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EVOLUTION OF PROJECT PLANNING TOOLS IN A MATRIX ORGANIZATION

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Introduction

Do you have a multi-project, matrix management environment? Do your teams continue to make the same mistakes? Is there a lack of consistency regarding how projects are established that prevents easy comparative analysis or benchmarking? Do you need documentation or training that allows new project managers to quickly come up to speed on your processes? Are these problems giving you ulcers? Would you like an example of some tools that would prevent these problems to help ensure success on all your projects? If the answer to any or all of these questions is yes, read on.

The Corporate Construction Program at Sandia National Laboratories in Albuquerque, New Mexico, manages a variety of new construction and renovation projects. The budget authority for these projects is currently greater than \$100 million, consisting of projects ranging from \$150,000 to \$56 million. In recent years, some of these projects have experienced difficulties; inadequate up-front planning and cost estimating left a legacy of schedule and budget problems. Projects also have to meet numerous, constantly changing requirements from a variety of sources: State and Federal environment, safety, and health regulations; Department of Energy (DOE) orders; and other government regulations. No one person could keep track of these requirements, yet failure to meet even one of these could result in significant project delays. Project cycles for federally funded projects were averaging 8 to 10 years, and personnel rarely stayed on a project team for the duration of the project, which only increased the chances that critical activities might be missed. In addition, project managers set up and managed projects in different ways. The program needed comprehensive project planning tools to ensure that projects were implemented consistently throughout a matrix organization and that no requirements were overlooked.

Observing that many projects were experiencing similar problems, the facilities director chartered a "Problem-Solving Council" comprised entirely of staff-level personnel to identify problems and recommend solutions for some of these problems. The Problem-Solving Council was a multi-disciplinary functional team that included people skilled in project management, engineering design, construction management, and operations and maintenance, as well as consultants who were experts in environment, safety, and health issues. The council developed an integrated project planning guide that exceeded the expectations of the director and will allow future teams to do a much better job of planning.

By itself, though, the project planning guide is incomplete. It is life-cycle-based and doesn't show how tasks fall into the overall work breakdown structure (WBS) or how project costs should be allocated. For this the Corporate Construction Program needed a WBS dictionary. At a high level, the dictionary breaks all work down into the two types of funding that Sandia project managers oversee—Congressionally approved capital funds and annual operating funds. Project managers can look up each task in the WBS dictionary to determine where to place it in the overall work structure and how to fund it.

Another major outcome of using these planning tools was the development of a matrix chart that maps all of the 265 activities in the planning guide against the seven major types of construction projects that are accomplished at Sandia National Laboratories

The project planning guide, the WBS dictionary, and the matrix chart have evolved into valuable tools that allow Sandia project managers to manage projects consistently, meet DOE requirements, clarify project tasks, develop cost estimates, write work packages, train project team members, and disseminate changes in requirements. They are discussed in detail in this paper.

Project Planning Guide

Description

The Project Planning Guide is a Microsoft® Project schedule that provides a standard template for project managers to use as a starting point to schedule individual construction projects. It contains 265 tasks that are broken down according to the life cycle of the project and gives an average duration for each task, with appropriate links. Each task shows a responsible person and a technical resource person or department, along with comments or notes about the particular

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activity. The standard template is meant to flag activities that may be required for a given project and provide average durations for these activities. Each project manager can add or delete tasks and change durations as necessary. The life cycle areas covered in the project planning guide are: Project Development Phase, Conceptual Design Phase, Design Phase, Construction Phase, Construction Acceptance Phase, Occupancy Phase, and Project Close-out Phase.

In addition to the standard template, standard views give the project manager instant access to the data in different forms. For example, the project manager may want to get a list of activities by responsible person or during a given year. Instead of recreating the various filters, the project manager simply clicks on a particular view. (See Figure 1 for an example.)

Benefits

From a project standpoint, the most important benefit to the standard template is that it prevents the project team from leaving out an important requirement or activity. This is especially helpful in an environment where requirements are constantly changing. This checklist of activities minimizes project delays and helps to reduce project overruns. For example, we had a project where the contractor had grading equipment on site ready to go, but we did not have a digging permit. Work had to be delayed for a week while we obtained the permit, and we were charged for the down time of the graders. If the checklist had been in place, this delay and additional cost to the project would not have occurred.

By identifying the responsible person for each activity, the guide establishes roles and responsibilities as well as accountability for each task. How many times have tasks slipped through the cracks because someone assumed that someone else was taking care of it? The guide also provides a tool that integrates cost, schedule, and performance requirements. It saves time in setting up a project schedule and establishes a point of reference for task durations, a timeline that links tasks, and a typical critical path. It helps the team to find subject matter experts and lists references. This has been helpful when new project managers are hired or take over an existing project.

From a program standpoint, the guide provides consistency between projects so that historical data can be gathered for comparative analysis and benchmarking. Project team experiences and lessons learned can be incorporated into the task notes and used to identify risk levels for each task. It covers the various life cycles of a project and can be used to determine areas that can be streamlined for increased efficiencies. The timeline can show whether an activity is value-added or bureaucracy. For example, our guide pointed out the extensive time it takes before start of construction, which led to the formation of a team to cut out unnecessary activities and streamline activities so they take less time. This can actually change the critical path of the project. The project planning guide can also be changed to avoid shortcomings of past projects.

In summary, the benefits derived from the guide include

- ensuring that no activities are forgotten
- establishing roles and responsibilities/accountability for every activity
- providing a tool that integrates cost, schedule, and performance requirements
- ensuring consistency in setting up projects for comparative analysis/benchmarking
- using a universal concept that can be applied to any project
- providing history-based, critical-path timeline
- providing a standard project planning template so the project manager doesn't have to start from scratch or reinvent the wheel
- providing a basis for task durations
- using a compilation of actual performance data from many project teams' experience/lessons learned
- having a life-cycle based tool
- identifying risk levels, other references, and subject matter experts
- providing a tool to analyze activities and determine if they add value or bureaucracy.

Work Breakdown Structure Dictionary

Background

In order to develop a WBS dictionary, we first needed to develop a standard WBS. Project managers brainstormed to generate items that should be included in the WBS. In addition, people from other departments were encouraged to submit their ideas. This generated numerous ideas from a broad knowledge and experience base. The proposed WBS elements were written on pieces of paper and posted on a large-scale WBS chart so they could be classified according to standard guidelines for cost accounting and project reporting. This resulted in a draft, "strawman" WBS that listed the four levels of work elements that are found in Sandia projects. Staff members then wrote descriptions for the WBS elements and compiled them into a first cut at the WBS dictionary, which describes how capital and operating funds are used to develop, design, construct, equip, and manage projects. Upon completion of the strawman WBS and the

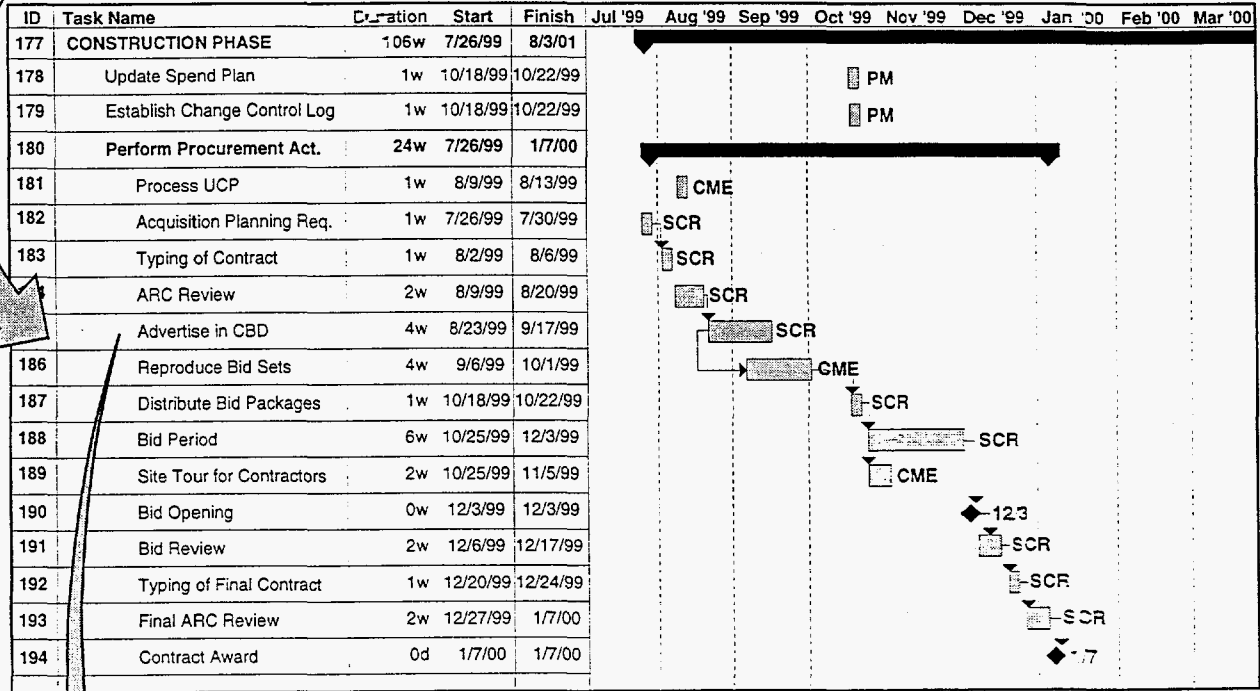
FIGURE 1. PROJECT PLANNING GUIDE AND WBS DICTIONARY--SAMPLE VIEWS

Line Item Project Planning Guide

Project View

ID	Task Name	Duration	Start	Finish	Predecessors	Responsible	Tech. Resource	Notes
184	ARC Review	2w	8/9/99	8/20/99	172	SCR		ARC meets only on Tues. & Fri.
185	Advertise in CBD	4w	8/23/99	9/17/99	184	SCR	CME	Ad minimum 30 days.
186	Reproduce Bid Sets	4w	9/6/99	10/1/99	185SS+2w	CME		

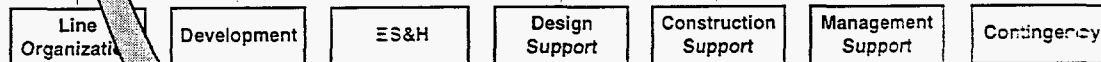
Gant Chart View



Line Item WBS Dictionary

Line Item
Expense-Funded

Standard WBS



- Pre Title I Design
 - Organize project team
 - Develop WBS
 - Energy conservation report
 - Design surveys (pre-Title I only)
 - Value engineering study
 - Independent cost estimate
 - Design criteria development
- A/E procurement activities
 - CBD advertisement
 - Purchase requisition preparation
 - ARC review

- A/E procurement activities - Includes all activities needed to advertise, bid, and award A/E design contracts.

- *CBD advertisement* - Some types of projects generally require specific advertisement for bids. Line Item projects generally require that the bid advertisement be posted in the *Commerce Business Daily* for 30 days. This advertisement allows all interested companies to have a chance to bid the project and theoretically provides the best possible bid to the government.

WBS Definition

dictionary, the project managers reviewed the applicable government guidelines and cost accounting regulations to ensure that no elements were left out. The WBS and dictionary were finalized so that they reflect the correct accounting and reporting structure. See Figure 1 for an example of the high-level WBS and a dictionary entry.

Benefits

The WBS dictionary has proven to be a valuable tool in planning and managing projects. Prior to the introduction of project management in the organization, there was no consistency in the planning and execution of projects, including cost estimating and project control. There was also no documented resource to incorporate lessons learned into a planning guide for new projects. The WBS dictionary has since been used as a basis for developing bottoms-up cost estimates for new projects and helps to ensure that all of the project elements are considered before rolling up and submitting the budget request. The resulting cost estimate detail provides the information required to assess project performance using earned value and variance analysis on a consistent basis for every project. Management can now make program- and project-level decisions based on an assessment of the data.

Sandia project managers are also able to use the standard WBS to provide a framework for comparing the cost-effectiveness of existing and proposed projects. With a consistent set of cost-accounting guidelines, the project manager can compare and analyze project costs to determine where savings efforts should be targeted. In addition, now that project costs are developed and reported consistently, project performance can be evaluated and compared with industry standards. The analysis can be used to validate the cost estimates of proposed projects and logically explain the differences. By setting up projects consistently, the WBS template helps to further improve the quality of program and project performance.

Additionally, the WBS dictionary has benefited other areas of project management:

- While the project WBS shows the work to be done on a project, Sandia uses a document called a project execution plan to show how the work will be done. Development of the project execution plan now follows the project WBS, which yields fewer changes to the plan as a result of using standard work elements.
- The WBS dictionary provides an accurate description of the project deliverables and helps to further clarify the work scope.
- The WBS and dictionary serve as a checklist to ensure that no project tasks are forgotten.
- Project teams that work on multiple projects find that the WBS provides consistency, which helps to improve process performance.
- The dictionary integrates the comprehensive WBS with cost accounting standards.
- The WBS and dictionary identify which activities may be paid for from capital funds as opposed to activities that should be paid for from operating expense and overhead.

The Matrix Chart

The matrix chart is another important element in the planning tools. Not only does it map all of the 265 activities in the planning guide against the various projects, it also delineates how activities will be funded--from overhead, capital, or expense (operating). Figure 2 shows the design phase portion of the chart. The chart is graphically powerful in that it depicts a graded approach to doing projects. Many of the low-risk activities are simply not necessary for the smaller projects. The program manager and the center director have used the matrix chart on numerous occasions to explain the overall complexity of the construction process and as the basis for the overhead costs. The development of the matrix chart was also an extremely valuable tool to help us develop consistent criteria in the application and reduction of overhead costs.

Integration and Implementation

The project planning guide, the WBS dictionary, and the matrix chart are used together to plan, execute, and monitor projects. During the planning process, the project manager reviews them to determine which items are applicable to the given project and makes changes to the standard templates accordingly. With the given set of activities and cost components, it is then possible to start coming up with estimates for the cost of doing the work and the time that it will take to do it. Thus the baseline schedule and the budget are developed.

During the execution of the project, the schedule is updated with actual dates and durations in order to track progress against the baseline. As additional tasks are identified, they are added to the schedule and to the WBS breakdown. When new tasks are added, the project manager determines the source of the funds for the work. The WBS definitions help him or her to determine the proper way to account for those costs.

FIGURE 2. MATRIX CHART--DESIGN PHASE

Throughout the project, the project planning guide, the WBS dictionary, and the matrix chart are used to monitor the project performance and cost breakdown. They serve as documentation for the baseline and budget assumptions. They can also be used after the completion of the project to update the standard templates with better estimates of duration, linking of tasks, and cost breakdowns.

Conclusion

Until recently, the Corporate Construction Program at Sandia National Laboratories in Albuquerque, New Mexico, was experiencing difficulties in managing projects; poor planning and cost estimating caused schedule and budget problems as projects progressed. The program needed comprehensive project planning tools to implement projects consistently throughout a matrix organization and make sure that all requirements were addressed.

The first step taken was the development of an integrated project planning guide, which is a Microsoft® Project schedule that provides a standard template for scheduling individual construction projects. It is broken down according to the life cycle of the project and prevents the project team from leaving out an important requirement or activity. This is especially helpful in an environment where requirements are constantly changing.

However, we needed more than just the project planning guide. As a life-cycle-based tool, it doesn't show how tasks fall into the overall WBS or how project costs should be allocated. For this the Corporate Construction Program developed a WBS dictionary that describes how capital and operating funds are used to develop, design, construct, equip, and manage projects. We also developed a matrix chart that maps the planning guide against the major types of construction projects that are accomplished at Sandia National Laboratories.

Together, these tools help project managers plan and develop work, estimate costs, and write work packages, ensuring that no requirement is left out. The guide, the dictionary, and the matrix chart offer enough flexibility that the project manager can make choices about how to structure work, yet ensure that all work rolls up to the cost categories and key DOE WBS elements. As requirements change, the tools can be updated to make people aware of the changes and their effects on projects. Thus the guide, dictionary, and matrix chart also serve as training tools for new project team members.

The project planning guide, WBS dictionary, and matrix chart have evolved into valuable tools that allow Sandia project managers to manage projects consistently, meet DOE requirements, clarify project tasks, develop cost estimates, write work packages, train project team members, and disseminate changes in requirements. Together, these guides help project managers avoid the shortcomings of past projects, reduce budget overruns, minimize project delays, and ensure success.

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