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Scope Development Problems in Estimating

Larry Dysert, CCC

For those in the business of executing projects, it is widely recognized that one of the most important ingredients to a successful project is the accurate definition and effective control of project scope. Recognizing project scope definition as one of the most important factors influencing project success is certainly not a new concept. In 1982, the Construction Industry Institute (CII) Business Roundtable issued a report stating that "poor scope definition at the (budget) estimate stage and loss of control of project scope rank as the most frequent contributing factors to cost overruns" [1]. Numerous other studies and publications performed over the years [2,3,6,8,9] state the same conclusions. Nevertheless, obtaining adequate scope definition for estimating purposes continues to be one of the most persistent problems faced by estimators.

This paper discusses issues involved in dealing with scope development problems during the preparation of capital cost estimates, specifically in relation to how these problems are addressed by the capital estimating department at Eastman Kodak Company. Topics covered include the minimum requirements to prepare various levels of estimates, communicating information requirements to project teams, how estimating techniques change with the level of scope provided, how to prod the project teams to produce scope information, and how to present the estimate in relation to scope definition.

MINIMUM REQUIREMENTS TO PREPARE ESTIMATES

At Eastman Kodak, we have an estimate classification system that defines 4 classes of project estimates, as follows:

- class S—strategic (preliminary sponsor approval)
- class 1—conceptual
- class 2—semidetailed (project funding approval)
- class 3—detailed

The class S and class 2 estimates are the primary estimates used in the funding process at Eastman Kodak. They will generally be prepared for all projects.

Class S estimates are typically prepared when engineering is less than 5% complete. They are usually prepared to provide a strategic analysis of the economic viability of a project and to evaluate alternative schemes. Class S estimates are used to support a formal funding request for preliminary sponsor approval of the project and for authorization of the funds required to cover engineering through the end of Kodak's front-end loading process (FEL), typically referred to as the end of class 2 engineering [7].

Class 1 estimates are usually prepared when engineering is between 10% and 25% complete. Class 1 estimates are used to provide a check estimate between the formal authorization requests made at class S and class 2 of our FEL process. Class 1 estimates are not prepared for all projects. They are typically prepared only for very large projects, projects involving new technology, and for projects for which the basic scheme of the project has changed from that on which the class S estimates was based.

Class 2 estimates are prepared when engineering is between 25% to 40% complete. Class 2 estimates are used to obtain formal funding approval of the project, and to establish the control baseline for the project.

Class 3 estimates are rarely prepared, but when they are used, engineering is normally more than 50% complete. Class 3 estimates are generally never provided for the entire project. They will normally be used only for change alert estimates on small portions of a project, and occasionally for fair price estimates to evaluate contractor bids.

One of the common problems in estimating is obtaining the proper level of information upon which to base the estimate. Engineering may not necessarily understand the estimating process enough to know the type of information required to produce an estimate or to meet a specific estimating technique or methodology. It's important to convey both estimating information requirements and an understanding of the estimating process to engineering and project teams.

The capital estimating department at Eastman Kodak has defined the minimum information requirements for preparing each class of estimate. This essentially defines the level of scope definition that is required to prepare each estimate.

Class S Technical Deliverables

The following are class S technical deliverables:

- preliminary requirements document and scope description,
- approximate plant/system capacity,
- block flow diagrams identifying production units with capacities/sizes,
- block layout drawings defining functional areas, relative locations and layout,
- general project location, and
- approximate major equipment capacity and metallurgy (if known).

Class 1 Technical Deliverables

The following are class 1 technical deliverables:

- approved requirements document;
- complete process flow diagrams (PFD's);
- preliminary utility load sheets;
- complete manufacturing systems layout drawings;
- complete machine concept layout drawings;
- preliminary process equipment list with in-house pricing;
- preliminary process equipment specification sheets for long lead items;
- complete general equipment arrangement drawings;
- complete plant/site layout drawings;
- preliminary piping and duct specifications with metallurgy;
- preliminary electrical one-line diagrams;
- preliminary electrical equipment/motor list with in-house pricing;
- preliminary electrical classifications;
- preliminary process control description/philosophy;
- preliminary instrument/major control device list with in-house pricing;
- approximate process control I/O count;
- preliminary process control software design document; and
- preliminary integrated project plan (including engineering/design plan, project control plan, fabrication plan, construction/execution plan, commissioning plan).

Class 2 Technical Deliverables

The following are class 2 technical deliverables:

- complete process and utility P&IDs,
- final utility load sheets,
- complete process equipment/spare parts list with informal vendor quotes,
- preliminary process equipment specification sheets,
- final piping and duct specifications,
- preliminary piping valve and specialty item list with informal vendor quotes,
- final electrical one-line diagrams,
- complete electrical/motor list with informal vendor quotes,
- final process control description/philosophy,
- updated instrument/major control device list with informal vendor quotes,
- final process control I/O and loop counts,
- final instrument data sheets,
- preliminary control panel layouts,
- updated process control software design documents,
- updated integrated project plan, and
- complete work breakdown structure and code of accounts.

Class 3 Technical Deliverables,

The following are class 3 technical deliverables:

- final process equipment/spare parts list with formal quotes and/or actual costs,
- final process equipment specification sheets,
- final piping valve and specialty item list with formal quotes and/or actual costs,
- piping and duct isometric drawings,
- final electrical equipment/motor list with formal quotes and/or actual costs,
- final electrical design drawings,
- final instrument/major control device list with formal quotes and/or actual costs,
- final instrument design drawings, and
- final process control software design documents.

The information requirements listed above are an integral part of Kodak's project process and provide a structured approach to the definition of project scope. As discussed previously, formal project funding and authorization are made based upon an estimate prepared with class 2 deliverables. This is the point at which the project's P&IDs are available, and thus a commitment has been made to a specific concept. This is, therefore, an important milestone in scope development for a project.

COMMUNICATING INFORMATION REQUIREMENTS TO PROJECT TEAMS

It isn't enough to develop information requirements but then be unable to convey them to the project teams. The listing of information requirements to prepare each class of estimate is formally documented in Kodak's **Capital Project Process Manual** and in the **Cost and Schedule Procedures Manual**, and is also communicated to the project teams in our estimating department brochure of products and services. In addition, this information is also published on Kodak's Intranet. The estimating department also makes regular presentations to the engineering/design departments and to project teams regarding these information requirements. Presentations are also made to upper management so that they have a clear understanding of the level of scope definition upon which each class of estimate should be based.

It is the estimator's responsibility to ensure that a project team understands the information needs for the estimate. The estimator must then ensure that the information provided is suitable to produce the quality of estimate desired. The project team is responsible for providing the necessary project deliverables and scope information to the estimator. The information requirements are normally discussed at the estimate kick-off meetings, and a schedule is determined for the delivery of the scope deliverables to the estimator.

CORRELATE ESTIMATING TECHNIQUES WITH LEVEL OF SCOPE DEFINITION

As the level of scope development (and thus project definition) increase on a project, estimating techniques tend to progress from stochastic and factored methods to more deterministic methods. With stochastic estimating methods, the independent variables used in the cost estimating algorithms are generally something other than a direct measure of the units of the item being estimated. These methods often involve simple or complex modeling based upon inferred or statistical relationships between costs and technical parameters. With deterministic methods, the independent variables are more or less a definitive measure of the item being estimated. Deterministic methods tend to rely on straight-forward counts or take-off of items multiplied by known unit costs.

At Kodak, class S estimates are usually prepared using capacity factoring based upon historical data, or prepared using specialized parametric estimating software [4]. Where no similar project history or parametric systems are available, judgment will often be relied upon to formulate the project estimate.

Class 1 estimates are prepared using equipment factored approaches and specialized parametric software. These methods will be supplemented with semidetailed line item estimates for outside battery limit items and items for which no parametric system applies. Ratio factors are usually used to estimate most project administration, engineering/design, and other nondirect costs. Both class S and class 1 estimates are normally organized by functional systems rather than work breakdown structures and/or disciplines.

Class 2 estimates are generally prepared on a semidetailed to detailed basis using a line item estimating system. Detailed estimates for project administration, engineering/design, and other nondirect costs are often provided by the project teams. Parametric and ratio factors are generally not used.

Class 3 estimates are prepared similarly to class 2 estimates but with more complete scope definition and better pricing information. As discussed previously, class 3 estimates are rarely prepared and usually only for a part of a total project.

Of course, any particular estimate may involve any combination of estimating techniques or methods. Also, stochastic methods are not necessarily less accurate than deterministic methods if the level of scope development is not adequate to support deterministic methods. An equipment-factored estimate may not be more accurate than a capacity-factored estimate if the equipment list is incomplete. A semidetailed or detailed estimate may not be more accurate than a factored estimate if it is based on incomplete information. The estimating techniques must match both the level of information provided and the completeness of that information.

PROD THE PROJECT TEAMS TO PRODUCE SCOPE INFORMATION

Despite understanding the level of information required and having a project process that identifies the steps to take in developing that information, some project teams still have a problem in actually producing a sufficient level of scope definition (especially in the early project stages). In the meantime, you've been assigned to prepare a certain class of estimate with a firm deadline. In situations where the engineering deliverables simply don't seem to be coming in at a pace to support the estimate, sometimes nothing else works as effectively as making up the scope yourself.

Now I don't mean to imply that you should go ahead and prepare the estimate on the scope that you have made up. Instead, make up the scope as you see it, and take it to the project and/or engineering teams and have them tell you why it's wrong. This often helps to break the stalemate while you wait for the engineering deliverables to arrive. When you show up at their desks with the equipment list that you've made up because you haven't received one yet (and the estimate is due by the end of the week), then usually the engineer will sit down and take the time to correct the list. Often, within a short time you will be able to obtain acceptance on scope definition. Providing a little "push" to the issues of scope development helps to prod the engineering and design efforts to meet your needs.

PRESENT THE ESTIMATE IN RELATION TO SCOPE DEFINITION

It's important that management has as much information as possible when making decisions regarding the funding of projects. Kodak's project process calls for preliminary project approval and funding authorization to cover FEL engineering be based upon a class S estimate. Full project and funding approval is to be based upon a class 2 estimate. Thus, when management receives a project funding request and its supporting estimate, they are inclined to assume that a specific level of project scope definition has been reached. Unfortunately, such is not always the case. The project environment is not a perfect world. For many reasons, the pressures to get project approval often mean that estimates are prepared without meeting the minimum level of project definition required.

As estimators, we prepare the best estimate possible with the information provided. Although we can communicate the level of information desired to prepare an estimate of a given classification, we are often at the mercy of the project team to provide that information. For example, although we don't receive all of the information required for a class 2 estimate, we are often under pressure from a project manager to prepare an estimate and call it a class 2 estimate so that the funding request can be made.

This presents a predicament for the estimator. We don't wish to be considered adversarial to the project manager or project team, but on the other hand, we don't wish to have management misunderstand the basis on which the estimate was prepared or otherwise connote a greater level of accuracy to the estimate than it deserves. Since the policy of the estimating department is that all estimates must be explicitly classified (class S, class 1, etc.), we have adopted the stance that estimates can also be classified "with exceptions." As an example, if an estimate substantially meets most of the scope requirements for a class 2 estimate, but not all, then we will classify the estimate as a "class 2 estimate with exceptions." In the basis of estimate document (which accompanies all estimates prepared by our department), we will then list the specific exceptions to the minimum information requirements for that classification of estimate. The list of information requirements is also attached in a checklist form to the basis of estimate with comments to identify the exceptions.

The estimate is thus presented in relation to the level of scope definition for the project. The estimator produces the best estimate possible and clearly identifies the scope upon which the estimate was based. If management chooses to approve a funding request that is supported by an estimate "with exceptions," then that is its prerogative. At least, management has been informed of the potential deficiencies in scope development and can then make its decisions accordingly.

A formal estimate classification system and explicit identification of the project scope information required to support each class of estimate helps to avoid some of the common problems that projects experience concerning scope development. At Kodak, the information requirements for estimates are documented as a part of the project process. Project teams have a clear understanding of the engineering and project deliverables required to prepare estimates. This often serves as a catalyst to concentrate on scope development early in the project where it provides the most opportunity to influence project costs in a positive manner. Numerous studies show that early scope development results in better projects.

Defining the level of scope development required to support specific classes of estimates provides management with better information upon which to assess project funding requests. Identifying those areas of an estimate that are lacking in scope development also assists management in the decision-making process.

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