Information System Cost Estimating: A Management Perspective

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Abstract

Information systems cost estimating is an important management concern. An estimate helps to cost justify individual proposals, to schedule their development, to staff them, to control and monitor their progress, and to evaluate estimators and implementers. Through a case study of a chemical manufacturer, the investigation reported in this article facilitates a better understanding of the management of the cost estimating process. Interviews with 17 information systems managers and staff members, and four user managers confirm that the practice of cost estimating can be viewed in terms of both a Rational Model and a Political Model, can identify impediments to accurate estimating, and can provide suggestions and warnings for managers and future researchers.

Keywords: Information systems, information management, planning, cost estimation

ACM Categories: D.2.9, K.6.1, K.6.3

Introduction

In principle, the expected economic value of a proposed information system governs the decision to develop it. An organization conventionally predicts the benefits of the system over its lifetime and estimates the costs of its initial development and ongoing operations to identify that value (Emery, 1971; King and Schrems, 1978). Such financial techniques as net present value, return on investment, or internal rate of return are often used to combine and summarize tangible benefits and costs (Guimaraes and Paxton, 1984). Ideally, a steering committee of senior managers evaluates these calculated figures, along with any available intangible values, and plans a portfolio of applications (Drury, 1984; McKeen and Guimaraes, 1985).

The accurate prediction of benefits and costs is crucial because of this approval process. Overestimated benefits or underestimated costs can result in the decision to develop projects that will ultimately fail to contribute to the organization and will waste scarce resources. Underestimated benefits or overestimated costs can result in the decision to refrain from developing potentially worthwhile projects. Thus, the failure to accurately assess all of the benefits and all of the costs can have a major, widespread impact on the organization.

The impact of inaccurate estimating has been so significant that it has reached the popular business press (*BusinessWeek*, 1988). This *BusinessWeek* article reports that a state of Oklahoma project was initially estimated at $500,000, but was later completed at $4 million. It also describes an Allstate Insurance system that was estimated at $100 million while under development; it was initially estimated at $8 million. In fact, a recent Peat Marwick Mitchell & Co. survey found that 35 percent of its largest clients admitted major cost overruns (*BusinessWeek*, 1988). Such catastrophes have destroyed the credibility of IS management.

The most significant cost is the expenditure for the labor (i.e., systems analyst and programmer time) used to develop an information system (Allen, 1982). One study identifies the estimation of labor requirements as an important IS planning issue among top IS managers (Lederer and Mendelow, 1986). That research found that these managers are concerned about the estimation of labor requirements because they must use these requirements to compute overall IS development costs. That study instigated the research reported in this article whose objective was to better understand the management of the labor cost estimation process through the in-depth study of the techniques and problems of one organization.

Background

Previous research regarding cost estimation has largely focussed on the study of algorithmic methods. These methods generally have three major features.

First, they require some well-defined level of knowledge of the proposed system. That is, the methods demand the identification of various, relevant parameters. For example, many methods require that the estimator identify the number of lines of executable code in the proposed system (Boehm, 1984; Freiman and Park, 1978; Herd, et al., 1977; Jensen, 1983; Nelson, 1966; Putnam, 1978; Watson and Felix, 1977; Wolverton, 1974). Other techniques focus on the functions of the proposed system and might require such parameters as the number and complexity of inputs, inquiries, outputs, and master files (Albrecht, 1979; Donelson, 1976; Halstead, 1977; McCabe, 1976). One particular method asks the estimators to rate such diverse characteristics (among many others) as the developers' familiarity with the application, the quality of the analysis of the project objectives, and the users' knowledge of data processing (Computer Associates, 1987).

Second, the methods generally require some historical base of information about past projects. This information includes durations of projects as well as some of the parameters mentioned above.

Third, the methods provide formulas that forecast the cost of the proposed system. The formulas are based on the system's parameters and on the corresponding parameters and costs of the systems in the historical base of information. The formulas range from simple to complex in mathematical sophistication. For example, some utilize such simple summary statistics as means and standard deviations (Donelson, 1976), while others employ differential equations (Putnum, 1978).

Objective studies of these methods have been few. Often the developers of a method describe their own technique and report their own assessment of its accuracy (Donelson, 1976; Jensen, 1983; Putnam, 1978; Watson and Felix, 1977; Wolverton, 1974). Other research has used the investigator's full knowledge of the scope of completed projects to develop a formula that would have predicted the projects' durations had the projects not been completed and their durations not already known. (In contrast, one might expect the investigator to test a proposed formula by predicting the duration of recently conceived projects and, after their completion, contrasting the predicted and actual durations.)

For example, one study evaluated the accuracy of four algorithmic methods by predicting the durations of projects that had already been completed (Kemerer, 1987). However, it found considerable inaccuracy with error rates ranging from 85 percent to 772 percent.

Nevertheless, the logic of the algorithmic methods is impressive. In fact, it has inspired the view that "the methods available today are more than adequate to establish an estimation approach. All that is needed is management's willingness to employ the planning and control philosophy used in other functional areas in the information systems department" (Benbasat and Vessey, 1980, p. 42). In attempting to understand the management of the estimating process, this study recognizes that there is a question of the adequacy of algorithmic methods versus the adequacy of the application of planning and control. It offers a new perspective on that question by focusing on a management point of view.

Conduct of the Study

This study employs a case methodology (Benbasat, et al., 1987). A case methodology is appropriate in research such as the management of cost estimating, where theory and research are in their early, formative stages (Roethlisberger, 1977). Moreover, the management of cost estimating is among those "sticky, practice-based problems where the experiences of the actors are important and the context of action critical" (Bonoma, 1983) and where a case methodology is warranted.

Accordingly, the authors gained the interest and cooperation of a chemicals manufacturer. The firm is the largest division of a *Fortune 200* corporation. The division has approximately $1.6 billion in annual revenue and 6,000 employees, of which over 250 are in the Information Systems Department (ISD). The ISD's annual budget is about $22 million. User departments have a backlog of requests for limited ISD service and must make judicious decisions about proposed systems because their departmental budgets are charged for them. In light of its budget, its size, its well-defined standards and documentation, the experience and education levels of its management and staff, and its extensive computer-based applications, an independent observer would probably consider the ISD to be technically sophisticated and well-managed. This is important to remember because the ensuing discussion might make it appear otherwise.

The authors interviewed 17 ISD managers and professionals. During a structured interview, subjects were asked to: (1) identify their job titles, as shown in Table 1; (2) describe their job responsibilities, especially with regard to their roles in the cost estimating process, as shown in Table 1; (3) explain how systems' costs are estimated; (4) identify any potential causes of estimating problems; and (5) identify potential means of improving the estimation process. The authors also interviewed four representatives from the functional areas of the organization with essentially the same questions; these representatives had all participated extensively on ISD development projects. The interviewers supplemented the five main questions with requests for clarification and related information. Each interview lasted about one and a half hours.

Three authors participated in each interview for purposes of control. One particular author was present for all of the sessions, while the remaining authors rotated as the other two interviewers. Immediately after each session, notes were transcribed independently by each interviewer, then compared and cross-checked to develop final versions. Later, the authors independently encoded and summarized all of the subjects' answers to the questions.

In addition, the authors obtained and reviewed management reports and data about past projects. A key ISD manager helped them obtain this information, choose interviewees, and verify current findings.

The most comprehensive report showed primarily small projects from January 1 through May 17, 1987. It covered 1,622 hours of labor over the 19-week period. Of all the projects on the report, 71.5 percent were completed beyond ± 10 percent of the estimate that appeared on the report. Likewise, of all the projects on the report, 60 percent were completed beyond the wider range of ± 20 percent. The greatest overruns included 60 percent, 64 percent, 119 percent, 247 percent, 520 percent, and 533 percent. However, most of those were small projects and hence, overruns or underruns might not be considered as deleterious as on larger projects. Nevertheless, they do suggest a potential problem in the area of cost estimating. In Figure 1, those data points outside the diagonal lines represent the 71.5 percent of the organization's small projects completed beyond ± 10 percent of their estimate.

At the conclusion of the study, the authors gave an oral presentation and a written report to a team of ISD managers. The subsequent discussion confirmed that the authors had clearly understood the cost estimating process of the organization.

Two Perspectives

The interviews revealed that ISD management had a documented method for managing the estimation process. Much of it was outlined in ISD's Standards and Guidelines Manual. However, simultaneously, activities not described in the manual also took place. Such parallel, coexisting activities are suggested by Robey and Markus (1984).

Robey and Markus allude to the existence of a rational system development process in which ISD and user participants follow a prescribed set of phases to create an information system. They state that a rational process has an identifiable and agreed upon set of goals with a prescribed means to achieve them.

Illustrating the rational process within the area of cost estimating is Jones' (1986) technique, called

Table 1. Titles of Respondents and Relevant Responsibilities

ISD Interviewees	
ISD Director	Responsible for entire Information Services Department
Manager of Systems Development	Responsible for development of large and some small systems
Manager, Financial Information Systems	Responsible for development of financial systems
Manager, Marketing Information Systems	Responsible for development of marketing systems
Manager, Manufacturing and Engineering Information Systems	Responsible for development of manufacturing and engineering systems
Manager of Systems Service Center	Responsible for small systems development and maintenance projects
Senior Systems Specialist	Serves as project manager for large projects
Systems Specialist	Serves as project manager for large projects
Contract and Financial Administrator	Responsible for financial information for ISD director
Manager of Systems and Programming Support	Provides technical assistance to systems specialists, programmers, etc.
Manager of Planning and Administration	Responsible for long-range information systems planning
Manager of Systems Planning	Responsible for initial planning of large projects
Programmer/Analyst	Responsible for systems development and maintenance
Programmer	Responsible for systems development and maintenance
Contract Programmer	Responsible for systems development and maintenance
Users	
Controller	Chief financial officer and major user
Manager of Cost and Lease Accounting	Liaison for systems development for accounting applications
Manager of Purchasing	Liaison for systems development for purchasing applications
Manager of Engineering Systems	Liaison for systems development for engineering applications

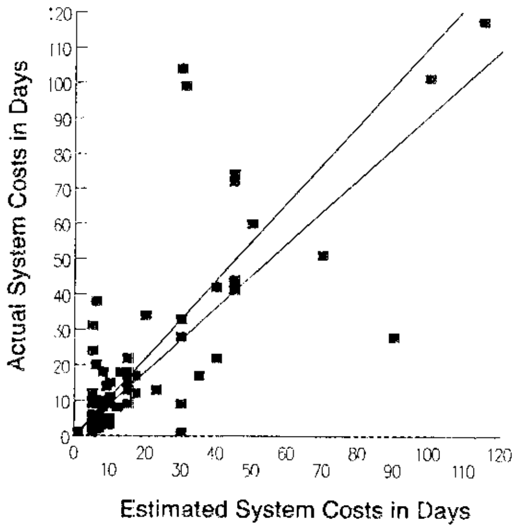

Figure 1. Estimates and Actuals

SPQR (software productivity, quality, and reliability). Based primarily on computations using 20 historical factors, SPQR predicts various types of systems development cost estimates and schedules, the rational process's identified and agreed upon goal. Examples of SPQR's major factors are programming languages used, program size, and experience of programmers and design personnel. The use of these factors represents the rational process's prescribed means of achieving the goal.

However, Robey and Markus as well as other earlier researchers (Keen, 1981; Pfeffer, 1981; Wildavsky, 1979) recognize the inadequacy of a rational process as a means of understanding behavior. For example, Wildavsky (1979) analyzed the federal government's budgetary process and found the rational paradigm to be inefficient, ineffective, and inappropriate because most outcomes emerged not so much through the extensive planning that was performed, but rather through considerable bargaining and mutual adjustment.

The inadequacy of the rational model is echoed by Pfeffer (1978) who observed that it does not recognize the origin of the personal objectives that lead to conflicts of interest. Moreover, he recognizes that the rational approach does not account for the fact that the outcome of such conflicts can be interpreted in terms of who benefits and who loses.

Hence, Robey and Markus also suggest the existence of a political systems development process in which participants' personal motives inspire their actions. They state that the participants in a political process have differing objectives and may use the situation to achieve their objectives to the disadvantage of each other. Such motive-driven behavior has been helpful in behavioral analysis in both the IS and other contexts (Allison, 1971; Borun, 1980; Grover, et al., 1988; Keen, 1981; Lund, 1980).

The political approach recognizes that conflicts of interest are common and expected. It further recognizes the necessity to understand the participants, their stands on the issues, the determinants of their relative power, and their process of arriving at a final decision. Activities result from bargaining and compromise, and the resulting decisions seldom reflect the preferences of a single group (Allison, 1971). Ultimately, the relative power of the participants provides both the sufficient and necessary means of reaching the decision (Pfeffer, 1978; Thompson and Tuden, 1959). In fact, with regard specifically to cost estimating, Jones proposes that "perhaps 10% to 15% of the really catastrophic project failures are at least partly caused by personal human dislikes and political or territorial disputes" (Jones, 1986, p. 235), although he does not elucidate such conflicts or formally include them in SPQR.

The next two sections describe the estimation process of the chemicals manufacturer. The first section describes a Rational Model in which the main identifiable and agreed upon goal is to provide an accurate estimate, and the prescribed means is a method of arriving at it. The second section describes a Political Model in which the participants have different objectives and use the cost estimating process to realize them. Each model reveals some of the management problems in estimating information systems development labor requirements.

Evidence of the rational model

In the Rational Model, five groups of employees from the chemical manufacturing company participate in systems development activities that are relevant to cost estimating:

1. **ISD estimators:** planners who work within the ISD to prepare initial project proposals, which include projected systems costs.
2. **ISD implementers:** systems analysts and programmers who develop the proposed system. They might also provide revised estimates, but frequently are not the same individuals who initially estimate costs.

3. **ISD management:** executives responsible for the ISD.
4. **User contacts:** liaisons from the application area of the business to the ISD. They might not be actual system users.
5. **User management:** executives responsible for the application area within the business organization.

Under the Rational Model, these managers and their staff carry out the following planning and development phases of a typical systems development life cycle approach (Lucas, 1986):

Phase 1—The Initial Investigation

User management or the user contact generates an idea in this phase. That person or group informally requests a provisional estimate by asking any available ISD representative (ISD manager, estimator, or implementer) for this number. The ISD representative gives a very rough estimate for the sole purpose of enabling the requester to decide whether to proceed with Phase 2. According to a senior systems specialist in the Manufacturing and Engineering Information Systems group, the very rough Phase 1 estimate is often very inaccurate because of the lack of knowledge about the scope of the project by all parties. The manager of Financial Information Systems (and four other interviewees) further pointed out that the ISD representative assumes the estimate will be forgotten when better estimates (i.e., based on more knowledge) are developed later on.

Phase 2—Preliminary System Study

According to the manager of Purchasing (a user), if the user contact believes that the system's benefits can exceed the Phase 1 cost estimate, a preliminary system study is carried out. During this phase, the ISD estimator examines the proposed application in order to produce an initial, serious estimate.

The estimator roughs out the system design to produce this estimate, a process described by the manager of Systems Planning. The estimator first identifies modules of programs with their functions, then determines files, and next assesses the complexity level of each module. Then the estimator looks up the number of days of analysis and programming for each module in an existing matrix of complexity levels and durations. Finally, the estimator sums the number of days and adjusts them based on experience and intuition. This algorithmic technique is hereafter referred to as "rough/refine" by the authors because the initial rough-cut estimate is later refined based on an increased understanding of the application and the user requirements.

The manager of Purchasing (a user) stated in the interview that "there is not enough brain power to catch" all requirements and that hence ISD management, user management, the user contact, and the estimator all recognize that this estimate is based on limited knowledge about the application and the requirements. They further recognize that the estimate will be refined later when there is more information about the application and requirements. Nevertheless, the Phase 2 estimate must be officially approved based on the Standards and Guidelines Manual. ISD management, user management, the user contact, and the estimator all sign off on the Phase 2 estimate to demonstrate their approval.

Phase 3—System Planning

Phase 3 includes a thorough analysis of the system with extensive user participation, and then, based on this analysis, a possible revision of the estimate. In the interview, the manager of Systems and Programming Support attributed this revision to the user's decision to change the requirements, while both the controller and the manager of Purchasing (both users) attributed it to a lack of understanding of the project. The manager of Systems Planning stated that at the beginning of this phase, the estimator gives his or her documentation to the implementer and withdraws from the project. The implementer then learns much more about the proposed system during this analysis.

The ISD implementer applies the rough/refine technique to create the Phase 3 estimate. If the ISD implementer's estimate exceeds the Phase 2 estimate, presumably because of more knowledge about the application and the requirements, then ISD management, user management, and the user contact again must sign off on a form shown in the Standards and Guidelines Manual. If the Phase 3 estimate is exorbitantly high, user and ISD management have the option to cancel the project.

Phase 4—System Design

Phase 4 represents the preparation of detailed system design. In terms of estimating activities, the implementer uses rough/ refine once again, but with considerably more information. As in

Phase 3, if the Phase 4 estimate changes, sign-off takes place. For example, in the interview, the controller described a stock transfer system that had originally been estimated at 100 man-days but was re-estimated at 200 man-days during the Phase 4 estimate. He threatened to cancel the project but signed off on this estimate instead because ISD told him that cancellation was impossible. Project cancellation does, however, often remain an option.

Phase 5—Program Specifications

The estimate probably remains unchanged while the ISD implementer writes the specifications for programming. If it changes, sign-off would again be required.

Phases 6–10

The next five phases are: Phase 6—Programming; Phase 7—Implementation Planning; Phase 8—Testing; Phase 9—User Training; Phase 10—Implementation. During these phases, formal estimates are not prepared. However, should an overrun appear imminent, the ISD implementer informs user management and user contacts of the new completion target date.

Evidence of the political model

Under the Political Model, the same groups of employees participate in the systems development process. The Political Model, however, recognizes their motives, objectives, conflicts of interest, and relative power. The groups seek to utilize their power to determine the outcome of the decision process of agreeing on a cost estimate and thus authorizing further system development. Their overriding and governing objective is to make contributions to the organization in order to increase their visibility, demonstrate their competence and enhance their reputations. By showing that they are performing well, they can increase their responsibilities, their staffs (if they have any), and ultimately their financial compensation (a political stategy akin to the "Reputation Game," as proposed by Bardach (1977) and elucidated by Grover, et al. (1988), in which parties attempt to persuade others that they are doing more or better than they actually are and thus increase their power).

Hence, they seek that the outcomes of the decision process facilitate this objetive. The specific means of influencing the decision and making their contributions visible may differ depending on their power and their responsibilities. To illustrate this Political Model, in coexistence with the Rational Model, brief examples (of which others might be identified) are given for each group of employees: (The subsequent extended discussion attributes assertions to specific interviewees.)

1. User contacts have the power to understate their needs in order to influence cost estimates. The source of this power is the user contacts' intimate understanding of proposed applications. User contacts might seek the approval of an expensive, new system that would increase the recognition of their contribution to their department. To obtain the approval of the initial proposal, user contacts can understate their needs and thus encourage an estimate low enough to gain approval. (Conversely, with different objectives user contacts can overstate their needs.)

2. User management has the power to sway user contacts to understate (or overstate) their needs in order to influence cost estimates. The source of this power is user management's influence over user contacts' salaries and promotions. If user management seeks to readily obtain more new systems to permit their subordinates to promptly complete more business-related work, they can encourage their user contacts to understate their needs, obtain low estimates, and gain their approval.

3. ISD management has the power to sway estimators to inflate (or reduce) estimates because of their direct influence over estimators' salaries and promotions. ISD management might seek to install a particular new system on time and within budget in order to increase corporate profits because such a contribution to the organization improves their reputation. In that case, ISD management might encourage estimators to inflate an estimate to ensure its timely completion.

4. ISD estimators have the power to use their estimates to convince user management and ISD management to authorize new systems. If authorized and installed, the estimators' contribution will be acknowledged. If proposed systems are not priced to sell (i.e., they are overpriced), managers will not authorize them, they will not be installed, the organization will not achieve their benefits, and little recognition

will accrue to the estimators. Estimators who continually evaluate systems, none of which are implemented, will not be recognized for their contributions to successfully installed information systems. The source of ISD estimators' power is their knowledge of the details of the estimating process.

5. ISD implementers seek to install systems at or below, the estimate. They may have no power in the creation of initial estimates. However by completing projects within the estimates, they will achieve recognition among managers and users. In contrast, overruns give them very bad reputations.

These managers and staff members attempt to realize their objectives as they carry out the following systems development phases as predicted by the Political Model. The discussion further illustrates the conflicts of interest between these managers and staff, and the use of their relative power to resolve them.

Phase 1—The Initial Investigation

In this phase, user management or the user contact comes up with an idea and informally asks an ISD representative for a provisional estimate.

These requests have taken place during a planned meeting with the ISD representative, during a phone call, or even during a meeting of senior corporate executives. In one case, a senior executive briefly left a meeting with other top executives to find an ISD representative who would immediately provide an estimate to take back to the meeting. The ISD representative who provided the estimate had no previous knowledge of the proposed system.

Although these premature estimates have later proved inaccurate, the authors believe the ISD representative can increase his or her visibility (at least in the short-run) by providing it. The ISD representative can appear confident, intelligent, and authoritative. Furthermore, it is unlikely that the estimate will be challenged because no one else knows the scope of the project (according to the manager of Purchasing, a user) and because the application might never be developed (according to the procedures defined in the Standards and Guidelines Manual). Likewise, the ISD representative is often not the implementer; someone else might need to meet the estimate. Both the manager of the Systems Service Center and the manager of Systems Planning described this separation of responsibility in the interview. Hence, the authors conclude that in some cases, the ISD representative has spoken too freely with the knowledge that he or she will probably not be accountable for this estimate.

However, the authors believe if the ISD representative refused to give an estimate, then he might appear incompetent. By offering the estimate, the individual might seem very confident and very capable.

Unlike the Rational Model, which assumes that management and staff will disregard the Phase 1 estimate when better ones are developed, the Political Model recognizes that user management sometimes never forgets it. ISD management often views the Phase 1 estimate as imprecise, but user management often sees it as "cast in concrete." Hence, it may be the most important estimate. Later, if user management chooses, it can recall its inaccuracy to challenge the capability of the ISD and to discredit other ISD efforts. The manager of Financial Information Systems illustrated this when he said: "ISD's worst enemy is when management comes in and asks us to give a ballpark estimate during a meeting. The estimate goes into the minutes of the meeting. You will never replace such a ballpark estimate." Similar sentiments were expressed by the manager of Systems Planning and a programmer, while two users—the controller and the manager of Purchasing—stated that they do disregard initial estimates.

Phase 2—Preliminary System Study

During Phase 2, the ISD estimator officially examines the proposed system to develop a more formal estimate to justify the project. However, the Phase 1 estimate has in some cases already created a significant problem.

That is, at the beginning of Phase 2, the user contact has received the Phase 1 estimate but has still not identified system benefits. Hence, the contact can consider the Phase 1 cost estimate while claiming benefits, but in doing so, need not be completely candid. During the interview, the manager of Cost Accounting and Lease Accounting (a user) stated that the user contact can inflate predicted benefits in order to achieve project justification and not necessarily be caught. "ISD management needs to know the benefits of a project in financial terms but doesn't care whether the figure is correct . . . It's a game," he stated. Hence, the authors deduce that the project justification principle (i.e., benefits must exceed costs) is compromised by the benefits projection. The cost-benefits analysis presented in Phase 2 is sometimes fictional, and that estimating process might actually undermine project justification.

Moreover, if the user contact believes that the cost estimate will be too high (meaning it is impossible to reasonably fabricate offsetting benefits) yet wants the project authorized, then he or she sometimes reduces the project scope to increase its chance of acceptance. The ISD estimator lowers the estimate for the reduced project. However, the user contact may have privately planned to increase the scope in a later phase. The user contact finally does increase the scope and claims that the ISD estimator misunderstood the original requirements. For example, one interviewee, the manager of Marketing Information Systems, stated, "Users back off of their initial request to cut the estimate to get approval and then tack their earlier needs back on later to get what they had originally wanted."

The user contact has little difficulty carrying out this temporary scope reduction. The authors noted that the lack of an independent control or audit permits it. Also, because some benefits are intangible and their values are difficult to predict, the user contact can merely decrease their worth to pressure the ISD estimator to lower the cost estimate. A programmer/analyst and a contract programmer who were interviewed both described such pressure to cut their estimate, while the manager of Marketing Information Systems stated, "ISD management might cut an estimate to meet a budgetary constraint. This cut is done after a review with upper-level ISD management who deem an estimate too high for whatever reason no matter how good the estimate was . . . Perhaps an agreement had been made at the Director level, an informal high-level agreement over lunch." Hence, the ISD estimator acquieces if he very much wants to achieve his objective of gaining project authorization.

This lowering of the cost estimate by the ISD estimator is not difficult. The authors observed that two flaws in the method permit the ISD estimators to create estimates that fit their objectives.

First, the method lacks firm objective criteria for categorizing modules by level of complexity. Eleven of the 17 ISD interviewees discussed this lack of objectivity. There are no written, or otherwise consistent and objective guidelines for this determination. That is, the estimator intuitively identifies the complexity level of each module. The ISD estimator is the systems specialist most knowledgeable about the application and can lower the cost estimate by reducing the stated complexity level of the modules without being detected.

Second, the method assumes that all or most application functions are known. However, by necessity, the Phase 2 estimate is prepared too quickly and therefore without a deep enough understanding of the application and its requirements. The ISD estimator can rely on a limited understanding of the application functions to supply a lower estimate.

After the ISD estimator has worked with the user contact to prepare the Phase 2 estimate, it must be officially approved according to the Standards and Guidelines Manual. Two negotiations take place to gain approval. First, ISD management and the ISD estimator negotiate the estimate. Ten of the 17 ISD interviewees discussed this negotiation process. Generally, ISD management wants to reduce the estimate. The manager of Systems Development referred to cost estimates when he said, "They're too high and I want the job done quicker . . . whatever they come up with." The ISD estimator (particularly if he or she expects to be the implementer) wants to maintain it. A contract programmer admitted that he built 10 percent to 15 percent slack into his estimates to be prepared for unexpected changes, and added, "It is better to come in under than over. There is a little politics involved." Nevertheless, ISD management sometimes persuades the ISD estimator to reduce the estimate.

The rationale behind this possible reduction is an ISD management belief that by reducing an estimated cost, an actual cost can also be reduced. The manager of Systems Development illustrated this with his previous quote. Presumably, according to him, systems analysts and programmers will work harder if pressured to meet a lower estimate. Furthermore, ISD management sometimes suspects that the ISD estimator (especially if he or she will later be the implementer) may have already excessively padded the estimate in order to prevent an overrun. A senior systems specialist interviewee stated that his "little extra padding" was not excessive but that ISD management tried to remove it with an ensuing argument. Six ISD interviewees acknowledged the reduction of padding.

Thus, the authors concluded that if ISD management does believe an estimate is too high (where too high means that user management will not authorize the project), then it sometimes lowers the estimate to enhance the chance of acceptance. ISD management can do this because no one is likely to successfully protest. The estimate will be an established fact when the ISD implementer first sees it. Furthermore, the ISD implementer will not protest if ISD management has expressed that the failure to meet the estimate will not affect the next performance review. One programmer/analyst and a senior systems specialist stated that during performance evaluations, they were not accountable for meeting estimates, while the managers of Manufacturing and Engineering Information Systems, of Marketing Information Systems, and of Financial Information Systems stated that they held their subordinates accountable.

The second negotiation is between ISD management and user management. User management usually wants a lower estimate (implying a lower final cost), while ISD management usually wants to maintain the level of the estimate to prevent an overrun. The manager of Engineering Systems (a user) illustrated the former point when he suggested that his department did not want to "overspend," while the manager of Systems and Programming Support illustrated the latter point by stating that ISD was concerned about its perceived accuracy in estimating. This negotiation is limited because user management cannot negotiate on the basis of any understanding of the estimating process. The manager of Cost and Lease Accounting, the manager of Purchasing, and the manager of Engineering Systems (all users) confirmed that they did not understand the means whereby ISD arrived at its estimates. Nevertheless, the negotiation sometimes forces both parties into inflexible positions. It can force user management to threaten project cancellation if the estimate is not lowered, as illustrated by the threat of the cancellation of an imports order entry project. Conversely, it can prevent ISD management from lowering its estimate without revealing that the estimate was based on subjectivity and a lack of understanding of the application and requirements. For instance, ISD could not sufficiently lower the imports order entry project estimate because it could not explain the rationale behind the original estimate.

Sign-off completes the Phase 2 estimate approval process. Its purpose might appear to ensure an accurate estimate. However, the signatures on the Phase 2 estimate neither ensure the accuracy of the estimate nor approve its correctness. Instead, user management signs to indicate a willingness to pay the estimate. According to the manager of Engineering Systems (a user), "Sign-off really does not mean much." ISD management signs to indicate that the ISD will develop the system. The manager of Systems Development stated that there were enough other signatures on the document that he feels "fairly comfortable," while the manager of Marketing Information Systems stated that her signature reflects only an acceptance of the estimate because she "rarely gets directly involved in estimating." Only the estimator's signature affirms the estimate. That signature indicates that someone (probably someone else) can complete the project within the estimate.

Phase 3—System Planning

Phase 3 includes a thorough analysis of the system with extensive user participation, and based on it, a possible revision of the estimate. According to the manager of Systems Planning at the beginning of this phase, the estimator gives the documentation to the implementer and withdraws from the project. The implementer learns more about the proposed system during this analysis.

The ISD implementer usually prepares an estimate by applying the rough/refine technique at this time. When doing so, the implementer often discovers that the application requirements were more complex than previously known. For instance, during the interview, the controller (a user) described a stock transfer project in which such a discovery took place. Hence, the implementer sometimes wants to increase the number and complexity of programs to raise the estimate and lower the chances of overrun. A senior systems specialist stated that he had to put as much padding in Phase 3 as possible because more explanation would be required if he tried to pad in Phase 4.

Usually, however, the ISD implementer declines to change the estimate. The influence of the Phase 2 estimate is substantial. ISD management sometimes forces the implementer to keep it. A programmer/analyst stated in the interview that she had no idea how her manager had arrived at Phase 1 and Phase 2 estimates and "felt forced to fit her estimate into the previous estimates." Alternatively, the ISD implementer sometimes chooses to prevent any embarrassment to the ISD that a change can cause. Another programmer/analyst described a system originally estimated at 220 days, but later re-estimated at 340 days; however, the original number was used to set up a target date and prevent any embarrassment in the eyes of the users.

Moreover, the implementer sometimes does not feel confident contradicting the Phase 2 estimate. This is because the implementer assumes that the ISD estimator better understood the system during Phase 2 than he or she (the ISD implementer) does in Phase 3. One programmer/analyst expressed lack of confidence doing so because Phase 1 and 2 estimates were usually done by more experienced senior systems specialists or planners. Thus, the manager of Marketing Information Systems stated that of the seven or eight major systems she had seen estimated, only the estimate of one had been officially changed.

Nevertheless, the user contact's requirements sometime change. The user contact learns more about the potential of a new system. The manager of Systems and Programming Support described how both the users and ISD recognized the growth of the users' requirements during the development of a material requirements planning system. The user's needs (or understanding of those needs) grow, and hence the system requirements grow. Both the user contact and the ISD implementer usually recognize these new needs.

Thus, the ISD implementer wants to increase the estimate to reflect the new requirements and then have the user contact sign off on the new Phase 3 estimate. However, the user contact sometimes wants to maintain the Phase 2 estimate because an increase could imply his or her incompetence during Phase 2. The manager of Cost and Lease Accounting (a user) pointed out that because users for whom he served as liaison depended on timely project completion, changes to target dates were an embarrassment for him.

To prevent the ISD implementer from raising the competency issue, the user contact sometimes suggests that the ISD estimator or ISD implementer failed to understand the organization's needs and also failed to explain all of the system's possibilities earlier in the development process. Many interviewees admitted that the failure to understand user requirements was a major impediment to accurate estimates. For example, the controller (a user) stated, "ISD and Accounting initially thought that they understood a written document describing a project but later learned that they did not. They had different interpretations." Thus, to avoid criticisms, the ISD implementer simply chooses to keep the Phase 2 estimate, when in fact, it should be increased. A senior systems specialist commented that "lots of explaining is necessary if there is a change of greater than 20 percent."

Phase 4—System Design

Phase 4 represents the preparation of a detailed system design. In terms of estimating activities, the implementer uses rough/refine once again, but with a considerably better understanding of the proposed system.

Conflict between the ISD implementer and user contact at times occurs as in Phase 3. The resulting Phase 4 estimate differs from the Phase 3 estimate.

Phase 5—Program Specifications

Generally, a new estimate is not prepared during this phase because of limited user contact.

Phase 6—Programming

ISD has the best handle on estimating during Phase 6, according to a senior systems specialist that was interviewed. Thus, some estimates have changed during this phase. When this happens, the ISD implementer must obtain a sign-off on a new estimate or must attempt to meet the previous estimate to avoid an overrun.

The ISD implementer uses three basic tactics to meet the estimate (i.e., substantiate its accuracy) and avoid an overrun. The first tactic is to defer deliverables. That is, the ISD implementer identifies a portion of the system and promises to complete it on schedule, while delaying the completion of the remainder. In this way, the ISD implementer can argue that most of the system has been completed within the estimate. The manager of Systems Planning illustrated this by saying, "It sometimes ends up that you do what you can for the amount of money approved. This budgetary limit sometimes translated into deferred items."

The ISD implementer's second tactic is to work harder and faster. Since systems development is largely mental work, ISD implementers are able to work harder and faster when under pressure. "Crashing the project" sometimes brings it in within its estimate. For example, the manager of Systems and Programming Support stated, "If a system overruns, ISD works overtime so that the user does not know about the overrun." A programmer/analyst added, "Meeting a completion date is the real issue. You have to work overtime to meet the date if there is insufficient staff."

The ISD implementer's third tactic is to refrain from recording hours worked on the project or to assign them to other tasks. The absence of tracking of overtime hours makes this especially easy to accomplish. Hence, "creative accounting" permits the ISD implementer to appear to meet the estimate. As the manager of Systems and Programming Support pointed out, "ISD never tells the user about a mistake. They would rather assign additional resources not charged to the user."

Phase 7—Implementation Planning; Phase 8—Testing

In terms of recognizing overruns, these phases resemble Phase 6.

Phase 9—User Training

There are no estimating activities in this phase.

Phase 10—Implementation

At cut-over, the ISD implementer has one final tactic to create the appearance of having met the estimate. He or she can flatly claim that the project was completed within the estimate even if that appears not to have been the case. The ISD implementer can declare that the user contact drastically altered the requirements during development and that any apparent overrun was attributable to this. Hence, the ISD implementer can assert that the estimate was accurate and the original project was, or would have been, completed within the estimate. The manager of Systems and Programming Support illustrated this belief when he stated that "the major problem is the perception of inaccuracy" because of significant changes in user requirements rather than because of inaccurate estimating per se.

Another view of the two perspectives

While the evidence for the Rational and Political Models came primarily from the interviewers' request that subjects explain how costs were estimated, the answers to the request to identify any potential causes of estimating problems can be interpreted similarly (as can the answers to the request to identify the potential means for improving the process—suggestions that were complementary to the causes and are therefore not shown). Table 2 shows that 10 most frequently mentioned causes of the problem. The reader may easily interpret them as legitimate causes of inaccurate estimating in terms of the Rational Model where the process has an agreed upon and stated goal of providing an accurate estimate. However, the problems they represent may also be interpreted under the Political Model as opportunities for pursuing actions driven by personal motives. Explanations for each item in Table 2 convey this interpretation.

Summary and Conclusions

User and ISD management demand much of an information system cost estimate. An estimate initially helps to justify each individual proposal and thus helps to establish a portfolio of applications. Moreover, the estimate can also serve to schedule the development of the application, to staff it, to control and monitor its progress, to evaluate estimators and implementers, and even to market a system to users or to convince the ISD to develop a system. Both of the models described in this article illustrate these uses of the estimate and also provide additional implications for managers and researchers.

Implications for managers

The study's most important implication to IS managers is the formal recognition of the existence and pervasiveness of the Political Model. At the authors' presentation of their findings to the ISD director and other top IS managers, some attendees observed that while they had been aware of much of their organization's politics, they had never before realized there might be so many examples of it in a single activity. This demonstrated its potential pervasiveness and its possible deleterious effects. Moreover, it suggested that as IS managers, they should be even more sensitive to it than they had been and that they should be prepared for action to prevent or respond to it.

At that presentation, the authors provided the chemicals manufacturer with detailed recommendations to reduce the uncertainty inherent in the estimating process and thereby improve its accuracy. These recommendations were inspired by both the Rational and Political Models and are consistent with the management literature. They are

Table 2. Potential Causes of Estimating Problems

1. Inability to anticipate programmer characteristics (10)	The estimate considers the skill level of the eventual programmer. However, the identity of the programmer is not known when the estimate is prepared. This uncertainty will enable the estimator to increase the estimate later or to explain an overrun by claiming that he or she expected more capable programmers. Thus he or she avoids culpability for the overrun.
2. Sloppy estimating with overlooked tasks (8)	The estimator can rely on his or her lack of understanding of the application (with the resulting overlooked tasks) to justify an increase in the estimate. The estimator may claim that the lack of understanding arose from insufficient explanations from the user.
3. Insufficient user/analyst communication and understanding (7)	As in #2, both estimator and user can claim that the other's failure to communicate resulted in the need to increase the estimate.
4. Lack of methodology or guidelines (5)	The lack of objective guidelines for identifying the level of complexity of a program gives the estimator latitude in assigning the estimate with little challenge.
5. Lack of coordination of ISD functions (5)	Each of the ISD areas, such as Planning, Systems Development, Database Administration, and Operations, have their own needs and priorities. Delays in one area affect the schedules of many projects. Later in the development cycle, the estimator attributes the need for a new estimate or for an overrun to the failure of other areas to deliver their resources when needed.
6. Management removal of padding (5)	The estimator seeks a high estimate to prevent an overrun while management seeks a lower estimate in order to provide less costly service.
7. Lack of setting and review of standards (4)	The lack of agreed-upon durations for programs of each complexity gives the estimator flexibility in assigning the estimate.
8. Lack of historical data (4)	Similar to #7, the lack of well-kept records of previous projects gives the estimator flexibility in assigning the estimate.
9. Frequent user change requests (4)	The implementer can attribute the need to change the estimate to new user requirements.
10. Changes in ISD personnel (4)	The estimator can attribute the need to change the estimate to errors by personnel formerly associated with the project.

Note: Number in parentheses denotes number of interviewees who mentioned that cause.

also useful to other organizations. The recommendations are:

1. **Educating:** A course for inexperienced users to help them understand the importance of explaining their needs to estimators and a course for ISD estimators to help them learn to better elicit user needs. Both of those recommendations reduce the uncertainty of the estimating process as imposed by unclear requirements. They are consistent with Gailbraith's (1977) observation that the increased participation of lower-level organizational members in decision making can help reduce task uncertainty.

2. **Marketing:** Executive briefings, white papers, and newsletters encourage user commitment, help dispel the perception that all ISD projects will overrun their estimates, and encourage mutual adjustment and communications. These recommendations represent Thompson's (1967) assertion that as organizational units move from pooled interdependence to sequential or reciprocal interdependence, coordination is best achieved by mutual adjustment and communications.

3. **Managing:** Procedures for reducing conflicts such as the implementation of a new project management and control system, the implementation of an internal EDP auditing function, the increased involvement of implementers in the estimation process, the prohibition of the premature quoting of an estimate, the rewarding of project completion within the estimate to serve as an incentive to estimators and implementers, and the requirement for a more detailed statement of benefits before cost estimating. The new project management and control system and the rewards for timely project completion illustrate Ouchi's (1979) view that linking performance (accurate estimates) to incentives is valuable when outputs (the accuracy of estimates) are easily monitored, but a transformation process (the recreating of the estimate) is difficult to monitor.

4. **Tracking and controlling:** Implementation of a detailed, standardized and periodical progress reporting system, the development of a new comprehensive checklist of potential system development tasks, and a more thorough collection of historical data. These procedures illustrate Cyert and March's (1963) suggestion that uncertainty can be avoided by imposing standard operating procedures and industry tradition.

5. **Auditing:** A more careful check of delivered systems against needs, of actuals against estimates, of user-claimed benefits, of the progress of project development, of the adherence to change request sign-off, and of the accuracy of project control system reports.

6. **Estimating:** Improvement of the existing rough/refine methodology or the acquisition of a cost-estimating software package.

By attempting to reconcile the two models, these recommendations could lead to estimates closer to their ultimate, actual costs. The marketing and educating recommendations diminish the deleterious effects of the Political Model by establishing constructive attitudes that emphasize cooperation and candor. The managing, tracking and controlling, and auditing recommendations reduce the detrimental effects of the Political Model by checking and restraining counterproductive, motive-driven behavior. The managing, tracking and controlling, auditing, and estimating recommendations anticipate and prevent many sincere oversights resulting from the Rational Model. Hence, the process would be improved by being left neither entirely to the whims of the politics of the organization nor to the shortcomings of the managers, estimators, implementers, and users.

The ISD director responded to these recommendations at the presentation by stating his intent to implement a new project management and control system along with a new project management and cost-estimating training program for ISD estimators and implementers. He also said that he and his managers would consider other recommendations. Several of the interviewees stated that the study made them more aware of the problems of cost estimating. Each had experienced some of the conflicts described in the study, but none had previously recognized their widespread impact on each other.

However, many of the recommendations represented politically sensitive and time-consuming activities. Several of them would limit the flexibility of the managers responsible for their approval. Others would demand more time from already busy users. Moreover, the sponsor of the study and its champion, the ISD director, retired a few months later, during a shake-up of other top ISD managers. Hence, a year and a half after the study, the chemicals manufacturer had followed merely one recommendation—the trial acquisition of a new estimating software package—but was still strongly considering a new project management and control system, as well as several other recommendations. The delay in management action was probably attributed in large part to the ISD management changes.

Implications for researchers

This research has provided an independent case study validation of Robey and Markus' (1984) proposed Rational and Political Models of IS development. The research extends their initial, sparse, and illustrative examples of the models into an in-depth analysis of a specific, critical dimension of IS development. No research had previously attempted to validate and extend those models in such a fashion. Moreover, the study offers the following implications for future researchers to consider in their investigations of cost estimating.

The Rational Model illustrates that the creation of an estimate is not a single event, but is instead, a multiple, serial process of considerable effort to continuously create, refine, and perfect a number. This suggests that when researchers objectively study algorithmic estimating methods, they need to record the actual estimates from each development phase to compare to the actual, final project duration.

The Rational Model also illustrates the importance of an estimate early in the development process. User and ISD management need the estimate well before ISD estimators can thoroughly understand the requirements of the proposed information system. Hence, methods that can provide early estimates are particularly valuable and are thus an important target for research.

In contrast, the Political Model reveals an estimation process with perhaps greater resemblance to a game of tug-of-war than to a prescribed management process. It demonstrates that participants in the system development process may be driven more by personal objectives than by organizational goals. Their fear of overrun and project cancellation may carry considerable influence. While this case research has revealed the existence of some error in cost estimating explainable by the Political Model, future research should assess the impact of that error. It may be significant.

Moreover, the research implications of the Political Model contradicts those of the Rational Model in an unexpected way. While the Rational Model suggests the use of objective studies comparing actual durations with the actual estimates from each phase, the Political Model disputes the accuracy of the actuals. Indeed, the "creative accounting" of project durations may invalidate such research. Researchers should investigate the extensiveness of "creative accounting" and should take care to ensure that estimates and actuals used in their research are as accurate as possible.

Most important, the Political Model demonstrates that the participants can attempt to subvert the Rational Model in order to achieve their own objectives. The possibility of their success raises a question mentioned earlier: Is cost estimating a management concern because of ineffective techniques or because of the poor planning and control of the estimating and development process?

Undoubtedly, the proponents of estimating techniques would argue in favor of the logic and elegance of their methods and would assert that managers simply must control their subordinates. Conversely, managers might argue that the methods fail to provide an accurate estimate early enough in the development process. In addition, ISD managers might argue that the methods' input parameters are easily compromised because they rely too heavily on the expertise and subjectivity of the user contact, ISD estimator, and ISD implementer.

This article has not definitively answered the question of whether poor estimating techniques or poor planning and control are responsible for making cost estimating a management concern. Still, by focussing on a management point of view and by considering the Rational and Political Models, it has provided a new perspective on cost estimating for further debate and investigation.

However, a single case study might not accurately represent cost estimating in all other firms. Therefore, with this case as the point of departure, researchers should study the management of cost estimating with a larger sample for the testing of hypotheses. They should attempt to ascertain the actual state of practice in cost estimating with such a sample. Finally, they should attempt to determine the extent to which the observations in this case study hold true and the extent to which they actually affect the process of information management.

References

Albrecht, A.J. "Measuring Application Development Productivity," *GUIDE/SHARE Application Development Symposium Proceedings*, Monterey, CA, October 1979, pp. 83-92.

Allen, B. "An Unmanaged Computer System Can Stop You Dead," *Harvard Business Review*, November-December 1982, pp. 77-87.

Allison, G.J. *Essence of Decision*, Little Brown and Co., Boston, MA, 1971.

Bardach, E. *The Implementation Game: What Happens After a Bill Becomes a Law*, MIT Press, Cambridge, MA, 1977.

Benbasat, I. and Vessey, I. "Programmer and Analyst Time/Cost Estimation," *MIS Quarterly* (4:2), June 1980, pp. 30-43.

Benbasat, I., Goldstein, D.K. and Mead, M. "The Case Research Strategy in Studies of Information Systems," *MIS Quarterly* (11:3), September 1987, pp. 369-388.

Boehm, B.W. "Software Engineering Economics," *IEEE Transactions on Software Engineering*, January 1984, pp. 4-21.

Bonoma, T.V. "A Case Study in Case Research: Marketing Implementation," Working Paper 9-585-142, Harvard University Graduate School of Business Administration, Boston, MA, May 1983.

Borun, F. "A Power-Strategy Alternative to Organization Development," *Organization Studies* (1:2), 1980, pp. 123-146.

BusinessWeek. "It's Late, Costly, Incompetent—But Try Firing a Computer System," Issue 3078, November 7, 1988, pp. 164-165.

Computer Associates. *CA-ESTIMACS: An Applications Development Project Estimation System*, Mt. Laurel, NJ, 1987.

Cyert, R.M. and March, J.G. *A Behavioral Theory of the Firm*, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1963.

Donelson, W.S. "Project Planning and Control," *Datamation*, June 1976, pp. 73-80.

Drury, D.H. "An Evaluation of Data Processing Steering Committees, *MIS Quarterly* (8:4), December 1984, pp. 257-265.

Emery, J.C. *Cost/Benefit Analysis of Information Systems*, The Society for Management Information Systems, Chicago, IL. 1971, pp. 16-46.

Freiman, F.R. and Park, R.D. "PRICE Software Model—Version 3: An Overview," *Proceedings of IEEE—PINY Workshop on Quantitative Software Models*, IEEE Cat. TH0067-9, Kiamesha, NY, October 1979, pp. 32-41.

Galbraith, J.G. *Organization Design*, Addison-Wesley, Reading, MA. 1977.

Grover, V., Lederer, A.L. and Sabherwal, R. "Recognizing the Politics of MIS," *Information and Management* (14:3), March 1988, pp. 145-156.

Guimaraes, T. and Paxton, W.E. "Impact of Financial Analysis Methods on Project Selection," *Journal of Systems Management*, February 1984, pp. 18-22.

Halstead, M.H. *Elements of Software Science*, Elsevier North Holland, New York, NY, 1977.

Herd, J.R., Postak, J.N., Russell, W.E. and Stuart, K.R. *Software Cost Estimation Study—Study Results*, Final Technical Report RADC-TR-77-220, Vol. 1 (of two), Doty Associates, Inc., Rockville, MD, June 1977.

Jensen, R.W. "An Improved Macrolevel Software Development Resource Estimation Model," *Proceedings of the 5th ISPA Conference*, St. Louis, MO, April 1983, pp. 384-389.

Jones, C. *Programming Productivity*, McGraw-Hill, New York, NY, 1986.

Kemerer, C. "An Empirical Validation of Software Cost Estimation Models," *Communications of the ACM* (30:5), May 1987, pp. 416-429.

Keen, P.G.W. "Information Systems and Organizational Change," *Communications of the ACM* (24:1), January 1981, pp. 24-33.

King, J.L. and Schrems, E.L. "Cost-Benefit Analysis in Information Systems Development and Operation," *Computing Surveys* (10:1), March 1978, pp. 19-34.

Lederer, A.L. and Mendelow, A.L. "Issues in Information Systems Planning," *Information and Management* (10:5), May 1986, pp. 245-249.

Lucas, H.C. Jr. *Information Systems Concepts for Management*, third edition, McGraw-Hill, New York, NY, 1986.

Lund, R. "Indirect Participation, Influence, and Power: Some Danish Experiences," *Organization Studies* (1:2), 1980, pp. 147-160.

McCabe, T.J. "A Complexity Measure," *IEEE Transactions on Software Engineering* (Vol. SE-2), December 1976, pp. 308-320.

McKeen, J.D. and Guimaraes, T. "Selecting MIS Projects by Steering Committees," *Communications of the ACM* (28:12), 1985, pp. 1344-1352.

Nelson, E.A. *Management Handbook for the Estimation of Computer Programming Costs*, AD-A648750, System Development Corporation, Santa Monica, CA. October 31, 1966.

Ouchi, W.G. "A Consensual Framework for the Design of Organizational Control Mechanisms," *Management Sciences* (25:9), September 1979, pp. 833–848.

Pfeffer, J. *Organizational Design,* Ahm Publishing Corp., Arlington Heights, IL, 1978.

Pfeffer, J. *Power in Organizations,* Pitman Publishing, Inc., Marshfield, MA, 1981.

Putnam, L.H. "A General Empirical Solution to the Macro Software Sizing and Estimating Problem," *IEEE Transactions on Software Engineering,* July 1978, pp. 345–361.

Robey, D. and Markus, M.L. "Rituals in Information System Design," *MIS Quarterly* (8:1), March 1984, pp. 5–15.

Roethlisberger, F.J. *The Elusive Phenomena,* Harvard Business School, Division of Research, Boston, MA, 1977.

Thompson, J.D. *Organizations in Action,* McGraw-Hill, New York, NY, 1967.

Thompson, J.D. and Tuden, A. "Strategies, Structures and Processes of Organizational Decision," in *Comparative Studies in Administration,* J.D. Thompson, P.B. Hammond, R.W. Hawkes, B.H. Junker and A. Tuden (eds.), University of Pittsburgh Press, Pittsburgh, PA, 1959, pp. 195–216.

Walston, C.E. and Felix, C.P. "A Method of Programming Measurement and Estimation," *IBM Systems Journal* (16:1), 1977, pp. 54–73.

Wildavsky, A. *The Politics of the Budgeting Process,* third edition, Little, Brown and Company, Boston, MA, 1979.

Wolverton, R.W. "The Cost of Development Large-Scale Software," *IEEE Transactions on Computers,* June 1974, pp. 615–636.

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