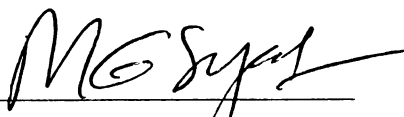3 1293 02079 9312

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Kenneth Alan Bertolini

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INFORMATION FLOW BETWEEN ESTIMATING AND JOB COST ACCOUNTING

By

Kenneth Alan Bertolini

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ABSTRACT

INFORMATION FLOW BETWEEN ESTIMATING AND JOB COST
ACCOUNTING

By

Kenneth Alan Bertolini

Construction estimating determines the cost of the construction project. This
stage lays the groundwork for how the success of the project will be measured
throughout the construction process. The estimate will become the reference standard
for the cost control when the project is executed. Despite its importance, the estimate
is not effectively or efficiently utilized by most construction companies after the
estimate has been developed. The purpose of this research project is to define the
relationship between job cost accounting and construction estimating. Job cost
accounting is viewed as the utilization of the construction estimate during the
construction process. The overall objectives of the research include: (1) Define the
information requirements of job cost accounting by modeling the information flow
between estimating and job cost accounting. (2) Determine the instances of
information duplication between estimating and job cost accounting. (3) Explore the
use of computer integration for the effective and efficient use of information between
these two functions.

Dedicated to:

My mother, Louise Bertolini, for her love of knowledge

My father, Leo Bertolini, for his dedication to education under adversity

My wife, Katherine Bertolini, for continual support, love, and encouragement

Acknowledgments

I would like to thank Dr. Matt Syal for the amount of responsibility he gave me while I was working with him. His level of knowledge and love for education is contagious, and I am a better person for knowing him. Thank you for your work ethic and your friendship.

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Chapter One

Introduction to Problem area

1.1. OVERVIEW:

Construction companies historically have had substantial differentiation between the estimating and accounting departments and information shared between the two departments has been minimal. Information transfer and utilization is an important aspect for any company relying on inter-departments fulfilling similar tasks. The estimate establishes the cost of the project prior to construction in companies that use separate estimating and accounting departments. The estimating department determines the actual cost after the completion of the project or its phases. When estimating the project costs, the estimator goes further than simply determining the dollar figure associated with the particular job. The project is first divided into its individual components. Depending on which estimating method is chosen (i.e., individual item take-off, work package take-off, etc.) the estimator will break down the project into the smallest components needed to accurately place fixed costs on each activity. Furthermore, the reduced components are determined in order to associate the proper resources that are needed to accomplish the work task. The actual costs are only determined after the resources have been established.

Traditional financial accounting methods determine the costs of the actual project and disassociate other relevant information needed by the estimator such as resources. These resources include: (1) labor, (2) equipment, (3) materials, and (4) subcontracted work.

Financial accounting can be viewed as the measurement of the specific and actual costs associated with the construction of the project.

It is the author's belief that the estimating and accounting departments of a construction company is one of the areas where the information flow can be improved dramatically. Historical data consolidated by the accounting department can be a useful form of information for the estimator if the information is more specific than just the actual cost. The speed at which the information is determined will play a critical factor on the relevance of the information flow between accounting and estimating.

Computer technology has changed the way many businesses operate. The computer's ability to manipulate data has helped companies become more efficient by giving timely and accurate information. The construction industry is one industry that can benefit the most from the speed of the computer. Time is always of the essence for any construction project. The author believes that other industries have the benefit of operating under much longer time frames, and also in more controlled settings. Industry's that operate within the confines of an enclosed building, such as manufacturing, have most or all of the workers on site for a particular amount of time per day, as well as the resources required for the manufacturing process. Manufacturing the same product over again also allows for a more thorough estimate for time and money. Even when a construction company constructs the same building more than once, weather, subcontractor availability, and small changes required by different owners can drastically alter the time and cost of the project. The construction industry generally operates under much shorter time frames and

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less controlled settings. The final estimate of the project often is not determined until the construction process is complete. Information is dissected after the actual costs and resources are determined upon completion, then compared to the original budget.

Control can be defined within the construction industry as calculating variances between actual measured cost and progress on one hand and target budgets and schedules on the other, then determining if operations are being performed as intended (Kangari & Miyatake, 1993). Job cost accounting helps to determine if operations are being performed as intended by measuring costs, as well as the resources used in the completion of a project. Where traditional accounting is more concerned with just the cost aspect when measuring the success of a project, job costing takes into consideration all of the resources and costs. This is accomplished prior to the completion of the project. When an estimate is developed, the resources are a key factor in determining costs. Resources need to be measured and checked against the budget to help ensure success on a current project as well as future projects.

1.2. PROBLEM AREA

An important contributor to the success of a construction project is the collection of actual costs related to the project by both the estimating and accounting departments. A construction company understands that no two projects will be the same, but historical information is the beginning of any construction planning stage, including estimating. Historical information is adjusted for the uniqueness of the future project and should be utilized for the estimate of the current project (Mott, 1981).

Typically there is a distinct separation between the estimating and accounting departments. This separation is in part due to the individualization of information that the two disciplines have established as important. It is the author's belief that accounting is a practice that has a predetermined set of information that needs to be tracked, measured, and reported. Income statements, accounts, and reporting to the government are some of the procedures that need to be followed without deviation, and with a high degree of consistency. Without this consistency, boards of directors, owners, banks, and government would not have a way of measuring financial activities that they are directly involved.

Estimating cannot claim such a lengthy development process. Today, the practice of estimating still relies on very important information that can only be found in the "back of the head" of only one or a few members of a construction company. Informal records may be kept but most companies lack a formal structure or system.

The problem is how to track the amount of resources and the costs that are being used in the actual construction of the project. It makes sense that since the resources and costs have already been estimated, the measurement of the actual costs needs to be performed by the accounting department. In order to measure the actual costs of the resources, the whole accounting system needs to be changed so it can measure construction resources as well as the cost associated with them. Job Costing is the accounting process that monitors the actual costs, as well as labor, equipment, materials, and subcontractors. This information is then compared to the original budgeted amount determined by the project

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estimate (Clough and Sears, 1991). The construction industry has become increasingly sophisticated in regard to job cost accounting systems. These systems are aimed at generating financial information and providing management with information from processing financial transaction data. Increasing construction costs have increased the importance of information useful for management decisions (Adrian, 1979). Prior to job costing, accountants were only concerned with the actual cost of the project and disregarded the differences of estimated resources compared to actual resources. Resources are an important aspect of the estimate that not only helps determine the success of the current job, but also allows the estimator to be more accurate for future estimates. Without this historical information the estimator is not able to utilize a very important tool of comparing the actual cost with the budgeted amount during the construction process. Important information that is processed in the Job Cost system are the budget estimates, actual cost, forecasts, variances, and reasons for variances (Clough and Sears, 1991).

The integration of information between the estimating and accounting department needs to be processed into a system that accommodates the need for historic information allowing the estimator to develop a more accurate project estimate. The initial flow of information at the inception of the system is one that has already been established by the project estimate. The estimate is then used by the accounting department as a basis for costs that are associated with the construction of the project. The area of concern which is the point of this research project is the information that is accumulated through accounting and then transferred back to estimating.

Currently, it is common practice to divide a project using the sixteen Construction Standards Institute (CSI) divisions. Projects may be subdivided further using the subdivisions of the CSI format. The accounting department establishes what the actual cost of construction was for the individual subdivision and determines if the division is either over or under the original estimated amount. It is the author's opinion that this system of accounting does not offer enough information for the estimator to properly evaluate the differences and determine the true reason for the variance(s). It is then less pragmatic to deem this information useful as historical information to be used for the estimate of the next construction project. Additional items that need to be measured and reported by the accounting department are the resources that make up the final cost of construction. This additional degree of measurement can be accomplished by substituting a job cost accounting system in place of the traditional accounting system.

Many construction companies utilize a computer based estimating program, and also use a computer based accounting system. Very few companies use an integrated estimating and accounting system. Often times the estimating computer system is nothing more than a simple spread sheet developed by the estimator. Software is available that integrates estimating and job cost accounting. Although the software is readily available, implementation can be very time consuming and difficult. For the purpose of this research effort, I have chosen to use Timberline Precision Extended estimating software (Timberline™, © 1990-1994), and the Timberline Gold Job Cost Accounting software (Timberline™, © 1990-1994) have been used. Timberline is a respected and reputable

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name for construction software. A company determined to implement an integrated job cost accounting and estimating system should survey their needs and establish a methodology of implementation.

If a model is established that can easily correlate the information that is shared between accounting and estimating, the implementation process can occur more readily. If a company can visualize the structure that will allow a successful implementation, the model will be able to determine areas of the organizational structure that will require re-engineering. Re-engineering can be defined as the area(s) of the company that will require a degree of change in order to implement the new system. Re-engineering is one way to replace an old system that is unable to meet the current and future needs of a company. In order to implement a new system, the structure of different departments of the company need to be evaluated and modified to best suit the needs of the new system.

The analysis, design and implementation of information systems is critical when establishing a system for any company. Research done in this area has determined that it is critical to emphasize the design and use of logical models where the introduction of physical implementation detail is deferred as long as possible (McCarthy and Rockwell, 1994). When designing an information system, a company needs to go through certain steps to insure a correct design. The steps include: (1) the survey process, (2) the structured analysis process, (3) computer hardware requirements, (4) software requirements, and (5) implementation (McCarthy and Rockwell, 1994). The survey process includes both what already exists (the current system), and what the system should

accomplish. It is critical to determine the design and use of logical models and actually implement the hardware and software as late in the process as possible. The reason for the late implementation of the actual system is due to the fact that there is always a degree of implementation compromise when implementing software. It is important to mention that implementation compromise is critical when software is being custom designed, and even more critical for commercially available software. Custom software is designed particularly for a company's specific needs. Compromise is necessary when it is too lengthy, time consuming, or economically impractical to design certain requirements into the software. Typically, commercially available software is more generic and therefore intrinsically less suited for a specific company's needs, but is also less expensive and more readily available than customized software. It is more important to decide what is required of the system for a specific company prior to the installation of the new system. It is not sufficient to decide what is needed of the system now, but also what will be required as the company grows into the future. If a system can be established that can accommodate future company growth and changes, less modification of the system will be needed at a later date.

Computer integration in the construction industry is not a new concept, but it is not being utilized to its full potential. Computer integration software for estimating and scheduling is available commercially. The construction industry can benefit more than most due to the relatively short construction cycle of a project and the speed and accuracy of computer technology. Software can currently be purchased that offers the availability of integration between job cost accounting and estimating. What needs to be considered is the amount of

work that needs to be done prior to installation of the software and decisions that need to be made while setting up the new system. Companies must evaluate their needs and determine a methodology of implementation in order to fully maximize the potential of the computer and software.

The separate estimate and cost accounting systems currently used by construction companies to control a project do not provide adequate information relevant to the decision making process while the construction process is underway. A job cost accounting system integrated with the estimate can effectively render information pertinent to cost decisions that need to be made to ensure a profitable job. A model that determines the information flow from the beginning of the estimating process to the conclusion of the accounting process will help a company evaluate all of the variables needed to put an integrated system into place.

1.3. RESEARCH OBJECTIVES:

The purpose of this research is to define the relationship between job cost accounting and the construction estimating process. The research gathered will: (1) explain the information flow between financial accounting and estimating, (2) review the possible use of a job cost accounting system within a construction company, (3) model the flow of information between construction estimating and financial accounting via job cost accounting, and (4) explore the use of computer integration for the effective and efficient information processing between these entities.

The primary objective of this research effort is the identification and modeling of information flow between estimating, job cost accounting, and financial accounting. The outcome of this research will identify the procedures a typical construction company would use in order to effectively plan and implement an integrated job cost accounting and estimating system. It is not as simple as loading the software and running it. The company needs to develop a re-engineering mentality and review its accounting and estimating departments in order to have them function in unison.

The second objective is to identify the problems that can arise in implementing such an integrated system. The identification will be developed via an implementation model that will list some of the difficulties that the author encountered while establishing an integrated job costing and construction estimating using the Timberline Gold Accounting system. Appropriate solutions will allow the company to overcome most, if not all of the potential problems.

Case studies will be used to establish a simulated situation where integration, re-engineering, and implementation of the system is determined. The developed model will be applied to case studies and its effectiveness evaluated. Effectiveness will be evaluated by the ease of use by comparing the information that is required for the model and its effective usefulness upon completion. Effectiveness will also be measured by the detail of procedures and the complexity of updating the company's information while actually implementing the model within the case studies.

Extensive work has already been done on the information flow of resources needed for the estimating process. This research effort will evaluate the job cost accounting cycle as viewed by a typical commercial construction company and develop a model that combines the like items associated with the accounting, job costing, and estimating cycles. Also, the model will help determine current and future requirements of the system that will help establish a useful system that is more closely correlated to the specific needs of the company.

1.4. RESEARCH METHODOLOGY:

This research study is expected to be relevant and useful to the construction industry today. The need for integrated information systems is an important area needing improvement. This is established through current research work and the evaluation of current computer software.

1.4.1. TIMBERLINE EXTENDED ESTIMATING

The first phase of research involves the familiarization of Timberline Extended estimating program. The author has had extensive experience with this program through a graduate teaching assistantship at Michigan State University, Building Construction Management program for B.C.M. 324-Construction Estimating. Work packages will be used when importing estimates from Timberline Extended into the Timberline Job Cost module. Use of work packages are used for the quickness of the estimate development, and because a

company using this estimating package will develop their own work packages rather than developing individual item estimating take-offs.

1.4.2. TIMBERLINE JOB COST MODULE

The next phase of research is the familiarization with Timberline Job Cost. Although this was developed by the same company as the estimating package, it is a very difficult and an involved process to use the program. Extensive set up time is required in order to have the packages operating efficiently and integrated with each other. The author has found that it is easier to integrate estimating and scheduling software from two different software companies than integrating estimating and job cost accounting from the same software company. This is due to the vast difference between the process of accounting and estimating. Accounting keeps track of many different cost ledgers. As one inputs information regarding a transaction, the appropriate ledger is updated accordingly.

This phase required literature review of job cost manuals, as well as computer time in order to become fluent in the operation of the module. Assistance from a Timberline licensed sales and training representative was utilized in order to shorten the learning curve. This phase also required learning additional and separate Timberline accounting modules.

It was important at this phase to also become familiar with Timberline General Ledger, Accounts Payable, and Recievables Management. These are the accounting ledgers that the job cost module will automatically update when using the job cost module. The

general ledger modules, job cost module, and estimating package were all purchased separately from Timberline and required an acute understanding prior to their implementation.

It is imperative that the language used within each module is consistent for the integration to be a success. The estimating department of a construction company commonly uses the CSI format to identify all the items that constitute an estimate. It is essential that all of these items to be transferred into the accounting system and have the same identification numbers for job, phase and sub-phase. As an individual item is transferred from estimating to job cost accounting, it will have the same identification number in job cost that it had in the estimate.

1.4.3. MODEL DEVELOPMENT AND CASE STUDY SIMULATION:

A model will be developed to demonstrate the flow of information from the estimating department to the accounting department and help to establish the importance of integrating estimating with job cost accounting. The model will show the importance of accurate measurement of resources during the construction of a project and of using the original estimate as the measuring stick for accuracy. The model will provide the framework for designing and implementing an integrated system that keeps track of the variances between estimated costs and actual costs determined in the field.

Because of the amount of information that needs to be processed in a relatively short period of time using a job cost accounting system, it would be impractical to implement a

manual job cost accounting system. Computers allow the system to be more flexible, accurate, and timely.

The estimate is at the inception of the information gathering process, and relies on updated historical information. By taking advantage of the resource organization processed during the estimating stage and using it in a job cost system, a construction company can expect to have better control over its project. The control will pass onto the next project by utilizing the updated historical costs generated by the previous projects. Future estimates will become more accurate using information provided by past projects and variances can between projects can be tracked and accounted for.

The model will give a detailed breakdown of organizational structure and resource requirements needed to restructure the organization. It will also give a breakdown on how to correlate the information from the project estimate to cost accounting. Two companies were chosen as case studies to analyze the current systems in place and to evaluate the model for the purpose of an integrated estimating and job cost accounting system. This simulation was used to test the model and validate the need for a structuring tool for re-organization. Time was spent evaluating the companies' current systems and the need for an integrated system. The estimating and accounting departments were evaluated to establish if they would operate efficiently if they became integrated. One point of critical importance was to determine if a job cost accounting system was in place, and at what time the final determination of cost over-runs or savings is completed.

1.4.4. EXISTING RESEARCH REVIEW:

Also included in the research will be the review of existing research. This will include theses pertaining to both job cost accounting systems and estimating, as well as research papers written about the integration of accounting and estimating.

1.5. EXPECTED OUTPUT:

This research study is intended to determine the practicality of integrating a job cost accounting and estimating system within an existing construction company. By creating a model to aid in the implementation process, the procedure of determining the methodology for the implementation as well as help to expedite the system within an organization where time is of the essence is expected to be simplified. The research will provide guidelines for the application of a similar system with minimal difficulty, and provide guidelines for users of such a system. It will also provide areas where additional research and restructuring needs to be applied prior to the system being developed. This study will also provide valuable information to the companies used as case studies regarding their current system, as well as begin the process of system review, evaluation, and implementation steps required for a more efficient and timely system.

1.6. ORGANIZATION OF THE THESIS:

The remaining chapters of the thesis are organized as follows:

1.6.1. CHAPTER 2: EXISTING RESEARCH AND LITERATURE REVIEW

Chapter 2 describes the existing research and literature review. The current work that has already been researched, and any implications that it may have on the research and findings of this work is presented as well as whether the existing research correlates with what is established with this research project and where it may differ. Existing theses and research will be reviewed and summarized.

1.6.2. CHAPTER 3: THE PLANNING INFORMATION REQUIRED FOR ESTIMATING AND JOB COST INTEGRATION

Chapter 3 will lay the ground work for the planning information required for estimating and job cost integration. Since the information that is gathered initially is that of the estimate, definitions of terminology used for the estimate will be covered including: (1) organization breakdown structure, and (2) the work breakdown structure. Using the organizational breakdown structure and the work breakdown structure will be the recommended way that an estimator determines the phase and categories for individual resource items of the estimate.

The traditional financial accounting system will be explained through the use of journals and the general ledger. The job cost accounting method will be reviewed as a viable alternative to traditional accounting for the purpose of an integrated estimating and accounting system. Cost account codes that make up the job cost system will be evaluated, as well as job cost reports that aid the management decision making process.

The estimating process will be evaluated to determine its suitability to be integrated with the job cost accounting process. An estimating model will be shown that details all aspects of the estimating process, as well as recommending a systematic approach to estimating. By creating a uniformed systematic estimating approach, an independent process, such as job cost accounting, will be easier to incorporate into the established system.

Construction project planning will be shown and described within the context of its usefulness for providing an integrated job cost-estimating system.

The cash cycle of a construction company will be evaluated to determine if the operations of the company are efficient, or if the cash systems need to be modified prior to establishing an integrated estimating-job cost system.

Lastly, the integrated job cost-estimating model will be explained.

1.6.3. CHAPTER 4: SETUP AND FUNCTIONING OF A COMPUTER-BASED JOB COST ACCOUNTING SYSTEM

Chapter four will lay the groundwork for setting up an integrated job cost and estimating system using the Timberline Gold system. Recommendations for company structure, dependent on company size, are explained throughout the process. This chapter establishes how involved the actual process is even for a commercial purchased software product. Many decisions need to be made prior to loading the system to ensure that the

correct settings are made as well as extensive knowledge regarding company estimating and accounting practices to insure a proper procedural setup. Chapter four will conclude with the setup requirements for an integrated job cost accounting and estimating system through the Timberline Gold Extended Accounting software, and Timberline Extended Estimating software.

1.6.4. CHAPTER 5: CASE STUDIES: MODEL IMPLEMENTATION

Chapter five will describe the models established for the purpose of this project. The models are explained in detail so the reader has an understanding how they function when they are put into use in the case studies. How the models are applied in the case studies will also be described so the reader can understand the reasoning behind the creation and have an understanding of its effectiveness.

The companies that are used as the case studies will be evaluated with a summary of the current systems that are in use. The models will then be applied to determine what the company is either lacking and/or needs. The models will show the integration of the accounting and estimating departments and what is needed in order to facilitate necessary change(s). The field data that is collected will be presented to the companies, and any comments by the parties involved will also be included in this chapter.

1.6.5. CHAPTER 6: SUMMARY AND CONCLUSION

Chapter 6 completes this research effort with the conclusions reached by the author and recommendations for the future research within this research area.

Chapter Two

Existing Research and Literature Review

2.0. Chapter two describes the existing research and literature that has influenced this research work. The existing research is reviewed within this chapter, and the focus of the research is evaluated as it affects the output for this research project.

2.1. "An Integrated Model of Computer-Aided Cost Estimating/Scheduling in Construction Management". Appau, Kwaku Addae

2.1.1 Overview

"An Integrated Model of Computer-Aided Cost Estimating/Scheduling in Construction Management" shows the correlations between computer aided cost estimating and scheduling. Similarities between the two are described through the use of the work breakdown structure (WBS). A construction project that is to be estimated will follow the WBS to determine the individual elements that make up the project. The WBS allows the project to be broken down to a simple level and costs to be allocated with each level. This will also allow the integration between estimating and scheduling. Once the individual element has been established within the estimate, it can be incorporated within the same structure to help facilitate the scheduling of that activity (work element).

2.1.2 Output

Each work element within the estimate correlates to a task within the confines of the project schedule. Each task involves an effort and the passage of time to complete. Each task has a defined start, finish, and can be broken into sub-tasks. Each work element represents a scheduling item, and is a common denominator for collecting and organizing cost estimate data.

The individual cost accounts that are developed for estimating an individual work element will become an integral part of an activity on the schedule. It is important for the estimator to develop a schedule of elements, or tasks, as well as the resources associated with them. The scheduler is then able to use these predetermined elements and resources as an individual item, or as a combined item on the schedule.

The cash flow of the project is mentioned within this thesis and is recognized as an integral and important aspect of the project. There is more emphasis being placed on the control of costs as a function of time due to increasing project complexity. It is up to the estimator to mark the expected time when expenditures are incurred.

Three types of project control are listed:

1. Cost Control: Actual cost compared to estimated cost.

2. Schedule Control: Actual start and completion dates compared.

3. Production Control: The value of production units in place as compared to the value of production units planned to be in place.

Reports are to be processed to make it possible for an early detection of excessive

expenses with regard to the cost status of the project. Timely information is a necessity to

allow management ample opportunity to determine a new course of action.

2.1.3 Critique

"An Integrated Model of Computer-Aided Cost Estimating/Scheduling in Construction

Management" concentrates on the integration process between estimating and scheduling.

It becomes relevant to this research project by its discussion regarding: the work

breakdown structure and, cash flow.

The work breakdown structure is an effective way to determine the individual elements

that make up a construction project. This thesis describes the work breakdown structure

in terms of integrating estimating and scheduling. The same description for individual

items of a construction project can be useful when integrating estimating and accounting.

The idea for using the work breakdown structure is to have similar items for two

disciplines.

The cash flow of a project is described as an important aspect of a construction project.

Cash flow is defined as 1) cost control, 2) schedule control, and 3) production control.

The mentioned three items are described in terms of estimating and scheduling without

regard to the accounting process. Theses concepts are accepted as being important, but

will be described later within this research project within the context of estimating and

accounting. It is the belief of the author that by expanding the cash flow concepts mentioned above within the context of integration between estimating and accounting, the integration efficiency will be maximized. The time and capital spent developing an integrated system will have a more desired return regarding cash flow measuring and reporting.

2.2. Automated Interactive Cost Estimating Systems for Reinforced Concrete Building Structures.

2.2.1 Overview

"Automated Interactive Cost Estimating Systems for Reinforced Concrete Building Structures" (Lee, 1992) determines that the traditional (manual) method of estimating is antiquated and has many limitations. The limitations include the waste of specialized skill and the lack of uniformity from one estimate to another. There are many estimating software programs available, but none that is able to help the designer determine detailed cost estimates during the design process.

2.2.2 Output

There are three major problems that are addressed regarding the current estimating systems:

1. Lack of linkage between the cost estimating process and the design process.

2. Lack of incorporation of a construction decision process into a cost estimating system.

3. Lack of application of the construction process in the duration estimating.

Cost is mentioned in this research effort as being one of the major stumbling blocks within the integrated system. The research effort contemplates linking the cost estimating process with the design process to help facilitate a detailed cost at the design stage. It is mentioned that it is impossible to get an accurate estimate within the design process because the estimate relies on a completed design. The cost estimate is described as being an effort that should be performed through both a construction decision process and an algorithmic (procedural) process, but many current systems do not consider the decision process. The procedural process relies on the quantification of construction resources, but by disregarding the decisional process, large inaccuracies of the estimate may be found.

Construction decision making during cost estimating is very important, because it affects the unit cost of each cost element. Each method of a construction application has its own cost and capability, and the cost must be balanced with the capability. Under some circumstances, capability constraints may require a higher cost.

An integrated and computerized system is stated as being most important when the project is of greater size. The estimators spend a large part of their time in performing some tasks that do not require any of their specialized knowledge. The estimator becomes overburdened with manual work that can be performed by less skilled employees.

2.2.3 Critique

"Automated Interactive Cost Estimating Systems for Reinforced Concrete Building Structures" attacks the problems of integrating between cost estimating and design. The main point of interest and its correlation with the research effort of this paper is the performance of the cost estimate from the decision process through the procedural process. It is stated that the procedural process relies on the quantification of construction resources. Also, there may be large inaccuracies between the budgeted resources and actual resources.

The proposed estimating system within this research provides detailed estimates of the quantity, cost, and duration automatically based on the available information at different stages of design. A detailed estimate should include all resources associated with any particular item that is being estimated. A project is broken into a set of tasks or activities, each having an identifiable quantity of work that must be performed for that task to be considered completed.

Estimating is described as performing two main processes: quantity takeoff and costing. Quantity takeoff involves measuring from architectural and engineering drawings, and converting the measurements into cost data. In order to determine the cost to perform work, it is necessary to estimate the rate of production. If an estimate is available that uses the database of the design engineer, the estimator will provide a more accurate estimate.

2.3. Cost, Schedule, and Time Variances and Integration

2.3.1. Overview:

"Cost, Schedule, and Time Variances and Integration" (Carr, 1993) demonstrates detailed

schedule and cost control relationships at the activity/cost account level using generic

microcomputer software to budget, track, and control projects. Time variances are

included to describe the difference between scheduled and actual times for an activity.

Variances can be calculated and reported at different levels of detail. Variance structures,

as well as an incorporated budget from estimating into scheduling, can allow for

integration of cost and schedule control for projects that share a common WBS.

Control is defined within this paper as determining the variances between actual and

targeted costs for the project(s). The target is the estimated cost, and the actual cost is

what is performed in the field. For projects that share a common WBS between

estimating and scheduling, it is possible to provide integrated cost and schedule control.

This thesis focuses on the work package to provide information regarding the combination

of individual construction elements and control of the project.

2.3.2. Output

Cost control is described as basic managerial accounting. This thesis describes links

among element schedule, cost, and time variables and variances to implement a more

detailed integration process. Variances become useful if they are available early enough in

the construction process. Integration of data requires a single unit of measure that combines like items. Cost and schedule variances are therefore reported in dollars.

Activities and cost accounts require a common measuring base as mentioned above. The basis used is the budgeted cost information. Schedule control depends on the resources that are used, whereas cost and schedule control depends on the measurement of the shared budgeted costs, resources, and quantities.

2.3.3. Critique

Cost control and schedule control are important tools for managing projects. Cost and schedule performance share common variables on which an integrated view of cost, schedule, and time variances can be built if they share a common WBS.

A cost schedule that performs for the accounting department should be considered when designing a cost schedule that is useful for both estimating and scheduling. The common measuring base that is needed for estimating and scheduling is just as useful for accounting.

2.4. Heavy Construction Estimates, with and without Computers

2.4.1. Overview:

This article is written for the effort of helping and enhancing the preparation of heavy-construction bid estimation and also discusses the difference between manual and computer estimation. The points of interest within the discussion are the development of proper systems within manual estimating. If a construction company takes the time to

develop an organized manual estimating system, the systems are in place to fully take advantage of the computerized estimating system. It is often stated that computers are only as good as the information that is placed into them; garbage in and garbage out. If the information entered into the computerized estimating system has been thoroughly examined and organized, then the computerized system has a better chance for success.

2.4.2. Output

Failure of most estimating programs is due to a lack of recognition of the size and complexity of the undertaking, and the steps essential for the successful resolution of the problem. This failure is in conformity with other statements in the literature reporting the general lack of agreed guidelines and methodology for estimate preparation (Moselhi et al. (1991a, 1991b); Carr 1989). In addition to the lack of agreed guidelines is that failure may be due to the highly experience based nature of the estimation process and the inadequacy of traditional computerized techniques to replicate and/or aid the process in a holistic manner. This has resulted in estimation programs that are powerful in certain aspects, yet insufficient to address all the elements of the estimation process.

Most estimating programs start an estimate with a list of possible work tasks stored in a database, and then assign costs to work tasks relevant to the project. These costs are later compiled and assigned to relevant contract items, primarily manually, or at best indirectly through specialized cost codes.

In manual estimation, on the other hand, the estimator focuses mainly on the contract items and performs the necessary estimation work in direct link to them, enabling the establishment of their respective direct cost. The process is more direct and enables faster and simpler review of the estimate.

2.4.3. Critique:

The author does question the fact that a suitable program may not be available at the time that the article was written for computerized estimating.. Much of the negatives that were discussed in the article have to do with the established database that comes with most programs. It is up to the estimators to establish customized databases for their estimating program. If the database that comes directly from the manufacturer is used, it will be limited for a specific company's needs.

It is mentioned in the article that the failure of most estimate programs is due to the lack of recognition of the size and complexity of the job and the steps essential for the successful resolution of the problem. Estimating is described in the article as a "highly experience-based nature." This is interpreted to mean that the knowledge base is highly centralized between one, or a few people within the company. Only by experience has this knowledge been acquired, and if that person were to leave, the knowledge would leave.

Manual estimating focuses on the individual contract items and consequently estimating is performed in direct link to the items. This process is viewed as more direct, but it is also much more time consuming.

Accounting is not mentioned in the article. The article explains that the estimating system is more complex as well as being rather haphazard in most companies today. In order to fully maximize the information transfer between estimating and accounting, it is extremely important to first establish an organized and systematic approach to estimating.

2.5. Introducing New Process Technologies into Construction Companies

2.5.1. Overview:

"Introducing New Process Technologies into Construction Companies" states that technology and innovation are not considered important by the construction industry. The argument of the paper is that they are both very applicable as well as important to the industry. New technology is defined as something that has not been used before in a company's normal operations. Innovation is defined as looking for, finding, and implementing a new technology to improve a company's everyday performance. The paper then sets the guidelines for a construction company to successfully introduce new technologies.

The construction industry is described as lagging behind other industries in relationship to taking advantage of new technology. Research and development account for only .4% of the annual construction expenditures in the United States. Without innovation and implementation of new technology, the industry is sacrificing improvements in safety, productivity, and cost effectiveness.

2.5.2. Output:

A set of questions were developed to examine the conditions of case studies regarding the effective implementation of new technology. A process for implementation is proposed and applied for both small and large contractors.

The question of how a company is to break away from its traditional ways and implement new technology is answered by providing the contractor with a set of guidelines for the successful introduction of new process technology, and defining terminology.

1. Construction Technology: The combination of construction methods, construction resources, work tasks, and project influences for performing a construction operation.

2. Construction Innovation: The first use of technology within a construction firm. Innovation is increasingly being recognized as essential to the success of the industry.

3. New Technology: A product or process that a company has not previously used in its construction operation.

A six step innovation process for an organization is given as the following:

1. Agenda setting: the need for technology is defined.

2. Matching: the need is considered along with the technology.

3. Decision Making: senior management decides to adopt or reject the technology.

4. Redefining/Restructuring: the technology and the company structure are modified to fit each other.

5. Clarifying: the relation between the technology and the organization are clearly defined, and the technology is put into regular use.

6. Routinizing: the technology is made an element of the organization and its everyday activities.

Five factors that influence the decision to adopt new technology are:

1. Knowledge

2. Persuasion

3. Decision

4. Implementation

5. Confirmation

Training of the employees is one of the most critical steps, and is one that should not be overlooked by the company.

2.5.3. Critique:

New technology is an essential element for the future success of most construction companies. "Introducing New Process Technologies into Construction Companies" shows that the construction industry lags far behind or moves at a slower rate than most other business in the area of adapting new technology. Improvements in new process technologies have become more affordable. Most construction companies operate on a small business platform. Price usually dictates if a new business practice is feasible or not. Computer technology has become affordable for even the smallest business platform.

This article takes the idea of expanding new technology within the construction industry by listing 1) definitions, 2) steps for the innovation process, and 3) factors that influence the decision process to adopt new technology. The three listings combined show the actual steps involved when considering new technology. These steps help to insure a successful implementation of new technology.

2.6. Conclusion

Chapter two examined existing research pertaining to the topic of this research effort. Concepts, ideas, and quotes were used from these sources, as well as other sources. The research was reviewed and evaluated on its benefit and usefulness to this research project.

Chapter 3

Planning Information Required for Estimation and Job Cost Integration

The planning that is required in order to implement an integrated job cost-estimating information system is complex. The complete structure of the organization needs to be evaluated, paying specific attention to the estimating and accounting departments.

The methods that are adopted when determining the cost of a project need to be systematic and repetitive for all projects. These methods also need to be carried over into the accounting department. When information is transferred between the estimating and accounting departments, the importance is placed on the information being incorporated into the accounting system. This is because the accounting department is more systematic than the estimating department. Rules and regulations are followed stringently within the accounting field. The estimating process for most construction companies is very independent of form or function, and is usually left up to the company, or individual estimator.

The following sections define terms and recommendations that have been established to help standardize the flow of information within a construction company. These concepts have been useful when transferring data between the estimating and scheduling processes, as seen in Chapter two.

3.1. Organizational Breakdown Structure

The Organizational Breakdown Structure (OBS) is how the company is organized. This can include both the main office, and the field personnel, as well as outside organizations that affect the company's operations such as outside accounting firms, subcontractors, owners, architects and engineers (Figure 3.1). Many outside organizations will have people who operate on the site as a representative. A good example of this would be the owner's representative, subcontractor foremen, and architect and engineering representatives. Within the organization, the construction company will provide a project manager, various job superintendents, and engineers who are responsible for either the whole job, or various aspects of work to be completed. The OBS is a hierarchical structure which dictates the level of responsibility for all parties involved in the project construction and completion. The lowest level of the OBS will be the labor force and/or subcontractors who are responsible for the individual levels of work. An example of an Organizational Breakdown Structure for the field aspect of a project and its various levels is shown in Figure 3.1

```
                    ┌──────────────┐
                    │    Owner     │
                    │Project Manager│
                    └──────┬───────┘
              ┌────────────┴────────────┐
         ┌────┴─────┐              ┌────┴─────┐
         │ Engineer │──────────────│    A/E   │
         └──────────┘              └──────────┘
```

General Construction	Plumbing	HVAC System	Electrical System
Direct Labor / Sub Contractor	Direct Labor / Sub Contractor	Direct Labor / Sub Contractor	Direct Labor / Sub Contractor
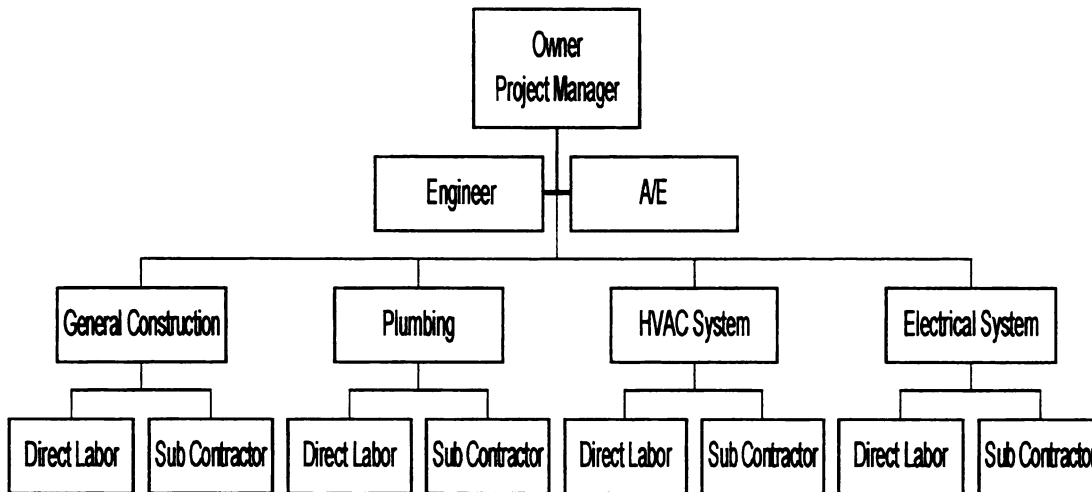
Figure 3.1   Organizational Breakdown Structure
(Modified from Takeda, 1991)

The organizational breakdown structure is an element of the business that needs to be

considered when implementing an integrated estimating and job cost accounting system.

A typical organizational structure for a construction company showing the hierarchical

structure from the main office to the field personnel is shown in Figure 3.2
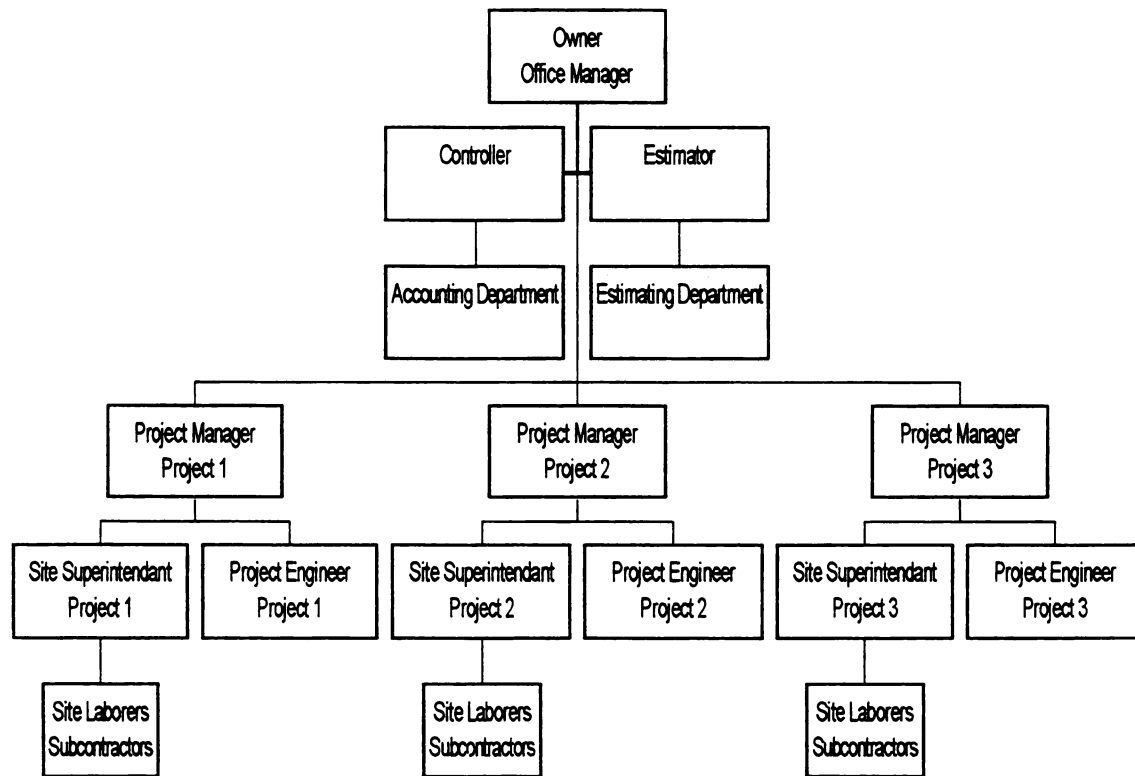
Figure 3.2
Organizational Breakdown Structure
Main Office-Field Personnel
(Modified from Takeda, 1991)

The simplified depiction of the office-field OBS (Figure 3.2) shows the separation that is

often found between the estimating and accounting departments. Sometimes a degree of

shared information exists, but it is acquired through the production of traditional

accounting reporting typically done at the end of the accounting period. The field

personnel shown in figure 3.2 illustrate the flow of information from the office to the field,

as well as the flow of information back from the field to the office. When considering the

implementation of an integrated job cost/estimating system, the generation of information

from the field personnel needs to be evaluated. Much of the new system will rely upon the

timeliness and accuracy of information that is gathered from various field people, and how the information is sent back to the needed departments in the main office.

Some companies have accounting people stationed on the job site which eliminates much of the information gathering problems that can be associated with a job cost accounting system. Although this practice is used by some companies, it is not the norm. Many of the construction companies in operation today either do not have the resources or the people available within the accounting department to have them set up on any particular job site. With this in mind, who will gather the information and how they will do it are critical components for the structuring of an integrated estimating/accounting system.

The job cost accounting management system is not an elaborate system, but must rely on the personnel of the construction company for its success. The actual design of such a system is quite company dependent. No two companies will establish systems that are the same. The degree that resources are measured will be dependent on the degree of information that the company, and managers, believe is needed. Also, the OBS of the company will need to be evaluated and/or modified in order to take advantage of the flow of information from the field to the accounting and estimating departments and between the estimator and the accountant. Those individuals who will be relied upon for the success of the system, including estimators, accounting personnel, field personnel, job site manager, and superintendent, need to be part of the system design team. If it is a system that they do not believe in, it will not be a complete success. These individuals are the information gatherers, and are the most critical aspect of the system.

3.2. Work Breakdown Structure

The Work Breakdown Structure (WBS) is a system that allows a company to place a job or project into various cost accounts based on a sub-series of work packages. The whole project is divided into a series of tasks that need to be completed for the success of the project. It is common for a company to follow a uniform coding system for all jobs, but there may be a difference in the degree, or the extent that the individual tasks are recognized. Much of the difference may be due to the amount of detail that is necessitated due to the type of project and the amount of subcontracting that may be done for a specific job.

Tasks are the items which constitute the construction of the project. Each project may be taken to the lowest level of detail that represents certain items of construction. For instance: the labor that is required to construct a section of a block wall, the mortar required for the section, and the blocks required. If the construction company is responsible for the labor (in house), then the degree, or level, of task may be taken down to the individual labor, equipment, and materials items. It is of great importance to have the level of information to its smallest degree to account for resources used. If the job task is subcontracted out, the level of importance, or the degree of which the item is represented to the construction management company would be the wall section. The work package is considered to be the wall section, and this is the lowest level of concern that the company has for this particular item. Taking time to consider the amount of resources required to complete the work package is time and energy that does not need to

be expended. The subcontractor responsible for the work may keep track of this information for its own company's records and future use. The management company may be responsible for the materials, but not for labor. If this were the case, material would be the lowest level of detail needed within the work package.

Tasks can be considered part of a hierarchical structure that constitute the construction of the project. The work breakdown structure includes the tasks taken to the level of useful importance for the construction firm. The project is the first level of detail in the WBS. The level of breakdown beneath the project level is completely determined by the current needs of the construction company and/or the project. A standard within the industry for estimating is to use the Construction Standards Institute (CSI) sixteen division breakdown as the work breakdown structure. If level one is the actual project, level two becomes the sixteen CSI divisions. Levels two and higher becomes a matter of choice and usefulness regarding the numbering requirements for the company.

The work breakdown structure of a company is another item that needs to be developed, defined, and followed without deviation in order to establish consistency of tracking and defining tasks required for the proper completion of a project. The initial stage of use for the WBS is with the estimating department. The importance of the breakdown level is directly a result of obtaining a dollar value to construct the project. If a company is utilizing in-house labor to construct the facility, the level of detail will be increased. When many subcontractors will be used to construct the facility, a slightly less detailed level of

tasks will be required. The use of the WBS should not begin and end in the estimating department.

A construction project is viewed as a hierarchy of work packages (Carr, 1991), and the elements that establish the work package need to be well thought out and kept track of throughout the whole construction process. It makes sense that a company should establish as many systems to run similar information using the same work packages for consistent measurement of progress and insuring a high degree of accuracy for comparing budgeted and actual information. The importance of establishing an integrated estimating and scheduling system has gathered much attention through recent research and publishing (Carr, 1991; Syal, 1991). The main focus of much of the research has been in establishing a defined flow of information through the whole process. Projects that are using shared cost and schedule controls share a common work breakdown structure and therefore provide integrated cost, and schedule control (Carr, 1991). The elements of a work package can be measured when a common WBS is used providing element control, as well as project control. The same can be said for integrating estimating and accounting.

By creating similar task measurement between the two departments, project control can be enhanced through accurate tracking of budgeted and actual costs of construction. The task measurement on the estimating side has already been established by the estimator in the form of the project estimate. The task measurement provided by the estimator becomes the budget that all costs will be compared to generating variances between the actual and the budget. The elements for costs will be organized using the work

breakdown structure. The information flow between the accounting and estimating departments will originally be established via the cost estimate, or original budget for the project. The estimating department may also have to adjust its practices to accommodate the accounting department. This system can be generated by developing cost accounts that correspond to the lowest level of the work breakdown structure of the estimate. The cost accounts need to follow similar guidelines of the WBS to accurately measure the variances. The boundaries between the elements need to be well defined. It is not required to have an established level of detail for all projects, but the level of details must remain consistent for a particular job between estimating and accounting. A well defined scope of work is necessary for each element to be measured efficiently and accurately.

3.3. Accounting

Accounting in the construction industry helps management control its costs and utilize its working capital (Coombs, 1995). A construction company needs to be aware of the resources that make up a construction project. In addition, the company needs to mobilize the resources in order to complete the work, and demobilize the resources away from the construction site upon completion. Traditional accounting methods need to be used in order to conform to laws governing the use of such methods. Traditional accounting methods serve well in providing information to outside parties, but whether the company utilizes the information to its full potential is worth questioning or looking at closely. The flow of accounting information is limited to the accounting department. Data collection and processing is being used solely for traditional accounting reporting, and not effectively

or efficiently utilized as a management information and decision making tool. Job cost accounting procedures provide the additional tools for these purposes.

3.4. Financial Accounting

Financial accounting measures the income of a company and determines its net worth via the income statement and measures the worth via the balance sheet. Strict laws have been established through time that place complicated and mandatory application practices upon the accounting field. The structure that is followed needs to be adhered to in order to maintain uniformity, as well as to have consistent measurement over time. Journals and ledgers are used to measure and keep track of a wide range of financial transaction information (Fig. 3.3).

3.4.1. Journals

The journals in the financial accounting system consist of the accounts receivable, accounts payable, and payroll journals. The accounts payable journal keeps track of vendor information, subcontractor insurance, invoices, and checks. The payroll journal lists the employee earnings, employee deductions, and employee taxes. The accounts receivable journal keeps tabs on what is owed to the company by outside sources.

3.4.2. General Ledger

The purpose of an accounting system is to group operational transactions so that an accurate judgment of the financial condition of a company can be evaluated. The general ledger serves as a summarization of all transactions of a company (Lucas, 1984). Every

accounting transaction entering into the system must pass through a journal and the

general ledger. This allows the system to control both duplication and omissions of

specific transactions. The purpose of the accounting cycle is to give a summarization of

financial information as financial statements at the end of the accounting cycle.

Transactions are entered initially in journals, then are summarized, or posted, into ledgers.

The ledger summarizes all financial entries that have been entered in specific accounts.

Debits and credits of an account are summarized and posted to the ledger. Ledgers are

established within a company for each account. All of the ledgers combined are what

define the company's general ledger (Adrian, 1979).

Figure 3.3 shows the flow of information through financial accounting practices.

Transactions enter the system and are posted to journals. Journals are then posted to the

general ledger where all transactions are summarized. Summarization of the general

ledger at the end of the accounting period results in cash flow information including the

balance sheet and the income statements for the business.

```
                                    Income
                                    Statement

           Posting              Balancing  Balance
                                           Sheet

Transaction  →  Journals  →  General  →  Balance
                             Ledger        Sheet
```

Journals
1. Accounts Payable
 • Vendor Information
 • Subcontractor Insurance
 • Invoices
 • Checks

2. Payroll
 • Earnings
 • Deductions
 • Taxes
 • Government Reports

General Ledger
 • Debits and Credits
 • Accounts
 • Base Accounts/Prefixes
 • Multiple Entities
 • Balances/Activities
 • Accounting Periods
 • Budgets by period
   (quarter/year)
 • Trial Balances
 • Current and YTD Ledgers

Accounting
 • Financial Reporting
 • Paying Employees
 • Vendor Issues
 • Government Reporting
 • Collecting for Services
 • Cash Management
 • Bonding Reporting

Figure 3.3 Financial Accounting Model
Bertolini, 1998

3.5. Job Cost Accounting System

One of the largest and most complicated accounting problems faced by construction

companies is the recording of costs. The recording of costs is done simply by the

accounting department. The recording of costs is done with great accuracy and precision

for the simplest purpose of recording information for taxes and government requirements.

Much is being invested into the normal operation of a company by tracking this financial

information based on a timeline that has nothing to do with the timeline of the project that

the information is representing. The accounting cycle determined by the company

representatives prior to the actualization of the first project procured by the company is

the dictating factor for the gathering and processing of financial information. The problem

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is that these costs may be determined after the projects have been completed. Financial and resource reports are not instituted when they can have the greatest effect on management decisions regarding the construction of the project(s). This is the premise on which a job cost system operates and the problem that it attempts to alleviate. Instead of developing financial reports solely for investors, government, and banks at the end of a predetermined accounting cycle, reports will be developed that help project management make decisions regarding the project. The overall objective of the job cost system is to show the project expenses as they occur and disburse them to the appropriate work package (sub-element) of the project (Halpin, 1985). Decisions can then be made to help adjust cost over-runs and help preserve the desired profit margin. The job cost accounting system serves two purposes. The first is to monitor and control costs compared to the original budgeted amount. The second is to collect information for future estimates. The system the company establishes can be very complex or quite simple. The system depends on the needs of the company and what is required for managerial decision making. Choosing the proper system and the degree of complexity is one of the most important aspects, and can greatly affect the success of the system. Detailed information is required to be collected from the field, and the collection timeliness is essential in order for the overall success of the system. This information will be processed according to the timeline of the project(s) under construction. Information processed quickly will allow data to be analyzed and acted upon in a sufficient manner as to head off future problems such as cost over-runs.

Figure 3.4 demonstrates the flow of information through the job cost accounting system. The estimate of a project is entered through cost accounts that correlate with the individual cost codes. The cost codes correlate with each individual element and resource required for estimating the project. These budgeted costs are compared with the actual costs of construction. Reports are generated as managerial decision making reports and historical data information for future estimates.
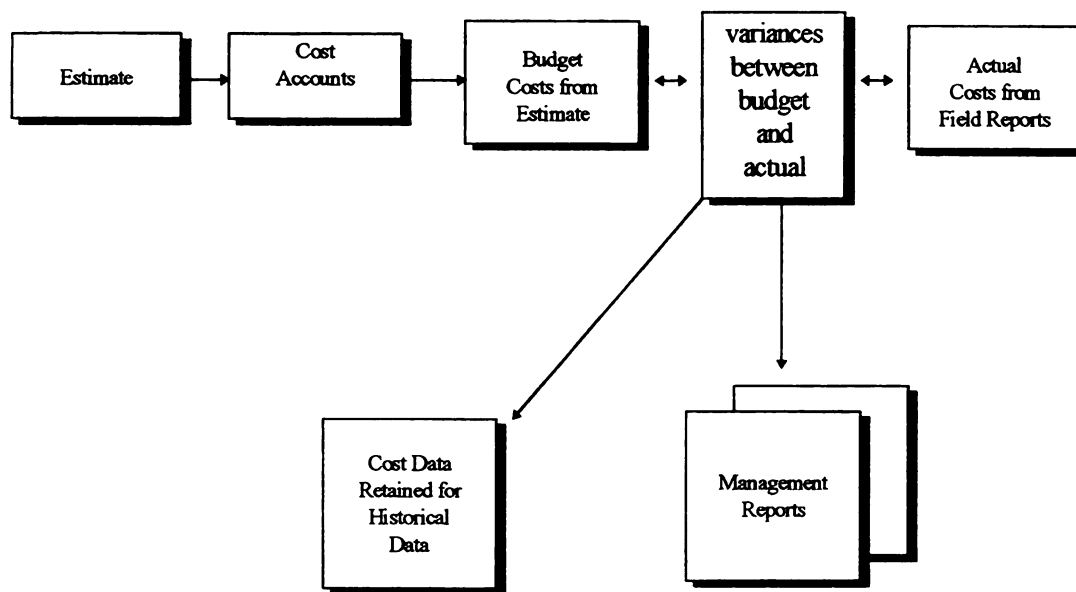
Figure 3.4
Information Flow through Job Cost Accounting
Bertolini, 1998

Money is already being spent to gather pertinent project information for financial accounting. The accounting system needs to be adjusted to maximize the use of the information already being generated, as well as additional resource information. The information should be collected and generated into practical decision making data concurrent to the project time frame, as well as to the accounting cycle.

The objective of the job cost system is to keep track of the project financial information in a timely fashion. The information then can be used to implement changes and verify the accuracy of the budgeted cost of the job (estimate). Verifying the accuracy of the budget

is done through establishing control over accounts payable, labor costs, material costs, and subcontracted costs (Coombs, 1995).

Because most contractors view themselves as true entrepreneurial spirits, they look negatively upon a structured management approach (Coombs, 1995). The accounting system needs to have separate accounts that identify labor, equipment, materials, and overhead costs. Tracking of these resources becomes an important management challenge for the contractor. This challenge can prove to save two to four percent on any given job if it is systematically implemented and followed (Coombs, 1995). One way that a company can implement the job cost system and begin to track the information flow is by developing cost codes that are used by both the estimator and the accountant.

3.6. Cost Accounting Codes

The estimate is the initial document that is used for the job cost system, and in particular, it provides the cost accounts for the job cost system. The cost accounts are set up to insure that all of the items of work and resources have been accounted for throughout the construction process. As the project is under construction, all of the costs need to be recorded in the cost accounts in a timely manner in order for the system to be useful. The costs accounts will determine if the estimated costs were accurate (Coombs, 1995). The cost accounts serve as the layout for how the project will be measured throughout the construction process. The construction company must have accounts established that are able to provide timely warning to cost variations and over-runs. The accounts should be developed around the time frame of the project, and the complexity should not interfere

with the timely gathering of information and reporting of variances to management (Halpin, 1985). Reports are processed during construction that analyze the estimated costs and compare them with the actual costs to forecast if the project is within budget. Since the profit of a project is a relatively small amount compared to all of the costs for the actual construction, it is extremely relevant and important to know where variances have occurred, which division and/or element, and make adjustments to the project at an early stage to offset any cost over-runs.

Cost accounts serve another purpose for the construction company. Once the project has been completed, and all of the budgeted costs have been compared to the actual costs via the cost accounts, they serve as historical data for future estimates. Accounting by nature is the measure of historic data, or that which has already occurred. A transaction takes place and is then recorded in specific ledgers that have been established by the company. Financial accounting, simply stated, organizes the information in such a way that is required by government standards. The final reports that are developed after the accounting period has ended are organized to report income (income statement) and profitability (balance sheet). This information is then made available to interested parties such as investors and the government in a standardized and uniform way. The final responsibility of the financial accounting information is in the preparation of periodic balance sheets, and statements of income. The obvious point is; how can this same information become more useful to the company. The information needs to be used as historical information for the estimating department, and as historical information for managerial decision making reports. Estimators find that the information provided by

traditional financial accounting methods do not provide proper historic information

(Oswald, 1984). The accounts that are established in financial accounting methods are set

up to conform to the processes required for the financial reports. The flow of information

does not correlate with the budget because the accounting and estimating departments are

not sharing the same cost accounts, and they are not sharing the same work breakdown

structure. A company must evaluate its organization breakdown structure and determine

how the estimating and accounting departments may better share the information. The

cost accounts should be matched per job(s) to represent the same key elements through

the use of the work breakdown structure.

The construction industry has been slow to implement integrated management systems,

though such systems can help prevent major cost overruns. Improper management

controls established within a company affect management planning and control. Reasons

for the variances between the cost estimate and actual costs include: (1) lack of planned

information systems, (2) poor correlation of work definitions, (3) improper control of

schedules and cost segregation, and (4) inaccurate cost allocation methods (Coombs,

1995).

3.7. Job Cost Reports

Various job cost reports are available to enable management decisions regarding the

accuracy of the initial budget for a construction job. The job cost reports are those that

offer increased information to the managers of a construction company. The information

reported is above and beyond what is reported via financial accounting statements.

The job cost report is one of the main control reports which measures how each job is doing. A comparison with the actual construction cost is made to determine the accuracy of the initial budget for construction. Change orders should reflect a change to both the budget and actual costs. The information is gathered through invoices that are currently being sent to the accounting department for work, materials, and labor for work on a particular job (Pansza, 1988). The timeliness of this information, as well as all other job cost reports, is of the utmost importance. In areas where information is not available, estimated costs are acceptable. The estimated costs need to be updated when the actual costs become certain. The absolute accuracy is of secondary importance to the timeliness of the information. The ability to react to cost over-runs and implement managerial changes is the primary purpose of the job cost system. The job cost report should be made available to management on a weekly basis.

The completed job's report gives information regarding costs for each job and should be conducted during the reporting month. The costs are broken down by the sixteen division breakdown system (CSI), and give information regarding the contract amounts, in total, for each job. Variances between the actual and budgeted cost amounts are shown for all completed jobs (Pansza, 1988). This information is then transferred to the estimating department as historical information. This information will be used as a tool to better estimate future projects.

The job cost system stands by itself, separate from the financial accounting system and keeps track of costs using the sixteen CSI divisions by job. It is tied to the financial accounting system through the general ledger system. This allows for the system to be up and running quite easily because the current system is already in use for the general ledger system. The job cost accounting system also allows for the system to be up and running quite easily because the current system is already in use for financial accounting. The total costs for the period are posted to the general ledger in the same way that manufacturing posts the Work in Process account at the end of the accounting period.

3.8. Cost Estimates

Cost estimating has been defined as the process of predicting the project costs and resources associated with a project (Lee, 1992). Cost estimates are used extensively by all companies associated with a construction project. The owner determines the feasibility of a project through initial cost analysis and estimating. The architects utilize a construction estimate to evaluate project alterations and changes. The company attempting to procure a job to construct uses estimating to develop a comprehensive cost for bidding. After procurement, the estimate is used for the budgeting of the project. One inherent flaw in the cost estimating process is the lack of incorporating construction decision processes into the construction estimating system (Lee, 1992). If a cost estimating system is linked with a job cost accounting system and the information flow is set up to measure detailed resource budgets and actual costs, and to compare variances, then estimators can find the impact of variances and react quickly during the construction process.

The estimating process is one which has both a personal process approach as well as a company procedural approach. Individual estimators may have an established system that they personally employ in order to arrive at budgeted costs for a project. This personal process system may have been developed over years of experience and may not be structurally organized anywhere except with the individual estimator. As stated earlier, accounting principles have been developed over a long history of practice. The purpose of financial accounting is to provide a framework in which financial information may be presented (Mott, 1981). The purpose of estimating is to predict a final cost at which a project will be constructed. Personal experiences will in large part play a significant role in how the breakdown of costs will be determined and costed.

Company procedural approaches attempt to provide a degree of uniformity to the estimating process for all jobs. The similarity will make the information more meaningful and provide more accurate information in the future. Company procedures will not designate specific starting points for the estimator, but will establish a final framework for how the estimate is to be presented in its final form. These procedural standards allows the estimator to personally decide on the strategy for determining individual costs for the project.

3.9. The Estimating Process

The estimating process is one in which an established procedure for determining the cost to construct is included in the process. By analyzing some of the inherent problems

associated with a profession that lacks general uniformity, the following sections show a suggested procedure to consider for determining a project estimate. Figure 3.5 provides a template an estimator should consider when determining the cost estimate for a project.

3.9.1. Detailed Study of the Plans and Specs

The estimating team will need to thoroughly evaluate the project plans and specifications. The evaluation process is shown in the second level of the cost estimating model (figure 3.5). Attention to detail is one of the most important aspects of this phase of the estimating process. All aspects of the building process needs to be considered and evaluated. At this stage of the estimating process, it is important to consider if a given project is one that a construction company wants to attempt.

3.9.2. Divide Plans into Preliminary Building Systems

Dividing the plans into preliminary building systems provides the estimator with an initial breakdown of the building process. An initial analysis is presented, not a detailed work breakdown structure. By placing the project into categories, the estimator can determine the complexity of the project while gaining insight regarding resources and time frames.

3.9.3. Develop Work Categories and WBS

The building systems are broken down into their work breakdown structures, and further into work elements. For divisions which are to be subcontracted entirely (including labor, equipment, and materials) the level of detail is minimized. Work items and the individual resources associated with the items are determined by the estimating team at this time.

3.9.4. Collect Costs

Once the work item levels are determined, along with the associated level of resource measurement, the cost is associated with each item. Subcontractors that will be required to perform work are summoned, and their costs are tallied.

3.9.5. Final Estimate

The itemized costs are added and reviewed at the time of the final estimate. The estimated costs and the work breakdown structure should be reviewed thoroughly by different company officials to ensure accuracy and verify that no items were missed or miss-represented.

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┌─────────────────────────────┐
│   Prepare Plans and Specs   │
└─────────────────────────────┘
              │
┌─────────────────────────────┐
│        Study Details        │
│      of Plans and Specs     │
└─────────────────────────────┘
              │
┌─────────────────────────────┐
│       Divide plans into     │
│       preliminary bldg      │
│           systems           │
└─────────────────────────────┘
              │
┌─────────────────────────────┐
│   Develop work catergories  │
│    and determine level of   │
│             WBS             │
└─────────────────────────────┘
              │
┌─────────────────────────────┐
│    Collect subs, suppliers  │
│         and estimates       │
└─────────────────────────────┘
              │
┌─────────────────────────────┐
│      Compute Quantities     │
└─────────────────────────────┘
              │
┌─────────────────────────────┐
│      Calculate Costs of     │
│        Categories and       │
│          Work Items         │
└─────────────────────────────┘
              │
┌─────────────────────────────┐
│   Calculate Overhead and    │
│            Profit           │
└─────────────────────────────┘
              │
┌─────────────────────────────┐
│   Determine Final Estimate  │
└─────────────────────────────┘
```
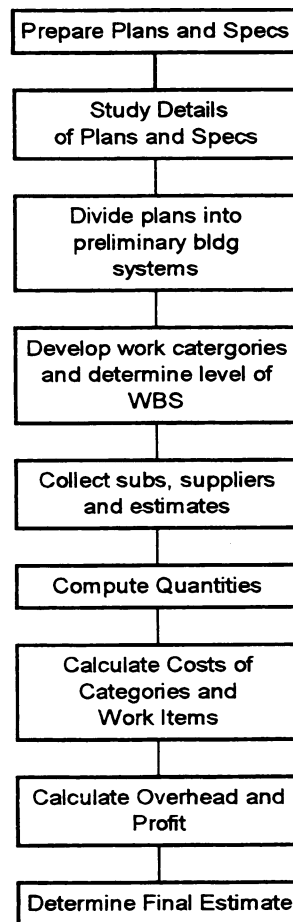
Figure 3.5
Cost Estimating Model
Bertolini, 1998
(Modified from Appau, 1995)

3.10. Integrating Job Cost Accounting and Estimating

The integration of the job cost accounting system and estimating systems is an important

aspect to consider when determining (1) the tracking of the information flow for project

costs through a construction company, and (2) the planning and control of cash circulating

through a construction company. Cash flow is an important aspect of a construction

company because of the complex nature of the industry. The complexities include

weather, economic status, variances between individual projects, and the large dollar value

of the projects. These items represent a unique challenge to the industry in the form of

planning and managing the flow of cash (Adrian, 1979).

3.11. Construction Project Planning

The life-cycle of a facility consists of several phases that measure particular milestones of

the facility. Four phases that mark significant points throughout the life-cycle include: (1)

Project feasibility phase, (2) project development and delivery phase, (3) facility

management phase, and (4) the demolition and disposal phase (Syal, 1991). The project

planning stage is considered to run from the start of the design to the completion of

construction. This stage of the facilities life-cycle is considered the project development

and delivery phase. It is within this stage, or time frame, that the construction company is

responsible for the cost budget, the construction, and the timely completion and delivery

of the project to the owner(s).

Figure 3.6 demonstrates the construction project planning stage and the point at which the

construction project planning takes place. Design decisions and construction decisions are

made at this point. Decisions regarding cost estimating are made after the design stage

and prior to execution.

```
┌──────────┐   ┌──────────────┐   ┌────────────┐   ┌────────────┐
│ Project  │   │   Project    │   │  Facility  │   │ Demolition │
│Feasibility│→ │ Development  │ → │ Management │ → │    and     │
│  Phase   │   │     and      │   │   Phase    │   │  Disposal  │
└──────────┘   │  Delevery    │   └────────────┘   │   Phase    │
               │    Phase     │                     └────────────┘
               └──────────────┘
```

┌───────────────────────────────────┐
│ ┌──────────┐ ┌────────┐ ┌────────┐ │
│ │Conceptual│ │Prelim. │ │Detailed│ │
│ │ Design   │ │ Design │ │ Design │ │
│ └──────────┘ └────────┘ └────────┘ │
└───────────────────────────────────┘
      Design Decisions

```
          ┌──────────┐
          │  Assign  │
          │  Const.  │
          │   Team   │
          └──────────┘
          ┌──────────┐
          │  Const.  │
          │ Project  │
          │ Planning │
          │  Stage   │
          └──────────┘
```

┌──────────────────────────────────┐
│ ┌─────────┐ ┌────────┐ ┌─────────┐ │
│ │Procure- │ │ Onsite │ │Execution│ │
│ │ ment   │ │Planning│ │   │ │
│ └─────────┘ └────────┘ └─────────┘ │
└──────────────────────────────────┘
      Construction Decisions
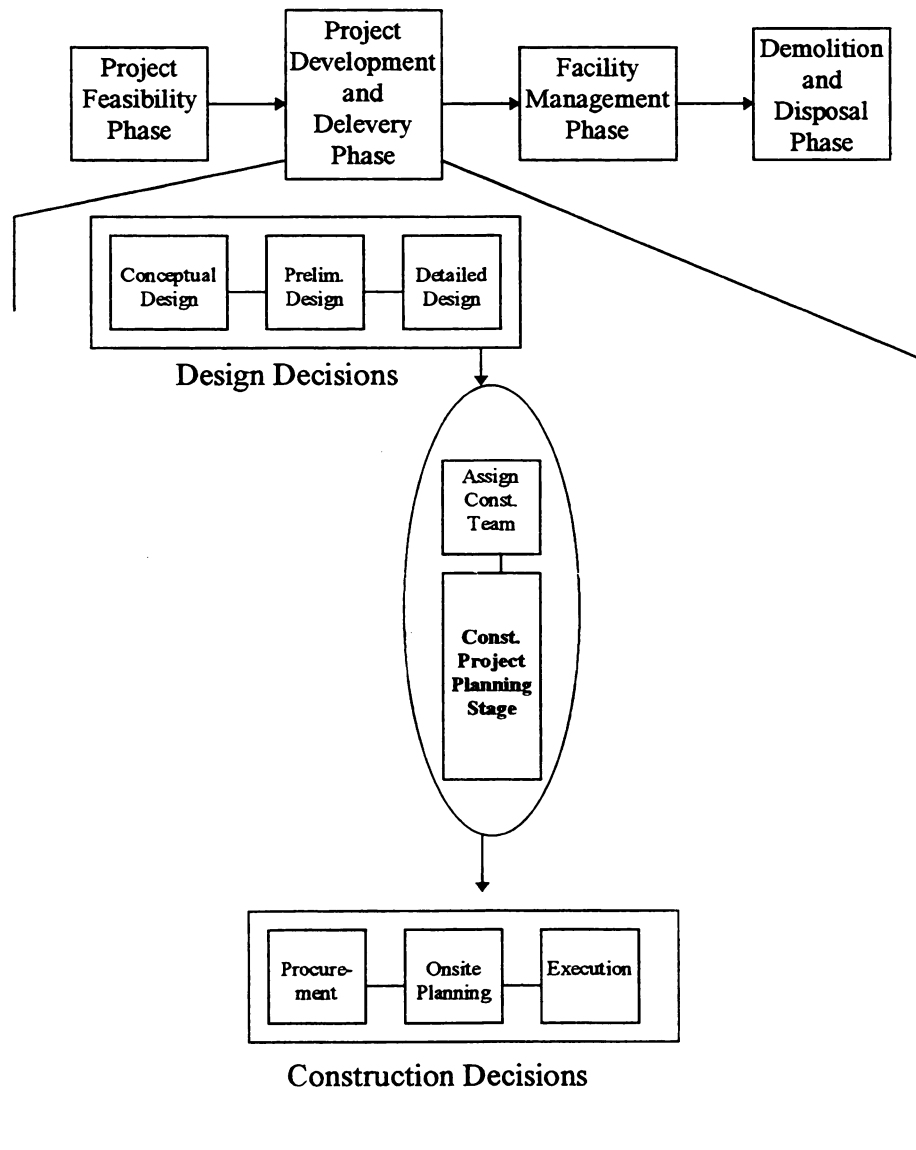
Figure 3.6
Construction Project Planning Stage
Syal, 1991

The project and delivery phase of the construction process is one of the more critical areas where comprehensive project planning is shown to increase profitability and timely completion of a project. One section of the project planning and delivery phase is the construction project planning group. This section takes over after the design of the facility has been completed by the architect and engineer and prior to the actual construction. This is the area where a construction team has the opportunity to plan for the successful completion of the building project. The construction team has the opportunity to plan for cost, time, and performance parameters (Syal, 1991), as well as to define the flow of information as it will travel through the estimating to the accounting departments.

A construction team project plan should consist of the preparation of a cost-flow analysis of cash, both received and disbursed through the construction of the project. The construction company must know when various activities are to be performed, when those services will be paid for, and when cash will be received by the owner (Adrian, 1979).

Project planning for the flow of activities and cash through the system entail determining the activities prior to the procurement of the project. This planning is done during the estimating process (figure 3.7). The estimator needs to determine the cost breakdown of the individual items that will make up the project as a whole. Figure 3.7 highlights the construction team project planning phase, and lists the importance of determining activities and cost codes prior to the start of construction.

```
          ┌─────────────────┐
          │    Project      │
          │  Development    │
          │  and Delivery   │
          │     Phase       │
          └─────────────────┘
                   │
                   ▼
          ┌─────────────────┐
          │    Design       │
          │    Phase        │
          └─────────────────┘
                   │
                   ▼
          ┌─────────────────┐
          │  Assign Const.  │
          │     Team        │
          └─────────────────┘
                   │
                   ▼
┌───────────────────────────────────────┐
│         Construction Team              │
│         Project Planning               │
│   ┌──────────────┐   ┌──────────────┐  │
│   │ Determine    │───│ Determine    │  │
│   │ Activities   │   │ Cost Codes   │  │
│   └──────────────┘   └──────────────┘  │
└───────────────────────────────────────┘
```
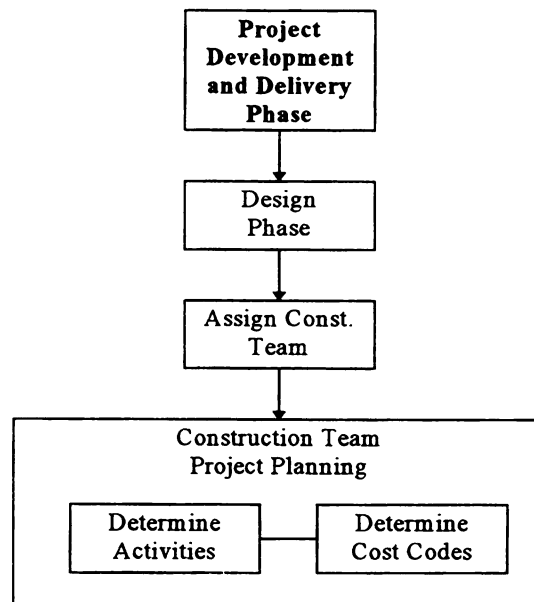
Figure 3.7
Construction Project Planning Model
Bertolini, 1998
(Modified from Syal, 1991)

A well organized company will have systems in place that will assist the construction

company's management team in the completion of the project both on time, and within the

determined budget of construction.

It is common for a construction firm to have a backlog of work, but not have a clear

understanding of whether or not a profit is being realized on a current project under

construction. Construction companies often are performing work while keeping a project within budget, but fail to know the current situation of the cash flow through the company. Success is often equated with the volume of work in which a firm is currently involved. The accounting system can often aggrevate this troublesome situation. The accounting journals are usually set up to include transactions from current and past projects with no distinction between the two. The evolved scientific approach of standardized accounting practices causes unique problems that a construction firm will face. The industry has a high degree of unique characteristics that prevent a complete systematic approach to the measurement of the cash flow through a company (Adrian, 1979). The implementation of an integrated job cost system and estimating system that allows the tracking of the flow of cash and information relating to job costs, both budgeted and current, will go a long way in reducing the information flow problems of a construction company. Establishing a job cost system that is integrated with the estimating department is the initial stage for attempting to truly measure the variances between the budgeted job cost and the actual job cost. Implementing this system will allow for measurement to take place on quite a different scale than traditional accounting. Instead of gearing the system around the time frame of the accounting cycle, the reports should be run at useful intervals for project review. Measurement is the first stage of taking action. Becoming aware of problems and potential problems allows the user(s) to conceptualize what is currently taking place, and what action is needed to help rectify, or eliminate the adverse condition. The information that will be produced through the job cost system may not be complete. That is, some estimates of the costs currently under construction may need to be made. Estimating costs is not a short coming of the system, but a proactive

attempt to establish costs for items currently under construction to become aware of the

possible variances between budget and actual costs. By determining an estimate prior to

work being completed, changes can be instituted at a time that is most appropriate; before

all the actual costs for the particular item have been completed.

3.12. Cash Cycle of a Construction Company

A typical construction company usually has more than one project underway at any given

time. The accounting systems established measure the money(s) coming into the system

and the money(s) going out of the system. Journals are established in order to measure

certain types of transactions. Accounts payable measures money that is leaving the

company for material billings, invoices for work completed (subcontractors), and other

costs to operate the business. Accounts Receivable journal measures the cash received by

the company through billings. The point of interest for the accounting department, and

the company, is that there is more money coming into the system than what is leaving the

system (figure 3.8).

```
                    ┌─────────────────┐
                    │    Starting     │
              ┌────▶│  Cash/Revenue   │
              │     └─────────────────┘
              │              │
              │              ▼
     ┌────────┼──────────────────────────────────────────┐
     │        │      Accounts Payable (-)                 │
     │   ┌──────────┐    ┌──────────┐    ┌──────────┐     │
     │   │ Material │    │          │    │  Other   │     │
     │   │ Bills (-)│────│ Labor (-)│────│ Costs (-)│     │
     │   └──────────┘    └──────────┘    └──────────┘     │
     │                                                    │
     └────────────────────────┬───────────────────────────┘
                              │
                              ▼
                    ┌─────────────────┐
                    │ Work in Progress│
                    │   (-) and (+)   │
                    └─────────────────┘
                              │
                              ▼
     ┌────────────────────────────────────────────────────┐
     │            Accounts Receivable (+)                  │
     │   ┌──────────────┐      ┌──────────────┐            │
     │   │              │      │    Cash      │            │
     │   │ Billings (+) │──────│ Received (+) │            │
     │   └──────────────┘      └──────────────┘            │
     │                                                    │
     └────────────────────────────────────────────────────┘
```
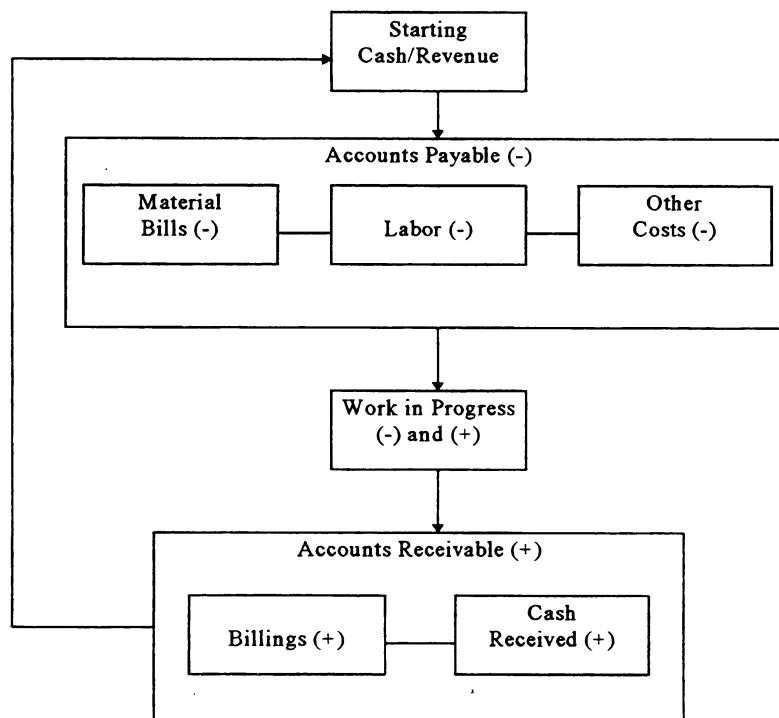
Figure 3.8

The Cash Cycle of a Construction Firm

Bertolini, 1998

(Modified from Adrian, 1979)

The mistake that is often made in a construction company is not setting up a system that measures the costs of individual projects. The variances between the budgeted amount and the actual cost of construction is not determined until after the project is completed and the overall costs are added and compared to the budget (estimate). For a financial accounting system, this practice is acceptable. When considering the time frame that decisions need to be made for individual projects while under construction, this practice is unacceptable. Valuable information which can serve the management team for decision

making during the construction of a project is being underutilized through normal accounting procedures.

Other financial concerns that can affect the overall balance of a construction company's cash flow include assets and liabilities. The purchasing of land can increase the amount of assets and liabilities that a company shows on its books. Also, the purchase and maintenance of equipment, including vehicles and equipment, can also increase the company's assets and liabilities. The selling of both land and equipment may boost a company's financial statements in the asset column for cash. When taking all of these items, as well as other possible alterations of indirect project expenses and assets, the "bottom line" of a construction company's financial statement can lead to incorrect assumptions regarding the profitability of one or all of the projects under construction for any particular accounting period. One thing to consider is that the work in progress is relatively easy to measure and keep track of in a construction company compared to a manufacturing company. Where a manufacturing company may produce a high quantity of "widgets" in a given accounting period, it is extremely difficult to itemize each individual work in progress and determine managerial information. Although a construction company may have a number of projects under construction in a given period, it is usually a number which is both readily known and easily measured.

In a perfect world, a construction company would not pay its suppliers and labor costs for construction until the company had been paid for its work. The time frame in which a construction firm pays for costs incurred and the time in which it receives its money can be

significant because of retainage clauses in the contract between the contractor and the owner. Therefore, it can be said that profits from a completed project may be used to pay contractors and suppliers for a project under construction. Without a cost control system, it becomes quite difficult to distinguish between loss and profits for a number of project when a company has multiple projects.

3.13. Integrated Approach to Estimating and Job Costing

Project estimating is predicting the cost for a one of a kind item. In project estimating a key concern is the long range impact that the project can have on the financial statements of a company (Oswald, 1984). There are many resources that are required to fulfill a contract for the construction of a facility. As mentioned earlier, a company may need to outlay capital up front to pay for supplies, labor, and subcontractors before receiving payments from the owner. Coupled together, resources and capital represent a high degree of volatility for a company which is unable to manage its cash flow correctly.

Resource allocation is determined by the estimator. The estimator determines the subdivision of a large process into smaller items which are less complex and more manageable. The estimate is usually broken down into the fifth level of the work breakdown structure. This level is considered sufficient to appropriate the proper costs to the individual resources required to complete the work. It may be adequate to break the project down to a lesser degree. If this is the case, outsourcing for material and labor may be necessary. Lump sum bids received by subcontractors may include labor and materials.

This would make it unnecessary for the estimator to determine labor and material. On the other hand, a higher degree of breakdown may be required if work was done in house.

Finally, cost codes are determined at the lowest level of the work breakdown structure. The cost codes are then implemented into the accounting system to serve as the original budget of the project.

A certain amount of data is required for an estimator to perform a proper estimate. Subcontractors will provide the estimator with costs associated with certain work packages, or items. Vendors will provide cost information for supplies required by the plans. Company information is needed to determine overhead costs associated with all projects, and overhead costs associated with the particular job being bid. Lastly, historical information is required for projects of a similar nature. This is an area that all would agree is important, but a high degree of organization is required to receive accurate historical data. The use of historical information allows the estimator to determine areas that had been misappropriated in past estimates, and reasons for particular discrepancies between actual and budgeted amounts. This information can help eliminate potential over-runs in the future and allow a more accurate assessment of the costs associated with the project being currently estimated.

Actual costs for the project need to be measured against the budget throughout the construction process. Systems need to be established that allow for the timely gathering, reporting and processing of the actual information. Most companies run into difficulty in

this area. Timeliness is the essence of a successful project. One can argue that the profitability is also critical, but timeliness is the main measure of success. The owner is less concerned about whether or not the contractor made a profit, and more concerned with the delivery of the facility to its useful purpose.

The gathering of actual cost information takes place by all contractors for every project. At one point or another, a contractor is well aware of how much, if any, profit was made on any given project. The concept of timeliness is what sets a functioning job cost system apart from a standard cost tracking system. The main point in question is whether the information will be made available at a time when it can be the most useful is the main point in question.

The systems needed in order to sufficiently utilize the cost information during construction are shown in the estimating-job cost integration model (figure 3.9). Cost data are received directly from the field and compared to the original budget which is set up as cost accounts. Field reports serve as the main provider of the information from the field. As stated, it is critical that the individuals in the field are part of the system design team and fully understand the importance of this information. Without their participation, the system is just a shell that will not accomplish the stated goal.

Figure 3.9 models both the job cost system and the estimating system. The model tracks the flow of information prior to and during construction. Prior to construction, information from the estimate is shown as input into the job cost system as cost accounts.
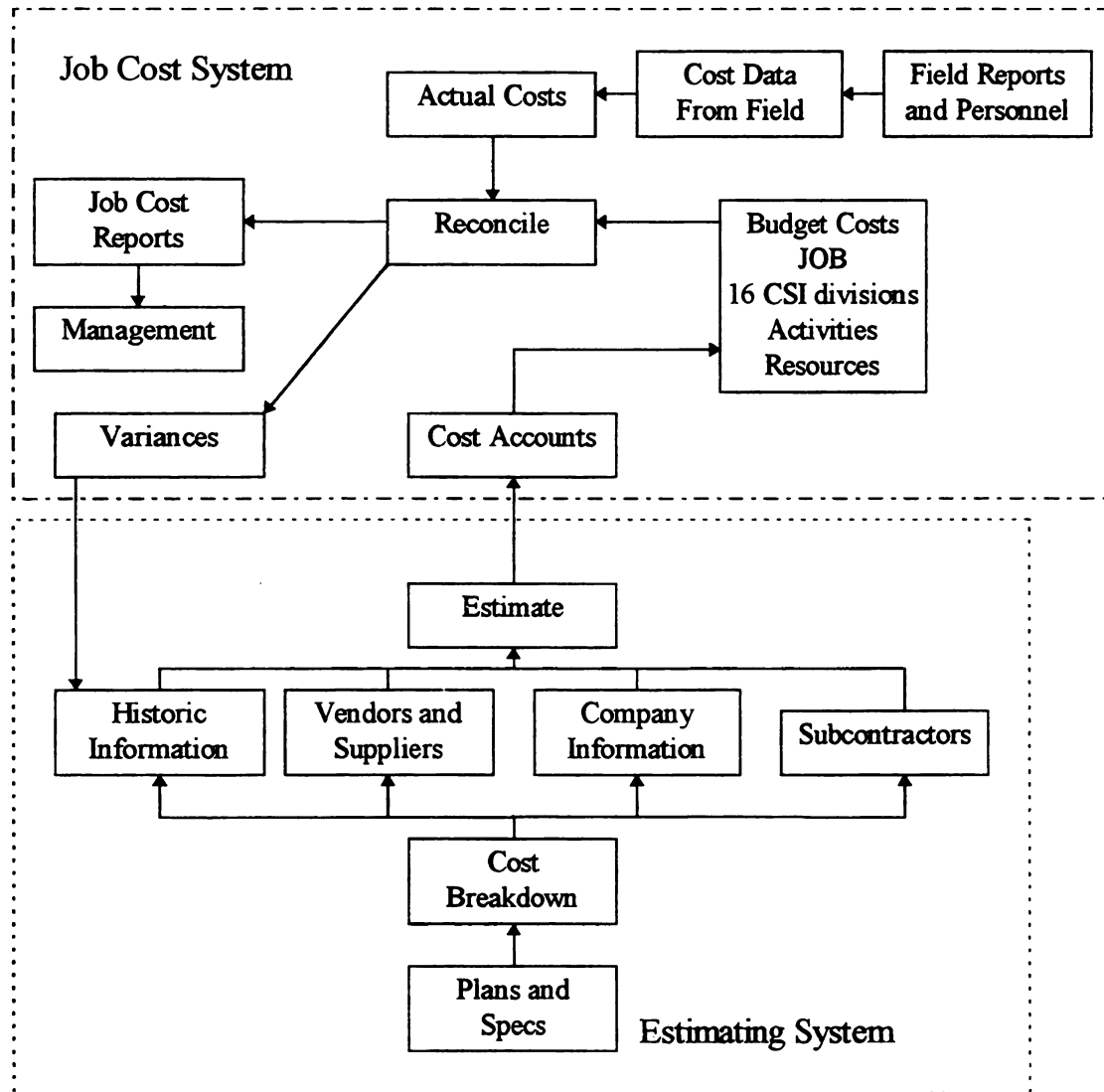
Figure 3.9
Estimating-Job Cost Integration Model
Bertolini, 1998

All of the information that helps to determine the estimate are listed below the estimate

box in the model. Information from the job cost system enters the estimating system as

variances. Actual costs are reconciled with the budgeted amounts within the job cost system which are then used as historic information for the next project.

A job cost ledger is needed to input costs from the field. The job cost ledger will accept the costing information that has already been established through the cost accounts. Information required from the field will include timecards that determine the amount of labor for a particular job, material invoices that give detailed cost information for materials provided by suppliers for the job, and other direct labor expenses. Other expenses may include some or additional cost information. Subcontractor billing for items, equipment expenses, job site trailer and management, and applied overhead for the project may be data that are collected from the field.

Job cost accounting procedures benefit those companies which produce many types of products, each being unique in some shape or form. In many cases, only one of any particular type of product is being made (Adrian, 1979). The general ledger system for any two construction companies may be vastly different so the actual layout of the system will not be covered. The purpose of the ledger is to list the date of the transaction, a description of the transaction, labor, material, subcontract, and miscellaneous expenses.

Job cost accounting procedures established in construction companies come in two forms: those that are maintained manually, and those that operate on a company's computer system. Regardless of which type of system is used, the main functions of the system is to identify all the project's direct costs, and apply the indirect costs to the project. The key

to profitability is that all the costs associated with the project should be allocated in a timely fashion so decisions can be made when confronted with variances.

The estimator is able to do more than establish the overall cost of the project under the job cost system. By analyzing the historical information, the estimator is able to determine standards by which work should be calculated for future project estimates. The data from previous jobs shows the variances and also breaks down the resource consumption to the level of the established cost codes. Construction methods may be one of the specifications that the estimator gathers from a previous job. The standards established are targets which should be readily accomplished by the construction team.

The reconciled difference between the actual and the budgeted information is transferred to be used in the estimating procedures for a future project. This information will be used along with the subcontractor bid, the vendors and suppliers information, as well as the company indirect information.

The actual cost information will be directed to the financial accounting department as well as the job cost system. The data in the financial department will be processed traditionally to determine the financial reports normally associated with the manufacturing/construction industry.

3.14 Estimating-Job Cost-Financial Accounting

The integrated Estimating-Job Cost-Financial Accounting model (Figure 3.10) includes the integration process for the information model by connecting the job cost level with the financial accounting level. With the addition of the financial accounting phase, the actual costs that are generated in the field affect both the job cost and financial accounting phases. Note that the financial accounting phase is not affected at all by the job cost phase. It is completely independent of the whole information system except for the actual costs. These costs provide input that are necessary for the balance sheet and income statements.

Figure 3.10 shows the necessary flow of information in order to have an integrated system providing accurate information in the estimating, job cost, and financial accounting phases.

Budget Costs
JOB
16 CSI Divisions
Activities
Resources

Reconciled

Actual Costs

Cost Data from Field

Field Reports and Personnel

Job Cost Reports

Cost Accounts

Management

Estimate

Subcontractors

Vendors and Suppliers

Company Information

Historic Information

Balance Sheet

Assets

Liabilities

Net Worth

Balance Sheet and Income Statement

Financial Accounting System

Cost Breakdown

Plans and Specs

Estimating System

Figure 3.10
Integrated Estimating-Job Cost-Financial Accounting Model
Bertolini, 1998

Computer integration is the next step that needs to be accomplished now that the flow of

information has been defined. Chapter four takes a current software program and

demonstrates the level of company knowledge that is necessary when developing the

information system with available software. The demonstration shows how modeling can

effectively and efficiently aid a company by providing the blueprints for the specific

structure of the information system required for an individual company.

Chapter 4
Set up and Functioning of a Computer Based Job Cost Accounting System

4.1.   Introduction

This chapter presents a comprehensive set-up example for an integrated computer job cost

accounting and construction estimating system. Timberline Gold Accounting software is

the commercially available product that was used for the purpose of this research project.

The first section represents the set up for the job cost module. The set up covers the

establishment of a company in the Timberline system, and the parameters that are required

for it.

The next section establishes an estimate using Timberline Extended Estimating software.

A work package estimate is created, then integrated into the job cost module. Once the

estimate is integrated, it can be used as the budget and used in job cost reports.

4.2.   Setting up Timberline Accounting

The Timberline Gold Accounting system is a software package that allows a construction

company to establish a system that will be useful as a management tool. It is important

that a system is established that will meet the company's current and future needs.

Parameters are established and decided upon throughout the company set up. Two key

factors in effective use of the software package are taking enough time to plan for the implementation of the new system and training the staff for operating the system.

4.3.   Company Set-Up in the Timberline Gold Accounting System

There are certain decisions that need to be made when setting up the company parameters within the Timberline Gold system.

4.3.1. Irreversible decisions within the general ledger

Decisions will need to be made to describe how the master file is created. These decisions are considered irreversible. Within the general ledger, the irreversible decisions are those that determine the amount of prefixes, and the base accounts, fiscal controls, and balance sheet information.

Prefixes: Prefixes determine the initial numbering sequence of the account numbering system. The number of prefixes utilized is determined by the company's current and future needs. Considerations that are essential in determining the number of prefixes are how many entities are within the company's umbrella, the amount of partnerships for the entities, and if there will be additional fiscal entities in the future . Prefix A, B, and C are allowed in the Timberline Gold system. The example that will be used within this report are prefixes A and B. Prefix A will be that of the Company and will have a size of 2 digits. Prefix B will be that of Division, and will also have a size of 2 digits. For example: Company prefix will be set at 10, and Division 10 (10-10) will be for commercial construction, and Division 20 (10-20) will be for residential construction. Other examples may include: Prefix A = Company, Prefix B = State, and

Prefix C = Subdivision.

Base Accounts: Base accounts are the identification numbers for the accounting structure. As a transaction enters the system, it is required to be processed through one of the ledgers, and/or one of the ledger accounts. This report will utilize the general ledger, and the job cost module. Typical accounts within the general ledger include: cash, accounts payable and receivable, work in progress, and retainage accounts. By establishing the structure of the base accounts, the sequence is being prescribed within the master file, and will be unable to be changed once the system is established and running. The base account will follow the prefix. For example: *10-10-1030* can be defined as: *CompanyLevel-Commercial Division-Accounts Receivable.*

Fiscal Controls: The information pertaining to the fiscal period(s) that are established for a company is called the fiscal controls. The most important aspects regarding fiscal controls are the period ending date and the fiscal ending date. Once these items are established in the system, they cannot be adjusted or modified.

Balance Sheet Controls: The balance sheet controls are established early in the system development. These controls establish at which level the balance sheet is determined. This is in direct relationship to the level of Prefix establishment. For our example, we are setting up a company which will have two divisions; commercial and residential construction. We can set up our balance sheet level to be either determined at the company level, or have separate balance sheets developed for both the commercial and the residential division. Again, these controls can not be modified or changed once the system is in operation.

4.3.2. Irreversible Decisions within the Job Cost Module

Decisions that are established at the inception of the job cost system and are not modified for the life of the system within the job cost module include: job format, phase format, categories, and the billing level. Once these items have been designated and the master file is created, any changes of the irreversible decisions will cause the system to be unable to recognize earlier data that have been used by the system (transactions).

Job Format: The job format is used to develop the job numbering system that will be used throughout the system. Each job within the system will be labeled by its number. It is possible to establish a one number system that may be adequate for some construction companies. Many companies may find it useful to establish a multi-numbering system. The importance of the job cost system is, in large part, the ability to create and run management reports for individual jobs. How the job numbering system is established will enhance this ability by being able to identify many different jobs. Identifying different jobs can be done by making the job number the "key" in the numbering system. For example; if a job number is one number (XXXXX), the only "key" is the job number itself. But, if the job number system uses a multi-numbering system where the first two digits represent the year of the inception of the job, and the second set of digits represents the job number within that year (XX-XXX), there is more versatility regarding report groupings. For instance, reports can be called up for all jobs performed in a given year. Also, individual jobs may be called up independently. The whole multi-number of the job number remains the "main key", while the first and second set of digits can represent an "alternate key"

that can be used to generate specific job reports. The job number may be established to include as many as three sections.

Phase Format: The phase structure is an irreversible decision that will dictate the structure of the individual phases within the system. The model in this example will use the CSI divisional breakdown. Each phase will be separated by a hyphen, and followed by the designation number within that phase. For example, the concrete division is designated by the number three within the CSI format. The Timberline database that is being used designates a five digit numeric system for packages within the divisions. Concrete wall forms use the numbering system of 11400. Therefore, the numbering system in this model will be established within the job cost module as *03-11400: Concrete wall forms.* As mentioned in the Job Format section, the complete number represents the main key, while both the 3 and 11400 represents the alternative keys. With this set up, individual job cost reports may be developed that either show all phase information for a particular job (or all jobs) regarding the concrete phase only. Also, a report can be run that will pertain to all concrete wall forms. The decision on how a particular construction company establishes its phase format is in direct correlation to the degree of reporting information that is required. A small residential company may not want as high a degree of informational breakdown as a larger commercial company. In addition, a residential company may have entire phases, if not the complete job accomplished by individual subcontractors. If this were the case, phase numbers may represent a one or two digit number from 1-16 that correlate directly with the CSI breakdown structure. With this in mind, it is extremely important to reconcile the current as well as future needs of the company prior to establishing the phase format.

Categories: The use of categories within the phase structure is an important decision that can also not be changed once the system is in operation. Categories refer to the development of particular cost types being associated with the job and the phase. Categories are more commonly referred to as resources. Common resources associated with job phase items are: labor, material, equipment, overhead, and subcontractor commitments. Categories are either established or not established to be within the system, but even if they are established, individual items do not need category designations. For instance, the general division of three: concrete, does not require a category designation. Individual items can be selectively chosen for the category reference. The level of tracking that is required for a company needs to be determined. If more than one type of cost is tracked, and if more than one type of cost is used in the phase level, then categories should be set up in the initial establishment of the system.

Billing Level: Simply stated, a company must consider two choices regarding the billing level: Should it be set at the job level, or at the phase level. This decision needs to be made at the inception of the process because it cannot be changed afterwards. If scheduled values are to be entered at the phase level now or in the future, the billing should be set at the phase level. Otherwise, the billing will need to be set at the job level.

Application	Decision	Options
TS-System	None	
General Ledger	Account Format	Can include a combination of: Prefix A Prefix B Prefix C Base Account Suffix
	Fiscal Controls	Can reside at: Company Prefix A Prefix B Prefix C
	Balance Sheet Level	Can reside at: Prefix A Prefix B Prefix C
Job Cost	Job Format	Up to three sections
	Phase Format	Up to four sections
	Use Categories	Always use Never use
	Billing Level	By Job By Phase sections
Checks management	none	
Accounts payable	none	
Payroll	none	

Figure 4.1
Irreversible Decisions
Timberline, 1994

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4.3.3. Processing Control Decisions

Processing control decisions will affect which accounts are used for various transactions. These decisions should be considered permanent decisions. Although they can be modified, doing so would alter the outcome of the company transactions. Processing control decisions do not affect either the general ledger or the job cost modules, but are prevalent in the main accounting system (TS-System). The processing decisions are those reflecting the accounting method and the use of batches.

Accounting Method: The accounting method that a construction company subscribes to depends greatly on the type and size of the company. Two types of accounting methods are commonly used in the construction company accounting system, cash or accrual. The cash accounting method is the concept that profits and revenue are not recognized until the job is completed and payment has been received. The accrual system is the accounting method that recognizes revenue at the time that the expense is invoiced and revenue is invoiced. The accrual type is in direct contrast to the cash method of accounting. In the accrual system, expenses and revenue are not determinant on the completion of the project. As long as an expense has been incurred and invoiced, as well as revenue generated and invoiced, they both are documented as both an expense and revenue generating event. Most large commercial and residential companies follow the accrual accounting method. A small residential construction company will benefit more from the cash accounting method because it is simpler to account for project's expenses and revenue once the project is completed. It takes more effort to use the accrual system and a more involved accounting department to document expenses and revenue in the official

ledgers while the project is underway. One very important point to make is that it is standard policy not to change from one system to another. Both have benefits and drawbacks, but once chosen, it is accounting policy not to change unless there is a substantive reason that can be accepted by the government.

Batch Use: Batch is the term used for the updating of accounting information within your computerized system. It is acceptable to choose the default, which is to have the system assign batch numbers. If the system assigns batch numbers, an available batch is any that is not in use. More importantly, when updating, all the available batches not currently activated are available. Batches are updated and are reflected in the system files for the particular application in process. The batch is updated and is balanced with the control total for the application. Batches provide an audit trail by allowing the user to trace transactions back to their sources. The batch is stored in each transaction and the batch record.. If the manual batch is chosen, the user can reopen the batch and make adjustments to the transaction. The batch that is open allows the user exclusive access. This prevents other users, particularly if the system is on a network, from making changes to the batch while in use. (Table 4.2)

Application	Decision	Options
TS System	Accounting Method	Cash
		Both
	Use Batches	Use
		Don't Use
General Ledger	None	
Job Cost	None	
Check Management	None	
Accounts payable	Bank Account Use Method	Operator Specifies for entire check run System automatically assigns per distribution
	Accumulate 1099 Totals by GL Prefix	Check box
	Intercompany Accounting	Check box
Payroll	Pay Groups	Minimun one pay group required
	Multiple Master files	One master file per federal reporting entity
	Intercompany Accounting	Check box

Figure 4.2
Processing Controls Decisions
Timberline, 1994

4.3.4. Report and Inquiry Decisions

Reports that are processed through the system will be designed by information decisions.

These decisions are considered report and inquiry decisions, and can be modified,

changed, or eliminated at any time the system is in use. These decisions affect only the

Job Cost Module of the Timberline Gold system. The job cost module portion of the

system is where the reports are generated for individual jobs and items within jobs. Many

of the decisions already established (job number, phase number) will entitle the user to

generate specific reports with as much versatility as is required. The information that is

established, and/or changed in the job cost module is the responsibility of *user defined*

keys.

User Defined Key: The user defined keys are pre-defined areas of the job cost report that

leave an area available for additional information. They can be chosen to represent a

specific level of information detail that is useful for the company, or not used at all.

Common applications for the user defined key can be the project manager's last name,

project architect, or project owner. By inputting this data, the information can serve as a

"key" to sort information for one particular project manager, architect, or owner. For

instance, all jobs that are under construction for a particular owner can be run, as opposed

to all jobs under construction.

Application	Decisions	Options
TS System	None	
General Ledger	None	
Job Cost	User Defined Key 1 User Defined Key 2 (Alternate Keys)	User Defined Key 1 User Defined Key 2
Check Management	None	
Accounts Payable	Report Inquiry Order (Alternate Keys)	Three Sections can be made Invoice Code 1 Job Commitment Approval ID GL Prefixes Equipment
Payroll	Job Cost Transaction Controls	Employee detail Tax ID and fringe ID detail Pay ID detail
	Summarize General Ledger expense, liability and cash entries	By Account By employee None

Table 4.3
Report and Inquiry Decisions
Timberline, 1994

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4.4. System Requirements

The operating system requires a windows environment. The 1997 requirements will be the Windows 95 operating system. The new windows based estimating system requires Windows 95, and the concept of integration requires this operating system.

This research project includes the information flow and integration between two Timberline software products, Gold Extended accounting and Precision Estimating Extended. The two systems can be purchased and used separately, or integrated together. Gold accounting can also be integrated with other estimating software packages produced by other companies. The author chose to use both Timberline packages to insure a seamless integration process. It is important to confirm that all data are being transferred without the loss of any information.

The modules that were chosen to be used in the Gold Extended system are the Job Cost and the General Ledger modules (see table 4.3). These modules constitute the majority of the accounting transactions, whereas the purchasing and accounts payable and receivable modules magnify the accounting procedures in the General Ledger. Job Cost insures that information used for the construction of particular jobs is transferred to relevant reports needed for immediate managerial decision making for the particular job.

4.5. System Setup for TS Gold

The setup for the Gold Extended system is the input of company information through the use of various pull down windows similar to the pull down windows found in the windows operating system. The company set up is performed to insure that all the information is established relevant to the companies structure.

4.6. Example Company

The company that will be established for the purpose of this report will contain a wide range of information to ensure that most of the applications available within the Timberline Estimating (PE Extended) and Accounting (Timberline Gold Extended, General Ledger module and Job Cost module) are utilized. The information that a company would want to keep track of, and various reports and accounts, are all dependent on the decision process when evaluating what is needed for the company. A construction company that is considering establishing a new system has in one form or another determined that there are weaknesses within the current system. Careful consideration should be given to current and future needs of a company when determining which system to adopt for a new management system.

It is all too common for a company to deem it necessary to establish a new management system, but not know the correct questions to ask regarding the weaknesses of the current system and requirements for the new management system. Chapter five will detail the systematic steps required to establish a job cost system that functions along with the

estimating system. The parameters of thought must be expanded beyond the abilities and limitations of the current system in use.

By determining the perfect system and creating a wish list, management can adopt a system that can either perform all or most of the requirements placed on its wish list. Those that are too difficult to operate within the system, or that are not cost effective in implementing can be eliminated through proper procedures of return on investment. If it is too expensive to include all of the things on the wish list, those items that are absolutely necessary will make it into the final system. Those that are not necessarily needed will not make the final system. Compromises will always be made in order to have an efficient and cost effective system, but it is important to realize the limiting factors associated with the system and understand the reasons regarding the compromises.

The example company will be a construction company that is involved with both commercial and residential construction projects. The area of elaborate company definition will be within the commercial division due to the instances of involved detail that is commonly required by commercial construction. The project example will be of a concrete wall construction phase for a commercial project. Other phases, as well as complete projects, will follow the same steps involved with the wall example. This report will demonstrate:

1. The creation of a company within the Gold Extended Timberline software
2. Set up decisions within the General Ledger

3. Set up decisions within Job Cost

4. Set up requirements for Timberline PE Extended

5. Creation of a Work Package Estimate with Timberline PE Extended

6. Steps to integrate the transfer the estimate from PE Extended to Gold Extended

7. Finalization of the estimate in Gold Extended

8. Processing and reporting within Gold Extended

4.7. Creating of a Company within Gold Extended Timberline Software

4.7.1. Creating a new company:

This step involves the pull down windows situated at the top of the screen in the initial Gold Extended window. Choose *Utilities/System Administration/Company Setup* (Figure 4.4). Input the company information, including address and phone numbers, and the directory path for the company. Do not use the current setup configuration (Figure 4.5).

Title Bar

| TS-Main-Timberline |
| Applications   Utilities |
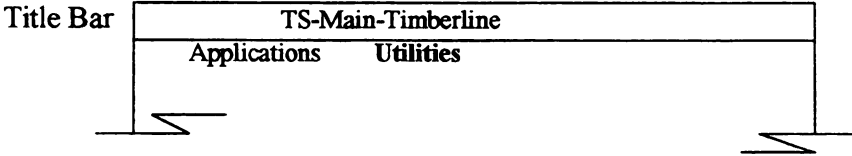
Utilities

System Administration	Company Setup
Print Files	Security
Log File	Preferences
Change Data Directory	Custom Fields
	Data File Controls
Delete Print File	
Delete Log File	Compact File
	Restructure File
Install Options	Check File
	Rebuild File
	Update Dictionary
	Release Notes

Figure 4.4
Creating a New Company in Timberline
Timberline, 1994

4.7.2. Enter accounting information:

Choose *Company Setup/General Information* choose an accounting method and if batches
will be used. We will recognize expenses and revenue when they are invoiced, therefore
we will use the accrual accounting method for the example company, and we will not use
batches. (Figure 4.5)

```
┌─────────────────────────────────────────────────────────┐
│  ┌───────────────────────────────────────────────────┐  │
│  │            Company Setup - General Ledger         │  │
│  └───────────────────────────────────────────────────┘  │
│                                                          │
│                                                          │
│   Company name   Jones Construction_____      │
│   Address        123 Main Street_____      │
│                  _____  │
│   City St ZIP    Portland_____      │
│   Phone          _____  │
│                                                          │
│         Accounting Method              Batches           │
│      ┌────────────────────┐      ┌──────────────────┐    │
│      │     X  Accral      │      │       Use        │    │
│      │        Cash        │      │   X Don't use    │    │
│      │     ·  Both        │      │                  │    │
│      └────────────────────┘      └──────────────────┘    │
│                                                          │
│  ┌──────┐ ┌────────┐ ┌─────────────────┐ ┌────────────────────┐ │
│  │  OK  │ │ Cancel │ │ Create New Company │ │ Batch Control Totals │ │
│  └──────┘ └────────┘ └─────────────────┘ └────────────────────┘ │
└─────────────────────────────────────────────────────────┘
```

Figure 4.5
Setting the Accounting Method
Timberline, 1994

4.7.3. Establish a window icon for the company:

Exit the Timberline Gold Extended program. From the program manager, choose

File/New to create a new icon for the company. Choose *program item,* and input the

company description. At the command line, input: *c:\tsgold\winprog\ts.exe* and input the

working directory. Press "OK".

The system has generated an individual icon that represents the company that is

established. By entering the Gold Extended window, click on the company icon and

immediately be within the TS Main system within the company. (Figure 4.6)

```
┌─────────────────────────────────────────────────┐
│              New Program Object                  │
│ New                                              │
│  ┌──────────────────────────┐   ┌────────────┐  │
│  │  ●  Program Group         │   │    OK      │  │
│  │  ●  Program Name          │   └────────────┘  │
│  └──────────────────────────┘   ┌────────────┐  │
│                                 │   Cancel    │  │
│                                 └────────────┘  │
│                                 ┌────────────┐  │
│                                 │    Help    │  │
│                                 └────────────┘  │
└─────────────────────────────────────────────────┘
```

```
┌──────────────────────────────────────────────────────────┐
│                  Program Item Properties                  │
│                                                           │
│  Description         Jones_____        ┌────────────┐  │
│  Command Line:       c:\tsgold\winprog\ts.exe │   OK   │  │
│  Working Directory:  c:\Jones_____        └────────────┘ │
│  Shortcut Key:       _____        ┌────────────┐ │
│                                            │   Cancel   │  │
│                                            └────────────┘  │
│                                            ┌────────────┐  │
│                                            │   Browse   │  │
│                                            └────────────┘  │
│                                            ┌────────────┐  │
│                                            │ Change Icon│  │
│                                            └────────────┘  │
│                                            ┌────────────┐  │
│                                            │    Help    │  │
│                                            └────────────┘  │
└──────────────────────────────────────────────────────────┘
```

Figure 4.6
Creating a Window Icon
Timberline, 1994

4.8. General Ledger Set Up Decisions:

4.8.1. Enter the account structure for the company:

Choose the company icon from Timberline. Choose *Utilities/System Administration/Custom Fields*, click on *GL Account* and press "set up sections." Enter "company" in prefix A- size "2" to determine that the company prefix of two will be the first numbers for the general ledger accounts. Add a hyphen between A and B and enter "division" in prefix B and "2" for the size. This establishes that the account for the general ledger will start with two digits for the company, and two digits for the particular division of the company. We will set up the company to have both a residential and a commercial division. "*10-10*" will represent "*Company-Commercial.*" "*10-20*" will represent "*Company-Residential*". These numbers will be the first four digits of the accounting code. Enter "4" for the base. The base will represent the actual account in which the transaction will be journalized in. For example: "*10-10-1030*" will be the account number for "*Company-Commercial Division-Accounts Receivable.*"

Account Structure

Prefix A	COMPANY	2 Digits
Prefix B	DIVISION	2 Digits
Base Account		4 Digits

```
+-----------------------------------------------------------------+
|  +-----------------------------------------------------------+  |
|  |                    GL Account Sections                    |  |
|  +-----------------------------------------------------------+  |
|                                                                 |
|          Sample  AA-BB-9999                                     |
|                                                                 |
|          Prefix A        Prefix B        Prefix C    Base  Suffix|
|                                                                 |
|  Desc  [ COMPANY ] [-] [ DIVISION ] [-] [ COMPANY ]             |
|                                                                 |
|  Size    [ 2 ]           [ 2 ]            [ ]      [ 4 ]  [ ]    |
|                                                                 |
|        [   OK   ]  [  Cancel  ]  [ Test entry ]  [  Help  ]     |
|                                                                 |
+-----------------------------------------------------------------+
```

Figure 4.7
Account Structure
Timberline, 1994

4.8.2. Set up General Ledger Controls:

From the TS Main screen, choose *Applications/General Ledger Plus* and click on the

"Setup" pull down window and choose *GL Controls.*. Create a General Ledger Master

File by accepting and pressing "OK" to create a file. "Fiscal Entity" is a prefix, "Retained

Earnings Account" is number 3010, and the "Suspense Account" is 99-99-9999. The

suspense account will not be found. It is not necessary to create one at this time.

4.8.3. Creating the Prefix (company) configuration for the General Ledger:

Choose *Setup/Prefix-Base/Company* to enter the information. Enter "10" for the

company as well as the company name. Set up the Fiscal Entity as "Division" and accept

this information. Enter "99" for the company, and "Suspense" for the name. Again, set

the Fiscal Entity to "Division" and accept. The company prefix will be number 10, and that

the fiscal information will be developed at the division level. This tells the system that the

fiscal dates will be dependent on the dates that are entered in the divisional configurations.

Doing this allows separate fiscal dates for both the commercial and residential divisions of

our company. The division level is defined in the proceeding step.

4.8.4. Creating the Prefix (division) configuration for the General Ledger:

Choose *Setup/Prefix-Base/Division* from the pull-down in GL. Enter "10-10" as the

division and "Commercial" for the name. Click the *Fiscal Controls* button and enter

period and fiscal ending dates. The period cycle of a company can be monthly, quarterly,

as well as bi-annually. Choose a quarterly cycle for the example. Set the balance sheet to

division and accept the fiscal controls as well as the division setup information. Choose

Setup/Prefix-Base/Division from the pull-down in GL. Enter "10-20" as the division and "Residential" for the name. Click the *Fiscal Controls* button and enter period and fiscal ending dates. Set the balance sheet to division and accept the fiscal controls as well as the division setup information. This procedure indicates that the model company will have two divisions, residential and commercial. The fiscal and period end dates have been indicated for each division and it is established that two separate balance sheets will be generated for both the individual divisions.

4.8.5. Create Base Accounts:

Base accounts are dependent on the accounting structure that the company requires for the processing of financial transaction data. They constitute cash accounts, payroll accounts, work in progress, and payable accounts. The detail is dependent on the company. Earlier within the *Company: Setup* window we chose a four digit account representation. Choose *Setup/Prefix-Base/Base Accounts* and input the accounts listed. By marking the *Control Account*, transactions for the account will be provided by interfacing with other modules. The control account box does not need to be marked for any of the accounts inserted since the Accounts Payable is not being used, as well as the Accounts Payable, Accounts Receivable, and Payroll modules.

The *Store Cash Flow* option allows the debit activity to be stored within the account. The *Store Budgets* option will include the account in the company's budget.

4.8.6. Generate Accounts:

Now that all the information pertaining to the numbering of the (1) company, (2) Division, and (3) Base Accounts have been placed in the system, accounts need to be generated and established for the different divisions. This will affix the prefix (company and division) and the base (account numbers) into the accounting system. Choose *Setup/Prefix-Base/Generate Accounts* and include all base accounts. Choose "OK." Choose the appropriate division from the General Accounts Division Records, and hit "Start". At this time accounts solely for the commercial division will be created (division 10-10).

4.8.7. Establish the Suspense Account:

Choose *Setup/GL Controls* and click on the *Suspense Account* Field. Press the Enter key and answer yes at the "add suspense account" message, then accept.

4.9. Job Cost Set Up Decisions:

The job cost module has two important irreversible decisions that need to be made. Job Format determines the format and size of the job numbers, and Phase Format determines the format and size of the phase descriptions.

4.9.1. Defining the Job Number (Job Format):

Choose the company icon from Timberline. Choose *Utilities/System Administration/Custom Fields*. In the "Custom Fields" section, click on the "JC Job: Size" section and press "Set up Section" button. In the "Description, Section 1" enter "Year", size "2", and a hyphen. In the "Description, Section 2" enter "Job" and the size enter "3". This establishes that the job number will be comprised of the first two digits

representing the year, and the following three digits representing the job number. For

example: "*97-001*" represents "*Year-Project number 1*"

Click the "OK" button to accept this change (Figure 4.8).

ID	Account Title	Account Type	Store Cash Flow	Control Account
1001	general cash	current asset	x	
1005	payroll cash	current asset	x	
1030	accounts receivable	current asset	x	x
1031	AR retainage	current asset	x	x
1101	wip labor	current asset	x	x
1102	wip material	current asset	x	x
1103	wip subcontract	current asset	x	x
1104	wip equipment	current asset	x	x
1105	wip overhead	current asset	x	x
1106	wip other	current asset	x	x
1803	furniture & fixtures	non-current asset	x	
2001	accouts payable	current liability	x	x

ID	account title	account type	store budgets	store cash flow	control account
2002	ap retainage	current liability		x	x
2040	tax liability	current liability		x	x
2300	pr deductions	current liability		x	x
3010	retained earnings	retained earnings		x	x
4000	revenue	income	x	x	x
4005	discount taken	income	x	x	x
5000	construction costs	cost	x	x	
6115	earnings paid	expense	x	x	x
6135	fringes paid	expense	x	x	x
6200	misc expenses	expense	x	x	x

Figure 4.8
Defining Job Number
Timberline, 1994

4.9.2. Define Phase Format:

It has been indicated that the CSI sixteen divisions will be utilized for part of the phase format. The existing database We which uses a five digit numbering sequence that proceeds after the sixteen divisions will also be used. It is vital to the operation of the system that the same format is followed between the estimating program and the job cost program. If the data are not represented in the same way, integration will not be successful. Other questions that need to be answered prior to establishing the phase format are: (1) are reports printed by specified phases, and (2) are the amounts at the phase level needed to be accumulated. If yes is answered to either of these questions, establish the system to understand the difference in phases. This is done by separating the phase and work package numbering sequences with a hyphen.

Choose the company icon from Timberline. Choose *Utilities/System Administration/Custom Fields*. In the "Custom Fields" section, click on the "JC Phase: Size" section and press "Set up Section" button. Under "Section 1" in the description heading, enter "Group" and in size enter "2". This tells the system that the initial two digits will represent the sixteen CSI divisions, and a space of two digits is being reserved for the divisions. Enter a hyphen between section 1 and section 2. Under "Section 2" in the description heading, enter "Section" and in size enter "5". This will reserve five digits for the numbering sequence of the work package description. The numbering sequence for the work packages are already established within the estimating database, and will now transfer when we integrate the estimate to job cost.

4.9.3. Create a Job Cost Master File:

Enter the Job Cost module by choosing *Applications/Job Cost* from the TS Main screen of your company. Choose *Setup/JC controls*. Answer "OK" at the message for creating a JC master file. Enter the controls regarding *Categories*. Use categories (resources including labor, equipment, materials, and subcontract). *Track Units;* including labor and materials. Click on *GL Transaction Controls* and input the accounts, while ignoring the journals (only the GL and JC journals are being used). *Retrieval Method:* By Category to allow the use of resources, and *Retrieve Prefix from Job* to denote the Company and Job that the transaction correlates. The informational changes that have been placed in the system through job cost setup controls has been accepted. The system will now give warning that if any of the irreversible decisions are attempted to be changed that it will result in the loss of data. It is important to point out that prior to creating a job cost master file, all data should be reviewed to insure that the proper numbering sequences are correct for the company application.

4.9.4. Setup Standard Categories:

Categories include labor, materials, equipment, and subcontractors. Choose *Setup/Standard Categories* and enter the appropriate information. Categories to be used include:

L-Labor, group A cost account-1101

M-Material, group A cost account-1102

S-Subcontract (Commitment), group A cost account-1103

EQ-Equipment, group A cost account-1104.

Accept these items.

4.10. Establishing an Estimate:

Precision Estimating Extended is an estimating package that incorporates the use of a spreadsheet and a database. Various databases can be utilized, including third party databases, Timberline databases (residential or commercial), a customized database, or a combination of all. The database and the spreadsheet remain independent of each other, and it is important that a particular spreadsheet is called up with the appropriate database that was originally used for the estimate. The database provides the relevant information that was used for the estimate, including: costing information, items, work packages, and formulas used.

The database used for this project is the Timberline commercial database because of the capability to incorporate work package takeoffs. The estimator is allowed to input relevant information for a package of the project, such as exterior walls. All relevant dimensional information is entered, and pre-defined formulas, as well as pre-established construction techniques will determine the quantities needed. It is not uncommon for a company to develop its own set of work packages for the style of construction that is commonly followed in the company, and/or area. Function keys are used extensively in PE Extended.

4.10.1. Set Up Requirements for Timberline PE Extended

Initial Set Up and Company Information

1. Enter PE Extended by typing "PE" at the DOS prompt

2. Ensure that the appropriate database is being used by choosing *Change Database Directory* at the Main Menu and enter "COMMDB-U" and press enter

3. Choose *EP-Edit Database*

4. Choose *EG-Edit General Information* and enter company name and address information. (Figure 4.9)

5. Ensure that JOB COST INTERFACE TYPE is set to "G" for Gold. This will insure that the integration process between Gold Extended and Job Cost is accurate. (Figure 4.10)

6. Press the *F-4: Job Cost Information key*

    Estimate Style phase formats: Yes. This continues the link that was initiated in the Job Cost module by establishing phase categories similar to the CSI divisional breakdown

    Gold Cost Phase Suffix: 0

    > Directory of Company in JC: C:\ *company directory*. This will enable the estimating file to be transferred to the correct Job Cost file area after the integration process is completed in the PE Extended end. Files are created and left in the directory of the Job Cost company information when the transfer is completed in the estimating end. It is then necessary to go into the JC module to complete the integration process. It is not a clean, two

way transfer, but a half pass from estimating, and a half completion in JC.

(Figure 4.11)

Gold JC Categories

        L: Labor

        M: Material

        S: Subcontractor

        EQ: Equipment

        These categories need to match the categories that were entered in

        Gold Extended Job Cost Setup

Choose *F1: Accept JC information changes*

Choose *F1: Accept general information changes*

Choose *END: Return to main menu*

EDIT DATABASE

	EG	Select an option and press ENTER
→	EG	Edit general information
	ES	Edit standards
	WB	Edit WBS informaiton
	EA	Edit addons
	EL	Edit labor/equip classes
	EF	Edit formulas
	EI	Edit items

Figure 4.9
Edit Database
Timberline, 1994

GENERAL INFORMATION

Company Name	XYZ Construction
Address	555 University Dr.
City	East Lansing
State	MI

Estimating Phase Suffix	2	
Job Cost Interface Type	G	Gold
Using 3rd pary database?	No	
Report hours	M	
Hours per day	8.0	
Hours per week	40.0	
Default crew pricing method	T	

Figure 4.10
General Company Information
Timberline, 1994

GENERAL INFORMATION
Job Cost Information

Estimating style phase formats? YES
Gold Job Cost phase suffix   0

Job Cost directory   C: \XYT

Gold JC cost categories:

Labor	L
Material	M
Subcontractor	S
Equipment	EQ
Other	O

Transfer crew units as man hours?   NO

Figure 4.11
Job Cost Information
Timberline, 1994

MAIN MENU

PE   Select an option and press ENTER

CD	Change database directory
ED	Edit database
PE	Produce estimate
UO	Utility options
END	Done with Estimating

Figure 4.12
Produce Estimate
Timberline, 1994

4.10.2. Creating a Work Package Estimate in PE Extended

Precision Estimating Extended has the capabilities to create a work package take-off. The default work packages provided by the software can be used and modified, or work packages can be customized for the specific needs of the construction company. This is not an easy task, and is one that requires proper training. The author will assume that the operator of the system has the ability to produce proper work package estimates. It is also important that the database is suitable for work package estimating. This is either done by the designer of the database, or by using a database that currently has the capability. The database being used for this example is one that is provided by the Timberline Company. It is the Commercial Builders database using Unit production standards. The steps involved with the creation of the work package estimate are as follows:

1. From the PE Main Screen, Choose *PE-Produce Estimate* (Figure 4.12)

2. Enter the name of estimate

3. Enter the drive on which to create new estimate (A or C) (Figure 4.13)

4. At "Copy an existing estimate" answer NO

5. Enter cover page information:

   Heading: The name of the construction project

   Estimate description and address

   Client information

6. At the bottom of the cover page, Choose *F4: Next screen* (Figure 4.14)

ESTIMATING FILE SELECTION

Create new estimate file?	YES
Name of this estimate file	2NDFLOOR
Drive on which to create this file	C
Password (optional)	_____

Figure 4.13
Computer Drive Selection
Timberline, 1994

ESTIMATE COVER PAGE

Heading: Michigan State University: 2nd Floor Pour _____

Estimate desc	2nd floor pour	Architect
Address	555 MAC	Phone
City	East Lansing	Engineer
State	MI	Phone
		Estimator
Client Name	Michigan State University	
Address		Job Size
City		Duration
State		Rate Table
Phone		Report hrs

Figure 4.14
Estimate Cover Page
Timberline, 1994

7. Enter the Gold Job Cost Number following the numbering sequence established in the Gold Extended Job Cost Setup: XX-XXX

8. Choose *F1-Accept Changes* at the bottom of the screen (Figure 4.15)

4.10.3. Creating a Work Package Estimate

1. From the Main Menu, Choose *PT-Perform Takeoff*

2. Choose *F5: Takeoff Options*

3. Highlight the "Work package takeoff" by scrolling to it and press ENTER

4. Choose *F10* for the available list of work package options

5. Choose *03-Concrete* from the available list by scrolling to it and pressing ENTER (Figure 4.16)

6. Choose *0312 Walls: Straight* from the additional list of options available, and press ENTER

7. Choose *F5: Enter dimensions* and enter the dimension and various questions needed to perform the work package (Figure 4.17)

8. When completed with the dimensions, choose *F1 Accept work package*

9. After the estimate is generated, choose *F1: Leave Takeoff*

10. From the estimate spreadsheet, choose *F1-Return to main menu*

11. From the main menu, choose *PR-Print Reports*

12. Print standard estimate (Figure 4.18)

ESTIMATING COVER PAGE		JOB CLASSIFICATION
		Project
Bid date		Definable field 1
MWBE Minority		Definable field 2
Women		Definable field 3
		Definable field 4
Gold Job Cost job number	97-100	Definable field 5
Bid winner		Definable field 6
Amount		Definable field 7
		Definable field 8
OTHER BIDS		Definable field 9
Name		Definable field 10
Name		Definable field 11
Name		Definable field 12

Figure 4.15
Job Cost Set-Up
Timberline, 1994

2nd Floor							
	TAKF		LABOR		MATERIAL		SUB
ITEM	QNTY	PRICE	AMT	PRICE	AMT	AMT	NAME

Takeoff options
    Item takeoff
    Work package takeoff
    Model takeoff

Figure 4.16
Work Package Estimate Set up
Timberline, 1994

2nd floor

Work Package Takeoff

Item	0312		Walls	Straight		

	Location		Enter dimensions	
	Memo		Quantity	2.0
			Length	300.00
			Height of wall	10.00
1	3307.00	c 30 wall C	Width	8.00
2	3114.00	f 10 wall F	# of pipe blockouts	12.00
3	3116.00	10 ledge	# diff ledge blkouts	0.00
4	3118.00	10 Pipe &	# runs of Chamfer	1.00
5	3159.00	20 Strip/	# runs pour strip	0.00
6	3390.01	rubl. Rub. C	conc. Strength (psi)	3,000.00
7	3395.00	10 Rub Fi	wall conc code	1
8	3159.00	25 Strip/	Is rub finish reqd?	NO
9	3162.00	10 Keyway		

74.7 cuyd   \$16,172.   \$218.338 / cuyd

Figure 4.17
Entering dimensions
Timberline, 1994

112

Total
Item Description
Amount

3000 Concrete 3114.00 Forms-Walls				
f 10 wall frms - patn sys	12,000.00 sf	10.00/ hr	9 .55/sf	7800
16,800		labor hrs	900	
3118 Forms - other blkouts				
10 pip & bm blckts etc.	24.00 ea	10.00/hr	120 10.00 ea	240
360		labor hrs	12	
3159 Forms - strip & oil				
20 strip/oil frms-walls	12,000.00 sf	10.00/hr	3,000 6.00/gal	378
3,378		labor hrs	300	
3161 Forms - chamfer strip				
10 chamfer strip (3/4")	600.00 lf	10.00/hr	480 .20/lf	120
600		labor hrs	48	
	concrete			8538
		labor hrs	1788	

Figure 4.18
Standard Estimate
Timberline, 1994

4.11. Integration of the Estimate and Job Cost module:

The setup of the interface option in Timberline PE Extended results in attaching the estimate, as well as all of the item information into the Job Cost Gold Extended package. The interface setup needs to be done after the estimate has been established in PE Extended and the company information, as well as prefixes and bases, have been developed in the Gold Extended package. The particular job needs to be decided in the estimate, but does not have to be established in the Gold Extended module prior to integration in the job cost package. The job number does need to follow the same year-job number configuration in estimating that was established in the accounting package. The file is sent to the job cost file that was determined in the initial job cost set up stages in the estimating software. The steps involved in the interface connection are as follows.

4.11.1. Creating the Interface From Precision Estimating and Job Cost Accounting

1. From the Main Menu in Precision Estimating, choose *IF: Interface*

2. From the Interface Menu, choose *GJ: Generate Estimate to Job Cost* (Figure 4.19)

   - Enter the Job Name

   - Is it necessary to delete the temp work file: Yes: this will eliminate the temporary file that is generated from Precision Estimating after it is used to input the data from Gold Extended

   - Accept Gold JC Job number

   - Reference number set to C: JC category

- Description set to C: JC Category description

- Round quantities: either yes or no

- Allocate Add-ons: our example does not use add-ons

- Generate Burden entries set to NO: our example does not use burden

  (Figure 4.20)

- Send to Printer

3. A report is generated that gives how many JC transactions were generated, and

   how many warnings (refused transactions). (Figure 4.21)

4. The transactions and their amounts are listed on a separate report; check the

   grand total to make sure the amount matches the bottom line on the estimate

   (Figure 4.22)

5. Exit Estimating

INTERFACE OPTIONS

          GL   Select an option and press ENTER

                  GJ   Generate estimate to job cost
                  IC   Import Cut & Fill volumes
                  GQ   Generate quote sheets to BidFax

                  END   Return to PRODUCE ESTIMATE

Figure 4.19
Interface Options
Timberline, 1994

GENERATE TO JOB COST OPTIONS

Gold JC Job number	97-100		
Transaction date	12-20-1998		
Reference number	C		
Description	C		
Round Quantities	YES		
Allocate addons	NO		
Generate burden entries	NO		
Optional user field 1		L	Location
Optional user field 2		Blank	no value

Figure 4.20
Generate to Job Cost
Timberline, 1994

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XYZ CONSTRUCTION   Estimating Ext
Generate JC Transactions   Exterior wall

TRANSACTION GENERATION TOTALS

Total warnings   0

Total JC transactions generated   13

Figure 4.21
Job Cost Transaction Report
Timberline, 1994

XYZ CONSTRUCTION CO   Estimating Ext
Generate JC Transactions   Exterior Wall

Job Number   97-100   Transaction Date   12-20-1999

311400   9,000.00   9,000.00
L

311400   7,800.00   7,800.00
M

311800   120.00   120.00
L

311800   240.00   240.00
M

315900   3,000.00   3,000.00
L

315900   378.00   378.00
M

GRAND TOTALS   20,538.00   20,538.00

Figure 4.22
Job Cost Transaction Grand Total Report
Timberline, 1994

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4.12. Finalizing the Integration of the Estimate within Gold Extended

There is now a **.JCT** file in the directory of the company in Job Cost-Gold Extended. The information has not been sent into the job cost system yet. It is necessary to open up the job cost module for the company and finish the integration process. The forward pass has been thrown, now it is up to the job cost module to move towards the pass and bring it into the system and complete the integration process. Once the integration process has been completed, the temporary **.JCT** file will be erased from the company's job cost directory.

4.12.1   Directing the .JCT File into the Job Cost Module

1.   Enter the company by clicking on the company icon

2.   Choose *Job Cost* from the *Applications* pull-down window

3.   Choose *Other/Import/Import Estimates* from the pull down window

4.   Click on "List" at the bottom of the Import Estimate screen

5.   Choose the file from estimating

6.   Choose a name for a file where rejected items will be transferred to. It is not necessary to place the **.JCT** extension on the file name. The creation of this file is essential since the **.JCT** file from estimating will be eliminated. The operator will be able to check this new file for any items missing from the transfer.

7.   Click on "Printer Setup", and turn off the print to file button

8.   Select "OK" and select "Start"

The report will print out a listing of accepted phases

Check the total amount and compare it to the printed estimate total
(Figure 4.23)

9. Choose *Workflow/Update Master File*

    click on "Printer Setup"

    click off the print to file button

    click "OK" and "Start"

    This process updates the master file with the items that have transferred

    from estimating (Figure 4.23)

10. Choose *Workflow/Estimates*

11. The new JC file is not found. Click "OK"

12. Click "List"

13. Choose your job number and select "OK"

14. Click "Finalize original Estimate" and press enter: This finalizes the estimate.

    It is important to know that once an estimate is finalized, any changes after that

    point need to be made as Change Orders.

15. Choose *Reports/Other/Estimate Spread Sheet*

16. Click on "*Conditions*"

    • click on *AND Grp Phase Condition NE "000"*

    • click "Change"

    • click on "000" and add two more zeros to make it "00000":
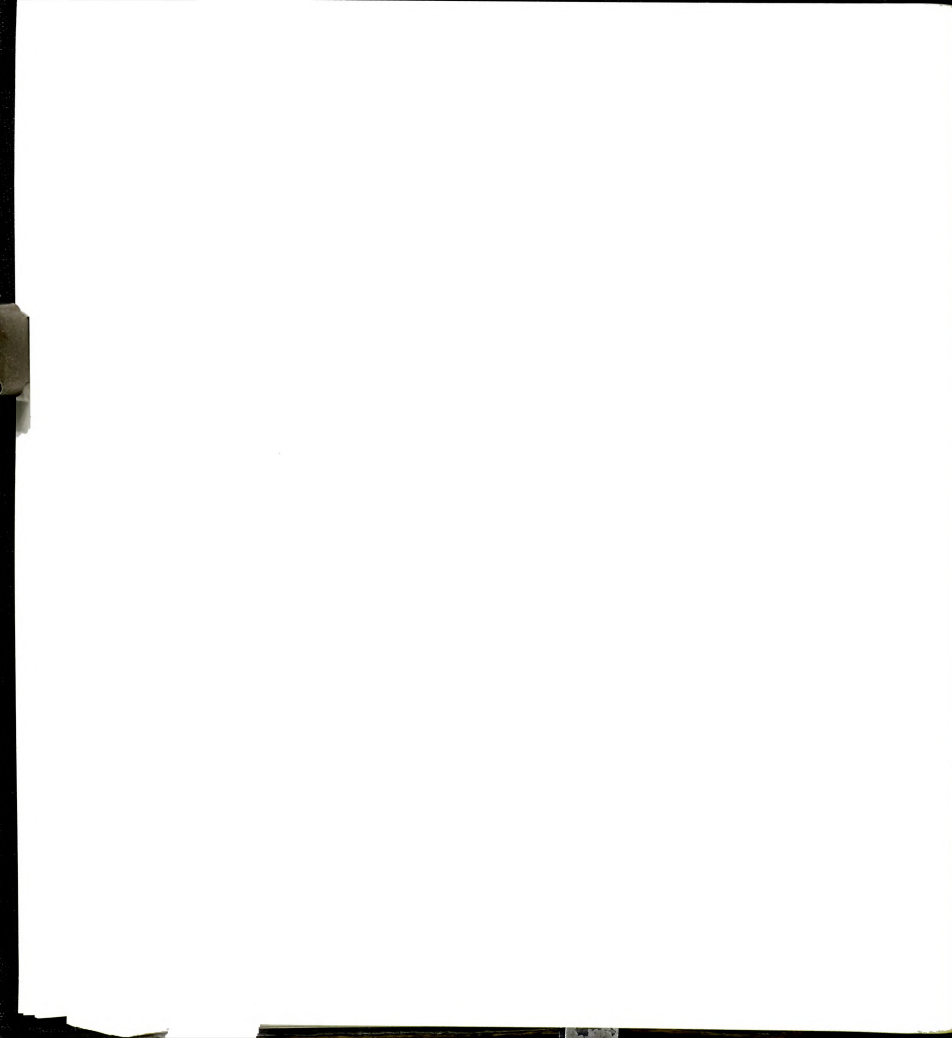
This is done to update the report to accept the five digit number proceeding the CSI divisional number. Without this change, the report would not be able to print the proper information.

- click "OK"

- click "OK" at Condition Selection Screen

- click on "Ranges" to select only the job just imported

- Choose the job number, and "OK"

- Select "Start" to print the estimate report from Job Cost

17. Set the printer up as indicated earlier

18. *Not fit on sheet*, accept "OK"

4.13. Processing within Gold Extended

4.13.1. Enter Descriptions to Phases:

The descriptions of the items are not carried through from the estimating database to job cost. The descriptions are required to be manually placed in the job cost module. This manual update is only required within the system once. Once the individual item is created in the job cost database, it is recognized when used for another imported estimate.

1. Choose the *Setup/Edit Job Information/Edit Phases* pull down window

2. Click on "List"

3. Choose the job number
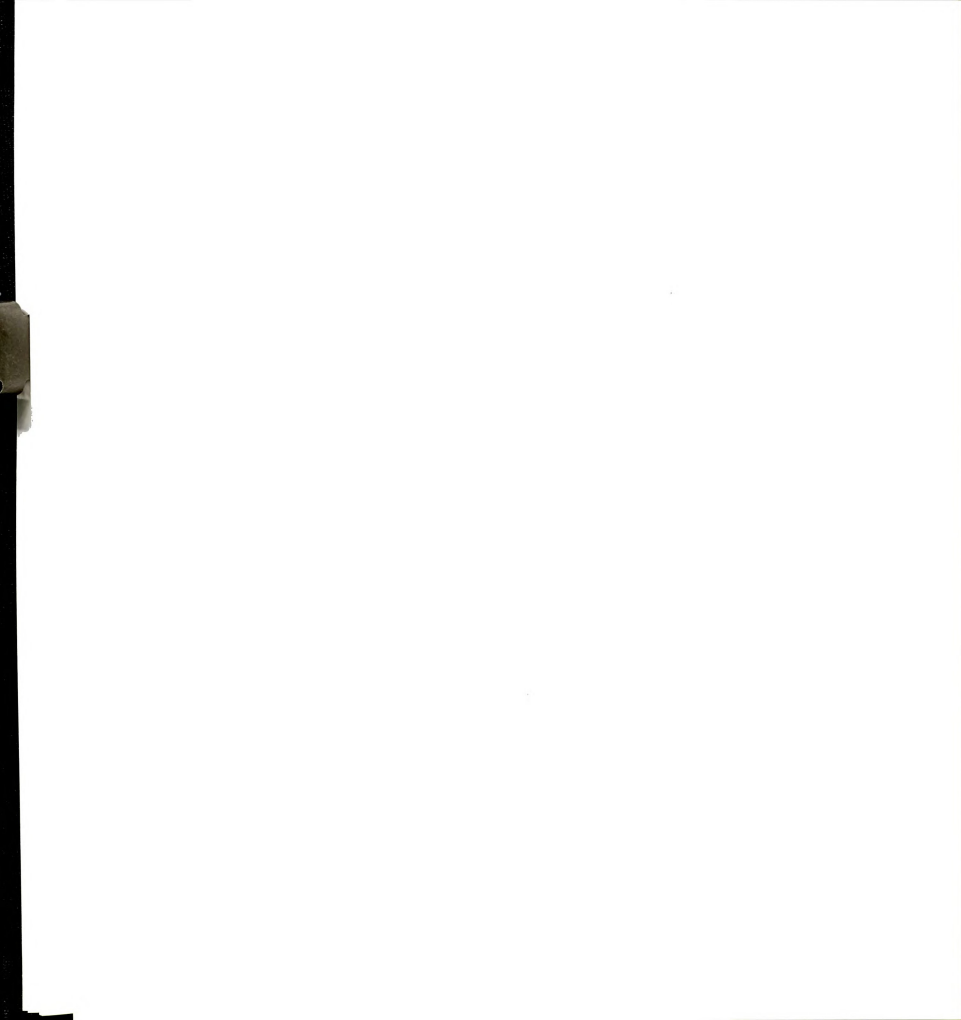
4. Click on "list" for imported phase records

5. Enter descriptions

6. Accept the change

7. Repeat the process for the remaining items

4.14. Applications and Reporting within Gold Extended

4.14.1. General Ledger

The applications associated with the general ledger are common to the accounting process. The speed and accuracy of the computer is the most important aspect of the system. Mistakes are limited to the input of data, not due to improper double entries. Transactions are posted immediately to the proper account, and the balances are readily available. The applications associated with the General Ledger are as follows:

1. The input of transaction data

2. Establishing the period and year beginning and ending dates

3. Expense allocation

4. Balance sheet reporting

5. Income Statement reporting

6. Revenue allocation

7. Error correction

8. Payable and Receivable tracking

4.14.2 Job Cost Reporting

The use of a job cost system establishes control over the monetary expenditure and profit percentage of a project. Immediately reporting data for the cost control of the job allows proper knowledge regarding the expenses, and facilitates changes that may need to occur in order to realize a potential profit margin, as well as maintaining costs within a targeted range. Reports currently available include:

1. Billing

   - Schedule of Work in Progress

   - Billing Summary

   - Billing Detail

   - Cash Flow Variance

2. Unit Control

   - Unit Cost

   - Unit Cost Summary

   - Historical Unit Cost

3. Estimates

4. Jobs

5. Cost Control

   - Profit

   - Profit Variance

   - Job Cost Summary

- Cost at Completion

- Cost by CSI Division

6. Committed Cost

- Committed Cot

- Subcontractor Documentation

- Purchase Order

7. Change Order

- Change Order Log

- Change Order Forecast

- Change Order Approval

- Change Order Documentation

8. Labor Control

- Labor Cost

- Labor Forecast

- Productivity Variance

	phase cat	units	amount
97-100	3-11400 L	0	9,000.00
97-100	3-11400 M	0	7,300.00
97-100	3-11800 L	0	120.00
97-100	3-11800M	0	240.00
97-100	3-15900L	0	3,000.00
97-100	3-15900M	0	378.00
97-100	3-16100L	0	480.00
97-100	3-16100M	0	120.00
97-100	3-16600M	0	1057.00
97-100	3-30700L	0	1111.11
97-100	3-30700M	0	6556.00
97-100	3-39001L	0	1400.00
97-100	3-39001M	0	120.00

Entry Totals

Number of transactions   13

Total amount of transactions   32,382.11

Additional Information

added	job 97-100	phase	3-000000	concrete
added	job 97-100	phase	3-11400	phase added by estimating
added	job 97-100	phase	3-11400	category l
added	job 97-100	phase	3-11400	category m
added	job 97-100	phase	3-119800	phase added by estimating
added	job 97-100	phase	3-11800	category l
added	job 97-100	phase	3-11800	category m
added	job 97-100	phase	3-15900	phase added by estimating
added	job 97-100	phase	3-15900	category l
added	job 97-100	phase	3-15900	category m
added	job 97-100	phase	3-16100	phase added by estimating
added	job 97-100	phase	3-16100	category l
added	job 97-100	phase	3-16100	category m
added	job 97-100	phase	3-16600	phase added by estimating
added	job 97-100	phase	3-16600	category m

Figure 4.23
Master File Update
Timberline, 1994

4.15. Summary

The company setup within the Timberline Gold Accounting system can be summarized by three basic steps. (1) establishment of the company within the system, (2) general ledger account structure, and (3) job cost set-up. These three steps are depicted in model form in Figure 4.25. Both the establishment of the company and the general ledger account structure correlate with each other in as much that they help to determine the numbering sequence for the accounting system. The correlation between the two help to establish the needed information for queries that will be used to gather information for reporting purposes.

The job cost set-up consists of two main functions. Determining the numbering sequence of the job number, and defining the numbering system for the individual items to be categorized both in the estimate and the job cost module. The importance of the job number is, as in the general ledger structure, to establish query capabilities for future reports. The item numbering sequence is established to directly correlate with the estimating database. The numbering system is the heart of the integration process between the estimate and job cost module. The model of the whole process is shown in Figure 4.25.
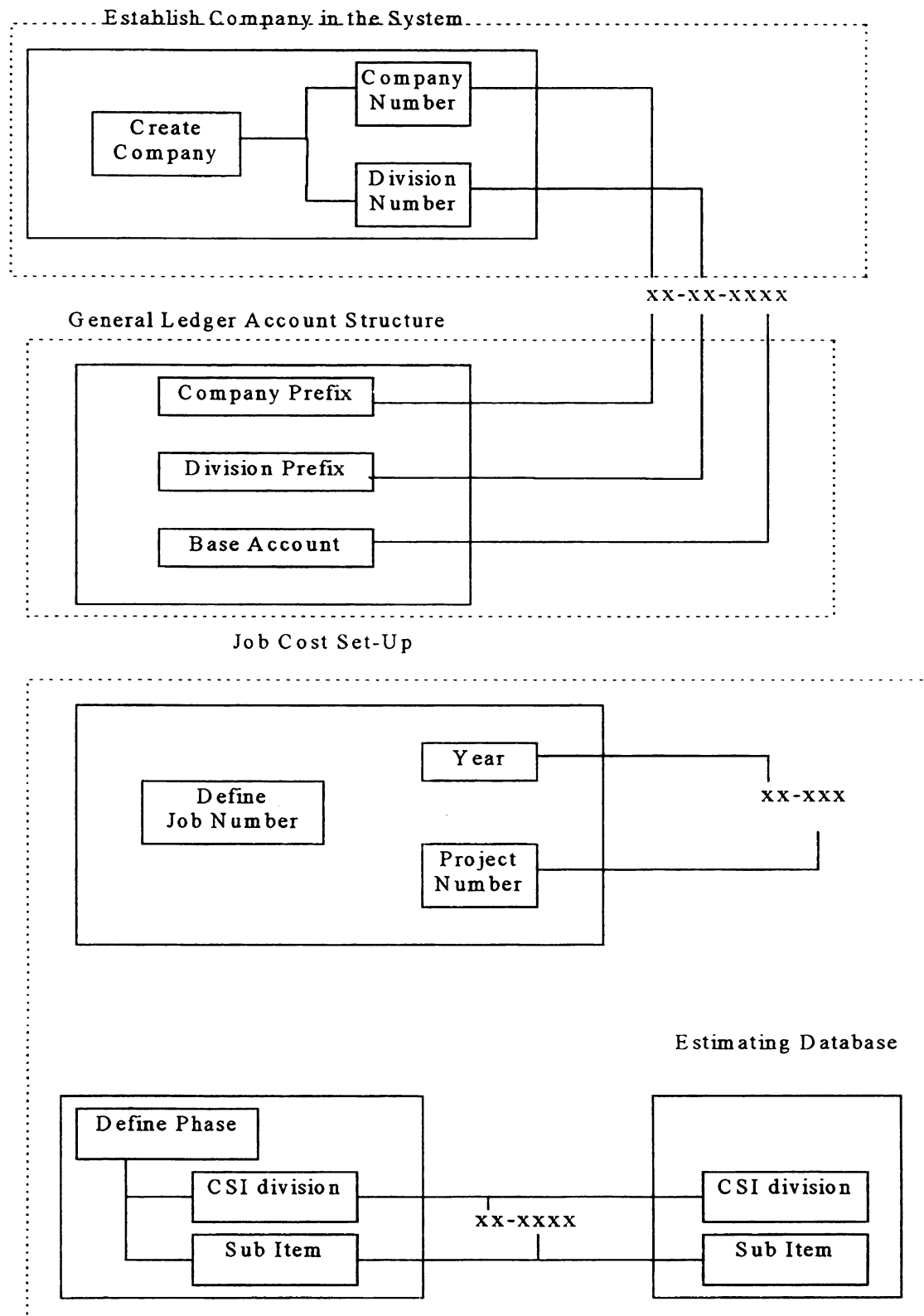
Figure 4.24
Job Cost Set-Up Summarization Model
Bertolini, 1998

Chapter 5

Case Studies and Model Implementation

5.1. Introduction

What is the purpose of a construction company? Is it to construct buildings, bridges, or any other type of facility, or is it to make money? The purpose of any business is to make a profit with their enterprise. It is important for a company to ask itself "what it is that we do". This may sound like an extremely obvious statement, but it is critical to fully understand the purpose of the company prior to evaluating or re-evaluating the informational system of the company. As stated above, it is obvious what a company does. It attempts to make a profit through its business practices. The business practice is what is important to define. By determining the company structure in its simplest form, it is possible to determine the areas of efficiency and inefficiency, as well as determine the areas that will most benefit from a comprehensive information management system.

When a company determines that the informational system that it is using is insufficient and needs to be changed, a tremendous opportunity exists to evaluate its whole business in order to define, design, and implement a new system. One way of evaluating the structure of the company is by developing a Value Chain (Batini, Ceri, Navathe, 1992). This is a model that depicts the way in which a company operates through the course of its business cycle. The overriding item of interest is the flow of money through the organization. Money is generated through investing, borrowing, and through profits. The flow of

money through the organization is the reason the company is in business, therefore this is the item which should be modeled.

The typical construction company value chain involves activities both within the company and outside the company. It is very common for the outside involvement to be both financed through investors or a bank, and subcontracted through outside labor forces.

The use of in-house labor has decreased over the years. Larger construction companies as well as smaller residential companies are utilizing a higher degree of subcontractors to perform the construction of their projects. This eliminates the need for carrying the expense of a construction crew, as well as the need to consistently have a project underway to keep the labor force busy (although this is what needs to occur to make money).

5.2. Value Chain

The value chain measures the processes involved with the company (Batini, Ceri, Navathe, 1992. Each major activity group is broken down into its individual components. Each process that is directly involved as an aspect of both the generation of profits (cash receipts) and expenses (cash disbursements) is subdivided and separated. Each of these subdivisions depicts the simplified processes involved for that particular area of the business. Each process consists of both an input and an output. The input is usually an outlay of cash in order to produce the necessary activity for that particular process. The output that is generated by the individual process becomes an input, in one form, into

another operation of the business. The interesting aspect of the value chain process is that the initial input into the company is capital, as well as the final output of the company. It can be argued that the final product of a construction company is the completed construction project. Through the use of the value chain model the beginning and final aspect being measured of a company is that of capital and profits. The value chain can be a useful tool for a construction company in helping to determine the processes that comprise the company and the development of an information system.

The usefulness of the value chain is its ability to determine the importance of certain aspects of a company. The model allows the view of the company through independent eyes. The benefit of using a consultant is the ability of an outsider to see the company without bias. The concept of the value chain is that the independent fresh view can be shown through modeling.

5.3. Value Chain for a Typical Construction Company

The value chain for the typical construction company can be simplified to six major components.

1. Financing Process

2. Subcontractor/Labor Process

3. Material Acquisition Process

4. Equipment Acquisition Process

5. Construction Process
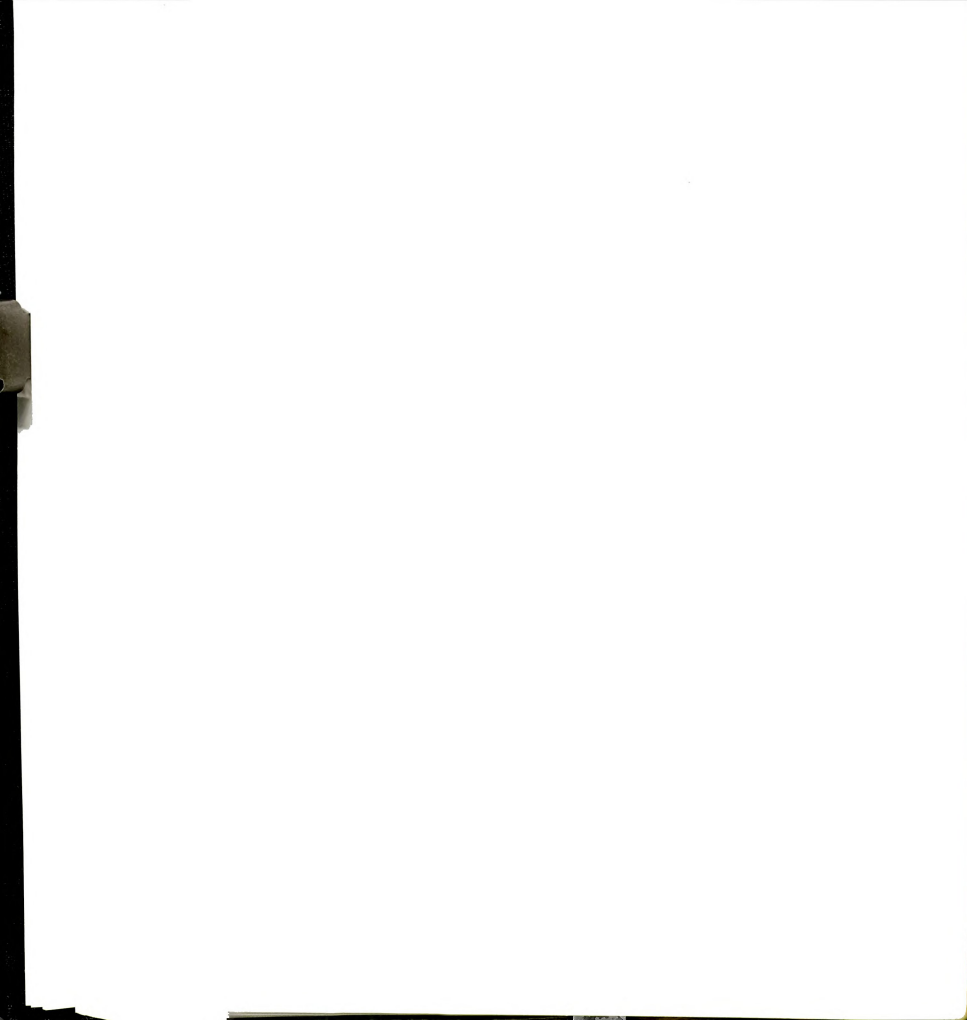
6. Contract (Phase) Finalization Process

5.4. Value Chain Model

The model shown as Figure 5.1 shows the relationship between the processes that make up the typical construction company's value chain as seen by the author. The individual processes are explained more thoroughly in the subsections of section 5.4.
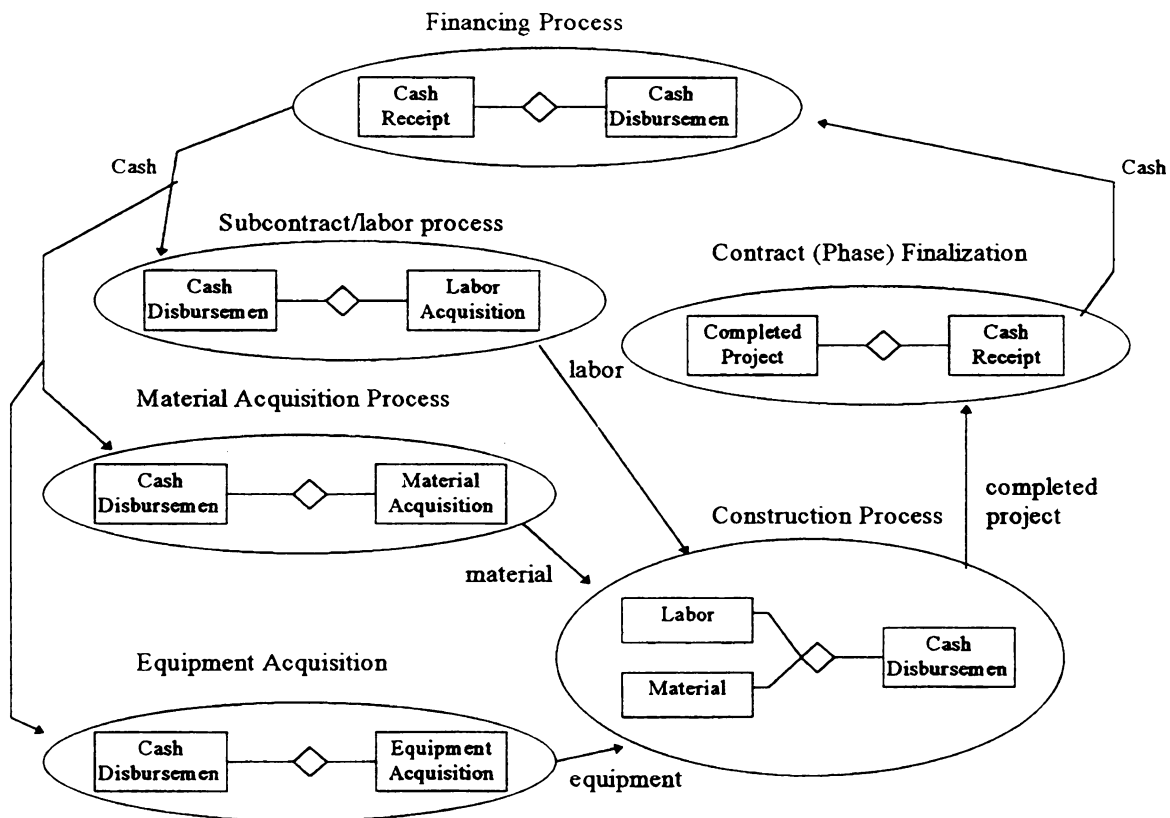
Figure 5.1.
Construction Process Value Chain
Bertolini, 1998
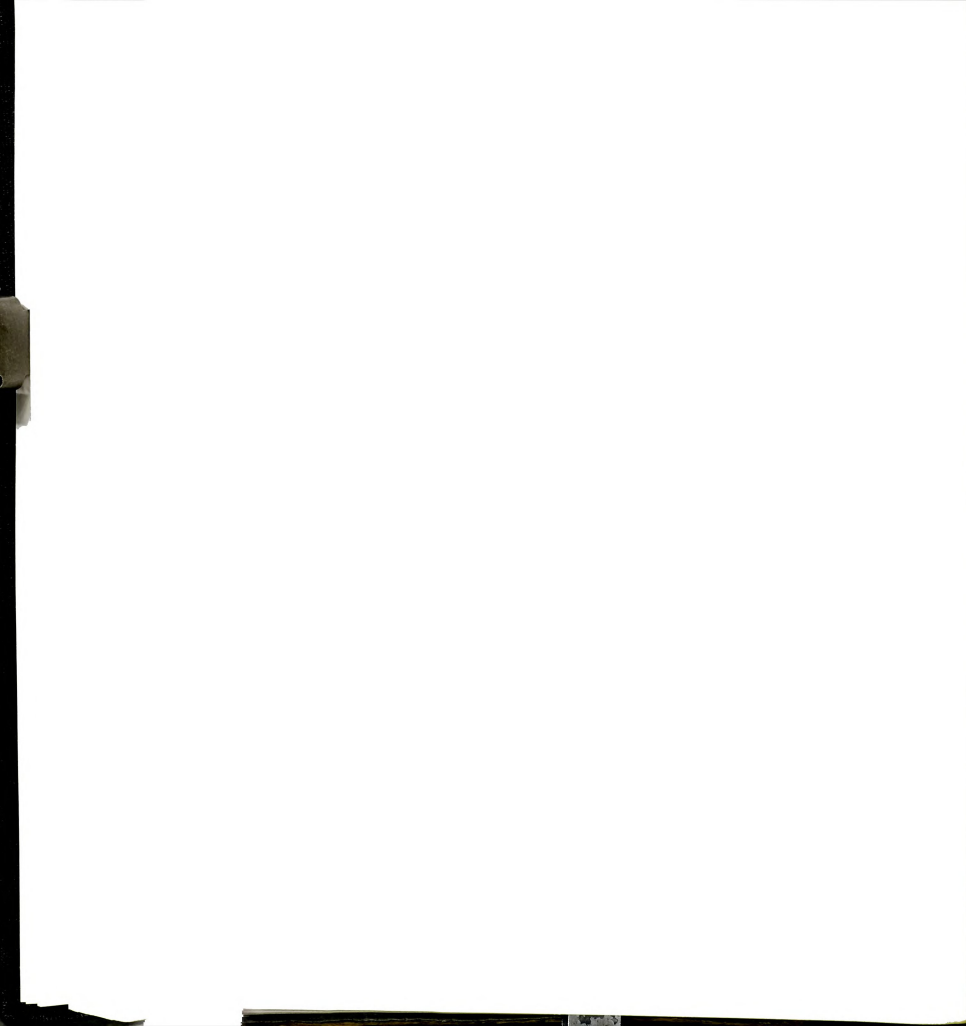
5.4.1. Value Chain Symbols

The symbols that are used in the value chain model depict the relationship that the individual items have with each other. The oval circles and the items within the circles represent processes. Each process requires an input, and produces an output. At the initial process, the main input is that of capital shown in the financing process in Figure

The boxes that are within the process circle represent an activity that correlates with another activity. It is the activity that is being depicted through the process. The diamond with lines extending to each activity that shows there is a relationship between the connected activities. For example: cash disbursed acquires labor, material and equipment. The arrows that lead to the process circle represents the input. The arrow going away from the process circle shows the output that the preceding process accomplished, and subsequently becomes the input for another process within the company.

5.4.2. Value Chain Financing Process:

The financing process consists of the initial investment and continued input of cash including that acquired through profits generated by the business (Figure 5.1). Cash receipts are those that are received either through construction loans and/or business loans. Cash receipts also include revenue generated through the course of business. Cash disbursements include payments made for the repayment of the business and construction loans. This process can represent the initiation of the company. Any start up company needs an infusion of capital in order to operate. Even if the initiation of cash is through investors, a return on investment is expected. A return on investment is expected if the

investment is made by partners or interested parties. The final result of the financing process is the availability of cash to be generated to the rest of the value chain model and the processes involved.

5.4.3. Value Chain Subcontractor/Labor Process:

This process involves the infusion of capital through cash disbursements of the company in order to acquire the labor to facilitate the construction of the project (Figure 5.1). The cash input is received from the financing process allowing the generation of labor through the subcontractor/labor process. This process can involve two possibilities. These can be used independently or in conjunction with each other. Subcontracted labor has become more popular for a majority of construction (management) companies. A construction company enters into a contractual arrangement with a subcontractor who will perform the work necessary to complete the project or a portion of the project. This work will usually consist of either a subsection of one of the CSI divisions, all of the CSI divisions, or a number of the CSI divisions. Labor constitutes the acquisition of a work force that will conduct the construction of the project. Again, this can be and is usually only a portion of the project and very rarely the whole project. Most projects consist of a combination of the two types of labor force. Cash disbursements consist of capital leaving the company to acquire the subcontractor/labor process. Labor, which is the output of this process, will become one of the inputs for the construction process.
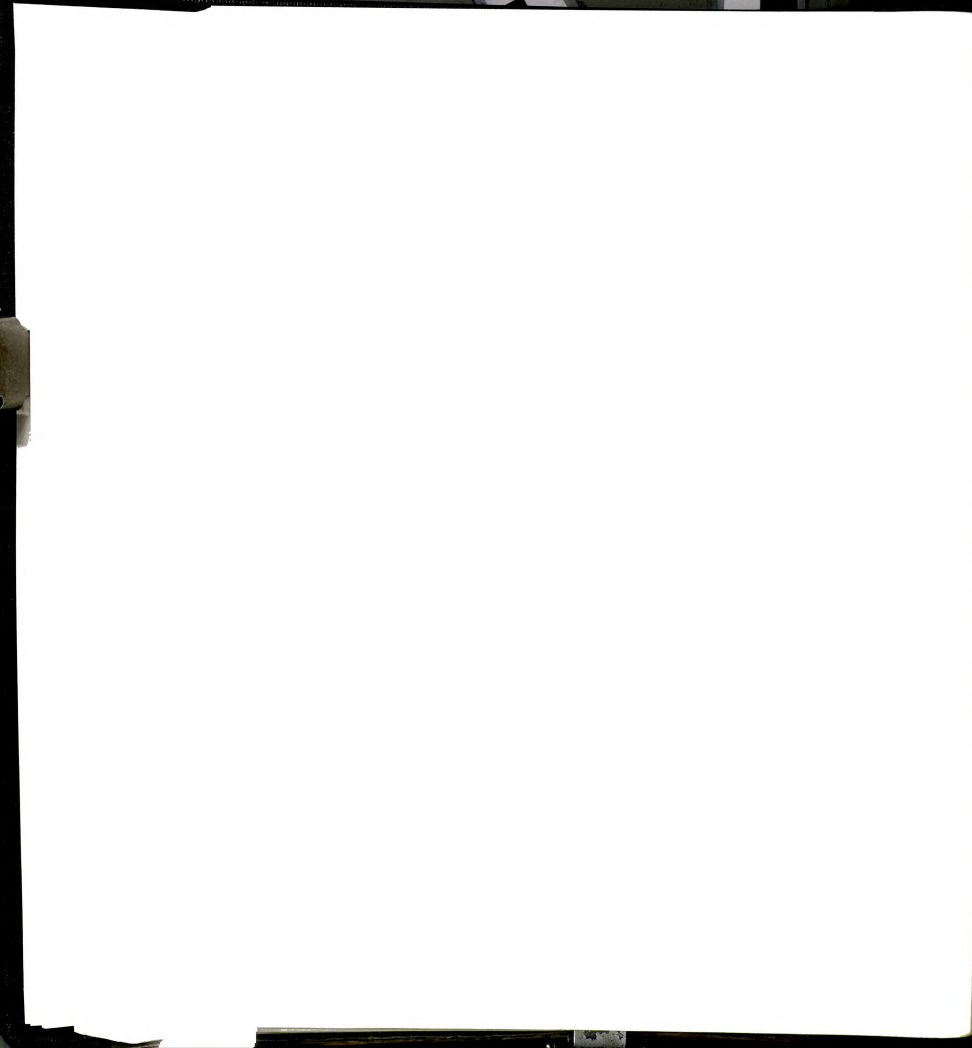
5.4.4. Value Chain Material Acquisition Process:

The material acquisition process is one that may or may not be used for a construction company (Figure 5.1). Most will have some degree of materials that will need to be purchased, even if the majority of work is being performed through a subcontracted work force. When subcontractors are used, they may be required through the contract to provide the materials for their section of the project. Often times there is a combination of the construction company and the subcontractor supplying the materials needed. Cash disbursement results from capital leaving the company for the acquisition of materials. The output of the Material Acquisition process is the material that will become one of the inputs for the construction process.

5.4.5. Value Chain Equipment Acquisition Process:

Equipment use is similar to that of material acquisition (Figure 5.1). Some projects may not require this particular process, therefore it would not be included in their value chain. Cash disbursements represent capital expenditure for the acquisition and use of machinery and equipment used for the project. The output from this process will become one of the inputs for the construction process.

5.4.6. Value Chain Construction Process:

The construction process includes the introduction of labor, materials, equipment, and subcontractors for the actual construction of the project (Figure 5.1). This is independent of the infusion of capitol. The investment in the individual sub/labor, material, and

equipment processes will be measured. The output of this process is the completed

project and will serve as the input into the contract (phase) finalization process.

5.4.7. Value Chain Contract (Phase) Finalization:

The contract (phase) finalization process is the culmination of the construction process by

either completing the project, or finishing a phase that allows for the receipt of money. All

money and resources that have been input into the system result in the finalization of this

phase. The output of the completed construction project or phase is received from the

construction phase and is used as the input into this final phase. The output is the cash

receipt (cash received) for the project or phase completion. This is the epicenter of the

value chain for any company; money received for work completed. The output of this

process is the cash that is generated and eventually re-entered into the company value

chain circle. After salaries, wages, benefits have been paid, the capital is re-invested either

in the subcontract, material or equipment processes or re-entered as payment for capital

received through investment and financing.

5.4.8. Value Chain Model Description:

Figure 5.1 depicts the value chain for the construction company. This generalized,

simplified model shows the different possible aspects that may constitute the daily activity

of the construction company. Some items may be left out if not used. Examples of this

can include dispute/litigation, warranty. If this is the case, the whole process can be easily

eliminated from the value chain because of the simple form of the model. For instance: if

a company does not rent, purchase, or provide machinery for the project, this process

would simply be eliminated from the value chain. It may be the responsibility of the owner, or more than likely the responsibility of the subcontractor to provide equipment. Although this thesis has concentrated mainly on the contracting company as being responsible for the whole project, this model can also represent the subcontractor as a business entity. Subcontractor/labor may include both hired laborers, skilled and unskilled, as well as secondary subcontractors that they may hire for certain aspects of the project.

The value chain lays the groundwork and establishes the entrepreneurial heart of the organization. It is the measurement of what the company does best. The construction of the project and how the company is established and prepared to realize this goal is the means for accomplishing the only real goal of any business, the generation of profits. It is only after the value chain is developed that a company can truly look at its operation and define the need for an information system that will benefit its business. A secondary benefit is that a company may find inefficiencies in a particular area or areas that may be modified to help streamline the organization. If one aspect of the value chain is not producing as it should, or is hampering the efficiency of a company, that portion of the company may need to be eliminated. For example, it may become obvious after reviewing the value chain model that too much emphasis is being placed on in house labor. Revenues are not being made or overall revenues of the company are being reduced due to inefficiencies. Through modeling, it may be established that hiring subcontractors may be a more efficient use of company capital providing a higher rate of return.

5.5. REA Modeling

REA (Resource-Event-Agent) modeling is the application of an object orientation to the modeling of the value chain of a business(Geerts, McCarthy, 1996). Object orientation in the case of the REA model is the visualization of how the system will operate. It does not involve the confusing language of a computer software system designer. This is one of the advantages of using the REA model. There are no predetermined rules of why something can or cannot be done due to the limitations of the software language. The symbols represent the relationship that an application has with another application of the system. The lack of limitations allows the design of a system to be what is needed, not what is currently available through technology, or not available due to a lack of technology.

The main idea behind the REA modeling technique is that it can serve as a template for the company's information system. How the information is supposed to flow through the system, and the relationship between various transactions and company representatives (estimating, accounting, sales, vendors) is shown in model format. By generating an REA system model, a company can determine the specific needs required by the system and can better judge if the existing system is operating efficiently and effectively.

The conceptual design of an information system for a company measures various levels of events that represent the company interaction in its process to accomplish its goals. In the case of a construction company, those goals are the completion of the project and the receipt of cash (and profits). The makeup of a construction company is composed of the

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data that relate to the input and output of various economic resources in the value chain processes of the company. Cash is exchanged for various resources including labor, materials, equipment and subcontractor commitments. These resources are converted into a completed construction process through the business practices of the company and exchanged for cash by the owner(s). The business practice is cyclical as money created as the final output is placed back into the company as an input with the hope that more money will be made at the end of the business cycle.

The accounting system is the primary system for tracking the value chain activities. REA modeling offers the opportunity to fully depict the economic transactions in an object orientated view for conceptualizing the data that depict the economic transactions within a business enterprise and its information system. The main idea within the REA model is the use of economic events, economic exchanges, and value chains, instead of the traditional double entry accounting method view. The objective of the model is to create a view of what the business enterprise does and attempt to design a system that takes full advantage of the strengths and weaknesses of the company within the system. The system need not waste time and money by generating information that is unnecessary (those relationships that do not support the value chain of the company). By determining what the system is required to do for the particular company, the information system can be designed and be set up to run more efficiently and easily, accomplishing the goals which are most important to the company.
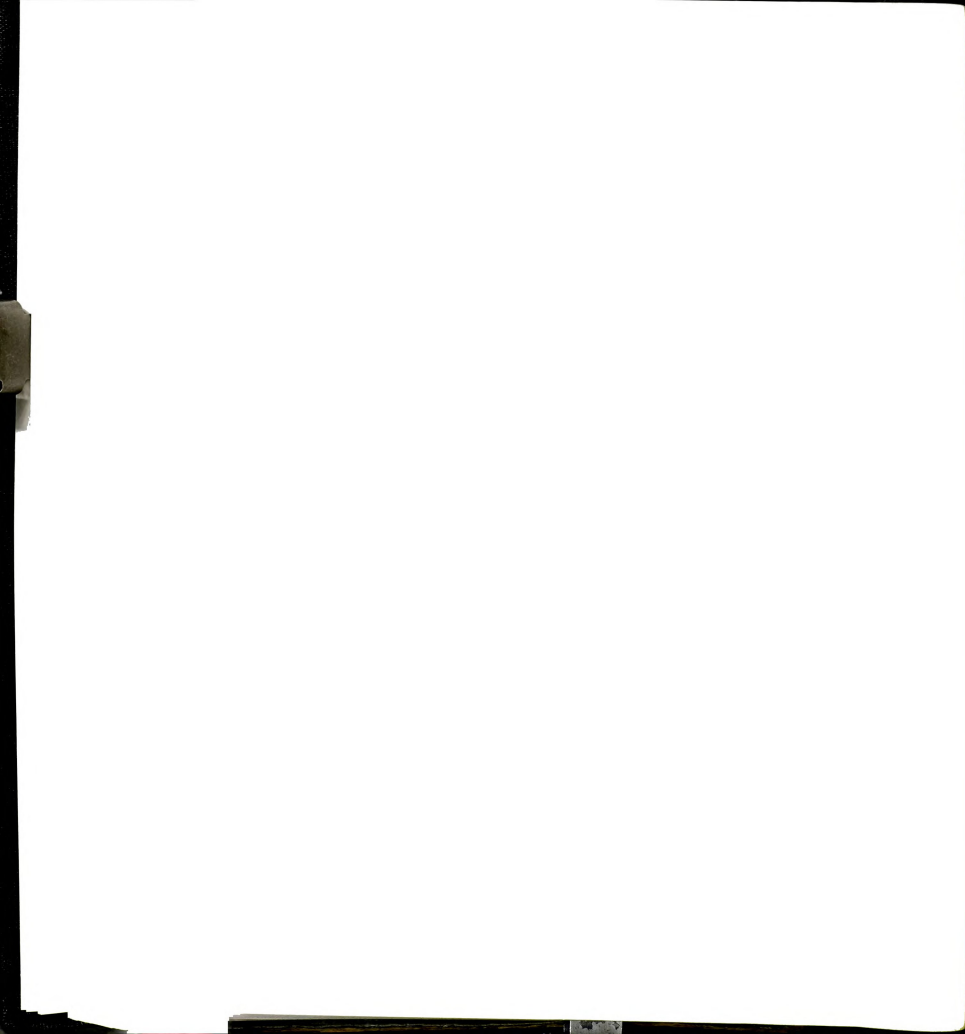
5.5.1. REA Entities:

Entities represent real world objects within the REA model (Batini, 1992) and are represented by boxes. Person, employee, materials, owner, and suppliers are examples of entities within the construction company.

5.5.2. REA Relationships:

Relationships represent two or more entities (Batini, 1992) that aggregate. *Material* has a direct relationship with a *Supplier*. Material and Supplier are the entities, and *is supplied* is the relationship. Relationships are depicted by a diamond in the REA model.

5.5.3. REA Attributes:

Attributes represent the information that is associated with the individual entities. *Supplier* may have a supplier number, name, address and phone number. One attribute is of importance to each entity and should be distinct only to that one single entity. No two suppliers will have the same attribute for *supplier number*. The attribute of supplier number is the defining key within the information system for that entity.

5.5.4. REA Agent:

For every economic activity there is an agent within the company (internal) or outside of the company (external) who is responsible for that activity. If a company makes a sale, a salesperson may be the internal agent that represents the activity.

5.5.5. REA Resource:

The business concept is that of providing services or goods for the return of money. This is considered one of the economic resources. There are generally two economic resources associated with any company: a give and a take. A give is the acquisition of some type of asset for the outlay of cash. The company is giving up one thing to acquire another. A take is when the company receives money for selling the goods or services. Typical economic events are the sale of goods, and the purchase of supplies.

5.5.6. REA Event:

The economic event is the actual sale (take) or purchase (give). The resources (supplies) are purchased (economic event) by a purchaser (agent). The event is what typically constitutes a business practice. Goods are usually purchased to be transferred into final sellable products.

5.6. REA Model

The REA model represents the simple form of the activities and relationships involved in the business operation. The REA model is easy to read, and the readability is enhanced by being able to draw it at different levels of detail (Batini, 1992). The REA model is a compromise between expressiveness, simplicity and minimality. The REA model resembles what is occurring in the business enterprise. Resources are consumed and the result is the (new) resource acquired, the outflow and inflow event of every business. The outflow has a resource that is consumed, and the inflow has a resource that is acquired. By incorporating the value chain, the company is modeled at what it does best. The value

chain is the determination of what tasks are needed to affect an event. With the REA model, tasks are exploded out until the enterprise is modeled to its highest degree of efficiency (how it makes money and provides value to the final customer). The REA model allows the company to change at the task level. The value chain and the REA structure remain constant, and the task level is wiped clean. This allows the distinct opportunity to re-engineer and to change while not compromising the goal of the enterprise.

5.7. REA Model of the Construction Company:

The REA model of the construction company is designed through the use of the value chain model. The value chain is exploded into its individual components in order to visualize the Resources, Agents, and Events.

The events are represented by the value chain processes: financing, subcontractor/labor, material, equipment, construction, and contract (phase).

Financing:

Financing is represented by the relationships between the entities of: Cash Receipts, Bank, and Cash Disbursements.

```
+----------------+       +------------+       +----------------+
|     Cash       |       |    Bank    |       |     Cash       |
|   Reciepts     |——<>——|            |——<>——|  Disburements  |
+----------------+       +------------+       +----------------+
```
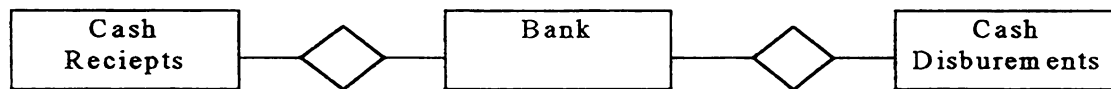
Figure 5.2
REA modeling of Financing
Modified from Batini, 1992

The connection of the diamond to the two events represents the relationship between the

two. The relationship between cash disbursements and cash receipts with the entity of

bank shows that this company stores its money in a bank account and all funds going in or

out of the account has a direct relationship with each other.

Resources:

The acquisition of labor, materials, subcontractors, and equipment can be simplified to

resources. The REA representation for this process includes the entities: Resources,

Project, and Cash Disbursement. Resources are acquired (inflow) for the project and are

paid (outflow) for via the cash disbursement account.
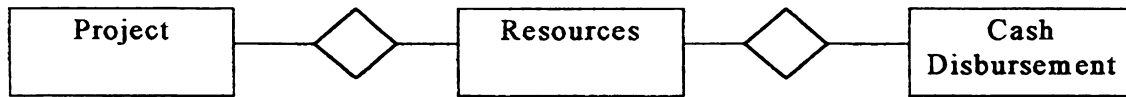
Figure 5.3

REA Modeling: Construction Resources (labor, materials, equipment, subs)
Modified from Batini, 1992

Construction:

The construction process involves the entities of Resources and Completed Construction.

Resources are utilized (outflow) for the acquisition of the completed project (inflow). The

project will have a project owner, and a project manager. The format is as follows:
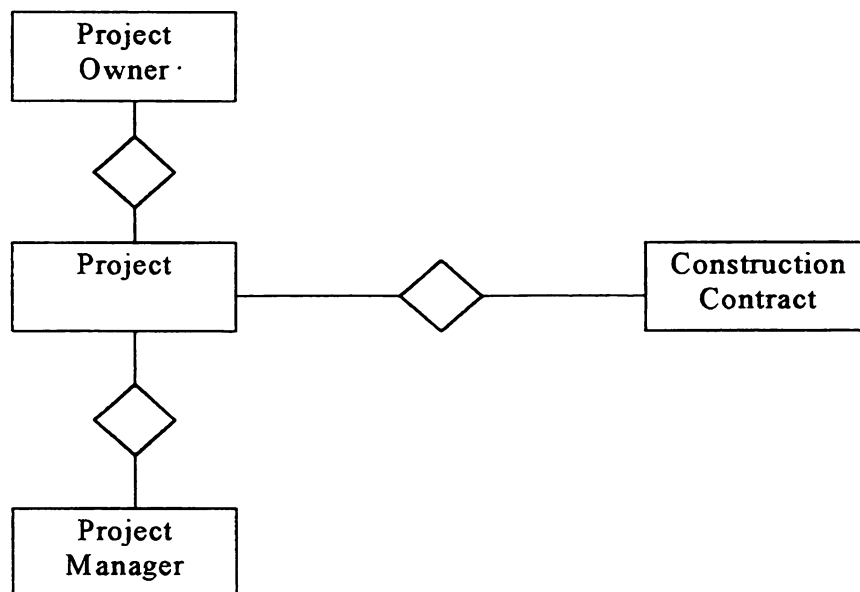
Figure 5.4
REA Model: Construction Process
Modified from Batini, 1992

5.8. REA Model for the Typical Construction Company:

The REA model representing the typical construction company distinguishes the overall

value added processes and highlights the activities that are involved in turning cash into

more cash (figure 5.5). The company should (1) look over the various levels of

abstraction, (2) determine the events involved with the making of cash and profit and also

determine which are more efficient, and (3) manage the processes that are directly

associated with the purpose of the company. Construction companies differentiate

themselves by their ability to deliver a timely project within the budgeted amount. The

relationship between time and money is directly related to the information system that the

company uses. By viewing the different relationships associated with the construction of a

typical project, the emphasis is on the transfer of capitol through the system. By setting

the system up to track this financial information, a company will have a competitive edge

in the marketplace due to its attention to cost.

When using the REA modeling technique, connections are made between items that are

to be associated within the information system. For example, the cash disbursements has a

direct relationship with the material supplier. This is a connection that will be set up in the

system, and any costs directly associated with that particular vendor can be tracked quite

easily if this were the final set up for the company. If the total costs were needed to be

tracked for the individual project, the system will need to operate through all of the

resource items and work back to the project because the information system does not have

a direct relationship between the project and cash disbursements. If this were an item that was considered necessary (tracking costs for the project without listing the individual resources), then the relationship would be made. It is important to mention that the more direct relationships, the more involved and complicated the system may be. This is considered a compromise of the system. If the individual costs of the resources were needed on a weekly basis, but the project total costs were needed monthly, then the way the example REA model is established would be sufficient. It would be unwise to establish a system that had enough power, memory storage, and additional costs of the system to warrant having both connections. The point is that the information can still be gathered (for the total project costs), but the system would be somewhat slower due to the additional path of gathering the information.

The REA modeling technique is considered an important tool for information system design decisions when establishing a system individually for a company. It can be considered an efficient way of establishing the "route" that the system designers will write into their design of the system. Any system designer will be able to understand the model and design the applicable software. The question that lingers is how many construction companies can afford, or are willing to consider designing their own informational system when there is commercial software available. The REA template can still be a useful tool in this circumstance as well. The REA template can be drawn for the company to view its needs through the use of object orientated analysis. Once this is established, the company can shop for a pre-designed software information system that can meet most of its needs. Again, compromises can be expected, but the REA template allows the company to truly

understand in what areas of design, speed, and functionality its system is compromised compared to the REA model that they would like to implement if budget were no object.

5.9. Construction Company REA Model
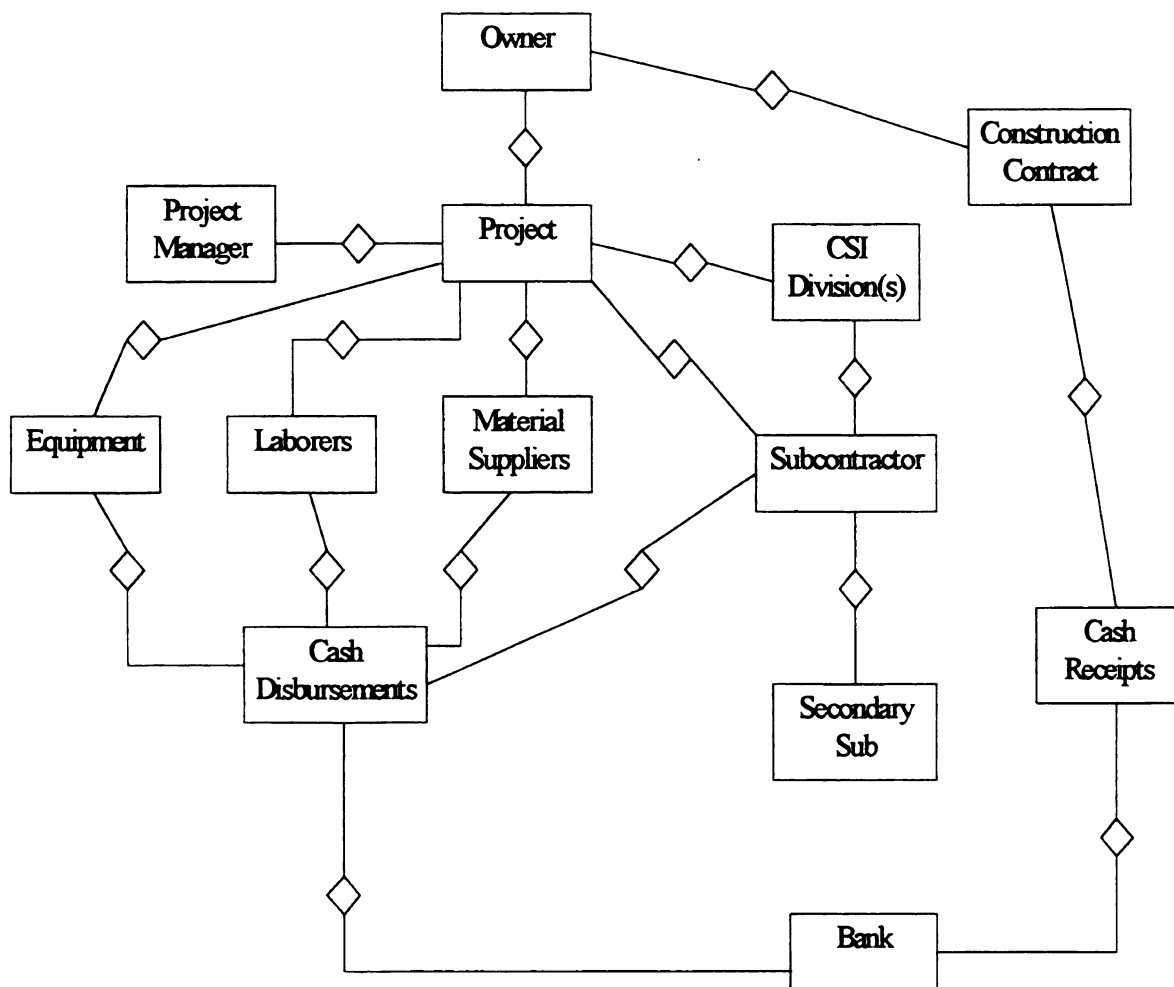
Figure5.5
Typical Construction REA Model
Bertolini, 1998

Each project has an owner that is responsible for issuing and going into a construction contract with the construction company. Each project also has a project manager that is responsible for the construction of the project. Each project will have a certain amount of the CSI divisions associated with it, as well as subcontractors that are associated with one or more of the CSI divisions. The subcontractors can also be assigned to the individual project, along with the other resources. A subcontractor may have a secondary subcontractor that performs a degree of the work. This system will show which secondary subs are associated with the subcontractor for our project. The cash receipt will be generated through the construction contract made with the owner and will be tracked as such. The individual resources, including subcontractors (but excluding secondary subs) will generate cash disbursements from the construction company. Our system will allow the tracking of the individual disbursements made to/for the resources. Cash receipts and disbursements will be forwarded to bank accounts which will also be kept track of.

5.10. Construction Information System Set-Up Model:

The construction information system set-up model (Figure 5.6) establishes the system prerequisites that are associated with the development of the job cost information system. The order in which the decisions need to be made are established in the model. Once the REA model has been established, the construction company is able to visualize the system that is needed. It is recommended that the job be the center of the model since most activities will have a direct or indirect relationship with the project in the REA model. Most job cost systems establish reports and inquiries directly related to a particular job. The company may be more interested in the overall costs of the individual CSI divisions

and would then develop an REA model that determines such costs regardless of the specific job to which the costs relate. This would demand a different REA template that allows such information to be removed from the system quickly and efficiently.

The construction information system set-up model gives the layout for system determination (figure 5.6). The reason for implementing a set up strategy is to create a system that reports the information that is relevant to the needs of the company. The establishment of the information system is done to create job cost reports that help control the project costs. Project reports are a component of the system that will follow what has been implemented through the information system set-up model. Decisions that are made throughout the model will affect the final report output. The numbering sequences that are incorporated will facilitate the proper output needed by the company. Keep in mind that the more complicated the system is, the more time consuming it becomes to both enter information and train the users of the system. This is why the set-up model is a critical element for helping to establish the information system. Questions need to be asked that will not only decide the current state of the business, but what is expected to take place in the future. The reason the future state of the company needs to be considered is that the user does not want to spend the time, energy, and money to create a system in the near future because changes have occurred that antiquate the system. It is impossible to identify all possible future needs, as well as unnecessary to make the current system too cumbersome for the off chance that a particular change may occur. The point is that if the designers are fairly certain in part due to the long term goals of the company that a future need of the system should be incorporated, now is the time for

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implementation. A good example of identifying future needs that many computer programmers are trying to deal with currently is the two digit reference for the year 2000. Much time and money is now being spent to write new programs into the current files of many company and government computer systems to try and solve this problem. It has been said that the initial writers of the programs in question would have had to spend 10% of their time and budget to insure that the programs would be able to understand the term 00 as meaning the year 2000. Now, mass amounts of energy, time, and money is being spent to fix something that would have taken a fraction of the current estimated budget. This demonstrates the importance of at least realizing that systems need to be established that will consider future contingencies. The model is shown in Figure 5.6 and the discussion of its various steps and processes are provided in the following sections.

5.10.1. Company Format:

The company format determines the company structure of the information system, both at the current level and the future level. If there are currently partners involved in the company, it may be necessary to distinguish between them. This would be done if there is an anticipation of future division, or if information is needed to be calculated for each individual partner. There may be individual entities of the company. Our project example in chapter four showed a company that is involved with both commercial and residential construction. The purpose of creating a company format separating the two divisions was to establish two balance sheets; one for each division. The company may be in more than one region or state. By creating a difference between the regions through numbering, the information system can quickly and efficiently report on each individual region. A possible

example would be that of a company which separates commercial, residential, and industrial construction. Individual numbering for the separate "divisions" will allow for cost reporting for each division, as well as separate balance sheet reporting for each division: 10-10: commercial, 10-20: residential, 10-30: industrial. It is important to keep the system as user friendly as possible. If there is no need, now or in the future, for separation of division or regions, then this distinction and numbering system does not need to be incorporated into the design of the system. More information regarding company format follows in the Accounting Method and Balance Sheet level of the model.

5.10.2. Accounting Method:

The accounting method is largely determinant on the size of the company, and type of construction. The accrual accounting method recognizes both profits and expenses when entering the system through invoicing. For expenses, the invoice is recognized at the accounting level when billed by a subcontractor, supplier or laborer. For income, the invoice is recognized when the company bills the owner for phase completion. Common uses for the accrual accounting method are commercial construction companies, and large residential construction companies. This is also a good reason to individualize the company format between two divisions of a company. The commercial and industrial divisions may use the accrual method, while the smaller residential division may choose to use the cash accounting method.

The cash accounting method is the recognition of income and expenses at the completion of the project. This would mean that even if a project were 99% completed at the end of

the fiscal year, its expenses and income would not be recognized until the following fiscal year. Smaller residential companies choose the cash accounting method because the system is less complicated and time consuming, although there are benefits and drawbacks to both methods. One point of interest is that once this decision is made, it is permanent within most accounting packages. If a change is made, most systems would have to be recreated.

Separate divisions will need to be evaluated and their accounting method determined for the proper implementation of the information system. It is possible that separate company format numbering was not required at the initial set up of the company, but is required for individual accounting methods. In this case, we would go back to the company format decision process.

5.10.3. Balance Sheet Level:

The level at which the balance sheet will report is another decisional process that involves the company format. If separate entities of the company have been established, the needs to decide how the balance sheet reporting will be handled. The company may decide to use one balance sheet for the whole company or may want separate balance sheets for different regions, different divisions, or different divisions of regions. This is a decision process that will affect the complexity of the system and that needs to be made at the forefront of the system development process.

A company format may not have been decided upon at the initial stage of the model, but may be required for the balance sheet reporting needs of the company. If this is the case, then the designing of the system needs to go back to the company format stage.

5.10.4. Fiscal Controls:

Fiscal controls are the dates that are required to be established for the period end and the fiscal year end. The period end must be determined as either monthly, quarterly, or bi-yearly. The fiscal year end date may be the calendar year end. This decision has more than likely already been established prior to this point.

5.10.5. Job Description and Numbering:

The job description and numbering decision can affect the future reports that need to be made. Certain decisions that are made will affect the types of reporting. A numeric system is what this research recommends. A single number with no hyphens is the simplest form of job numbering, although it does not provide much detail for reporting purposes. Only one primary key for the system makes it easy to distinguish for reports (xxxxx). If more flexibility is required, a number separated with a hyphen will provide a primary search key, as well as two secondary keys (xx-xxx). The example provided the use of the year as the first two digits followed by the project completed within that year (97-001). The primary search key is the whole job number. Reports can be defined to provide all of the jobs performed within a certain year using the first two digits as the secondary search key (97). Job numbers may also be defined within the division in which they were constructed within (x-xx-xxx). If the company format were not established as

such, but determined within this stage of the model to be beneficial, the user would be required to re-enter the Company Format section and set up the division as necessary.

5.10.6. Base Accounts:

Base accounts are the numbering system that define the individual accounts within the general ledger. It includes cash, accounts payable and accounts receivable. A four digit number is used that has already been established within the accounting department of the company. Unless they need to be changed, or accounts added, the existing account structure can be applied.

5.10.7. Estimating Database Numbering System:

The estimating numbering system is the numeric structure of accounts that are used from the estimating database. The author recommends the use of the sixteen CSI divisions followed by a number representing a work package, or a subsection of the division (xx-xxxxx). The hyphen is included in order to allow the use of the two secondary search keys needed for additional job cost reporting capabilities. This numbering set up will allow the whole number to be used as the primary search key (xx-xxxxx). Reports can be defined to distinguish between particular job phases using the first two digits as a secondary search key. Work packages or subsections can be defined and reported using the last five digits as a secondary search key.

It is important that the numbering system in the information system remain consistent with the numbering system used in the estimating database. It may be determined that the
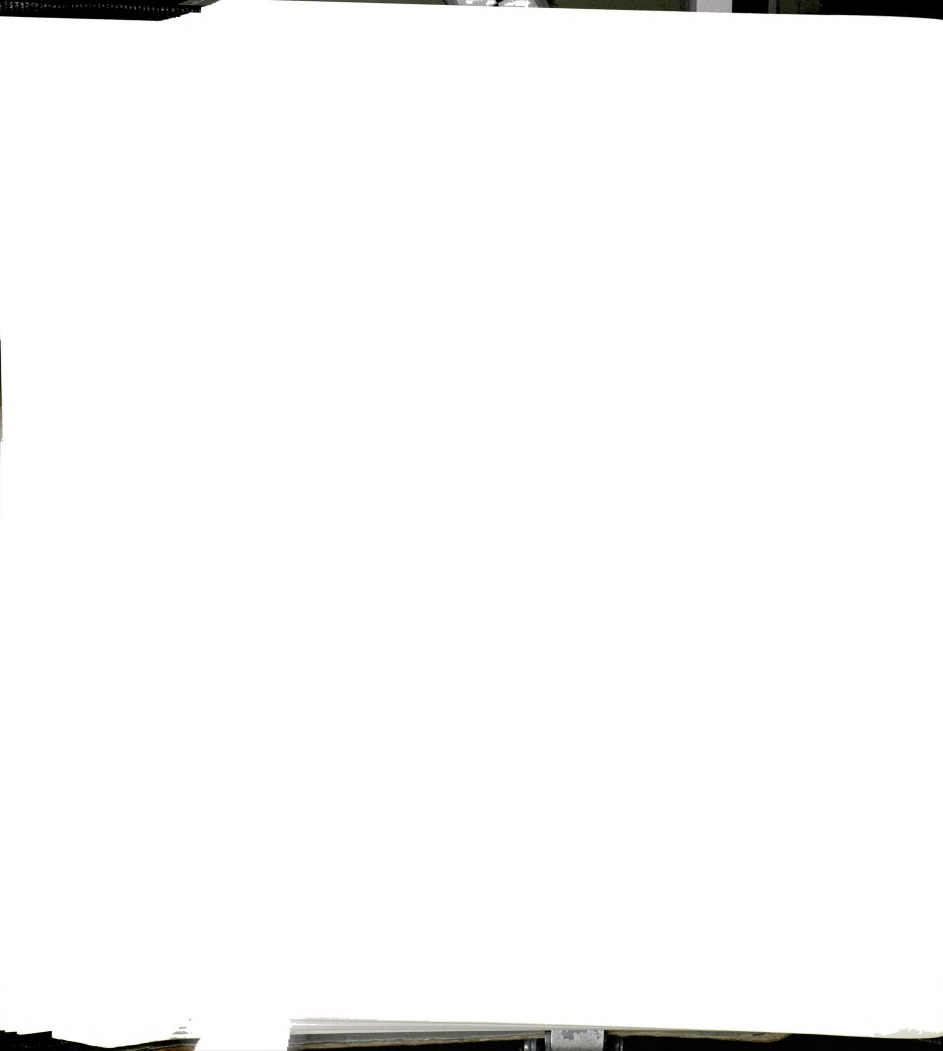
numbering system in the estimating database is not sufficient to accomplish what is needed in the information system. The user may find it necessary to modify the estimating database in order to fulfill the requirements of the job cost system. If a compromise is made at this stage, the system may not be as useful as it could be considering that the main reason for establishing an in depth job cost system is to keep track of costs. This numeric system is one of the core ingredients for a successful implementation of the job cost information system, as well as an integrated job cost and estimating system.

5.10.8. Resource Use:

The job cost system offers the user a means of keeping track of the cost of items that make up the successful completion of a construction project. The estimating database numbering system provides a cost for a particular item of a subsection of a CSI division. The individual item may be broken down into its individual resources. For example: form footing may be estimating database number 03-12345. This item may be further broken down into its resources of labor and material. Therefore, we may want to keep track of two items: 03-12345 L (form footing-labor) and 03-12345 M (form footing-material). It must be determined to what extent the system will track resources. Most common are: labor, material, equipment, and subcontract. Again, it is important that the designation of resources is consistent with the estimating database in order to have a smooth integration process between estimating and job cost.
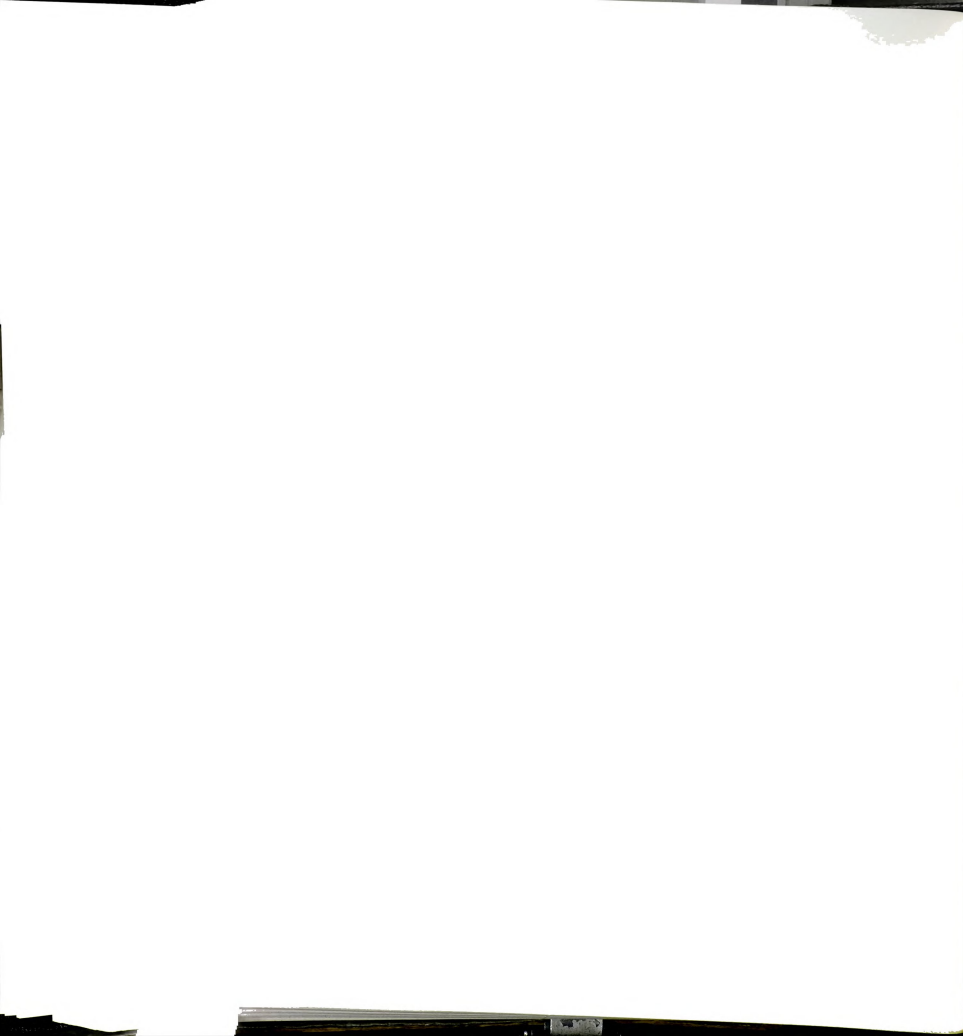
5.10.9. Billing Level:

At what level the billing will take place needs to be determined. This is particularly

important if there are separate (1) partners, (2) business entities, (3) regions, or (4)

divisions. The billing level can take place at any one of these levels depending on the

business practices of the company. If the company format was not established to have any

one, or all of the above breakdowns but is necessary if only for billing purposes, the user

will be required to go back to the initial company format section and establish the level of

breakdown of the company.

```
┌─────────────────────────────────┐
│ Determine Company Format        │
│ •  Partners                     │
│ •  Subsidiaries                 │
│ •  Future needs evaluation      │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐        ┌──────────────────────────────────────┐
│                                 │───────▶│ Accrual                              │
│   Determine Accounting Method   │        │ •  Profits and expenses recognized after │
│                                 │        │    invoicing                         │
└─────────────────────────────────┘        └──────────────────────────────────────┘
              │                            ┌──────────────────────────────────────┐
              │                    └──────▶│ Cash                                 │
              │                            │ •  Profits and expenses recognized at │
              ▼                            │    completion of the project         │
┌─────────────────────────────────┐        └──────────────────────────────────────┘
│ Balance Sheet Level             │
│ •  Recognition of the balance sheet │
│ •  Job, Company, Division, Partners │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│ Determine Fiscal Controls       │
│ •  Period End Date              │
│ •  Business Year End Date       │
└─────────────────────────────────┘
              │
              ▼
┌──────────────────────────────────────────────┐
│ Job Description and Numbering                 │
│ •  Project Type                     "xxxxx"   │
│ •  Descriptive Decisions for Reporting "xx-xxx" │
│ •  Primary/Secondary Search Keys    "x-xx-xxx" │
└──────────────────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│ Base Account Set-up and Numbering │
│ •  General Ledger Account Numbers │
│      •  Cash                    │
│      •  Accounts Payable        │
│      •  Accounts Receivable     │
│      •  Payroll                 │
└─────────────────────────────────┘
              │
              ▼
┌──────────────────────────────────────────────┐
│ Estimating Database Numbering System          │
│ •  Evaluation of the current numbering system │
│ •  Numbering must correspond to the JC system │
└──────────────────────────────────────────────┘
              │
              ▼
┌──────────────────────────────────────────────┐
│ Determine the level of resource use           │
│ •  Labor, material, equipment, subcontractors │
└──────────────────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│ Determine the Billing Level     │
│ •  Job Level                    │
│ •  Phase Level                  │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│ Job Cost Reports                │
│ •  Project Costs                │
│ •  Change Orders                │
│ •  Billing                      │
│ •  Actual Costs                 │
│ •  Resource Use                 │
│ •  Budgeted Amount              │
└─────────────────────────────────┘
```

Figure 5.6
Construction Information System Set-Up Model
Bertolini, 1998
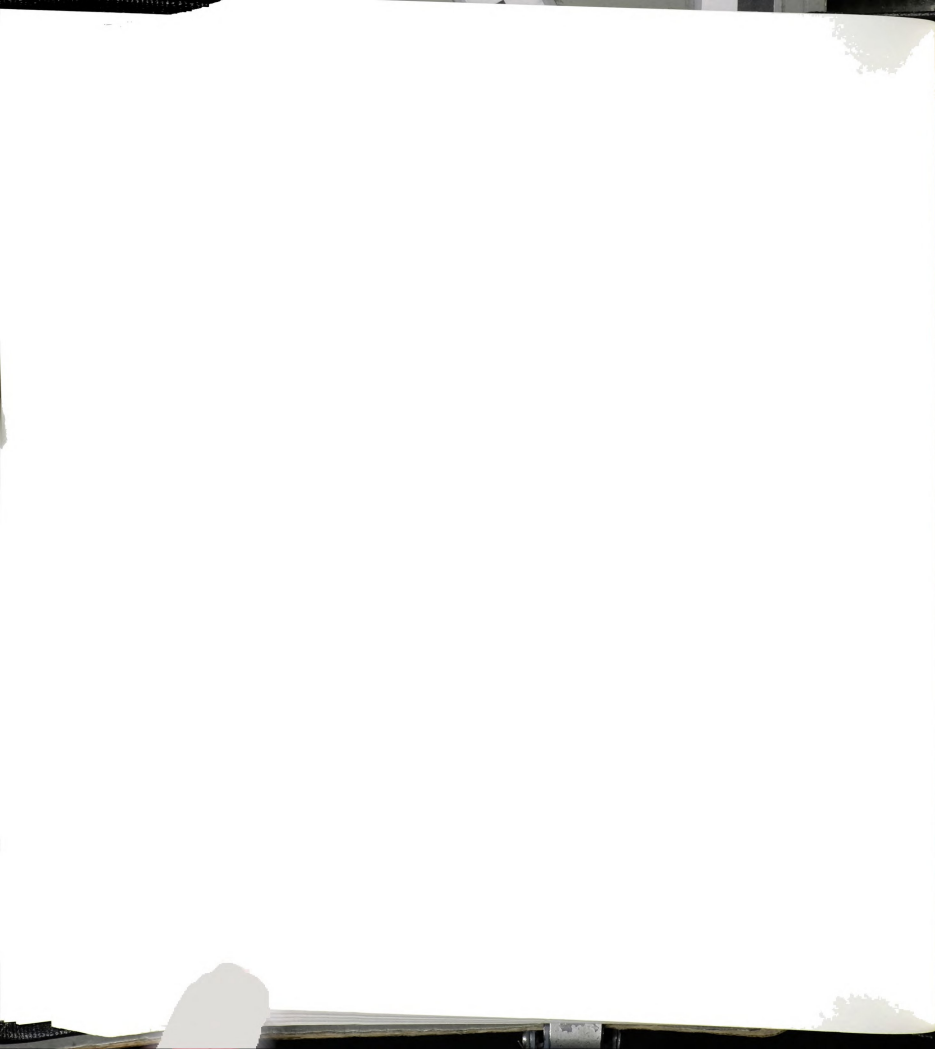
5.11. Job Cost Reports:

It should become obvious that many of the decisions that are made using the construction information set-up model (Figure 5.7) are done in order to provide the necessary reporting required for the company. The process of designing the numbering system within the job cost module determines the level of detail at which the system will perform. A small simple company may not want the level of detail that was prescribed above. This is fine, but it does not eliminate the fact that the company should still determine exactly what its needs are prior to system completion. The REA template starts us out by providing a complete view of the system needed. The construction information system set-up model shows the steps involved in assigning the control values within the system. The system will now be ready to accomplish the company required goals. The illustration company will provide information to the user by following these steps:

5.12. Information Flow Model

The information flow model (Figure 5.7) represents the accumulation of data from the inception including the original budget, and the cost data that is collected from the field. At the top of the model, the numbering sequence indicates that the company is interested in knowing what division of the company, and what job number the data represents. The example within the information model represents data collected for the concrete division. Note that the concrete division is numbered using both the CSI format and a numbering sequence. The resource items that represent this particular concrete item are both labor

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and material. The budget information and the actual cost data are used in both financial

accounting and job cost accounting applications.
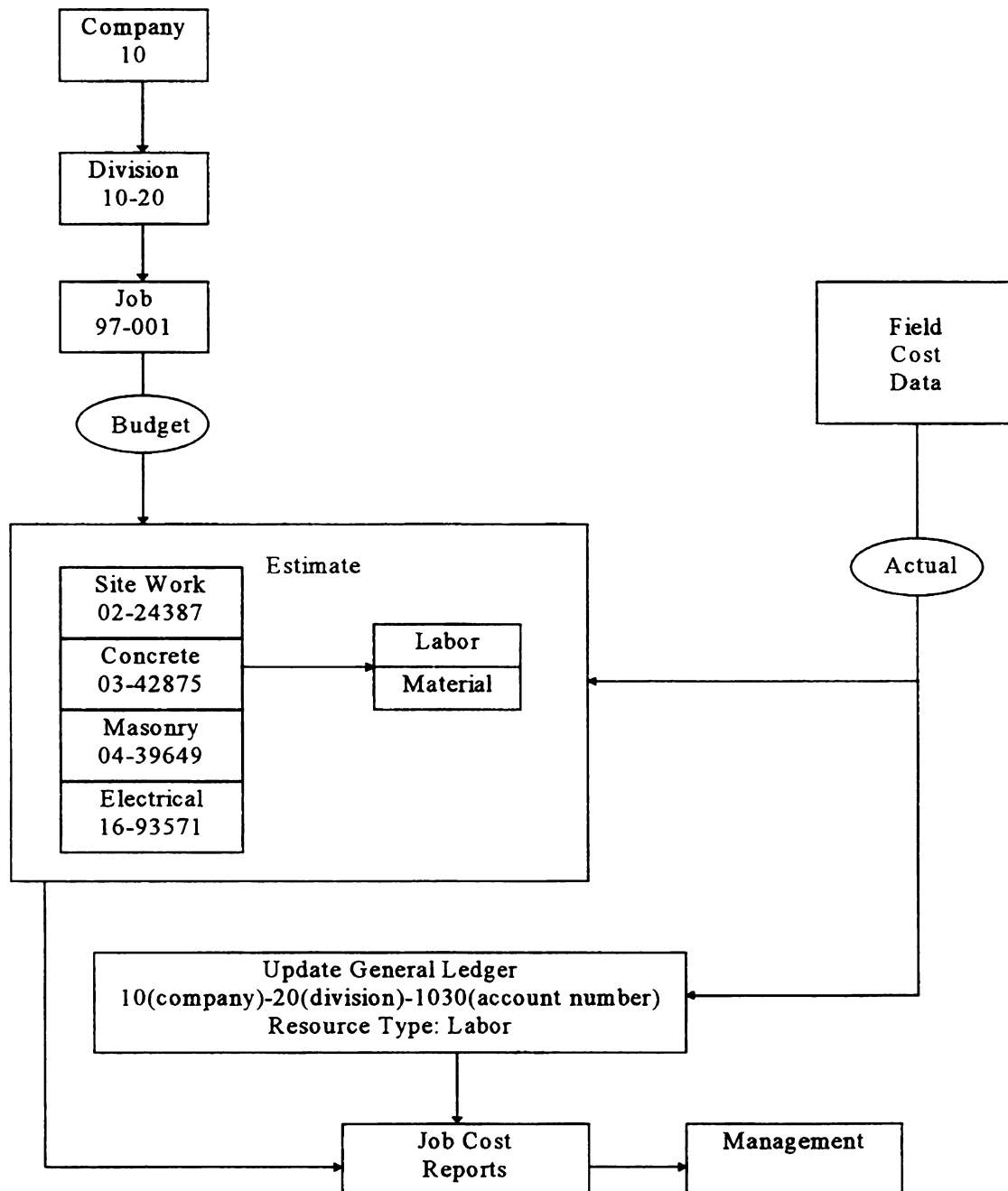
Figure 5.7
Information Flow Model
Bertolini, 1994
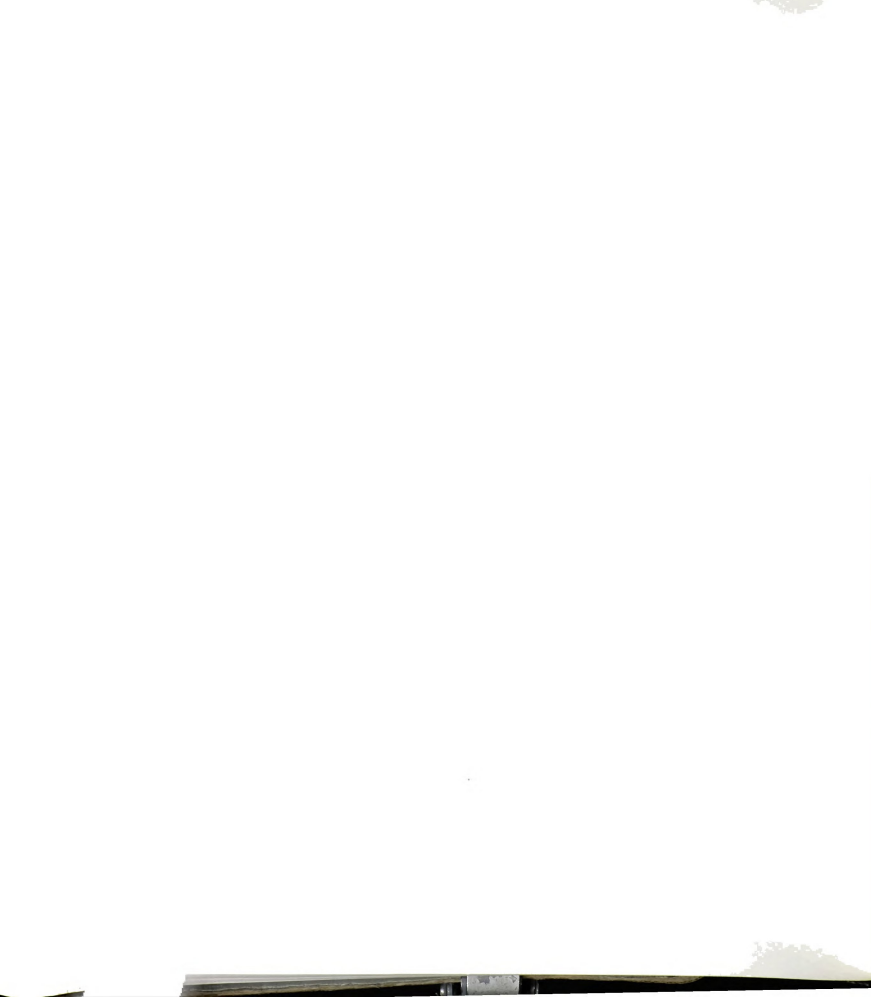
5.13. Application of the Information Flow Model in Case Studies

Two Companies in the Lansing area were used as case studies. The first is a leading mid-Michigan construction company in institutional, industrial, and commercial construction that specializes in construction management, general contracting, and design build projects. This company will be referred as the commercial construction company throughout the rest of this research project. The second case study focused on a leading Mid-Michigan residential construction company that specializes in both land development and the construction of medium priced semi-custom homes as well as custom homes. This company will be referred to as the residential construction company throughout the rest of this research project.

5.14. Commercial Construction Company

The commercial construction company is one of the leading companies in the mid-Michigan region. The company set up is quite diverse, as are the projects that are constructed by this company. The projects that they are currently working on include medium to large commercial, industrial, and institutional construction sites.

One project was specifically used for the case study, as well as individual interviews of office personnel. The main office personnel interviewed included one of the estimators/project managers and a representative of the accounting department. Most of

the work that is being done on the project is being done by subcontractors except for concrete and carpentry. Cost codes are set up for the labor and materials for both of these divisions, and all of the budgeted costs are broken down into individual line items. The CSI divisional cost code sequence is used. The cost codes are given to the foreman in charge of the work to be accomplished, and kept track through time cards that are used in the field. The laborers keep track of their hours, and the amount of time working on individual items. These hours are approved by the foreman and sent to the office to be accounted for in the job cost accounts. The amount of codes that are established is dependent on the Project Manager. It is the project manager's responsibility to determine the level of breakdown for each item and account. It is the project manager's opinion that a drawback in the system is the gathering of accurate information through the field. If there is a problem, it is not because of the accounting department. They are keeping track of information that is provided to them by the field personnel. Improper information coming into the accounting department can lead to improper historical data for future estimates. Another potential problem is that if the accounts are not correctly established at the beginning, more time is spent determining the proper account that this information represents. When this confusion occurs it causes problems throughout the construction process.

5.14.1. Information System Model: Commercial

The following figure represents the information flow between estimating and job cost accounting for the Commercial Construction company (represented in figure 5.8).

Commercial Information System: Estimating and Accounting

```
┌─────────────────────────────────────────┐
│      Computer Generated Estimate:        │
│   •   self performed takeoff             │
│   •   Division 3 and 6                   │
└─────────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐
│                Bid Day:                  │
│  •  Receive all sub costs (hard bid)     │
│  •  All costs are transferred to a spread sheet │
│        •  General Conditions             │
│        •  Sub Costs                      │
│        •  Self performed work            │
└─────────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐
│    Receive Job: Estimating Department    │
│  •  All items are transferred from estimating │
│     spreadsheet to cost code sheet by hand │
│  •  Accouting has different cost accounting item │
│     numbers for the estimating item numbers │
└─────────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐
│           Accounting Department:         │
│  •  Cost codes are manually entered into the computer │
│     from the cost code sheets            │
│  •  Cost information is received from field foreman │
│        •  Field-Payroll Dept.-Job Cost   │
│  •  Job Cost Reports are run             │
│        •  Weekly Labor Reports           │
│        •  Unit Cost Reports              │
│        •  Weekly Resource Reports        │
│  •  Financial Reporting                  │
│        •  Balance Sheet                  │
│        •  Income Statement               │
└─────────────────────────────────────────┘
```

Figure 5.8
Commercial Construction Information System (Existing)
Bertolini, 1998

5.14.2. Analysis: Commercial Construction

This commercial construction company is using a job cost system to facilitate the information flow through its accounting department. The system is providing the necessary reports to keep track of costs throughout the construction process. The system that they are using is not an integrated system, which results in information being entered into the system multiple times. This repetition of entering data slows the system down and creates the possibility of errors due to improper data entry. An integrated system that employs the same estimating and accounting item numbers which can automatically update the accounting system from estimating would eliminate this possibility for errors. It would also eliminate the need for employees to manually update information from estimating to job cost accounting. It is more practical to have estimators estimating a project as opposed to having to write out individual items to be transposed from the estimate to accounting.

Employees within the company mentioned that the software used in the individual departments were doing the job they were intended to do (estimating and accounting), but mentioned that the company has not been able to find software that does both to its standards.

It is a common occurrence for a company to know that they need a new system, either estimating or accounting, but are not sure exactly what they would change regarding their present system if presented with the question. Individual employees may express opinions

regarding their work and what would be more efficient. Most often, the determination of what is needed is left up to a software salesperson who is more concerned with selling software than what the exact needs of an individual company.

The REA template would allow the commercial construction company to visualize its estimating-accounting process and would help establish the minimum that a system should be able to accomplish. With this information in hand, any company is less likely to be "sold" a product as opposed to requesting certain functions that the system must be able to accomplish. The likelihood that a system is available that would accomplish all of the prerequisites is minimal, but a company would have a better understanding of what compromises the prospective system would have and if it is acceptable or not. Armed with this information a system can be purchased that will better match the current and future needs of the company.

5.14.3. Construction Information System Set-Up Model: Commercial Construction

The proposed information set-up model for the commercial construction company is shown in figure 5.9. The company format should be changed to allow for the different divisions already established within the company as well as the opportunity for new divisions in the future. The major changes of the system should be the numbering sequence. The job description numbering should have three categories that will allow for the separation of information, as well as the ease of quickly locating information in the future. The base accounts that represent the accounting numeric system also need to be representative of the division of the company. The estimating database numbering system

should follow the CSI format, as well as identifying the subdivision within the particular

division.

```
Company Format:
• Company: xx
    • allows for future company restructuring
• Division: xx-xx
    • division 10: General Contractors
    • division 20: Proffesional Services (Construction Management)
```

```
Accounting Method:
• Accrual: Profits and Expenses recognized upon invoicing
```

```
Balance Sheet Level:
• Set at either the Company level or the Division level
```

```
Job Description/Numbering:
• x-xx-xxx:
    • x-division
    • xx-year
    • xxx-job number for the year
```

```
Base Accounts
• xx-xx-xxxx
• xx-Company
• xx-Division
• xxxx-Account Number
```

```
Estimating Database Numbering System:
• xx-xxxxx
• xx-CSI Divisions
• xxxxx-CSI Subdivisions (item number)
• Establish the same numbering system within the Job Cost system
```

```
Resources:
    • Labor, Material, Equipment, Subcontractors
```

```
Billing Level
    • Division (General Contract, Proffesional Services)
```

Figure 5.9
Commercial Construction Set-Up Model (Proposed)
Bertolini, 1998

5.14.4. Commercial Construction Company feedback

One of the vice presidents for the commercial company was interviewed and given an opportunity to react to the analysis of its accounting and estimating system and offer any recommendations.

The feed back from the vice president was that none of the information was surprising. He believed that the topic was well conceived. As a business person, he appreciated that the models were concise and to the point. The information was explained to be specific enough to get to the point, but not too concise to miss the point.

Overall, the topic is extremely relevant as a current issue that needs addressing within this construction company. No immediate recommendations were offered except to maintain the concise nature of the modeling for use in industry.

5.15. Residential construction company

This residential construction company is a leader within the mid-Michigan residential home market. It is a proactive company that is continuously looking for ways to improve their individual company. It is actively involved with the education of builders within the industry through leadership in research and training through the Housing Education and Research Center at Michigan State University, as well as leadership in the Greater Lansing Home Builders Association.

The owner and the controller were interviewed to gather data regarding the existing

estimating and job cost accounting system that is currently in place. Most of the work

performed in the field is accomplished through the use of subcontractors which is typical

of most residential construction companies. Ninety-eight percent of work performed is

through the use of subs.

5.15.1. Estimating

A Lotus spreadsheet has been designed that catalogs all cost data for the construction of a

home. The cost data is maintained both in a file that is referenced when estimating is

done, and on the spreadsheet. The spreadsheet does not carry all cost information, so the

estimating requires that both the spreadsheet, and the knowledge of the estimator be used.

The owner of the company performs the daily estimating of the projects, and is familiar

with the local costs associated with most construction items. The book is referenced

often, and is updated continuously, as well as the spreadsheet cost data. The company

feels comfortable with the cost data and its use as historical information. The cost codes

are divisions that were developed by the company, and do not necessarily follow the CSI

divisional breakdown formula. Invoices for actual cost information is sent directly to the

main office by the subcontractors responsible for the work. The invoices are approved

and entered into the accounting system. The system can generate budget vs. actual cost

data on demand, as well as final job cost reports.
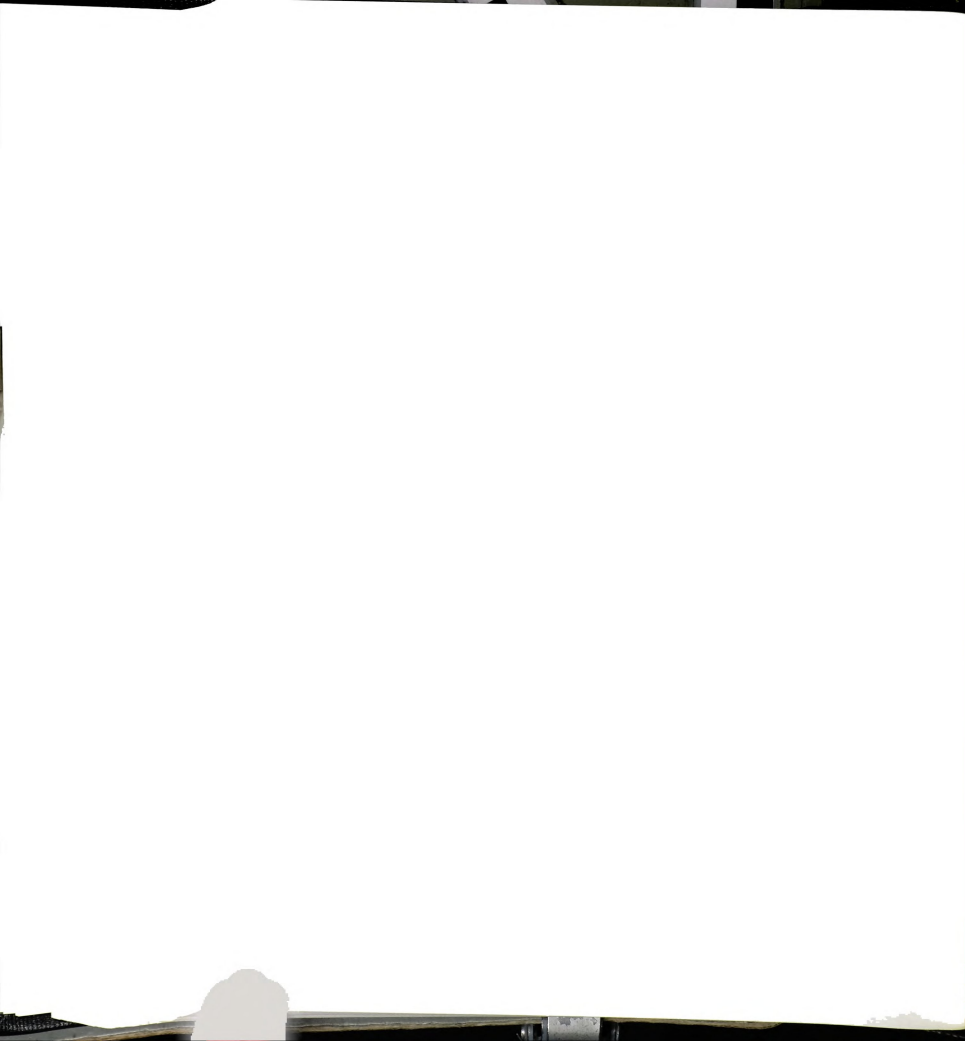
5.15.2. Accounting

The accounting department prescribes to the completed contract (cash) accounting method. Companies operating under 10 million per year have a choice between the cash or accrual accounting methods. Payroll for the company is out-sourced. The job cost system is a subsidiary ledger of the general ledger established so that the job cost system is able to record directly to the general ledger. The system is viewed as extremely flexible considering both cost of the system and maintenance. The system is also able to generate sworn statements, but is using three different programs to accomplish it. Sworn statements for draws, customized waivers, and purchase orders are available through the system using a series of macros.

5.15.3. Residential Information system: Estimating and Job Cost accounting

The following is the review of the existing information system within the residential construction company, and the recommendations of this research effort.
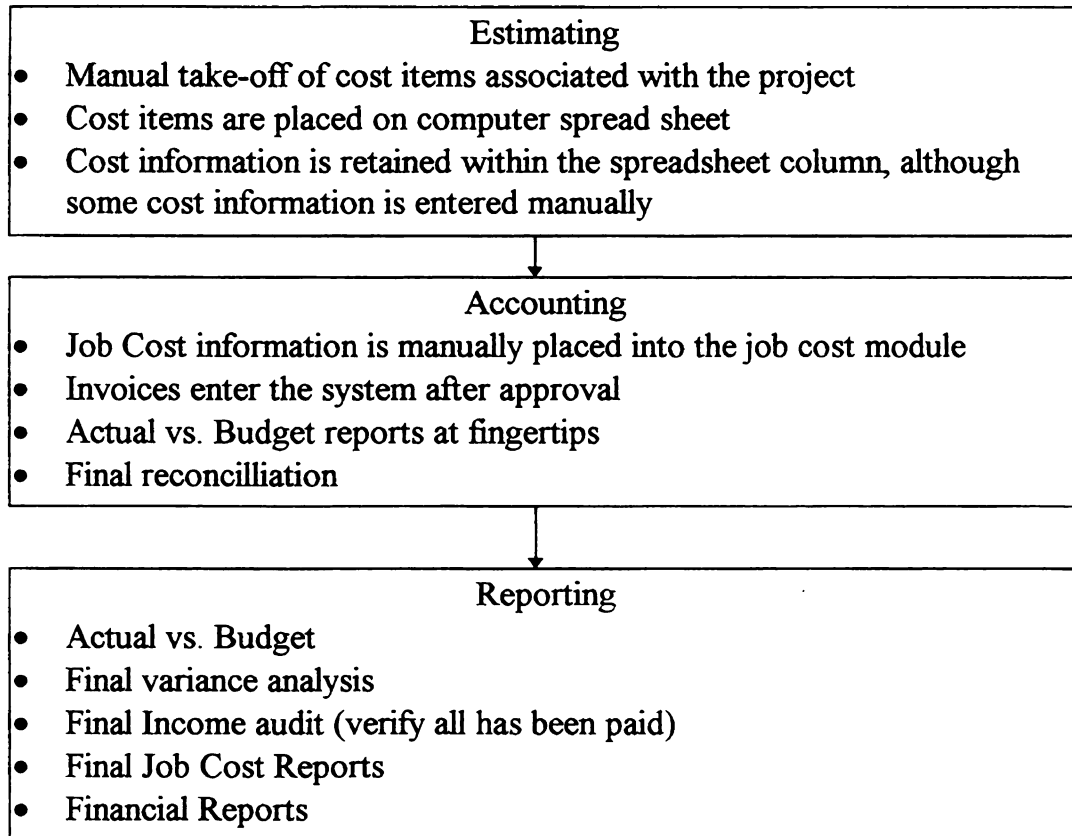
```
┌─────────────────────────────────────────────────────────────┐
│                        Estimating                           │
│  •  Manual take-off of cost items associated with the project│
│  •  Cost items are placed on computer spread sheet          │
│  •  Cost information is retained within the spreadsheet column, although │
│     some cost information is entered manually               │
└─────────────────────────────────────────────────────────────┘
                              │
                              ▼
┌─────────────────────────────────────────────────────────────┐
│                        Accounting                           │
│  •  Job Cost information is manually placed into the job cost module │
│  •  Invoices enter the system after approval               │
│  •  Actual vs. Budget reports at fingertips                │
│  •  Final reconcilliation                                  │
└─────────────────────────────────────────────────────────────┘
                              │
                              ▼
┌─────────────────────────────────────────────────────────────┐
│                        Reporting                            │
│  •  Actual vs. Budget                                      │
│  •  Final variance analysis                                │
│  •  Final Income audit (verify all has been paid)          │
│  •  Final Job Cost Reports                                 │
│  •  Financial Reports                                      │
└─────────────────────────────────────────────────────────────┘
```

Figure 5.10
Residential Information System Model (Existing)
Bertolini, 1998

5.15.4. Residential Construction Company Analysis

The residential construction company is currently using a computerized job cost system.

The estimating process is both a manual and computerized estimating system. The

individual cost items are taken off the plans and placed on a computer spreadsheet, while

cost information is manually placed on the spreadsheet for the cost data that is not

currently on the spreadsheet. While this is not the most efficient spreadsheet design, it is

an effective system for a company this size. One of the negatives of using a spreadsheet
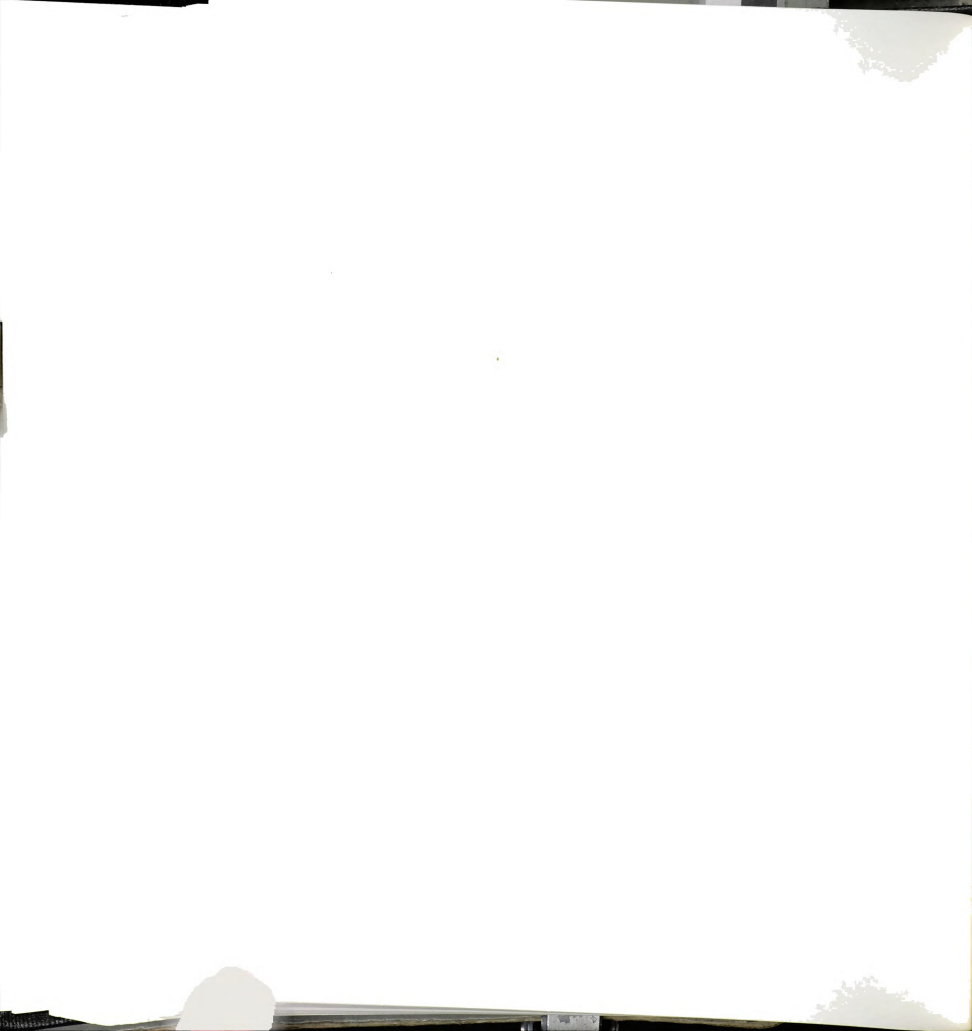
alone without the use of a separate database is that all of the items will be listed. This means that even if an estimate item is not needed for a particular estimate, it will still show up on the spreadsheet. This would cause more problems for a company that handles larger projects. Although it can be an encumbrance, it is still a useful system for a residential company. This does not necessarily represent a problem when considering the size of the company and the knowledge base of the owner/estimator. It does represent a loss of time on the part of the estimator. If a cost database were designed and maintained, it could be integrated into the current estimating spreadsheet, and updated for changing costs. The time that it takes to input the information on the spreadsheet manually would be eliminated, offering the estimator time to conduct other aspects of the business. Due to the size of the company, this may or may not be a beneficial undertaking. It would have to determine if the cost and/or time needed for developing the database is worth the benefits that it would provide. It would offer the opportunity of reduced time and possible errors of omission, as well as improper input of data.

The estimating system is not directly integrated with the job cost system. The data needs to be manually placed in the job cost system from estimating. If cost codes were established for both accounting and estimating, the system could carry over all cost information from estimating to job cost without having to be re-entered into the system.

It would be beneficial to generate an REA model for this company. The REA model would look quite different from the commercial company in large part due to the size of the company and the less detailed accounting requirements. The use of the cash

accounting method directly correlates to the simplistic accounting structure. This is one of the benefits of operating a residential construction company. The idea of the REA model still hold true to the importance of its use even with a small-medium sized residential construction company. A company manager must be concerned with where the energies of the employees is going. Although it is true that a less expensive, simpler system is more acceptable in a smaller company, the loss of productivity needs to be measured. The way this is done is through the visual REA model. The system that is currently being used by this company is very impressive. They are benefiting from a job cost system, and appear to be very structured and organized. With this said, it is important to view the system purely through the eyes of being efficient and effective. The system is extremely effective as stated above. The system is not extremely efficient. Redundancy of the input of information is one of the problems. The amount of manual entry is another. Reducing these two critical components while still providing a cost effective system that performs what is currently necessary of the company would be quite a challenge.

5.15.5. Residential Information System Set-Up Recommendations:

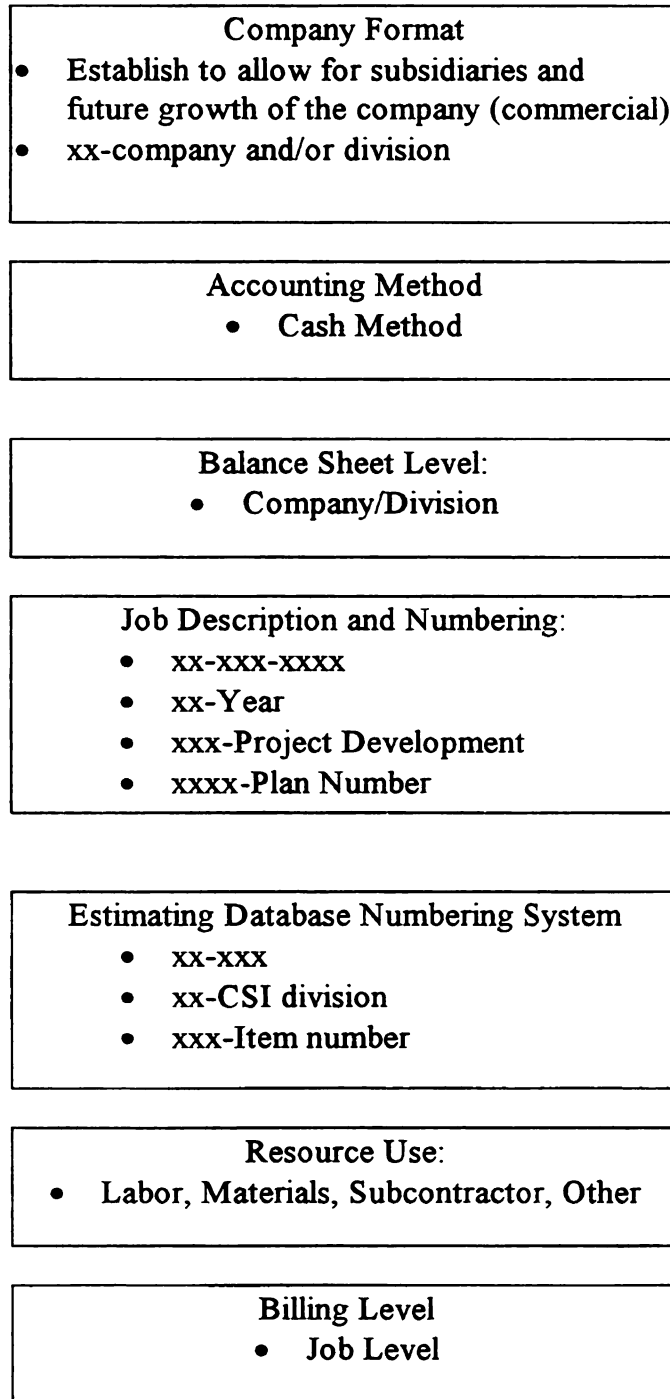The following model lists the recommendations of this research effort.

```
┌─────────────────────────────────────────────┐
│              Company Format                   │
│  •  Establish to allow for subsidiaries and   │
│     future growth of the company (commercial) │
│  •  xx-company and/or division                │
│                                               │
└─────────────────────────────────────────────┘

┌─────────────────────────────────────────────┐
│             Accounting Method                 │
│           •  Cash Method                      │
│                                               │
└─────────────────────────────────────────────┘

┌─────────────────────────────────────────────┐
│            Balance Sheet Level:               │
│          •  Company/Division                  │
│                                               │
└─────────────────────────────────────────────┘

┌─────────────────────────────────────────────┐
│        Job Description and Numbering:         │
│          •  xx-xxx-xxxx                        │
│          •  xx-Year                            │
│          •  xxx-Project Development            │
│          •  xxxx-Plan Number                   │
└─────────────────────────────────────────────┘

┌─────────────────────────────────────────────┐
│      Estimating Database Numbering System     │
│          •  xx-xxx                             │
│          •  xx-CSI division                    │
│          •  xxx-Item number                    │
└─────────────────────────────────────────────┘

┌─────────────────────────────────────────────┐
│              Resource Use:                    │
│  •  Labor, Materials, Subcontractor, Other    │
│                                               │
└─────────────────────────────────────────────┘

┌─────────────────────────────────────────────┐
│              Billing Level                    │
│          •  Job Level                          │
│                                               │
└─────────────────────────────────────────────┘
```

Figure 5.11
Residential Set-Up Model (Proposed)
Bertolini, 1998

5.15.5.1. Company Format

This company has other areas of interest other than residential construction. Some of the areas are currently underway within the company structure. The company format needs to reflect this diversity, while providing the necessary information for all of the interests of all subsidiaries. The company format should be established as a numeric item within the information system. Transactions, job numbers, estimates, resources and billings could correspond to a particular company number. This would allow for the generation of financial statements for each individual company or division within the company.

5.15.5.2. Balance Sheet Level

As mentioned above, the balance sheet level can be established within the information system to be automatically generated for either the company, or any division or subsidiary within. All data that is entered into the system would need to be specified for the individual subsidiary or division. The additional layer can add more keystrokes when entering data, but can expedite the flow of information for more useful managerial decisional purposes.

5.15.5.3. Job Description and Numbering

The job description and numbering was divided into three separate numeric digits that provide useful information for future managerial concerns: (1) year, (2) project development, and (3) plan number. By entering this information into the system, key searches can easily be done to generate reports on specific jobs for certain years, developments, and/or particular plans. The individual plan that may be built often through

the course of many years may be called up to determine cost variations through time for a particular development.

5.15.5.4. Estimating Database Numbering System

It is recommended that this company adopt the 16 CSI divisional project breakdown structure. The system has been proven to be effective when determining cost estimates, and is being used more often in the accounting departments of construction companies. The first two digits of the number would determine the CSI division. The last three numbers would represent 999 possible entries available for that particular division. This is ample available entries considering the amount of subcontracting that most residential companies employ.

5.16. Residential Construction Company Feed back

The information as presented to the owner/estimator of the residential company was considered useful and needed. The information that was presented did not suprise the owner, but confirmed that there are areas of the system that need adjustment, and/or changing.

The most useful piece of information for this company is the idea of the numbering sequence use to generate future reports quickly and easily. Also, the fact that the estimating and accounting system has no integration, and that all of the data needs to be entered twice is valuable information. This loss of productivity is something that they have been aware of, but have not been motivated to do something about. It appears that

hearing the analysis from an outside party may be enough to modify the system to a more efficient as well as effective integrated system.

5.17. Chapter Summary

The models that were introduced at the beginning of the chapter were designed so that a person who is not an information model expert could review a company's needs, and play an integral part in the design of the new information system. There is a tremendous amount of opportunity to evaluate and completely change the information system when it is determined to be needed. It is common that the existing system will be modified, leaving the base of the new system as the antiquated system that was deemed insufficient. This may work for the short term, but a company cannot stack too much on top of a system that is not adequate.

The information evaluation, and set-up models helps to ask the question of "what is needed". Often the question needs to include the opportunity for future needs of the system and the company. By establishing an information system that represents the company's needs, operations of the company should run more smoothly over a longer period of time.

Chapter 6

Summary and Conclusion

6.0 Overview

This research has determined that the information flow through the estimating and accounting departments of a construction company is a critical component for controlling costs. A commercial and a residential company were examined to provide a cross section of the industry and to measure the differences when determining the type of integrated information system needed. Job cost accounting was researched and an example company was established with an integrated estimating, job cost accounting, and general ledger information system. This chapter summarizes the research results and defines future areas of research.

6.1. Research Results

The estimating and accounting departments of a construction company have proven to be one of the areas where the information flow can be improved. Data collection from the estimating department is not being implemented efficiently within the accounting department. Construction companies are manually inputting data into the accounting system that has already been entered into the estimating system. Different numbering sequences are being used between the two departments as well.
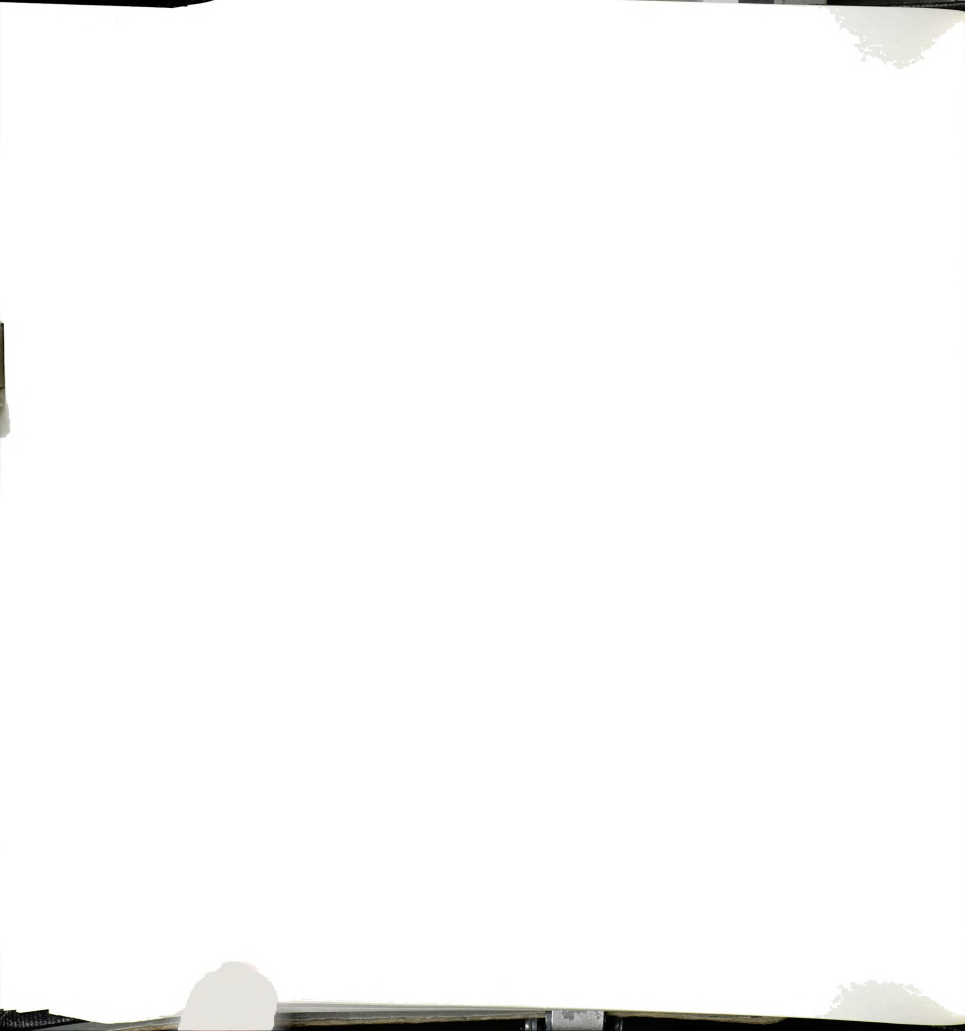
### 6.1.1. Organizational Structure

Designing an efficient as well as an effective integrated information system begins with a clear understanding of the main processes of the organization. It is important to clearly define the levels of activity within the company. Only then is a systems designer able to understand the flow of information, and where the critical areas of importance are. The value chain model helps simplify the broad spectrum of activity that make up the daily intricacies of an organization. The model is a simple way of measuring the flow of money and resources through the company leading directly to the flow of information.

6.1.2. Information flow

Information begins with the idea of cost and resources, but needs further refinement. The relationships within the individual value chain need to be exploded into a view that is both understandable, and which helps determine the systems needs. Layers of information is readily available for all companies, but decisions need to be made regarding the importance of the information. Will the system be too laborious and expensive thereby providing too much information? The REA model needs to clarify this question and others as well.

### 6.1.3. Information System Set-Up Model

Once the system detail is resolved through the REA template, decisions regarding the finer details of the system can be answered. It is at this point a company can determine the true needs associated with its job cost system including reporting and numbering. Much of the
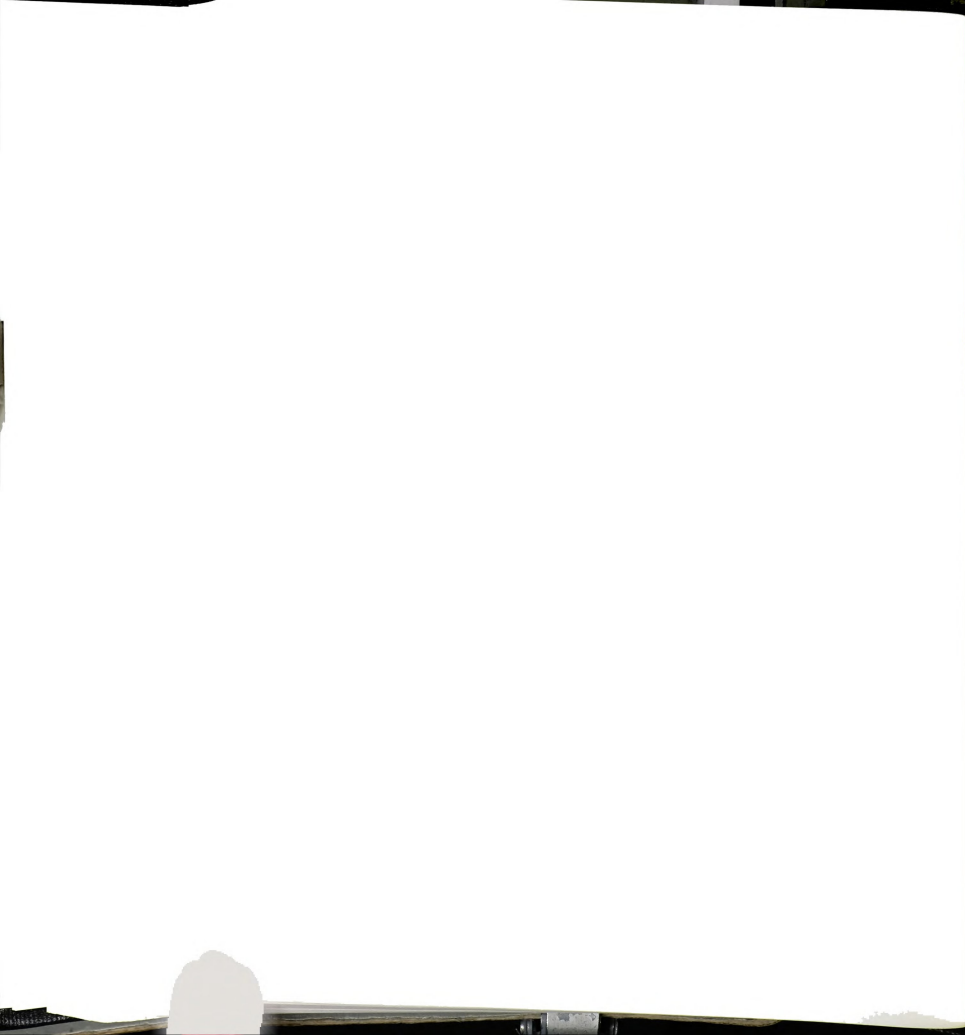
power of a job cost system is determinant on the initial set up of the system. What is to be reported is directly related to the measuring needs of the company. The level of detail is a response to the type of company that is using the system and the amount of resources that need to be measured. By incorporating the value chain and the REA template, a company can then utilize the Information System set-up model and determine what type of system is needed. The decision may include either a custom designed system, or one that is purchased from a software supplier. If the product is purchased, the modeling is as important, if not more. Money can be saved by having the background knowledge that the models provide. Not all people need the latest and greatest with all the bells and whistles regarding computers and software. Many people purchase a computer system that is well above what is required for their needs. This is done due to their lack of knowledge. Knowledge is power, and in the case of system design and implementation, it holds just as true.

6.2 Case Studies

The case studies provided a unique opportunity to incorporate the knowledge found through research along with what is actually occurring within the industry. Companies are dealing with inadequate information systems on a daily basis. Time is money in any industry, but holds especially true within the construction industry. Critical time is being wasted by personnel, time that could put forth toward what their job descriptions (and pay) are more suited toward doing.
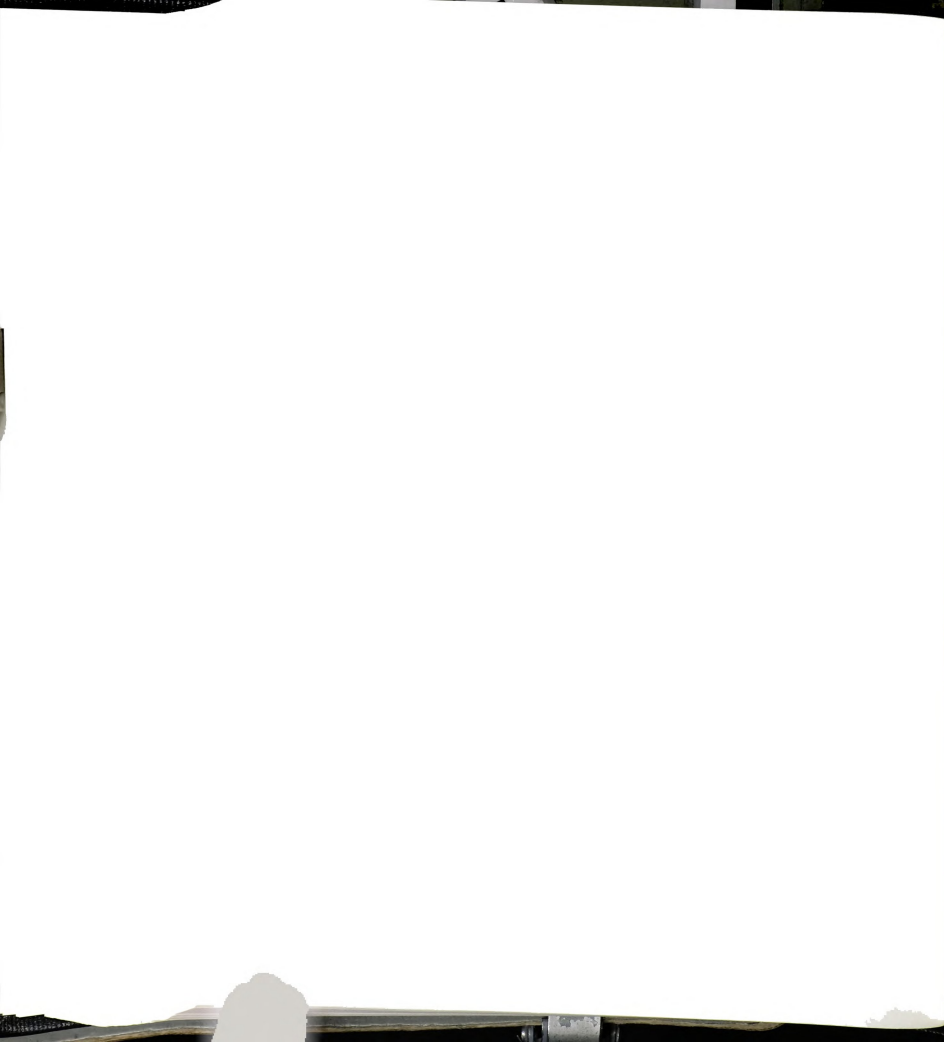
6.3. Research Contributions

This research contributes to the effective design and implementation of an integrated information system. It contributes to the design and purchase of a system through the process of suggesting logical steps and questions which allow a successful understanding of what is not only required of the system, but how to understand where compromises of the system may be necessary in order to have an efficient system. The research also contributes to the effective implementation of the system through the organization of the data required to be processed through both estimating and accounting, and through the detailed design of the shared components that need to be considered when connecting an estimate to job cost accounting.

6.4. Future Research

Suggestions for future areas of study related to the work presented in this thesis fall into several categories:

1. Design and implementation of the value chain model for different size construction companies including residential and commercial independent of each other. The value chain presented is a catch all for the whole industry.

2. Implementing the REA model in existing companies to determine the current efficiency of the information systems in use within these companies.

3. Detailed design of an estimating database

4. Research involving the need for a job cost accounting system within a Construction Management company.

6.5. Limitations of Current Research

The limitations that were faced throughout this research process was the lack of material on the subject matter. Substantial work has been done regarding the integration between estimating and scheduling, but far fewer projects are available regarding the integration between estimating and accounting. One reason may be that the two disciplines are different. Accounting and estimating are quite different in the fact that they attract people with different skills. Estimators usually have a strong construction background, while accountants have more of a general business background. Estimating and scheduling attract like minded professionals.

6.6. Conclusion

Overall, this research establishes modeling that should help the industry to understand software limitations, as well as software development. The integration process was demonstrated between estimating and job cost accounting and the importance of the initial set-up requirements for an integrated computer system was distinguished. The value chain and the REA template were also introduced to the construction industry, and recommended as a modeling tool that should be used to establish the flow of information within a company. These models do not take into consideration the limiting factors of current software, but help to establish the "perfect" system as viewed by the members of a company.
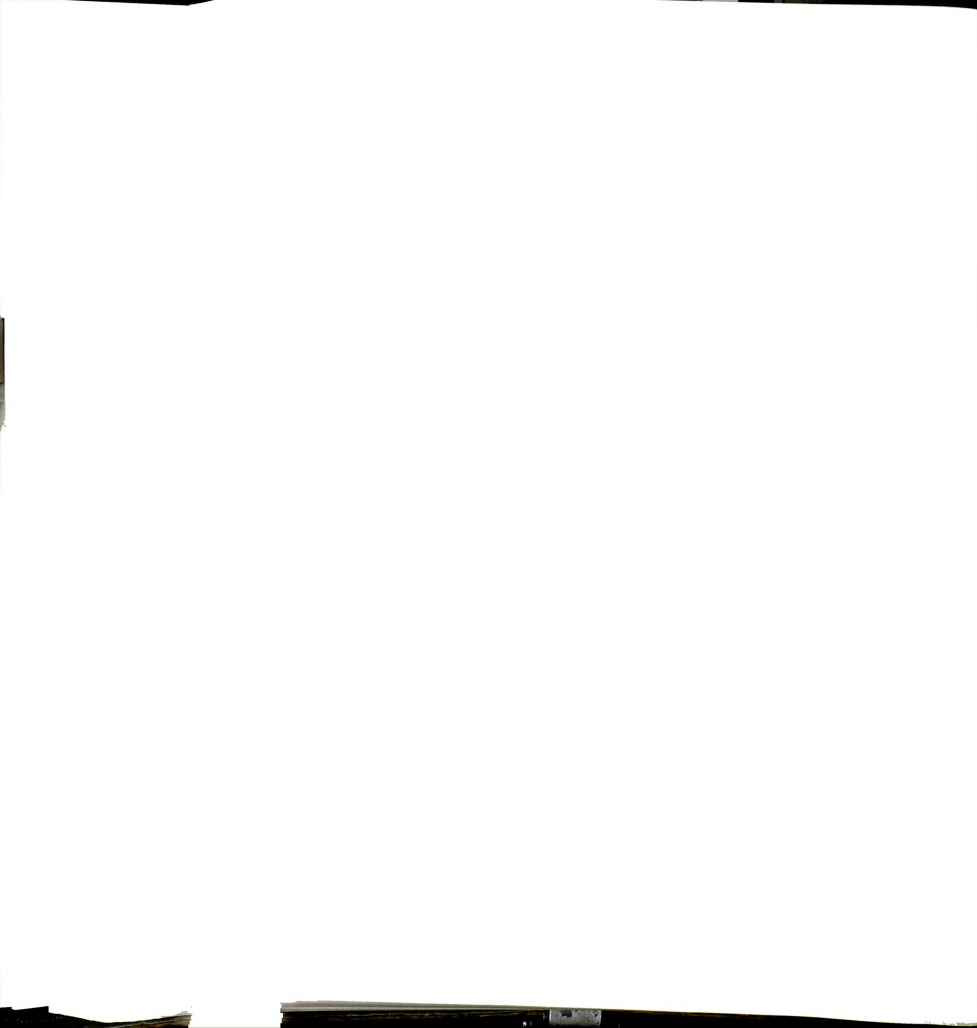
The value chain model, REA model and the Integrated Estimating-Job Cost-Financial Accounting Model defined the flow of information between estimating and accounting. Chapter three discussed the positive attributes a job cost accounting system can have for a construction company. Chapters four and five explored the use of a computerized integrated job cost and estimating system and tested the concept on two construction companies. The planning stage was shown to be the most important point of implementing a new system and this research effort lays the groundwork for the planning process through implementation.
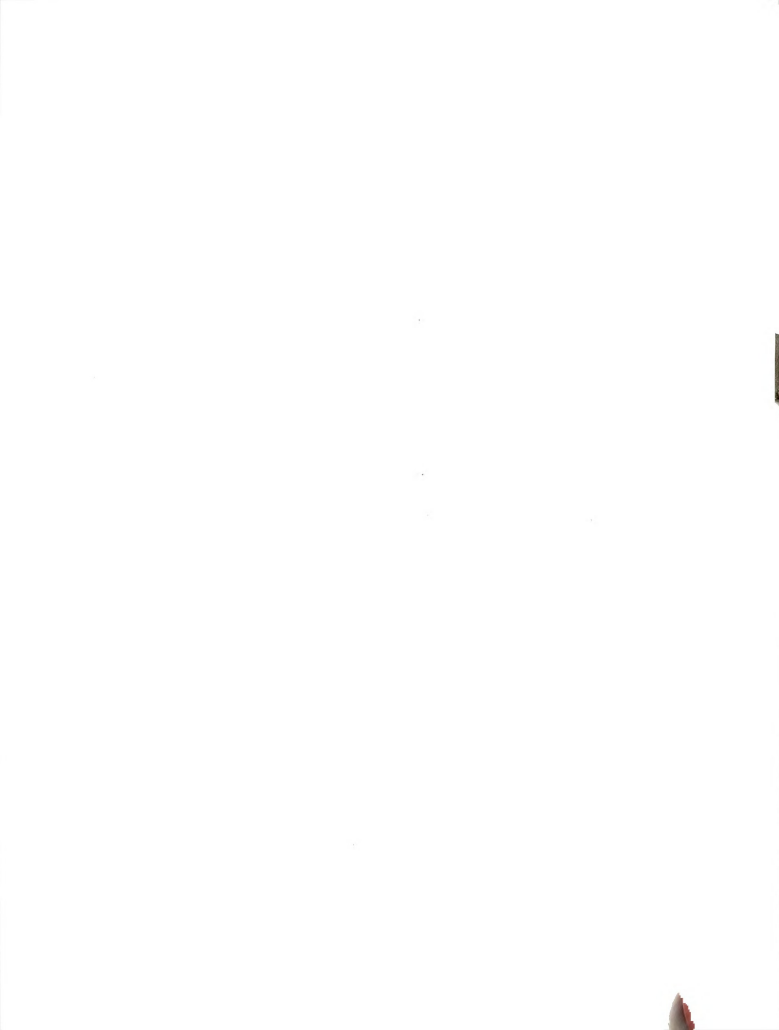
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