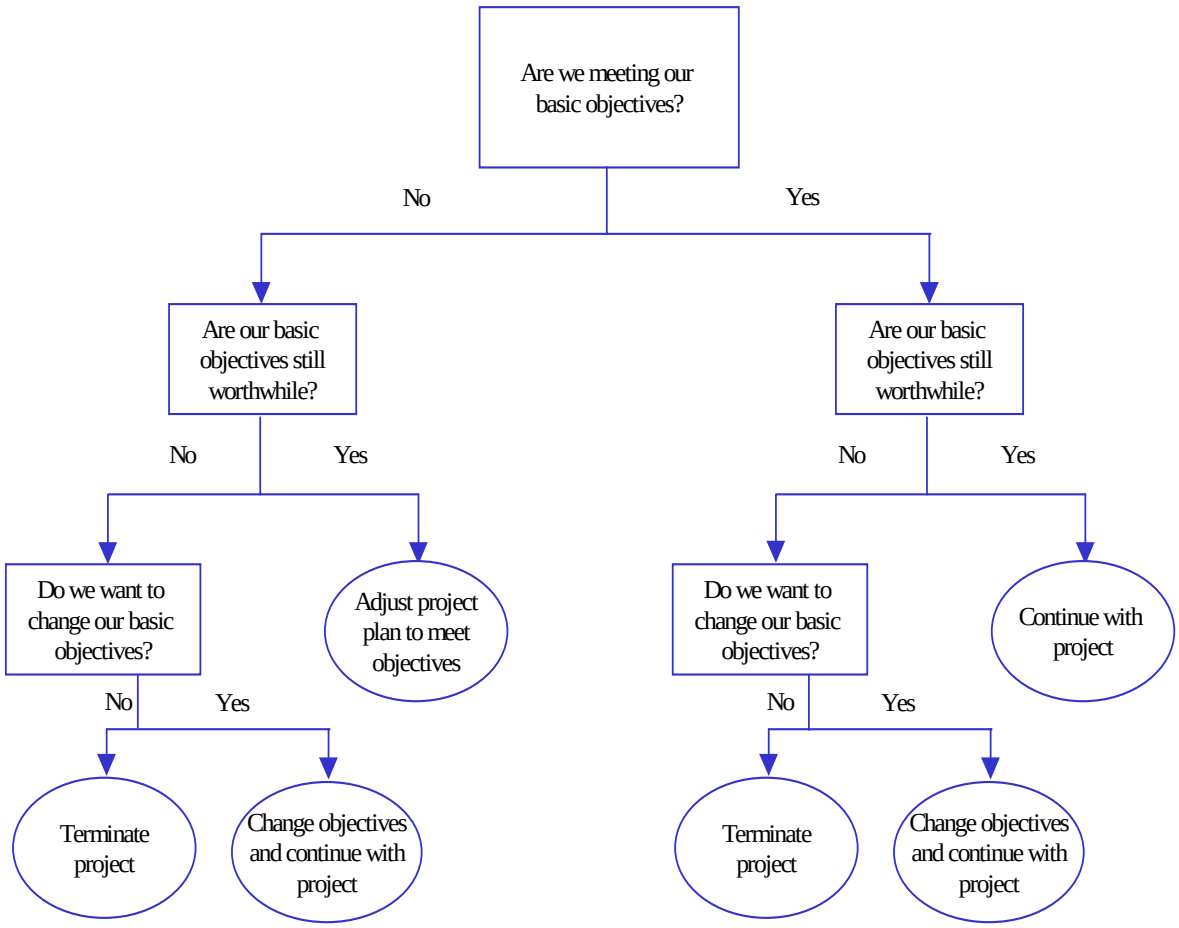


Figure 2. Logical Checkpoints Decision tree

5.1.2 Approval to Commence Operation/Production/Delivery

The prerequisite for these activities is the demonstrated capability of the desired product to meet technical performance goals, customer requirements and specifications, and goals specified in the baselines. The demonstrated capability usually involves an acceptance process through which official acceptance is received from the customer.

5.2 Scheduling

Project scheduling is accomplished by deciding in advance when and where work will be performed. It comprises a series of time-related decisions, though usually connected with scheduling processes, resources, and/or personnel. In this context, the scheduling process centers around time to do the work, the department which will perform the work, the resources to be applied, providing status of work progress versus work scheduled, and monitoring and reporting.

Since the schedule process affects the project team and other related departments, the process for scheduling must be clear and concise, so that communication by all concerned parties can be accomplished at each management level. There are a number of methods used for estimating the duration of a project to generate the schedule from a WBS including Top-down, Bottom-up, Network Diagram, COCOMO, Critical Path, PERT, and Monte Carlo.

5.2.1 Top-Down

Top-down estimating is basically parametric cost estimating. It focuses on formulating cost estimates by examining fundamental parametric relationships. With parametric cost estimating, fundamental parameters that offer insights into the cost of a project are identified. An example of one such parameter is that two thousand person-hours roughly constitutes one person year of work. The following is a simplistic example of top-down (parametric) estimating.

If it is estimated that a project would require one-fourth of a person year (500 person hours) of professional effort, other estimates can fall into place. If one person-hour of professional effort costs $20, five hundred person-hours would cost $10,000. If it is then known from experience that for every hour of professional effort, for hours of technical support effort are consumed (a parameter), the project will require two thousand person-hours of professional effort at $15 per hour ($30,000). Thus, labor costs will be an estimated $40,000. If we also know from experience that fringe benefits and overhead can be computed by multiplying direct wages by 1.6 (a parameter) we find that this amounts to $42,400. Therefore, total salary-related costs would be $82,400. To this we may be able to add other costs from experience such as $1,000 for travel for every $15,000 of salary-related costs.

5.2.2 Bottom-Up

The Bottom-Up estimating method is used when a WBS is created at the lowest level of detail, providing a basis for scheduling and resource assignments. The detail can de based on a firm statement of work, detailed drawings and specifications, and other information used to describe discrete tasks to be performed, material to be acquired, and components to be produced and installed.

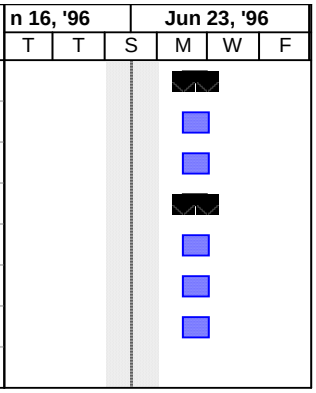
Low-level estimates are usually made by analogy to prior projects and therefore the method is not as accurate for new products or tasks. Large, complex projects demand WBS-based bottom-up estimates. When possible and practical, it might be a good idea to do both bottom-up and top-down estimating. The two approaches can serve as a check-and-balance to each other.

5.2.3 Work Breakdown Structure

The work breakdown structure (WBS) is a deliverable oriented grouping of project elements that organize and define the total scope of the project. Generally, the first level of the WBS is the same as the project life cycle. The subsequent levels break the work into increasingly smaller and more manageable pieces.

The WBS facilitates communication between and among the project team and stakeholders and provides a basis for estimating staff, cost, and time. The following is an example of a WBS produced with Microsoft Project, which is one of many such tools available.

ID	Task Name	Duration	Start	Finish
1	**PLANNING STAGE**	**1 day**	**Tue 6/25/96**	**Tue 6/25/96**
2	Conduct project kick-off meeting	1 day	Tue 6/25/96	Tue 6/25/96
3	Feasibility Statement	1 day	Tue 6/25/96	Tue 6/25/96
4	**Project plan**	**1 day**	**Tue 6/25/96**	**Tue 6/25/96**
5	Develop document	1 day	Tue 6/25/96	Tue 6/25/96
6	Prepare Risk Assessment	1 day	Tue 6/25/96	Tue 6/25/96
7	Conduct structured walkthrough(s)	1 day	Tue 6/25/96	Tue 6/25/96



5.2.4 Network Diagrams

A project network diagram is a schematic display of the project's activities and their dependencies. The project network diagram can be produced either manually or with a computer. It may include full project details or have one or more summary activities. The project network diagram is often incorrectly called a *PERT chart* (for Program Evaluation and Review Technique).

There are two methods for drawing network diagrams. The Precedence Diagram method (PDM) or Activity-on-Node (AON) diagram is a method of constructing a project network diagram using nodes to represent the activities and connecting them with arrows to show the dependencies. The Arrow Diagramming Method or Activity-on-Arrow (AOA) method is a diagram where the activities are represented by arrows.

5.2.5 Critical Path Method (CPM)

The CPM calculates a single, early and late start and finish date for each activity based on specified, sequential network logic and a single duration estimate. The focus of CPM is on calculating the float in order to determine which activities have the least scheduling flexibility.

5.2.6 PERT

A PERT chart is a specific type of project network diagram that is used for estimating activity duration using three estimates per activity (optimistic, pessimistic, and most likely). PERT uses sequential network logic in a weighted, average duration estimate, to calculate project duration.

5.2.7 Monte Carlo Analysis

Monte Carlo Analysis is a schedule risk assessment technique that performs a project simulation many times in order to calculate a distribution of likely results. It is a statistical technique by which a quantity is calculated repeatedly, using randomly selected "what-if" scenarios for each calculation. Though the simulation process is internally complex, commercial computer software performs the calculations as a single operation, presenting results in simple graphs and tables.

These results approximate the full range of possible outcomes, and the likelihood of each. When Monte Carlo simulation is applied to risk assessment, risk appears as a frequency distribution graph similar to the familiar bell-shaped curve, which non-statisticians can understand intuitively. As a universal numerical technique, the method became possible only with the advent of computers, and its application continues to expand with each new computer generation.

5.2.8 Constructive Cost Model (COCOMO)

COCOMO is a software cost estimation method that is based on a set of empirically derived equations. The equations incorporate a number of variables considered to be the major cost drivers of software development and maintenance.

The different phases of COCOMO are based on the classical waterfall model of the software life cycle. It provides effort estimates for the development life cycle stages/phases only (software design, programming, and integration and test). The planning, requirements, and maintenance stages/phases are estimated as separate quantities.

5.3 Establishing Baselines

When a project schedule is established, the baseline is set. Schedule progress is then measured to the baseline to determine if the project is on track. During the course of projects, changes to the baseline are likely to occur as more details about the project become known. Project managers should have an orderly formal process for considering changes and then deciding how to handle the change. Generally baseline changes need to be approved by senior management.

5.4 Project Completion

The project is completed when the product desired by the customer has been developed, tested and validated and verified to be operationally ready and functionally certified to the customers' requirements and specifications during a customer and/or user participant acceptance testing process. The acceptance, a written statement, is a signed acknowledgment by the customer and stakeholders that the work performed has been accepted as being in accordance with approved plans, requirements and specifications.

6.0 Controlling and Reporting

As discussed below, there are several DOE standards programs, which provide standards and guidance for projects. The actual standards that a project will follow are documented in the project plan for all stakeholders to see. Guidance to meet reporting requirements is provided, however, reporting plans and strategies should be documented in individual project plans.

6.1 DOE IA Standards Program

The DOE Information Architecture (IA) Standards Program has the responsibility to lead, manage, integrate, and coordinate efforts centrally to achieve and implement standards to support the DOE IA. Its purpose is to ensure the wise stewardship of IT resources by promoting a DOE-wide standards program that is participatory and consensus-based. The goal of the IA Standards program is to be flexible, forward thinking, and aligned with technology directions. The DOE IA Standards program applies to all DOE Elements, including contractors and laboratories.

The IA Standards program sponsors and maintains a Profile of Adopted Standards and an ongoing IA Standards Adoption and Retirement Process. The Profile consists of processes supported by representatives from the DOE community who are responsible for IA Standards activities. The Profile is maintained in a repository on the DOE IA Standards Web site. The project manager should consult the Profile to determine if the proposed project is compatible with the established DOE IA

📖 IA standards and access to standards repository:
http://cio.doe.gov/ITReform/ArchitectureStandards/ASP.html

6.2 DOE Technical Standards Program

The DOE Technical Standards program, managed by the Environment, Safety and Health organization (EH) at Headquarters, promotes the use of non-Government standards across the Department. EH also oversees the development of DOE technical standards, including information technology standards. Project managers should consult the DOE Technical Standards to determine if the proposed project is compatible with the technical standards established by DOE.

📖 DOE Technical Standards and access to repository: http://tis.eh.doe.gov/techstds/

6.3 Project Standards

Standards that will be followed for the project should be identified and documented, typically in the project plan, or in a separate "Standards" project document. All standards should be identified including technical, documentation, testing, and development. References to standards and guidance documents that will be followed should be identified. Standards should be identified during project planning and should be reviewed and approved along with the project plan.

6.4 Project Reporting

There are many categories of project reporting, including status, schedule, cost, labor, exception, technical, and performance. The requirements for reporting will be based on the size and complexity of a project, as defined by the Program Manager in the task SOW, as detailed in the contract, and/or as identified in the Project Plan.

At a minimum, a report on project status should be provided to Federal project managers and/or Technical Monitors through a monthly status report. The report should include the project manager's concise narrative assessment of the status of the work being performed under a task assignment. Federal Technical Monitors will use the status report to monitor project status, costs, identify potential problems, and to report to their Program Manager.

The status report should contain, but is not limited to, the following, compliant with DOE 1332.1A. The required headings are:

- Variances from baselines.
- Causative factors and actions taken.
- Changes in objectives and technical approach.
- Task progress.
- Summary of the current situation.
- Forecast of the near future and expected impact on the project (Status Assessment and Forecast).

📖 DOE 413 and 413.1: http://www.directives.doe.gov/index.htm

6.5 OCIO Status Reporting

The Office of the Chief Information Officer (CIO) status reporting is accomplished according to the Office of the Deputy Secretary guidelines, which are aligned with the reporting requirements of the Secretary of the Department of Energy. Federal TMs report to the Group Leaders weekly, and Group Leaders roll-up the reporting to the CIO weekly. Reporting focus is on major events such as emerging issues, Secretarial commitments, the future, employment levels, Congressional hearings, awards (grant, contract, CRADAs), honors, and employee awards (monetary) and recognition.

6.5.1 Corporate and Major IT Projects

In addition to the weekly reporting, the CIO Quarterly Review Process for Corporate and Major Information Systems was instituted to provide a vehicle for reviewing all corporate and major information systems. This process is in concert with the framework of the Capital Planning and Investment Control (CPIC) process.

It provides a life cycle review process from system inception to retirement, and a corollary between the CPIC and EA processes, as well as other significant Departmental programs and

projects. The Quarterly Review serves as a forum to raise issues and concerns that will impact the project and ensure that acceptable actions or corrective plans exist for addressing any significant negative impacts.

📖 Guide for OCIO Reviews: http://cio.doe.gov/ITReform/sqse/pm_trck.htm

6.6 Earned Value

Earned Value (EV) is a method for measuring project performance. EV is a program management technique that uses "work in progress" to indicate what will happen to work in the future. It compares the amount of work that was planned with what was actually accomplished to determine if cost and schedule performance is as planned. It uses progress against previously defined work plans to forecast such important concerns as estimated completion costs, finish dates, and the effectiveness of corrective action plans. The key benefits of EV include:

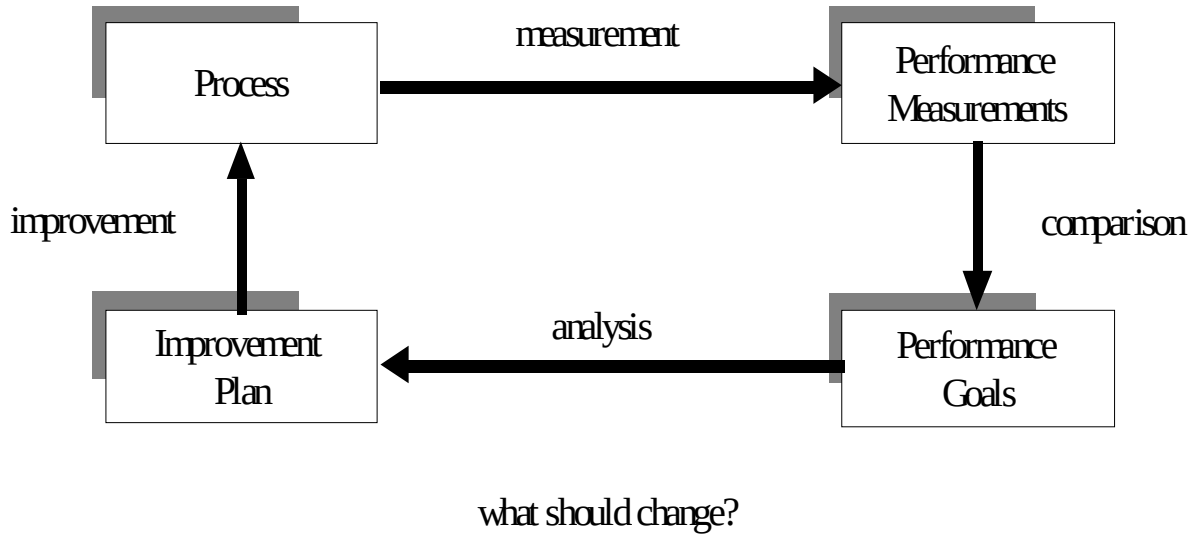
- Provides a clear definition of work prior to beginning that work.
- Helps the project manager credibly request appropriate resources.
- Provides the basis for a realistic plan against which to measure performance.
- Provides an objective measurement of work accomplished.
- Assists program and functional management to identify areas requiring additional management attention.
- Provides true cost condition.
- Encourages realistic projections of final cost.
- Enhances accuracy of funding forecasts.
- Reduces propensity of customer/boss to add work without adding budget.
- Ties budget directly to work.
- Requires all work transfers to include associated budget.
- Requires all budget transfers to include associated work.

Earned Value requires four basic steps to be effective. These steps are not only necessary for using Earned Value techniques, but they also make for good management practices.

- Define the work.
- Plan the work.
- Cost the work.
- Monitor and status the work.

6.5 Measuring Project Performance

An effective set of project performance measures will provide actionable information, on a focused set of metrics, to provide a balanced view of project performance that can be used to make decisions to improve the project management process. Performance measures also enable accountability by laying out what is expected, when it is expected, and what action will be taken if planned achievements do not occur.



The following definition of performance measures is from the Performance-Based Special Interest Group: http://www.orau.gov/pbm

"Performance Measurement is the ongoing monitoring and reporting of program accomplishments, particularly progress towards pre-established goals, typically conducted by program or agency management. Performance measures may address the type or level of program activities conducted (process), the direct products and services delivered by a program (outputs), and or the results of those products and services (outcomes). A "program" may be any activity, project, function, or policy that has an identifiable purpose or set of objectives."

Requirement

OMB Circular A-130 indicates that, as part of an agency's Capital Planning and Investment Process, it must institute performance measures and management processes that monitor actual performance to expected results. Measurements can be reported at the program and project level and include resource and cost goals, schedule and progress goals, trade-offs and risk outcomes, product quality and customer satisfaction goals.

Performance Measures - Basic categories

Measures of efforts. Efforts are the amount of resources, in terms of money, people, materials, etc., applied to a program or project.
Examples: The amount of money spent and the number of person-hours burned on a project.

Measures of accomplishments. Accomplishments are milestones achieved with the resources used. There are two types of accomplishments - outputs and outcomes. Outputs relate to the quantity of goods or services produced; outcomes relate to the results of providing those outputs.
Examples - Output: Number of modules coded, number tested, number inspected.
Example - Outcome: Gross salary function of new payroll system completed on schedule.

Measures that relate efforts to accomplishments. These measures are associated with resources or cost relative to accomplishments achieved. They provide information about the production of an output at a given level of resource use and demonstrate an entity's capability when compared with previous results, internally established goals and objectives, generally accepted norms or standards, or results achieved by similar entities.
Example: Amount of money expended for the portion of project completed versus the amount of money planned to be expended for the portion of work planned at a set point during the project (e.g., earned value).

📖 OMB Guidance on Performance Measures: http://wwww.whitehouse.gov/omb

Definitions

Performance. The execution or accomplishment of work.

Measure. The result of the activity involved in determining dimension, i.e., size, etc. through measuring. Measures should be objective, timely, simple, accurate, useful, and cost-effective.

Metric. The Institute of Electrical and Electronics Engineers (IEEE) defines metric as a *quantitative measure* of the degree to which a system, component, or process possesses a given attribute.

Indicator. An indicator is a metric or combination of metrics that provide insight into a process, a project, or a product, to enable assessment and improvement.

Performance Measurements - Key Objectives

- Assess project status.
- Develop early warning indicators.
- Monitor product quality.
- Manage schedule, budget, and scope.
- Track the project's alignment with business goals.

Types Of Performance Measures

Metric	Objective
Process Metrics	Increase capability level (i.e., SEI-CMM levels) Do more with less (shorter schedule, less resources) Improve quality (less defects, less re-work)
Project Metrics	Track project progress Assess project status Award contract fees
Product Metrics	Determine product quality Identify defect rates Ensure product performance

Typical Metric Categories

Category	What to Measure
Schedule	Actual vs. planned: - Schedule and progress
Budget	Actual vs. planned: - Resources and cost
Functionality	Delivered vs. planned: - Product characteristics - Technology effectiveness - Process performance - Customer satisfaction

Measures vs. Indicators - Example: Finding defects in products (e.g. a Requirements Doc.)

Basic Measures	Indicators
- No. of requirements reviewed - No. of reviewers involved - No. of defects found - Effort expended	Indicators: Efficiency - No. reviewed/effort - No. reviewed/time - No. found per effort, time Indicators: Effectiveness - % found of those expected - % escaped

Examples of Performance Measures

The following table provides a minimum set of examples (one for each category) of performance measures that are typical for many IT projects.

📖 For a complete set of examples visit: http://cio.doe.gov/ITReform/sqse/pm_metric.htm

Category	Focus	Purpose	Measure of Success
Schedule performance	Tasks completed vs. tasks planned at a point in time.	Assess project progress. Apply project resources.	100% completion of tasks on critical path; 90% all others
Budget performance	Revisions to cost estimates.	Assess and manage project cost.	100% of revisions are reviewed and approved.
Product Quality	Test case failures vs. number of cases planned.	Assess product functionality and absence of defects.	100% of planned test cases execute successfully.
Compliance	Compliance with DOE Enterprise Architecture model requirements.	Track progress towards Department-wide architecture model.	Zero deviations without proper approvals.
Redundancy	Elimination of duplicate or overlapping DOE systems.	Ensure return on investment.	Retirement of 100% of identified systems (as committed in Business Case or ABC)
Cost Avoidance	System is easily upgraded.	Take advantage of e.g., COTS upgrades.	"Glue code" is not required to upgrade to subsequent releases (of COTS apps.)
Customer Satisfaction	System availability.	Measure system availability.	100% of requirement is met. (e.g., up time of 99% M-F 8am to 6pm, and 90% S & S, 8am to 5pm).
Business Goals/ Mission	Functionality tracks reportable inventory.	Validate system supports program mission.	All reportable inventory is tracked in system.
Productivity	Number of deliverables produced.	Assess capability to deliver products.	Improve product delivery 10% in each of the next 3 years.
	Time taken to complete tasks.	To evaluate estimates.	Completions are within 90% of estimates.

6.6 Return on Investment

Return on Investment (ROI) is the calculated benefit that an organization is projected to receive in return for investing money (resources) in a project. Within the context of DOE IT projects, the investment would be in an information system development or enhancement effort. ROI information is used to assess the status of the business viability of the project at key checkpoints throughout the project's life cycle.

ROI may include the benefits associated with improved mission performance, reduced cost, increased quality, speed, or flexibility, and increased customer and employee satisfaction. ROI should reflect such risk factors as the project's technical complexity, the agency's management capacity, the likelihood of cost overruns, and the consequences of under- or non-performance. Where appropriate, ROI should reflect actual returns observed through pilot projects and prototypes.

ROI should be quantified in terms of dollars and should include a calculation of the break-even point (BEP), which is the date when the investment begins to generate a positive return. ROI should be re-calculated at every major checkpoint of a project to see if the BEP is still on schedule, based on project spending and accomplishments to date. If the project is behind schedule or over budget, the BEP may move out in time; if the project is ahead of schedule or under budget the BEP may occur earlier. In either case, the information is important for decision-making based on the value of the investment throughout the project life cycle.

Any project that has developed a business case is expected to refresh the ROI at each key project decision point (i.e., stage exit) or at least yearly.

Exclusions

If detailed data collection, calculation of benefits and costs, and capitalization data from which ROI is derived was not required for a particular project (e.g., project was mandated) then it may not be realistic or practical to require the calculation of ROI.

In this case, it is recommended that a memorandum of record be developed as a substitute for ROI. The memorandum should provide a brief history of the program, a description of the major benefits realized to date with as much quantitative data as possible, and a summary of the process used to identify and select system enhancements.

Some of the major benefits experienced by sites that installed the information system that would be important to include in the memorandum are:

- Decommissioning of mainframe computers
- Reduction/redirection of labor
- Elimination of redundant systems
- Ability to more cost effectively upgrade all sites with one standard upgrade package

In each case above, identify the specific site, systems, and labor involved in determining the cited benefit. Identify any costs or dollar savings that are known or have been estimated. The memorandum will be used as a tool for responding to any future IG or GAO audit inquiries on project ROI.

Appendix A - DISE Resources

Federal

1 Federal Acquisition Jumpstation, http://nais.nasa.gov/fedproc/home.html

2 GAO Guide for Assessing Acquisition Risk, http://www.gao.gov/policy/guidance.htm

3 Office of Management and Budget Circular A-11 provides detailed instructions and guidance on the preparation and submission of agency budget requests and related material for the 1998 budget. Part 2 of the Circular provides specific instructions on the preparation and submission of agency strategic plans required by the Government Performance and Results Act of 1993.

4 Office of Management and Budget, Circular, A-130, Management of Federal Information Resources, provides uniform government-wide information resources management policies as required by the Paperwork Reduction Act of 1980, as amended by the Paperwork Reduction Act of 1995, 44 U.S.C. Chapter 35.

5 Office of Management and Budget Guideline: Evaluating Information Technology Investments

6 Public Law 104-106, Information Technology Management Reform Act (ITMRA) of 1995, authorizes military activities appropriations for fiscal year 1996 and effective August 8, 1996, rescinds the Federal Information Resources Management Regulations (FIRMR) and establishes the Chief Information Officer (CIO) functions.

7 Public Law 103-62, Government Performance and Results Act of 1993, requires agencies develop strategic plans and performance measures. It starts with a series of pilot programs and allows waivers of regulations for some of the pilots.

Department of Energy

1 Analysis of Benefits and Costs (ABC) Guideline: Volume 1, A Manager's Guide to Analysis of Benefits and Costs, and Volume 2, an Analyst's Handbook for Analysis of Benefits and Costs, http://cio.doe.gov/ITReform/sqse/pm_abc.htm

2 DOE Capital Planning Process, http://cio.doe.gov/ITReform/Planning/index.htm

3 DOE HQ Computer Security Program, http://cio.doe.gov/Cybersec/index.html

4 DOE Information Architecture, http://cio.doe.gov/ITReform/ArchitectureStandards/ASP.html

5 DOE IT Standards Program, http://cio.doe.gov/ITReform/ArchitectureStandards/ASP.html

6 DOE Office of Procurement and Assistance Management, http://www.pr.doe.gov

7 DOE Order 200.1, Information Management

8 DOE Systems Engineering Methodology (SEM), Version 3, September 2002, http://cio.doe.gov/ITReform/sqse/sem_main.htm

9 DOE Software Quality and Systems Engineering, http://cio.doe.gov/ITReform/sqse/index.html

10 DOE/HR-0175 Information Architecture, Profile of Adopted Standards

11 DOE/HR-0141 Information Architecture, Volume I, The foundations

12 DOE/HR-0171 Information Architecture, Volume II, Baseline Analysis Summary

13 DOE/HR-0178 Information Architecture, Volume III, Guidance

14 DOE/HR-0190 Information Architecture, Volume IV, Vision

15 DOE Cyber Security Program, http://cio.doe.gov/Cybersec/index.html

16 FY1999 DOE IM Operational/Action Plan, http://www-it.hr.doe.gov/implan/fy99imop.htm

17 Information Management Planning, http://www-it.hr.doe.gov/implan/

18 Information Management Strategic Plan, http://www-it.hr.doe.gov/implan/reference/stratpln.htm

19 Project Planning Questionnaire, http://cio.doe.gov/ITReform/sqse/pm_plan.htm

20 Software Quality Assurance Sub-Committee (SQAS), http://cio.doe.gov/sqas

Industry

1 American Society for Quality, http://www.asq.org/

2 Controlling Software Projects, Tom DeMarco, Yourdon Press, 1992

3 Cultivating Successful Software Development, Donaldson & Siegel, Prentice Hall, 1997

4 Electronic Industries Association, http://www.eia.org

5 Inroads to Software Quality, Jarvis & Crandall, Prentice Hall, 1997

6 Institute of Electrical and Electronics Engineers, Inc., http://www.ieee.org

7 International Council for Systems Engineering, http://www.incose.org

8 International Organization for Standardization, http://www.iso.ch

9 Managing the System Life Cycle, Edward Yourdon, Prentice Hall, 1988

10 Martin, James N, Systems Engineering Guidebook, A process for Developing Systems and Products, CRC Press, New York, 1996

11 Quality Assurance Institute, http://www.qaiusa.com

12 Software Engineering Institute, http://www.sei.cmu.edu

13 Systems Safety Society, http://www.system-safety.org

14 The New Project Management, Davidson Frame, Jossy Bass, 1994

15 The Project Management Institute, http://www.pmi.org

Appendix B – Glossary and Acronyms

Glossary

Business Area. As stated in the DOE Strategic Plan, the four core business areas are Energy Resources, National Security, Environmental Quality, and Science.

Information Systems. A combination of information, computer, and telecommunications resources and other information technology and personnel resources that collects, records, processes, stores, communicates, retrieves, and displays information; DOD Directive #7920.1, Life Cycle Management of Automated Information Systems, June 1988.

Information Systems Engineering (ISE). ISE is a subset of systems engineering (SE). ISE is limited to the development of IS products and their environment.

Information Systems Solutions. A solution to a need either through new or enhanced information system or infrastructure component. May include COTS, glue-code, customization of business rules, etc., to implement a business solution.

Information Technology. Any equipment or interconnected system or subsystem of equipment, that is used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information. *Clinger-Cohen Act*, 104th Congress, 1996.

Solution Providers. Solution providers are Federal or contractor staff responsible for delivering or maintaining an Information Systems Solution.

Systems Engineering (SE). The discipline of developing systems products or processes based on a total systems perspective and utilizing a system engineering approach. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and systems validation while considering the complete problem: operations, performance, test, manufacturing, cost and schedule, training and support, and disposal. Systems Engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems Engineering considers both the business and technical needs of all customers with the goal of providing a quality product that meets the user needs; INCOSE, "What is Systems Engineering?" - 1996.

Acronyms

ABC – Analysis of Benefits and Costs

ASQ – American Society for Quality

CIO – Chief Information Officer

CMIP – Corporate Management Information Program

CMM – Capability Maturity Model

COTS – Commercial-Off-The-Shelf

DEAR - DOE Acquisition Regulation

DIAP – Departmental Information Architecture Project

DISE – Departmental Information Systems Engineering

DOE – Department of Energy

DSEPG – Departmentwide Systems Engineering Process Group

ECIM – Executive Committee for Information Management

EH – Environment, Safety and Health organization

EIA – Electronic Industries Alliance

FAR – Federal Acquisition Regulation

FIRMR – Federal Information Resources Management Regulations

GAO – General Accounting Office

GSA – General Services Administration

GWAC – Government-wide Acquisition Contracts

IA – Information Architecture

IEC – International Electrotechnical Commission

IEEE – Institute of Electronics and Electrical Engineers

IFB – Invitations for Bid

IG – Inspector General

IM – Information Management

IMSC – Information Management Steering Committee

INCOSE – International Council on Systems Engineering

IS – Information Systems

ISE – Information Systems Engineering

ISEM – Information Systems Engineering Manager

ISO – International Organization for Standardization

ISR – Information Systems Reviews

IT – Information Technology

ITMRA – Information Technology Management Reform Act

LOC – Lines of Code

M&O – Management and Operating

NNSA – National Nuclear Security Administration

NWC – DOE Nuclear Weapons Complex

OCIO – Office of the Chief Information Officer

OMB – Office of Management and Budget

PIR – Post Implementation Review

PMI – Project Management Institute

QA – Quality Assurance

QAI – Quality Assurance Institute

RFP – Requests for Proposals

SE – Systems Engineering

SEI – Software Engineering Institute

SEM – Systems Engineering Methodology

SQA – Software Quality Assurance

SQAS – Software Quality Assurance Subcommittee of the Nuclear Weapons Complex

US – United States

V&V – Verification and Validation