



WORK PACKAGING FOR PROJECT CONTROL

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INTRODUCTION

It has been said that a manager can only effectively coordinate the work of about seven individuals reporting directly to that manager. Whatever the numbers might be, there is a finite limit to the scope of an operation that an individual can comprehend and manage in detail. A president of a large business or a project manager of a large project cannot possibly know all the details of every included operation. Instead, at the lowest management level, operations are managed in detail; at each higher level, operations are managed at a more summary level, the president or project manager providing broad control, with detailed involvement only on an exception basis. It is for this reason that organizational structures were born.

Work packaging is an application of this philosophy. To manage a complete, complex operation, that operation must be broken into well-defined components at successive levels of detail and, at each level of detail, responsibility assigned for management of each component. Through this hierarchical arrangement, management of the total is possible.

As will be explained in subsequent chapters, work packaging is a concept that applies to the engineering, procurement, construction, and startup phases of a project. It provides tools which facilitate the scheduling, budgeting, controlling, and data recovery. Among these tools are work breakdown structures, work packages, activities, tasks, control accounts, codes of accounts, and a variety of documents and databases—each of these will also be explained. As will be shown, work packaging is an essential ingredient for integrating cost, schedule, and materials control, and is an absolute necessity for efficiently managing an engineering-procurement-construction (EPC) project.

Much of the material in this publication is based upon the CII source document, *Work Packaging for Project Control* (Reference 1), which is available from CII. That document was generated from two separate University of Maryland research reports that are referenced in the source document and that are on file at that university. Those reports contain a number of specific applications within industry of the principles discussed in this publication.

In addition to reviewing Reference 1 for more detailed coverage of work packaging, readers are invited to review each of the following CII publications, which includes discussion of various aspects of work packaging as that subject relates to the major theme of each publication:

- CII Publication 6-1, *Scope Definition and Control* (Reference 2)
- CII Publication 6-2, *Project Control for Engineering* (Reference 3)
- CII Publication 6-3, *Model Planning and Controlling System for EPC of Industrial Projects* (Reference 4)

- CII Publication 6-4, *Contractor Planning for Fixed-Price Construction* (Reference 5)
- CII Publication 6-5, *Project Control for Construction* (Reference 6)

In this report a number of acronyms are utilized. Although each is defined when first used, a summary listing with equivalent full titles is provided in the Appendix.

WORK PACKAGING BASICS

Work Packaging as a Planning Tool

When referring to a complete EPC project, the players include the owner, engineer, project manager (if a separate one is used), contractors, subcontractors, and vendors. Project planning must consider the needs of all these organizations—it is an essential step in the development of the “team” atmosphere that is sought on a project. The owner and project manager provide the basic planning guidance through definition of the project’s scope and establishment of project milestones. Then, planning begins to expand. As detailed in Reference 4 for an EPC project, the planners begin with the owner’s need date and work backwards to rough out the schedule for startup, construction, procurement, detailed engineering, and conceptual engineering. As project definition becomes more complete, the level of planning detail expands to the point where required engineering packages, required construction contracts, key procurements, and startup sequences are identified. To integrate these requirements toward the common goal of meeting the owner’s need date, a Control Schedule will be established. It will provide the sequencing and relationships of the many actions to be taken by the many players. The activities on this schedule are one level of work packages. The Control Schedule will be expanded in detail by the affected organizations to accomplish short-range planning. Again, they are working with work packages, but at a more detailed level. Thus, work packages are the building blocks that comprise a total project and are essential planning tools for all players.

The usefulness of work packaging is not confined to the project at hand. As is well known, a key determinant of success in any engineering-construction project is the completeness of planning. The potential for complete planning, however, is largely determined by the completeness and accuracy of the historical database and proper application of that data. The completeness and accuracy of that database is dependent upon the validity of data reported from the field. Thus, a structure must be employed on a project which facilitates the continuous cycle of planning, controlling, and data recovery. Work packaging also provides this structure.

Key Definitions

A number of terms are used in this and related CII publications (References 2-6). Their definitions follow.

- A *Work Breakdown Structure* (WBS) is the hierarchical representation of a complete project or program, its components being arrayed in ever-increasing detail.
- A *WBS Element* is a component at any level on a WBS.

- A *Cost Breakdown Structure* (CBS) is the hierarchical representation of all cost accounts in a project to include indirects and overhead. The WBS is included within the CBS.
- A *Work Package* is a well-defined scope of work that terminates in a deliverable product(s) or completion of a service. Each package may vary in size, but it must be a measurable and controllable unit of work to be performed. To complete a work package, one or more tasks will be performed. Thus, a work package may encompass the work of more than one crew or staff.
- A *task* is an operation performed by an individual, crew(s), and/or equipment, such operation being directly or indirectly required for completion of a work package.
- *Control Accounts* are selected accounts used by managers as the basis for resource allocation, productivity management, and/or data collection for the historical database. A control account can be a single work package at a chosen level of the WBS, a task, or can encompass all work packages or tasks of the same type. For example, there can be 10 similar reinforced concrete foundations on a project. Although each may be treated as a work package for detailed scheduling, they may be treated as a group (control account) for purposes of estimating, tracking productivity in the field, and data recovery for the historical database.
- *Activities* are associated with the scheduling function and refer to the work represented by arrows on a arrow-diagram-method (ADM) critical path format schedule, nodes on a precedence-diagram-method (PDM) critical path format schedule, or bars on a barchart (Gantt chart). An activity can be a task on a detailed schedule or a work package on a more summary schedule.

Providing further interpretation of these definitions, the following can be said about a WBS, work packages, tasks, activities, and control accounts:

- There is no established level of detail for a work package. A work package can be the total project or a logical subdivision thereof. Thus, a manager of many small projects may consider each project as a work package for control purposes. On the other hand, the civil superintendent on a project will consider each foundation a work package.
- A work package:
 - is a package of products or services requiring management as a unit in connection with engineering, procurement, construction, and startup.
 - can be thought of as a noun.
 - can be readily described in terms of boundaries and included elements.
 - will require one or more tasks to complete.
- A task:
 - involves the application of worker and/or equipment/tool effort, although it may involve only passage of time.

- can be thought of as a verb.
 - requires time for completion.
 - has a well-defined start and finish.
 - usually can be broken into subtasks.
 - is cataloged in generic fashion to be consistent with the planning/estimating database so that data collected can be used in planning subsequent projects.
- A control account:
 - can be either a task or work package depending upon the purpose served. A task is an appropriate control account for collecting information for the historical database. A control schedule work package is an appropriate control account for collecting information for in-process status reporting to an owner. Both types can be used simultaneously and are readily served due to the format of the code structure and select-sort capabilities of modern computer systems.
 - is not an appropriate unit for scheduling if it includes similar tasks performed at different points in time.
 - Schedule activities can be either work packages or tasks. When a work package is used, planners are simply operating at a summary level that wraps up all included tasks. For example, a construction work package may be a reinforced concrete slab, which may be the accepted level of detail on the control schedule. When so shown, it incorporates the included tasks of site preparation, forming, resteel installation, placing and finishing concrete, curing, and form removal.

Developing the WBS

To create a WBS, planners start with the total scope of work in the project and then break it into its major subdivisions (engineering, construction, etc.) and sub-subdivisions, with each part at each level being distinguishable from the others. Each succeeding level of the WBS will reflect the way work is traditionally managed by the entity performing that function. For example, the construction portion of the WBS must cater to the constructor; that is, it must reflect the way construction will be logically controlled.

The first WBS level of detail is the total project. This is referred to as Level 0 in CII publications. On an EPC project the next level will be engineering, procurement, construction, startup, and other major categories of support activity. Each of these is then logically divided. Using construction as an example, work will probably be cataloged by area. Area can refer to either a geographical subdivision of the project site or a category of facilities which crosses several geographic areas. For example, "Process Area A" would include all major process components to be erected in geographic area A. Yet, in area A and other areas of the project will be roads, utilities, and fencing which are best controlled on a project-wide basis. For these, the area designations might be "Utilities" or "Yard Structures." The engineering portion of the WBS will be compatible with the construction WBS.

Subsequent levels of detail will be consistent with the logic for the WBS component. Again, using construction, a building can be broken into its foundation, structural frame, exterior, HVAC, and so forth, and each of these is further subdivided as appropriate. It is important that all components are included and that boundaries between components be clearly defined.

Developing Work Packages

Work packages, as their name suggests, are packages of tasks in which completion is required for the facility to be built. These tasks are accomplished by design engineering, procurement, construction, startup, and overhead personnel.

For the design personnel, the products or services to be provided are the drawings, specifications, procedures, and comparable items required by vendors or constructors to complete their work. For procurement personnel, the product or service is the timely delivery of vendor equipment information to support the engineering process and/or timely delivery of materials and equipment to support the construction process. For construction personnel, the product is the constructed facility to be turned over to the owner. For startup and test personnel, the products are the operational certifications of systems. For overhead personnel, the products and services are those typically associated with such items as management, quality control, and warehousing.

For a total project, the sum of all work packages will account for all planned expenditures of personnel, materials, and equipment required for facility completion. Having so cataloged these items, the structure is established for integration of cost, schedule, and resource control.

Code Structures

Modern computer systems enable employment of elaborate codes of accounts to fully support work packaging. While a variety of code formats will prove adequate, the following elements must be uniquely identifiable within the total structure:

- **WBS.** This structure catalogs the total effort at various levels of detail and is unique for each project. It is hierarchical in format to enable summary of data at any level.
- **CBS.** This is an extension of the WBS to include overhead and indirect accounts.
- **Tasks.** This is a structure which catalogs engineering, procurement, construction, startup, and overhead tasks to be performed. These tasks are generically described and can include several levels of detail in hierarchical format within a task category. This code structure should be standard within a company and be used in the historical database. A selected level or levels of tasks may be used as control accounts for purposes of collecting performance data for return to the historical database.