# : What is a cost estimation DSS?

by Dan Power

Editor, DSSResources.com

In many industries, bids are submitted in response to requests for proposals (RFPs). Preparing a bid for a project requires facts, estimates and experience. The most common method of preparing a bid is to estimate actual project costs and then add a charge for overhead and profit. Predicting costs for a project or task is often difficult. One approach to bidding is to use historical cost data. Another approach is to use data and quantitative models to adjust for changes in costs or cost uncertainty. Cost estimation models are most often algebraic models where an analyst or cost estimator can adjust parameters. Not many years ago, cost estimation was a vague, heuristic task, but data and model-driven DSS are now commonly used to improve the accuracy of the cost estimate or prediction. Specialized cost estimation DSS are used for many tasks including construction cost estimating, custom software development bids, and custom manufacturing bids.

Many managers want examples of DSS and students are often interested in "building" a real DSS. Finding small-scale, yet interesting, DSS projects for students can however be difficult. Building and discussing cost estimation DSS is one possibility. A cost estimation DSS is a software application that helps a person estimate cost elements and finalize a bid for a prospective customer. "Cost estimation" refers to the purpose of the Decision Support System and does not constrain how the system is implemented. The generic task is subtle and semi-structured and it can be approached in many ways. A cost estimation DSS may be a model-driven or a data-driven DSS. Data-driven DSS help "add up" cost elements from a database and usually provide limited analytics. Cost estimation DSS are frequently model-driven and spreadsheet-based, but other types of DSS are developed and marketed for assisting in this task (see TechComm Associates, 2003). Successfully estimating costs is important to the survival and profitability of many firms in many different industries. A common problem is underestimating costs and losing money on a project. A hidden problem is overestimating costs and losing a bid when the project could have been completed profitably.

According to the U.S. Department of Labor (BLS, 2010-11), "cost estimators develop the cost information that business owners or managers need to make a bid for a contract or to determine if a proposed new product will be profitable". In some businesses, cost estimates are prepared on the back of an envelope or on a simple "bid" sheet. As the complexity of the estimating task increases computerized decision support becomes increasingly important. "Cost estimators held about 217,800 jobs in 2008. About 59 percent of estimators were in the construction industry and another 15 percent were employed in manufacturing. The remainder worked in a wide range of other industries." Currently, most estimators **DO NOT** use computerized decision support.

So what is involved in preparing a cost estimate? What is the decision process? A general description suggests the importance of the task. The BLS handbook notes "The methods of and motivations for estimating costs can vary greatly, depending on the industry. On a construction

project, for example, the estimating process begins with the decision to submit a bid. After reviewing various preliminary drawings and specifications, the estimator visits the site of the proposed project. The estimator needs to gather information on access to the site and availability of electricity, water, and other services, as well as on surface topography and drainage ... After the site visit is completed, the estimator determines the quantity of materials and labor the firm will need to furnish. This process, called the quantity survey or "takeoff," involves completing standard estimating forms, filling in dimensions, number of units, and other information. A cost estimator working for a general contractor, for example, will estimate the costs of all items the contractor must provide. Although subcontractors will estimate their costs as part of their own bidding process, the general contractor's cost estimator often analyzes bids made by subcontractors as well. Also during the takeoff process, the estimator must make decisions concerning equipment needs, sequence of operations, and crew size. Allowances for the waste of materials, inclement weather, shipping delays, and other factors that may increase costs also must be incorporated in the estimate. On completion of the quantity surveys, the estimator prepares a total project-cost summary, including the costs of labor, equipment, materials, subcontracts, overhead, taxes, insurance, markup, and any other costs that may affect the project. The chief estimator then prepares the bid proposal for submission to the owner."

The BLS report notes "In manufacturing and other firms, cost estimators usually are assigned to the engineering, cost, or pricing departments. The estimators' goal in manufacturing is to accurately estimate the costs associated with making products."

For the many years, students in my DSS course worked in teams to analyze, design and then build a spreadsheet-based DSS for cost estimation. This project was small-scale and varied in purpose, yet students could use a readily available spreadsheet package, like Excel, to build a "real" DSS. The project provides many opportunities for student creativity and initiative; teams work on an important, non-trivial task; students can apply Excel skills they have learned on a small-scale "real" project. Also, students go through the steps in analysis and development and they create and submit deliverables. I encourage teams to follow a decision-oriented design approach and begin by studying a specific cost estimating process in a specific business.

Teams pick an estimating situation and then research, plan, and develop a specific DSS for that situation. The team develops a model-driven DSS for estimating the cost of an event/project and preparing a competitive bid to submit to the person requesting a proposal. The specific DSS supports a person working as a cost estimator or bid specialist or a similar job title. The specific model-driven DSS that is developed should help an estimator input data, apply a detailed quantitative estimating model, conduct sensitivity and "what if" analyses, and prepare a formal bid proposal. Project teams submit 4 deliverables during the semester. Deliverable 1 is a project analysis, specification and research summary report; Deliverable 2 is a model specification and project plan; Deliverable 3 is the completed Spreadsheet-based DSS; and Deliverable 4 is the documentation.

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An algebraic model provides the decision support functionality, but the model-driven DSS application needs to facilitate elicitation of values and estimates and then help the estimator complete "what if?" and sensitivity analysis. Some teams break the estimating task into phases or separable divisions. Some teams try to identify standard cost data to compare to model estimates. Occasionally a team will propose calculating a bid from an established, fixed "price sheet". This approach neglects all of the cost estimation issues and provides no information to the decision maker about the profitability of a job or project. Creating a fixed "price sheet" application is **NOT** a decision support system even though a spreadsheet might be used to help with calculations. In general, teams should receive negative feedback about this simplistic type of application. Understanding all the costs in an estimating situation is usually a major challenge and teams need to face this challenge to build a successful DSS.

Occasionally development teams try to help an estimator answer the question "Should we bid?" in addition to "How much should we bid?" Rarely do teams grapple with the complexity of bidding in the context of a portfolio of bids. In general, a model-driven DSS focuses on a "fixed" price or a "not to exceed" bid situation. Teams need to determine how much detail should be in the cost estimate and how overhead should be allocated. A major issue facing estimators is assessing profitability and keeping the bid amount competitive. Also developers need to determine if it is more appropriate to provide for a profit markup or a markdown. Should profit be an across-the-board percentage or should the DSS provide for selective adjustments to cost elements? Markup pricing usually covers overhead and profit contribution so the issue becomes how much markup? In some situations, labor time estimates are especially difficult to forecast. Perhaps both labor productivity and labor costs need to be considered in an estimate. Also, some teams neglect "what if?" analysis and sensitivity analysis. In a model-driven DSS this capability is important. Also, developers need to determine if common size percentages of cost categories will help the estimator. Is it helpful to show the estimator a bar chart of amounts for major cost elements? Each cost estimating process has its own demands, nuances and idiosyncrasies. The development team needs to make design decisions that accommodate the specific estimator and estimating situation.

Teams are encouraged to look for projects in three industry situations: construction cost estimating, convention and meeting cost estimating, and software development cost estimating. It is important that the project involve sufficient complexity to justify building and using a spreadsheet-based DSS in the estimating situation. Some representative cost estimation DSS project titles from the past few years include: 1) "Cost estimation for a major event on a college campus", 2) "Light industrial construction cost estimating", 3) "Meetings and banquets cost estimating for a hotel", 4) "New home construction estimating", 5) "Prepare attestation bids for a medium-sized accounting firm", 6) "Provide cost estimates for weddings", 7) "Custom software project cost estimating", and 8) "Web site development cost estimating"

Typically the elements of a cost estimate include: 1) Quantity Takeoff: quantities of various materials needed, 2) Labor Hours: for crews or on a unit man-hour basis, 3) Labor Rates and payroll burden: cost per hour, 4) Material Prices, 5) Equipment Costs, 6) Subcontractor Quotes, 7) Allocation of Indirect Costs, 8) Profit Amount or Percentage (cf. Manfredonia, Majewski and Perryman, 2010).

The Occupational Outlook Handbook (BLS, 2010-11) reports that "Computers play a vital role in cost estimation because the process often involves complex mathematical calculations and requires advanced mathematical techniques. For example, to undertake a parametric analysis (a process used to estimate costs per unit based on square footage or other specific requirements of a project), cost estimators use a computer database containing information on the costs and conditions of many other similar projects. Although computers cannot be used for the entire estimating process, they can relieve estimators of much of the drudgery associated with routine, repetitive, and time-consuming calculations. New and improved cost estimating software has lead to more efficient computations, leaving estimators more time to visit and analyze projects."

Cost estimation DSS can help cost estimators prepare bids faster and more accurately. A sophisticated DSS can help insure that when a company wins a bid that it will be able to profitably complete the event/project.

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Author: Daniel Power
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