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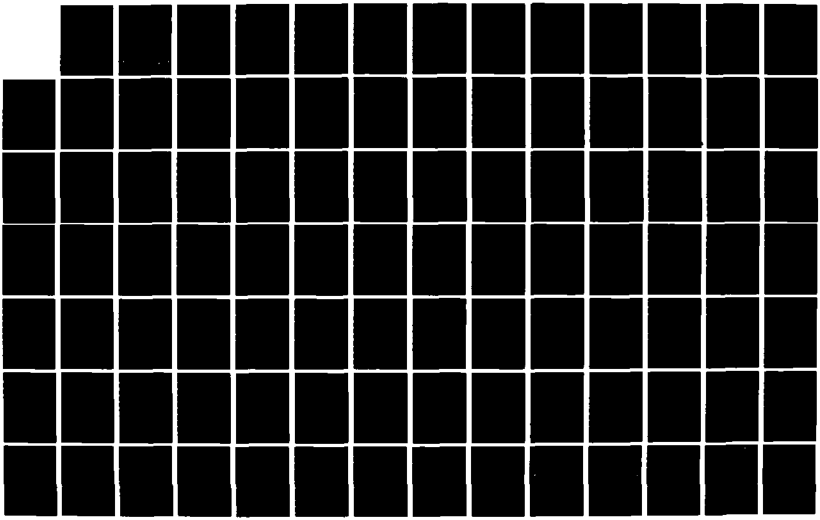

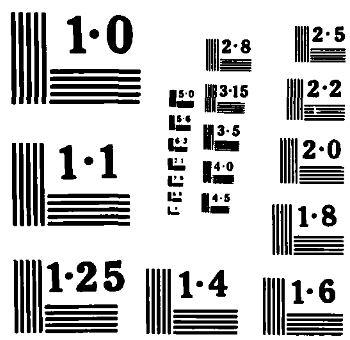

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USE AND APPLICATION OF COMPUTERS
IN CONSTRUCTION ESTIMATING

BY

TERRENCE R. HUXEL

A REPORT PRESENTED TO THE GRADUATE COMMITTEE
OF THE DEPARTMENT OF CIVIL ENGINEERING IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF ENGINEERING

UNIVERSITY OF FLORIDA

SPRING 1985

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DEDICATION

This report is dedicated to my wife, Jan. Her love, patience and support have given me the strength and purpose to complete this work.

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ABSTRACT

Construction estimating is a major function in the construction industry. Estimates range from being preliminary (owner's feasibility analysis of proposed project), to very detailed (contractors submitting bids that are low enough to get the award of the contract but still sufficient for contractors to earn a profit, not sustain a loss). New technology has advanced the capabilities of the "tools" that aid the estimator in predicting job costs. The most recent tool is the computer. Computer estimating systems help to eliminate the human error and reduce the time elements of estimating. The computer is able to store data and process it and new input through programmed software which calculates the costs of the estimate. The software can be purchased as packaged programs or developed by the user. The software must be able to calculate the desired output or the entire system will be inefficient. The computerized estimating systems are relatively new and their use in the construction industry is increasing. The applications of the computer estimating systems vary from company to company but they have improved the timeliness and accuracy of cost estimates.

CHAPTER I
INTRODUCTION TO CONSTRUCTION ESTIMATING

1.1 Statement of Purpose

The purpose of this paper is to provide a general overview of construction estimating and an insight to computer-aided estimating. Increased knowledge about computerized estimating and confidence in the computer's potential use can result in providing more timely and accurate estimates. Although computerized estimating is relatively new in the construction industry, its usage has been proven to be beneficial as will be seen through case studies provided in this paper.

1.2 Development of Construction Estimating

Estimators have always been associated with the construction industry; although it wasn't until recent years that greater emphasis was placed upon estimating. In the beginning years of the construction industry, the estimate was very elementary in that it answered the basic questions: 1) Is sufficient material available? 2) Is sufficient manpower available? and 3) How long will the construction take? The question of cost wasn't a big issue because competition in construction was minimal; thus a contractor was easily awarded a project for his proposed cost. Within the last fifty years, though, the attitude toward the cost of construction has changed drastically; so the estimator's job has changed significantly, too. "This change is due to the increased complexity and size of construction projects, changes in economy, changes in estimating tools and in the magnitude of competition for the jobs" (8). The ability of the estimator to predict, as accurately as possible, the cost of construction today, correlates directly to the survival rate of a construction company. The timeliness and accuracy of the construction contractor's estimate is fundamental to his existence. This is why today's estimators are looking for better and more accurate tools to calculate their estimates. In recent years there have been advancements in mechanical quantity take-off aids and calculators. These both aid in the accuracy of manually calculated estimates. "The single biggest change, however, is the use of the computer in aiding the estimator" (8). The use of computer estimating is relatively new, but its acceptance is increasing continually. The role of the computer is to store data and process input and data through programs, thus producing costs for items of construction. The computer reduces the human time element and the human error element in estimating.

1.3 Introduction to Estimating

Estimating is perhaps the most difficult phase of any construction project. The livelihood of the contractor depends upon his bid. The contractor is trying to arrive

at a price that will provide him with the award of the contract and also allow enough profit to make the work worthwhile (25). There are many methods used to arrive at the bid price but they are all approximations based on judgment, data and experience. The estimator must build the project on paper to get an accurate estimate. This will include being able to determine all material, labor and equipment needed for the entire project from a set of drawings and specifications. For each area of construction work (e.g., formwork, masonry, concrete, etc.), he must:
1) hypothesize alternatives to lessen project costs;
2) determine availability of labor; 3) determine equipment needs; 4) calculate material needs; and 5) determine the productivity (3). Once each section of construction is estimated, a cost for project overhead, profit, and mark-up is added to complete the estimated cost. The extent of the accuracy of the estimate is based on the amount of detail and use of accurate techniques applied in determining the total cost (2).

Estimates are also based on the available information and experience of the estimator. The amount of available information determines the extent of the estimate: the less the information, the more preliminary the estimate; and the more detailed information, the more detailed the estimate. Preliminary estimating methods are not as numerous as the detailed estimating methods. The preliminary estimates are therefore less accurate, but they are acquired faster and change orders, both additions and deductions, during construction. Also, this type of bid gives those involved detailed insight to all costs and can determine the expensive portions of the project. This estimate is good because if the project is estimated over budget, proper changes can be made to enable the project to be completed without redesigning the entire project. This also aids the contractor in determining the costly sections of work and possible delay areas. Profit is dependent upon the accuracy of the unit cost per item; thus great care must be taken when preparing this type of estimate.

2.4 Summary

Various estimating methods are used when calculating costs because estimates are used for different reasons and, thus, provide different answers. The estimating methods looked at in this section range from relatively simple (preliminary) to very detailed estimates. The method chosen must be adequate to provide the desired estimate. The owner, designer, and contractor's needs for estimates differ; therefore, various methods are used.

The preliminary estimates are used mainly to insure the economic feasibility of the project. This estimate is extremely important to the owner and designer because it sets a basis for formulating costs. The detailed estimate is much inaccurate bid. This type of bid does aid the prime contractor if he plans to subcontract the entire project. In this case, subcontractors submit their costs to the prime contractor who, then, includes the costs of all subcontractors' bids to arrive at his bid estimate. This is a convenient way to do an estimate, but if the final cost is not calculated with care, the contractor will be responsible for any additional costs encountered during construction. Therefore, his lump sum bid must be based on accurate estimating to be both competitive and insure a profit is made (15).

2.3.3 Detailed Unit Cost Estimate

There are both preliminary and detailed unit cost estimates. The difference is that the detailed unit cost estimate is based on a complete set of drawings and specifications and each item in the contract has a quoted price (e.g., cost per cubic yard of concrete). Using the information from the drawings and specifications and cost data, a cost per unit of each item can be calculated. Then this value is escalated to include the indirect costs (overhead and mark-up). This total cost per unit is then listed in the bid. The total cost of a project is then calculated by multiplying each unit cost by its respective quantity. This type of estimate is most commonly used when there are expected

2.3.1 Quantity Surveys

To arrive at a cost estimate that is as close as possible to the actual cost of construction, the quantity survey method is used. This method entails getting actual quantities of materials needed from either detailed drawings or field surveys. These quantities are then multiplied by the cost of material, the cost of labor, the cost of equipment, and added to the overhead and mark-up to reach a total cost estimate. This estimate is acquired from a detailed study of the project, the price tendencies of the area, the costs of similar projects, the cost of managing this type project, and the desired profit of the company. The accuracy of this estimate is dependent upon the time and effort spent preparing the estimate as well as the knowledge of estimating and experience of the estimator. This estimate is the total construction project completed on paper, a detailed estimate (6).

2.3.2 Lump Sum

Oftentimes, the owner wants to know just the total cost of a project. In this case, the contractor submits a bid with the only cost figure being the total cost of the project--a lump sum cost. This is convenient for the owner but the contractor must do a detailed estimate to arrive at this price or he may lose money on an

The detailed estimate is more expensive than the preliminary estimate. It involves much more time in both gathering information (project drawings and specs, cost data, etc.) and doing the cost calculations. The accuracy of the detailed estimate is proportional to the time spent preparing it. "The time factor involved in preparing the detailed estimate is dependent upon the estimator's proper evaluation of the five basic factors making up the estimate: 1) Labor productivity; 2) Market competitiveness; 3) Effects of local practices; 4) Forecasted weather condition; and 5) Plans and specifications of the project" (2). The experience of the estimator and the availability of a good cost data base are also extremely important in formulating an accurate detailed estimate.

Three types of detailed estimates that will be discussed are: 1) Quantity Survey; 2) Lump Sum; and 3) Detailed Unit Cost Estimate.

Whatever the method, though, the process in formulating a bid through estimating is similar:

PROCESS

Owner request for bids

Contractor receives contract documents

Quantity take-off

Pricing of direct abor & material	Equipment cost	Sub-contractors' estimates

Job overhead — Company overhead

Profit

Bid

these volumes by designated price as per type of construction. This variation can be computed in another way: take a percentage of the unfinished volume and the total of the finished volume, add them together and multiply by one cost per cubic foot. Either of these variations reduces the costs of nonfinished volumes, and thus produces a more accurate estimate (22). An example is included in Appendix 4.

The only drawback to this type of preliminary estimate is that it is best used for totally enclosed spaces (warehouses, etc.). If semi-covered or open areas are to be estimated, they must be done separately from that of the enclosed building. Thus, the cost and time to estimate will increase. When estimators begin increasing the time and money to increase this type estimate it may be more worthwhile, and definitely more accurate, to produce a detailed estimate.

2.3 Detailed Estimates

This section will review some of the detailed methods of estimating. A detailed estimate is more accurate than a preliminary estimate and provides a complete listing of the construction costs for a project. The detailed estimate, prepared by the contractor, includes the direct costs of construction, the overhead cost related to doing the project, and the potential profit for the contractor.

design; thus the drawings are not detailed. Walls and stairwells may be excluded from the drawing; and so the estimate will be under priced. Another more serious problem is insuring that the correct cost per square foot is used. The cost per square foot is an average estimate because a square foot of space (area in center of room) has minimal cost compared to that of a square foot of wall area, cabinet space, etc. In this method, every square foot is considered to cost the same, so the problem lies with determining the cost as per type of construction employed. The best way to lessen this problem is to keep accurate records and produce one's own cost data base (15).

2.2.4.3 Cubic Foot Estimates

The cubic foot estimate is similar to that of the square foot method. The only difference being that the estimated cost is determined by the cubic feet of volume of a proposed building. This method is more accurate than the square foot method. To calculate the cost, simply multiply the total volume of the building (cubic foot) by a selected price per cubic foot from a similar type construction. A more extensive type of cubic foot estiimate can also be done. This type involves separating volumes of the building into various categories (i.e., basements, attics, office space, etc.) and multiplying residences, and garages. This method compares the costs of various buildings of similar type or where floor area is important. This method can also aid in calculating the function element of the function estimate.

There are four variations of the square foot estimate. The first is to allow a certain price per square foot of floor, including basements, roofs and attics. The second is to use different costs for the basement, the roof, the attic, and the other floors. The third is to use different costs for the different floors. The first floor will include the cost of the foundation and basement. The price of the upper floor should include the roof and the attic costs. The other floors are estimated individually. The fourth method is to use the same unit cost for all usable floors, omitting the roof area and basement area. The areas of the roof and basement are calculated separately. If there is a porch or semi-covered area, the cost of this section is calculated by multiplying the unit cost by half of the actual area. The fourth method is preferred by most estimators (22). There is an example in Appendix 3 using the different methods.

There are difficulties in calculating square foot estimates. The actual floor area may be different than the area used to calculate the estimate because this estimate is usually done in the preliminary stages of

2.2.4 Unit Cost Estimates

There are different types of unit cost estimates, but if based on reliable data and used properly, their results are acceptable. These estimates are used mainly by owners to determine if the project costs are within tolerable budget limits. The estimates are quick, easy and relatively inexpensive; and their resultant cost estimates prove to be within an acceptable percentage of accuracy. Three types of unit cost estimates are discussed.

2.2.4.1 Function Estimate

The function estimate measures the cost of a building relative to its function. An example of this is a hospital's construction cost which is relative to the number of beds proposed for the new facility. The estimator must know or estimate the costs per functional element (e.g., cost per bed). This value is then multiplied by the number of beds which gives the estimated total cost of construction. This is a simple estimate that compares like projects to get the estimated cost (1).

2.2.4.2 Square Foot Estimates

The square foot estimate is applicable to structures such as office buildings, schools, warehouses, factories, hospitals, churches, stores, This estimating method deals with equipment installation of a project (e.g., pumps, refrigerators, etc.). It is used mainly in industrial construction. There are two approaches to this method. "The first approach, the equipment-cost-ratio, multiplies the purchase price of the equipment by an empirically documented factor (published listing of calculated factors by the construction industry) to estimate installation costs, including shipping, erection labor, ancillary fittings and supplies" (2). Appendix 1 is an example of a list of equipment installation factors.

"The second method, plant-cost-ratio, multiplies the vendor-price-quotations by predetermined factors of various pieces of equipment to calculate the estimated cost" (2). Appendix 2 is an example of a listing of factors used in the plant-cost-ratio.

Both types of estimates are dependent upon good data to produce the factors used for each item. The estimator's judgment regarding such things as degree of shop fabrication, productivity of labor field, etc., plays an important role in upgrading or downgrading these factors as each project dictates. The accuracy of these two types of estimates fluctuates easily; therefore, it is used only as a guideline or ballpark figure by the owner or designer.

$$C_2 = C_1\left(\frac{Q_2}{Q_1}\right)^x$$

C_2 - estimated cost of new facility of capacity (Q_2)

C_1 - known cost of facility of capacity (Q_1)

x - cost capacity factor for this type of construction

Q_1 - gross floor area of an existing structure

Q_2 - gross floor area of proposed structure

The cost capacity factors vary with the type of construction project. This estimate is an approximate cost of a proposed project. This estimate, when used, is used mainly in the early stages of a project's life, by the owner, to get a general idea of the total expected cost. Some estimators have increased the accuracy of the cost capacity estimate by combining it with the cost index estimate. This is done by using the following equation (also from reference #2):

$$C_2 = C_1\left(\frac{I_2}{I_1}\right)\left(\frac{Q_2}{Q_1}\right)^x$$

(All values remain as previously defined.) This estimate is also an approximated cost but it is more realistic compared to the actual cost than is the capacity estimate (2).

2.2.3. Component Ratio

Component ratios are sometimes referred to as either equipment-installation-cost-ratios or plant-cost ratios.

$$C_c = C_r * \left(\frac{I_c}{I_r}\right)$$

C_c - present cost in dollars

C_r - original reference cost in dollars

I_c - index value at present time

I_r - index value at time of reference cost.

When choosing the indexes to use, the estimator should make sure they reflect the entire construction project, region, local environment, economy of indexes of the area, etc. The indexes, though, are not complete and accurate because there is a lot of complexity in determining these values. A listed cost index applies to a specific place and time; thus, it does not directly reflect accurate conversion factors or previous prices to present prices. The estimates are good, but not accurate enough to base the future of a construction company's success. Therefore, they are more commonly used to calculate preliminary estimates (2).

2.2.2 Cost Capacity

The cost capacity estimate is similar to the cost index estimate in that it uses past data to calculate a present or future cost. It takes into account changes in size, scope or capacity of projects of similar types. The equation used is very straightforward and taken from reference #2:

2.2.1 Cost Indexes--Cost Over Time

The costs of one project are not the same for another similar project. The changes in cost are due, in fact, to inflation. Because of inflation's impact on cost and/or productivity, the estimator must continually adjust the costs and/or productivity for inflation. Cost indexes are one means for this needed adjustment.

"Cost indexes reflect the changes in construction, methods, productivity and inflationary trends from year to year" (2). These data enable the estimator to forecast the costs of similar projects from past to present and/or future periods without doing a detailed estimate. A reasonable cost approximation should result if the estimator uses discretion in choosing the proper index.

Cost indexes convert applicable costs of similar past projects to equivalent costs now or in the future. The cost indexes can be either found in published reports (e.g., Building Cost Indexes, Wholesale Price Index, and Construction Cost Index) or the estimator can develop his own index; "whichever the case, the cost index is merely a dimensionless number for a given year showing the cost at that time relevant to a given base year" (2). The cost of construction is determined by multiplying the previous known cost by the number or ratio of the present index value to the index value calculated at the time the previous cost was obtained. The cost is calculated by the following formula from reference #2:

CHAPTER II
DIVISIONS OF ESTIMATING

2.1 Introduction

"There is no business skill of more importance to the construction industry than estimating" (8). Accurate estimating is important to the owner, the design team and the construction contractor. The owner judges the economic feasibility of a project on the basis of the cost estimate. The design team prepares detailed estimates in order to determine the scope and cost of each proposed design element of the project. The construction contractor prepares a detailed estimate whose accuracy is of utmost importance since it is the basis for his winning or losing the contract. The contractor's estimate should also clearly outline the potential profit most likely to result from efficient and timely performance (1).

The estimates needed by any party may vary from one project to the next. The needed estimate can be as preliminary as a "ball-park-figure" to as detailed as an individual item unit cost for each item involved in the project. The various methods of estimating, both preliminary and detailed estimates, will be reviewed in this chapter.

cost less. The preliminary estimates are based on prelimin-are designs and used generally for determining the economic feasibility of the project. (Are the costs affordable at this stage?) If the project progresses beyond the preliminary stage, additional information will be collected, structured and varied before the detailed estimate is made. Most estimates used by contractors to bid on projects are detailed estimates (1). Both preliminary and detailed estimates are calculated by mathematical formulas that can be solved by using manual calculations or by a computer. In this paper various estimating procedures will be reviewed, as well as the use of computers in determining estimated construction costs.

1. Summary

Estimating has become an increasingly important fundamental practice of the construction contractor. His ability to calculate timely and accurate estimates reflects his potential to be successful in the construction industry (12). New technology has improved the contractor's estimating ability. This technology can be used at any stage of the estimate, preliminary or detailed. "Construction estimating will never be totally scientific, it is partly a science and partly an art" (1). New technology aids in increasing the accuracy of the science and experience of the estimator improves the accuracy of the art. Accurate estimating optimizes good contracting.

more important to the contractor because the timeliness and accuracy of the estimate determines if he gets the contract or not. "The estimate's accuracy depends upon the judgment, skill, and experience of the estimator; upon the care with which the estimate is prepared; and upon the correctness of the prices used" (22). The detailed estimates are more time consuming; therefore, more expensive. However, accurately estimated costs result in the concractor being awarded contracts and making a profit from his work. Good estimating is the essence of good business.

CHAPTER III
COMPONENTS OF AN ESTIMATE

3.1 Introduction

Estimates, no matter whether they are preliminary or detailed, are all calculated from determining costs of material, labor, overhead, equipment and profit. These are the most commonly calculated components of the total estimated costs. Some projects do not call for all these components to be calculated for the estimate. On occasion, there are additional components to an estimate that must be included beyond those listed above (e.g., bonds, licenses, etc.) The basics for calculating the five basic components will be reviewed in this chapter. The review of these components is based on chapter two of Jack Lewis' book, Basic Construction Estimating (Reference 15), and lecture notes from Dr. Herbsman's class, Cost Estimating, Fall 1984 (Reference 11).

3.2 The Estimate Components

The square foot, quantity survey, lump sum, and the unit cost estimate are the most commonly used estimates in the construction industry. These estimates, if done accurately, enable contractors to be competitive when bidding jobs.

The five major components of these estimates are: 1) Materials, 2) Labor, 3) Overhead, 4) Equipment, and 5) Profit. If care is taken in each of these areas of an estimate, a contractor's bid will reflect the actual costs the contractor will encounter if he is awarded the job.

3.2.1 Materials

To calcuate the amount of material needed for a project, the quantity take-off method is usually used. It is simply the amount of material it takes to do the construction plus allowances for waste. Waste is the excess material ordered for but not used on a project. Waste could be as low as zero percent, mechanical units, or as high as 40% of material cost. The waste allowance depends upon the type of material as well as the type of construction. If waste is controlled, material cost will reduce. It is hard to calculate the exact amount of waste for a given project. This is one area where the experience of the estimator will contribute to a better estimate. His experience of past similar projects as well as historical data will benefit him in a more accurate material estimate.

3.2.2 Labor

One of the most difficult portions of the estimate is the determination of actual labor costs. There are many influencing factors when determining the costs.

The most apparent is that of productivity. Not all personnel work at the same pace. Unions have tried to set a "standard pace" by having rules which set maximum amounts of work per working period. (This limits output and over-predicts productivity if the maximum is not achieved.) The influencing factors include: location of project, weather conditions, union rules, etc.

Updated information regarding labor cost is readily available for most construction. (One such resource is Means Building Construction Cost Manual.) These guides are only valuable as general information because they do not consider the influencing factors for a given job. In essence, the best way for a contractor to estimate labor costs is to keep good up-to-date company time and cost records. From these records, the experienced estimator will be able to predict labor costs for different items of construction for future projects.

3.2.3 Overhead Costs

A successful construction company is run by experienced management. Like labor and material, management needs to be paid for by the various projects. Included with management costs are office equipment, office staff, office rent, utilities, stationery, insurance, etc. These costs are all fixed or permanent items relating to the cost of maintaining the business. These costs are equated on a cost-of-construction percentage or calculated as weekly or hourly amounts charged to each project. The size of each project dictates the the magnitude of fixed overhead costs assessed to that project.

There are also variable overhead costs that are directly related to each project. Examples of these are: utilities for the site; fencing and security measures; job permits; etc. There are two ways to account for variable overhead in an estimate: 1) include as a lump sum amount; or 2) list as a percentage of cost. In either case, this cost is assessed to the project.

The total of both fixed and variable overhead make up the total overhead charge assessed to a project. The accuracy of this cost is dependent upon accurate data and the experience of the estimator. Improper calculation of overhead costs can cause the company to lose money on a job or prevent it from getting the job. Care must be taken in this area because there are no set overhead costs; they vary from job to job, company to company.

3.2.4 Equipment

The cost of equipment used on a project must be recoupable. This estimate will be different if the equipment is owned or leased. If owned, the depreciation, investment, maintenance, and operating cost must be taken into account. Each project must return a portion of the cost of equipment over its useful life. If the equipment is leased, the contractor need only be compensated for the costs of operation and rent. The leased equipment costs are easier to calculate. Equipment, owned or leased, is an essential part of the estimate.

3.2.5 Profit

The mark-up is the most questionable area of the estimate. There is no set percentage; therefore, it can range from 1% to 50% of the contracted amount. The construction industry seems to go from "times of plenty" to "times of scarcity." During times of plenty, the mark-ups are high. The contractor feels he can get a better price because of the magnitude of work. In retrospect, though, it is just the opposite during times of scarcity. Contractors may work for costs just to stay in business and keep their crews together.

Every business operates to make money and in the construction industry the only way to do so is to make more money than it costs to do a project. The mark-up portion of the estimate fluctuates most from job to job; therefore special attention must be given to this area. The larger companies try to be consistent in this area, working for a 5% to 10% profit on every job; whereas the samller companies fluctuate more readily with the times of plenty and times of scarcity theories.

3.3 Summary

The components of an estimate vary with the project type. Because they make up the total estimate, it is essential that great care be taken in calculating their cost. Estimators are continually searching--trying new ways to increase the accuracy of the component costs of the estimate. Today, computers aid the estimator in calculating the component costs. In the following chapters, 4 and 5, the make-up of the computer and its application to estimating will be reviewed.

CHAPTER IV
TODAY'S COMPUTERS: THE DESK-TOP MICROCOMPUTERS

4.1 Introduction

There have been extensive changes in computers since the late 1940's. The changes have been in both technology and in the machines themselves. The new technology has increased the computer system's capabilities in manipulation of numbers (data) to produce various outputs (e.g.: accounting, payroll, job scheduling, quality control, estimating). The changes in machines deal with going from large expensive mainframes to desk-top microcomputer systems. Prior to the arrival of the microcomputers, the high cost of the computer mainframe limited its usage in many construction companies. The development of powerful low cost microcomputers has made it feasible for all sizes of construction companies to automate their company (12). In addition to the low cost, microcomputers are flexible in that they make it possible to develop interactive programs that are similar to manual processes employed by the company. Thus, the computer output results are similar to the manually calculated outputs for functions such as purchasing, bookkeeping, accounting, payroll, estimating, etc. The computer system's usage is ever increasing because of the low-cost, high-power systems and because a knowledgeable user can benefit in both time and money by utilizing the microcomputer and all its capabilities.

4.2 Today's Computers

Today's computers have increased memory capacity, are able to retrieve data from remote locations (other storage banks), can execute several different calculations, do various jobs simultaneously, allow the user to control the input data, and offer inherent user-friendliness. "This new generation of computers referred to as microcomputers has revolutionized electronic data processing" (12). Microcomputers do not require special installation, electrical or environmental. The computers are easily handled, small enough to fit on a desk top, and their power source is an ordinary electrical outlet. These units are self-contained within the user's office, therefore there are fewer problems with confidentiality of information (12).

The microcomputers consist of two major components: the hardware and the software. When purchasing a computer system, the purchaser should be certain that programs (the software) can be bought or written for the system purchased (the hardware).

4.2.1 Hardware

Hardware consists of the physical components of a computer system. It is the electronic circuits and mechanical parts which make up the computer. The basic pieces of hardware are: the input device (keyboard), the central processing unit (CPU), the output device (screen, printer, etc.), and in some systems, secondary storage units. There are other pieces of hardware (plotters, graphics, etc.) but they only need to be purchased if the user desires these capabilities (7).

There are many hardware systems on the market today. The system chosen, though, must have the upward compatibility of software to manipulate the data to produce desired results. The hardware executes the program. Simply, it stores, controls, and processes the input data into useable output data.

4.2.2 Software

Software is the set of programs, rules, documentation and procedures associated with the operation of a computer system. Software is the lifeblood of the hardware. Its function in the computer system is to manipulate the stored and input data into useable output (13).

Software can either be written by the user or purchased as complete packages written by hardware/ software manufacturers and/or consultants. Whichever the case, the software used must be capable of manipulating numbers as needed by the user.

4.3 Summary

The computer's usage in the construction industry is continually increasing. This acceptance is due largely to the fact that high-power, low-cost microcomputers are available and are user-friendly. Their use ranges from routine bookkeeping to detailed estimating. Whatever their uses, though, it is imperative that the software needed be compatible with the hardware purchased. Hardware should not be purchased until it is certain that it is capable of handling all software needed by the user. As will be seen in the next chapter, cost estimating is one area of computer usage in which good software should be purchased or developed before purchasing the hardware.

CHAPTER V
COMPUTERIZED ESTIMATING

5.1 Introduction

Accurate cost estimating leads to good business. Estimating, though, is a risky, complex and expensive practice. A good estimator calls upon experience, judgment and resources to perform each estimate. In the past, estimators only had pencils, paper, scales and calculators to assist them in cost estimating. Today, however, they have a new tool, the computer, to aid them in estimating. The computer has the capaability to store large amounts of data and the ability to process and do calculations on this data instantaneously. It also has the capability of taking input data and calculating needed costs from it. The computer output is only limited by the estimator. It will produce that for which it is programmed. A good computerized estimating system enables the contractor to produce timelier and more accurate estimates and have more confidence in these estimates than those manually calculated.

Success in the construction industry is contingent upon the estimator's ability to produce timely and accurate cost estimates (12). Because of the importance of estimating, it is essential that the estimator use the most reliable tools to aid him in producing the best estimate. Computers are the new tools available today. Since computers are costly and their use in estimating is relatively new, care must be taken when purchasing a computer. "Whatever the situation, first-time purchaser or not, a systematic approach with certain key elements should be utilized in the selection process to insure what will hopefully be the right decision for the right reasons" (5).

5.2 Determining Goals and Objectives for Obtaining A Computer Estimating System/Qualities of A Computer Estimating System

Before venturing into the computer market, goals and objectives for a desired system must be established. These goals should be developed by the firm with no outside influence (computer salesman). With the goals and objectives outlined, the purchaser must then familiarize himself with a computer's potential to assist in achieving the set goals. This knowledge will enable him to ask the intelligent questions to determine if the product is indeed usable and applicable for the company (18).

In establishing the goals of an estimating branch, the mission of this department must first be established. For estimators, this mission, in general, is to provide timely and accurate estimated costs for a project. Timely, in that they are produced in the most efficient way and in advance of a bid date. This enables the estimator to evaluate and analyze his bid and make cost-saving adjustments to it. The accuracy is that the final estimate is as close as possible to the final construction cost. The accuracy will increase if the potential mathematical errors associated with estimating are eliminated. The use of computerized estimating will reduce both the time to do the estimate and the possible mathematical errors in estimating. It is at this point that the computer packages available in construction estimating can be examined to find the compatible system to produce the output sufficient to complete the mission of the estimating department.

Examining the computer packages is not taking the list of goals and asking a salesman if his system can produce output to achieve them. Rather, the company should have someone from within, who is knowledgeable of computers and who knows what to look for in a system, select a package (12). There is a checklist of specifications that can be used as an outline or as a complete basis for evaluating systems. This was written by Lee A. Peters (Reference 18) and is as follows:

1) Interactive Input. Batch and Interactive are two ways in which to enter data into a computer. Batch input means that the data are input and then run at one time. Interactive input means that the data are entered into the computer as it is obtained or developed.

The interactive input allows the estimator to review his assumptions and quantities as they are entered into the needs. This selection process is well worth the cost and effort if the system that is purchased will aid the estimator in producing timely and accurate estimates. The software packages available must suit the company's needs or software must be developed for the company. Whichever the case, the computer is the new tool to aid estimators.

The benefits and competitive edge gained with using the computer are sufficient to entice all estimators to inquire about the computer's capabilities. These benefits should encourage all companies to develop a computerized estimating system. With new technology being advanced every day, the transition from one system to another will be easier than trying to "catch up" to the rest of the industry. The estimator's competitive edges are here and they will get sharper and sharper as today's technology is refined.

take-off, etc., because this information will be stored for similar projects. Also, it will reduce the manual manipulation of quantities and costs.

Third, the human error element in estimating will be reduced. It will eliminate calculation errors as well as provide a check-list to insure the estimate is completed correctly.

Fourth, and just as important as the others, it is easy to use. Once a system is implemented, it will be easy to train new estimators to use the system. This will provide more concise and similar estimates no matter which estimator is responsible for the cost estimate. It is also easy to revise the information stored in the data base. This enables the estimator to continually update costs, productivity factors, etc., to assure accurate costing is being used in calculating the estimate (26).

The benefits are good and the estimated costs are accurate if the right system is purchased and properly used by the estimator.

5.5 Summary

Selecting a computerized estimating system is not a "pick-off-the-shelf" type purchase; especially if the estimating is the lifeblood of the company. It is a timely and costly process to insure the system to be purchased is capable of calculating all costs associated with the user's

Some of the software packages are too advanced for the smaller construction companies. These packages offer many capabilities not needed by these small users; therefore, their software must be developed. (Appendix 6 is an example of a print-out utilizing a simple software package.)

The software chosen or developed must meet the needs of the user. At the same time, the user must be familiar with all the capabilities of the software package to assure its sufficient use.

5.4 Benefits of Computerized Estimating

If or when an estimator becomes familiar with and confident in using a computerized estimating system, the company will benefit from its adaption. First, the company will increase its marketing effectiveness. The computer will aid in developing more timely and accurate bids. By eliminating some of the time from the manually calculated estimate, the estimator will be responsive to the client. He will be able to give the client any cost data desired (e.g., item costs, job phase costs, equipment costs, etc.). Increasing his marketability will increase his productivity (26).

Second, the cost to perform the estimate will decrease. There will be less time involved in determining the cost estimate. The take-offs will be easier to do. A cost data base will eliminate detailed material take-off, labor

Some of the estimating software packages available are IBM, MC^2, and Spread Sheets (i.e., Vacs, Lotus, and Symphony). The IBM package, used by one of the companies in the case studies, Akira, is good for repetitive construction. Its capabilities include manipulating input data, lineal feet of wall and wall stud spacing to calculate the material needed for the wall; and by searching a cost data base, output the estimated costs of constructing the desired wall type. This is an excellent estimating procedure for repetitive type house building. By keeping an updated data base and inputting correct quantities, the estimated costs will be accurate. The IBM package has additional cost estimating capabilities but a total review is beyond the depth of this paper.

The MC^2 package (Appendix 5) is set up to aid the heavy construction estimator. After reviewing it, though, it is overly oriented toward repetitive type construction. The heavy and highway construction differs from job to job; therefore, these packages are not applicable for them. The ideal software for the large non-repetitive construction companies should have an accessible cost catalog of all possible functions of the compay and with a spread sheet be able to calculate the costs of different projects. Hubbard Construction Company (Case Study 4) is in the process of developing such software capabilities.

of software packages that will run on their computer systems. The hardware systems are capable of running software packages that are used for other functions (e.g., bookkeeping, accounting, scheduling, etc.) within the construction industry. The hardware chosen by the respective purchaser must be capable of running software that is needed for the desired functions. Estimating is one function; therefore, the hardware purchased is generally not just for estimating. To vastly benefit from the computer, the user must employ all its capabilities related to the operations of the employer (16). "Hardware selection, then, should depend on what software is available and what is the manufacturer's commitment to supporting software development" (16).

5.3.3 Computerized Estimating Software

Estimating software packages can be purchased or developed by the user. There are different estimating software packages available but their applications to various estimated projects are limited. The software packages on the market are best for estimating repetitive construction (e.g., housing construction). For nonrepetitive construction (e.g., heavy highway construction), though, these software packages are not as applicable. User developed software is better equipped to estimate nonrepetitive type projects.

Modern technology allows for data bases to be kept by a computer in three ways: the relational model; the hierarchy model; and the network model. Each model allows the data to be stored differently and therefore it can be accessed differently. The estimator's needs for cost data will determine which model is selected by the company.

Companies that have similar yet different projects (e.g., highway and runway construction) should have a large data base that is also easily and randomly accessible. An ideal cost data base would be to list all costing in a catalog format. Then, by inputting codes (relating data to each code), be able to retrieve the stored data for each code. This is expensive to set up and needs to be updated regularly, but once available, it will be a great aid to estimators. It will reduce the time and expense of manually calculating and/or researching project records to correlate the costs. This will allow the estimator more time to improve his "judgment calls" and reduce calculated quantity errors.

5.3.2 Computerized Estimating Hardware

Most of the computer hardware today can run various packages of software. The major American hardware vendors such as IBM, Data General, Wang, Digital Equipment Corporation, and Hewlett Packard, all provide catalogs determining if the project is feasible. The data base can range from a simple job history file to a detailed ready, (random), cost data base. The estimator for these projects must know the requirements of future estimates to insure that the cost data base he chooses is the most economical and has the capabilities to perform desired functions.

5.3.1.3 Definitive Estimates-Similar Projects-Highly Competitive Environment

This situation is the most rigorous case. In this case it is the contractor, his livelihood depending on contract awards, who must use all available tools to insure his estimate reflects actual costs. The data he needs may come from both subscription services and his private data base. The subscription service will aid in providing timely information of commodities, equipment items, and additional current prices. These current prices alone do not make an estimate; the quantities and past cost listings are as critical, if not more critical, in estimating construction costs. For similar type construction this data base can contain items as simple as nail costs or as complex as total excavation costs and total job costs. This stored information should be readily and randomly accessible.

The projects to be built will vary (e.g.: warehouse, school, housing development, etc.).

The data needed for these projects can be gathered from available services, i.e., Means Building Construction Cost Manual. The collection of a company data base is unrealistic because the projects are not similar and the cost data is useless for different projects. The services data, on the other hand, are up-to-date and can be purchased in book form or on a disket. The data obtained in this way are average, and for the level of this type estimate they are acceptable. This method is relatively inexpensive and the results are average. Therefore, the estimate developed from this cost data base is generally for feasibility purposes, not bidding purposes.

5.3.1.2 Conceptual Estimates-Similar Projects-High or Low Competitive Levels

This situation deals with estimates made for special type construction, i.e., nuclear power plants or chemical plants. In these fields, the production is similar from project to project but the competition for bid awards differs. The estimates made on these projects are largely based on past job costs. The extent to which the cost data base is relevant to the cost estimate is proportional to either the competitive environment for the construction project, or to the estimate used for

In order to make the purchasing and establishing of a cost data base worthwhile, the data stored must be useful to the estimator. The estimator must be able to use these data to prepare estimates for future projects. There are various distinct situations for forming a cost data base. The situation is dependent upon the company's construction activity. The more competitive the environment, the more detailed and accurate the estimate.

In the estimating process, the estimator needs a reliable listing of current figures as well as a comprehensive listing of the company's past record. The working environment will determine the size of the listing in the cost base. Mr. Gideon Samid (Reference 24) has generalized, in categories, the extent to which a cost data base may be needed. These categories suggest data base requirements for types of estimates in conjunction with the competitive market for which the estimate is used. An explanation of these categories follows.

5.3.1.1 Conceptual Estimates-Different Projects-Low Competition

This situation is typical for an estimate made for an owner. It is only a rough figure to present to upper management to determine the economic feasibility of a project.

projects. The majority of the packages deal with estimating repetitive projects, such as housing developments--both single and multi-family housing. Estimating packages for heavy construction estimating are available but do not always meet the needs of the various companies. Whichever software system is purchased or developed, it must be able to be used on the hardware the company owns.

The estimating software packages available are good, but because they are relatively new, their acceptance and usage by estimators is limited. One capability of the computer that is being used extensively is the cost data base. Its use is becoming more and more popular. Once this usage is established, companies tend to advance their computer applications to other aspects of estimating. Easily accessible cost data is a want and need of every estimator and the computer meets this need.

5.3.1 Cost Data Base

A cost data base is just what it says: a data base of costs. In his early work of developing a cost data base, C. J. Date defined it as "a system whose purpose is to record and maintain information." This definition has evolved since the early 1970's into today's interpretation: "a cost data base is a system in which data is kept in a way that will make it useful for future needs" (24). The word useful is stressed in this definition.

This will allow the estimator (user) to enter his data in the same form he uses manually. Once the user gains confidence using the computer, he may progress to utilizing the system's full capabilities.

9) Reports. The reports should be easy to read and allow options as to how the estimate is to be printed out. The estimate can be in the form of lump sum, unit price, labor costs, material costs, equipment costs, sub-contractor costs, overhead and profit, phase construction packages, etc. In essence, the report should be easy to read and list the estimated costs as per bidding instructions.

This checklist is rigorous, but it does provide a good basis for evaluating the various versions of computerized estimating systems on the market today. Established goals and objectives of a company will determine the extent to which these guidelines are followed. As will be shown in the case studies in Chapter VI, purchasing and using a computer estimating system varies with the size of the construction company. The larger the construction company, the more attention should be paid to the computer estimating system's capabilities to insure it can perform the needed functions.

5.3 Computer Estimating Systems

There are various software packages available to the construction estimator. They range from simple programs of single wall construction to heavy and/or highway construction estimate or on a completely different one. Also the user should not have to follow a given sequence to work on the estimate. He should be able to work on any portion of the estimate at any time. This allows the estimator to work on any estimate package, portion of an estimate package, or individual cost factors.

7) Quantity Survey. The system should be able to take a single set of input data and determine the quantities of work associated with any portion of the project. By entering a set of parameters, which identifies the work package, the quantities of work will be calculated, including all materials and crafts associated with this cost item.

8) Unit Pricing. "The system should maintain a listing of the most frequently used costs and variables used in calculating the unit prices" (18). The list should include material waste costs (percentage of material), labor costs, equipment costs (both rental and owned), labor productivity, and crew combinations. Also, the system should allow for unique input data (variables, costs, and unit prices) to be entered into the existing lists and used to calculate costs for these separate elements of work. This enables the user to update or change the listed items as dictated by the job. This process allows the estimator to keep and update the cost lists he uses for estimating unit prices.

The user should be able to enter the unit prices in any form: lump sum; crew productivity; man-hours per unit; etc.

costings of items, labor, etc., directly from the costing agent. The cost data base will be reviewed in greater detail later in the chapter.

3) Perform All Calculations. The computer must be able to handle all calculations, extensions and pricing for the estimator. It will perform those functions which are previously done manually. The mathematical errors are eliminated in this phase of computer estimating. Also, by the computer performing these time-consuming, manually calculated values, it enables the estimator to review and analyze the estimate, thus allowing the estimator to insure his judgment and experience variable related to the estimated cost of the project are accurate.

4) Allow Different Procedures. Every company and every estimator will have different estimating requirements. Therefore, the program must be adaptable to various estimating procedures. For example, determining the use of in-house labor as compared to a sub-contractor work force.

5) Allow Different Levels of Accuracy. The system should be able to estimate a project at either the preliminary level or detailed level of the same project or of different projects. The level of the estimate is determined by the input information in the computer. The more general the input data, the more preliminary the estimate; the more detailed the input data, the more detailed the estimate.

6) Multiple Users. The system must be able to accommodate more than one user. The users can work on the same

computer. This allows him to change, update, remove or expand data at any time. This gives the estimator the flexibility to change/correct the estimated costs as they are being calculated.

A preliminary estimate can be run at any time during the loading of the data to insure the input data are correctly entered and that the estimate is being processed correctly. This immediate feedback helps identify problem areas and aids the estimator in correcting mistakes. In the interactive mode, the estimator creates and controls what is entered into the computer to produce the cost estimate.

2) User Modified/Created Data Base. The user must be able to modify data or add data to the data base. This includes enabling the user to enter his own data base to adjust costs to the company's procedures, job location, time of project, method of construction or any other variation in productivity.

The user should be able to modify both parameters (dimensions or other elements that are used to define the limits of a physical item of construction) and variables (unit prices and productivity rates) for all cost factors. The data base should be easily accessible so that any person can update it. An example of this easy access is to have the purchasing clerk be able to update material costs, the engineer update crews and productivity rate for activities, and the estimator update quantities needed for various activities. This enables the estimator to get up-to-date

CHAPTER VI
CASE STUDIES

6.1 Introduction

This chapter will deal with the practical applications of computers when estimating the cost of construction. The case studies are based on interviews with various construction contractors in the Gainesville and Orlando areas. The interviews are found in Appendix 7 through 10. This is not an all-inclusive research of construction industries of these areas; rather, they are examples of how computerized estimating has been incorporated in the construction business. The contractors studied range from a small housing restoration specialist to a multi-million dollar heavy, highway construction company. The application of the computer in the different estimating procedures varies as determined by the estimator and/or available software.

6.2 Case Study I: Restoration Specialists Incorporated

Restoration Specialists Incorporated is a small cnstruction company managed and operated by its owner, Richard Goodman. The company's main business is that of housing restoration work, both remodeling and insurance claim repairs. The dollar magnitude of their work ranges from approximately one hundred dollars to ten thousand dollars per job. In order to stay competitive in this business, the company must have the ability to produce estimates quickly and accurately. To assist in estimating this type of construction work, Mr. Goodman has found the use of the computer to be very beneficial.

6.2.1 Computer Application

When the company began in April, 1984, the estimating was all compiled by manual calculations. The estimates produced this way were accurate but costly and time-consuming to produce. The insurance adjusters were not pleased with the time delays in receiving the estimates. In early August, on advice from others, Mr. Goodman purchased a Commodore 64 to aid in his estimating. He did not purchase a pre-programmed software estimating package. Instead, he chose to program his own software.

The program is very basic, but it satisfies the needs of his company. First, all the necessary input needs to be entered in the program. The input consists of: 1) who is doing the work (name and address); 2) who is receiving the work (name and address); 3) who is the insurance adjuster (insurance claim cases); 4) the units (square footage, lineal feet, cubic yards, etc.) for the items of work; 5) the material cost per unit item; 6) the man hours to accomplish work items; and 7) the cost per man hour. Each item of construction is entered in steps 4 through 6, one at a time, by answering questions on the computer. The computer then calculates the material cost per item, the labor cost per item, and the total cost per item. After the total actual construction costs are computed, a percentage of total costs for taxes, overhead, and profit can be added as desired job to job. The computer then prints out a final copy of the estimate one item at a time, and includes the percentage markup costs for taxes, overhead and profit. An example of this output can be found in Appendix 6.

To use this program, the units per area of construction work must be manually calculated, material cost from vendors must be accumulated, and labor cost known. This portion could be done by the computer, using a cost data base, but because the magnitude of individual jobs is relatively small, it is felt that it is cheaper to accumulate these data manually versus continually updating a cost data base.

The use of the computer in this company has improved the accuracy and timeliness of their estimates. Also, the insurance companies and other customers are more than pleased with the detailed cost estimate printout. At this time, the computer program incorporated by this company has proved to be very beneficial, if the company expands in the future, so will its computer application to estimating.

The data for this case study write-up can be found in Appendix 7.

6.3 Case Study II: Barry Ruttenberg Homes

Barry Ruttenberg Homes is owned and operated by Barry Ruttenberg. The company is located in Gainesville. Barry Ruttenberg Homes specializes in home building construction. The majority of their construction work is single, unattached home units or attached home units (townhouse type structures), to be built in new land developments. Their houses are all constructed from similar type plans. Each new development has a set variety of housing styles from which to choose. They build custom homes, but this is only on a limited basis.

Their estimating of job costs is all done manually. Because of the similarity in the houses they build (same square footage, lineal feet of walls, etc.), the estimates are relatively easy to calculate. The work is repetitive enough that the experienced estimator can predict the estimated housing cost to within 5% of the actual calculated estimate. They do have a computer, but its only function in estimating is providing a cost data base. This data base is an updated cost listing of all items they use in home construction. Because of their repetitive type construction this type estimating has been sufficient to date. The only problem with this is that they are beginning to build more and more custom homes, thus the estimates are no longer of a repetitive nature. The cost of each custom home must be estimated from ground zero. A complete and total estimate is needed for these new structures. Vicki Welch's opinion, their primary estimator, is that if they continue to expand in the custom home construction then a computer software package will be needed to assist in estimating these costs. Software packages are available to assist them but until future expansion of the company they will continue to manually calculate their cost estimates. The data for this case can be found in Appendix 8.

6.4 Case Study III: Akira Wood and Building Works Incorporated

The Akira Wood and Building Works Incorporated is owned and operated by Mr. Akira. This company does both cabinet and mill work and construction work. The cabinet and mill work comprises about two-thirds of the company's revenue and the construction work, mostly housing projects, comprises the remaining one-third of business. The information gathered for this case study can be found in Appendix 9, interview with Terry Rugger, Akira Wood and Building specialist.

6.4.1 Computer Applications

There are two separate functions of the computer in preparing estimates. The first is using Lotus to prepare a spread sheet to determine the cost per hour of the cabinet makers and mill workers. This is done by inputting cabinet production per day, hours worked, material costs and labor.

The second phase is the use of the computer to determine the estimated cost of construction. The software they use is a pre-programmed estimating package from IBM. This is a standard package set sold by IBM. This software is very applicable to estimating their construction jobs because of the repetitive materials, equipment, labor and supervision needed for their housing construction. The construction work can be broken down into sixteen divisions. The divisions can then be divided into a possible ten subdivisions and the subdivisions can be subdivided into one hundred parameters (items). This division of construction work breaks the job down into phases. The phase can be floors, rooms, areas, etc., depending upon the user's wants. These divisions include the costs of material, labor and equipment to complete each phase of the job. These divisions can be input in any order or sequence that the estimator wishes. Once the input divisions, subdivisions and parameters are recorded, the estimator need only input the take-off quantities (e.g., lineal feet of wall, square feet of floor, etc.) and the computer will then calculate cost per item, cost per phase and total projected cost. It must be remembered that the divisions, subdivisions and parameters need only be input once because these dimensions will be needed for all housing construction. The only needed input is the dimensions of new projects. The costs associated with each division, subdivision and parameter must be updated to insure more accurate estimates. The overhead and markup of the estimate is added as a percentage of total estimated cost at the end of the computer run. This computer's program offers flexibility in the desired output the estimator wants. Examples of various outputs are item costs, phase costing and lump sum costing.

The Akira company's application of the computer in preparing estimates is still in the preliminary stages because of lack of confidence and experience with computer usage. At this point, their estimates are being done by the computer and cross-checked by manual calculations. This presently used process is expensive and time-consuming, but in time they hope to build confidence in the estimator so he will use the computer for all estimates. The computerized estimates they have done have been very accurate and there is a consistency in the results. The data for this case study can be found in Appendix 10.

6.5 Case Study IV: Hubbard Construction Company

The Hubbard Construction Company's area of expertise is in heavy highway construction and heavy construction from the ground level down. An example of the construction from ground level down is the roadways and tunnel foundation of the Epcot Center. The company is located in Orlando, Florida. Their construction jobs generally range in costs from two hundred and fifty thousand dollars to five million dollars. The estimates for these jobs are time-consuming because each job is different; therefore, repetitive calculations from job to job, like in housing construction, are nonexistent. There are many types of material, labor and equipment that are not used on every job. Because there is this lack of repetitiveness in jobs, the estimator cannot rely on one type of packaged software to complete the estimate. Therefore, the use of the computer for Hubbard Construction Company's estimates differs from the housing construction estimator's uses.

6.5.1 Computer Application

To date, their use of computers in estimating project costs is still in the preliminary stages. The majority of estimates are being manually calculated because there is no established set of instructions to guide the inexperienced estimator in computer applications. Thomas McClelland, a member of the estimating staff, is working on the computer to develop a software package that will be useful for all types of construction jobs in which the company is involved. The best way to accomplish this is: 1) to set up a Symphony spread sheet to list costs and items; and 2) to develop a catalog of all items that encompasses their construction work. With this all-inclusive catalog of items and costs, they hope to be able to input codes and quantities, hours, etc., of needed items to complete any given job; and the spread sheet program will recall the cost from the data base and then calculate the cost of each item of the project. The idea behind this approach is to have one cost data base but be able to modify it as per job. They are using the spread sheet method now, but the cost data base is not all-inclusive; therefore, additional input of costs have to be included as per job. Refer to Appendix 11, the spread sheet estimate being used by the company. Appendix 12 is a listing of material costs by item number. This list is used continually. When an item number is called in the spread sheet estimate, it goes to the material cost index and, by multiplying this by the quantity input, the total cost is calculated.

The other job descriptions that do not have item numbers (e.g., clearing and grubbing), and which are not part of the data base, have to be input into the computer as the job dictates. The crew size, labor cost and equipment cost must be predetermined before inputting this data into the spread sheet. This portion of the estimate does not save any more time than if manually calculated. Once a catalog is developed for all these costs, the only needed input will be item numbers and quantity take-offs for the entire project. Then the program will calculate all the unit costs and total cost for the entire project.

They also use a separate computer to assist in determining excavation and earth work quantity take-offs. By inputting "X" and "Y" coordinates of a site and zero basing the desired elevation, the computer formulates a two-dimensional layout of the area. Then by inputting the various elevations, the estimator imposes a grid type pattern in the computer. The computer, through cross section analysis then calculates the cut and fill quantities of excavation work. The computer will then print out cross sections of the site, diagramming the fill and cut excavation to be done. (An example of such a cross section is found in Appendix 13.) Then it will print out the cut and fill quantities of each programmed cross-sectional area. (An example of this print-out is Appendices 14 and 15.) This approach to quantity take-off of earth work has proved to be more accurate, but not any less time consuming than manual calculations. The time to input all the variables of the cross sections that were preselected before going to the computer takes as much time as manually calculating the quantities. The use of the computer with this portion of the estimate is left to the discretion of the estimator.

6.6 Summary

As shown by the case studies, construction companies varying in size, have found the computer a help in improving the quality of their estimates. The smaller companies' use of the computer is basic, but it meets the companies' needs. The housing construction companies, because of their repetitive work have the ability to work with packaged software to get their desired output. They save time and money by not having to program their software. The heavy construction company, though, is tasked with developing its own software because of the complexity of its jobs The underlying fact is that the companies, despite their place in the construction industry, feel the application of the computer when determining estimated costs is very beneficial to the company in both time and accuracy.

Those companies that are using the computer hope to further develop their software to increase the computer's capacity to aid them. The companies that limit their use of the computer realize that the computer is a tool to aid them and feel that its use will expand in future operations.

The cost data base is the most widely used phase of computerized estimating. This computer use is generally the starting point for most companies. From this point the use of the computer expands to aid the estimator in all phases of estimating. The expansion of the use of the computer is proportional to the users' confidence in working with the system. The results of computerized estimating are acceptable and accurate, meeting the users' needs.

CHAPTER VII
CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Estimating is both a science and an art. There is no substitution for the art of estimating. This is totally a result of the estimator's work experience, job locale knowledge, and judgment. The increased improvement of an estimator's art of estimating is proportional to his time working as an estimator. The accuracy levels of the estimator's art of estimating varies; therefore, the science portion of an estimate must be as accurate as possible. This will help insure the estimated cost reflects the actual construction costs. If the scientific portion of the estimate is accurate, then the lack of experience of the estimator may not cause the bid to be either rejected because the estimate is too high or be accepted and have the contractor lose money because the estimate is low compared to costs.

There are many ways to improve the science portion of the estimate, the biggest being reduction of human error. When calculating the estimated cost to perform work there are various areas that manually calculated estimates can be bungled. In labor, material or equipment costs, there are various numbers calculated together and, if one is entered incorrectly in a calculator, the estimated cost will be inaccurate. In all the manipulations of numbers done manually, there is the possibility of a mistake. The probability of mistakes can be reduced if sufficient supervision is used when calculating a cost estimate. The drawback to this, though, is the more people involved in creating an estimate, the more costs and time required to produce the estimate.

There is another approach to reducing human error and that is having a computer manipulate the data to calculate the estimated cost. Having a software program that is capable of computing the given input data into needed output costs reduces the human error element to this portion of the estimate. The only human error element left in this type estimating is determining quantity take-off values and inputting these values into the computer. The time and costs to insure the quantity take-offs are correct and entered properly into the computer is less than the cost to cross-check the manually calculated estimate. The use of the computer reduces the estimator's time to produce the estimated cost. It also decreases/eliminates the calculating errors. Properly used, computerized estimating will produce an accurate cost estimate that is less expensive to produce than the manually calculated one.

The challenging part to using the computer in estimating is obtaining or developing the computer software that will produce the desired estimated output. The software can

THE BID ITEM SCREEN

The Bid Item screen expands the information for a particular item listed on the Bid Sheet screen. This screen is used whenever you want to review or enter a new quotation. There are bid totals for labor, material, equipment and subcontract at the bottom of the Bid Item screen. As you can see on the screen below, dollar amounts are still entered according to cost type (T); Labor, Material, Equipment or Subcontract (L/M/E/S).

```
                              BID ITEM                           (C)MC)1984
id Id: SAMP
       SAMPLE BUILDING                                    as of---) 11 09 35

tem:00222 Excavation & Backfill                                   With tax
                      Bid     C    Comments                        & Ins.
 L-Labor.......      2,500   C OUR FORCES                          3,025

 M-Material....

 E-Equipment...     20,000   X ESTIMATE                           20,000

 S-Subcontract
                                  Estimate
   Total.......     22,500             50,000                     23,025

0000000000000000000000000000000000000000000000000000000000000000000000000007
 T                  AMT.     C    Comments                                 3
                                                                           3
000000000000000000000000000000000000000000000000000000000000000000000000000Y
 L-Labor            X-Estimate *     W-Wild guess  *   O-OTHER
 M-Material         F-Firm Est.      R-Replaces all    2-USER CODE 2
 E-Equipment        Q-Quote(firm)    B-Quote (bond)    3-USER CODE 3
 S-Subcontract      C-Company forces H-History only    4-USER CODE 4
```

Under the entry window, notice the listing of codes used to designate the status of the quote. These codes are entered under the C in the window followed by any comment you may have concerning the quote. If you chose not to use the comment field, PC BIDDAY automatically inserts the description of the Action Code used. Also notice that there are four miscellaneous codes (A-J-K-L). These codes may be defined by you to reflect any unique attribute of a particular quote.

Action Codes add flexibility to the PC BIDDAY System. You no longer have to apply a subcontract bond to all subcontract quotes in a bid, but only those quotes where a bond is required.

THE BID SHEET SCREEN

```
                    Management Computer Controls, Inc.          (C)MC)1984
                                  BID SHEET
Bid Id: SAMP                                                as of---> 11 08 59
                               SAMPLE BUILDING

Item  Description                      Labor     Material      Equip.        Sub.
 100 General Requirements           120,000 C    85,000 C    20,000 C
 222 Excavation & Backfill            2,500 C                20,000 X.
 280 Lawns & Planting                                                    20,000 A
 330 Cast-In-Place Concrete          75,000 C   250,000 C    25,000 C
 400 Masonry                                                             61,000 X
 550 Misc & Ornamental Metal         10,000 C    50,000 X
 750 Roofing & Sheetmetal                            150 SQUARES         48,500 Q
 925 Gypsum Drywall                                                      62,500 X
1500 Plumbing                                                            65,000 B
1560 HVAC Systems                                                      · 220,000 X
1600 Electrical                                                         175,000 X


                             Totals may include items not shown on this screen
Enter item # 00000                   207,500      385,000      65,000      652,000
        BID TOTAL        $1,489,211              Total L,M,E&S     1,309,500
```

The Bid Sheet screen contains not only each item for the project, but also 'Action Codes' next to the labor, material, subcontract and equipment costs for each item. Action Codes designate the status of the quote; whether it is a firm quote, a quote to be bonded, a WAG from your estimate or work to be done by your own forces. The Action Codes automatically highlight bid items that are not firm numbers. They also play a major role in bid analysis, a feature discussed later.

To select an item for closer examination or for entry of a new quotation, you simply type the item number on the Bid Sheet screen and press ENTER.

THE BID SUMMARY SCREEN

Please examine the sample Summary screen from PC BIDDAY, shown next.

	Management Computer Controls, Inc.		(C)MC)1984
Bid Id: SAMP	BIDDAY Summary		11 08 47
	SAMPLE BUILDING		
Labor Cost		207,500	
Labor burden / Total Labor cost		43,575	251,075
Material Cost		385,000	
Material sales tax / Total Material Cost		23,581	408,581
Equipment Cost			65,000
Subcontract Cost		652,000	
Subcontract Bond / Total Subcontract Cost		1,300	653,300
Other Cost			
Total L,M,E&S / Gross Cost		1,309,500	$1,377,956
Indirect Expenses			
Gross Receipts Tax			
Insurance		5,063	
MISCELLANEOUS #1 ($)		1,500	
MISCELLANEOUS #2 (%)			
Bond		14,003	
Overhead		90,689	
Fee			
Total Indirect Expenses			111,255
Total Bid			$1,489,211

After a quote is entered, all labor, material, subcontract and equipment prices, as well as all taxes, burdens and fees are automatically updated to give you the most accurate bottom line possible.

THE SUMMARY FACTORS

The Summary Factors screen allows you to enter a miscellaneous contingency either as a percentage or as a lump sum dollar amount. This allows the flexibility of the BIDDAY System to accommodate any possible type of contingency or special item.

```
                  Management Computer Controls, Inc.                  (C)MC)1984
Bid Id: SAMP                    SUMMARY FACTORS                         08 48 10

              Base/Alt Description.........  SAMPLE BUILDING
              Labor Burden.................     21.0000 %
              Material Sales Tax...........      6.1250 %
              Subcontract Bond.............      2.0000 %

              Other Cost...................$

              Gross Receipts Tax...........            %
              Insurance....................       .3400 %
              MISCELLANEOUS #1   ($)       $
              MISCELLANEOUS #2   (%)                   %
              Calculate bond?                        Y (Y/N)

             OOOOO Overhead & Fee Calculation Methods OOOOO
           1 - % of gross                     3 - % of total bid
           2 - % of L,M,E&S                   4 - Fixed amount
              Method     %/$/Labor   Material   Equipment  Subcontract
     Overhead   2         15.0000     5.0000     20.0000     3.0000
     Fee        3          5.0000
OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO
       F1-Menu  F2-Summary  F3-Base/Alt Id  F7-End of Job  F8-Print Bid
```

You may access this screen directly from the Bid Sheet screen so there are no intermediate steps when you wish to change your markups.

APPENDIX 5

MANAGEMENT COMPUTER CONTROLS, INC. (MC^2)

Examples of the MC^2 Packages' Capabilities

APPENDIX 4
CUBIC FOOT ESTIMATE

Illustrative estimate. A certain building is 40 by 60 ft in size and consists of basement; first, second, and third floors; and attic. The heights, including floor thicknesses, are 8.5, 10, 9, and 9 ft for the basement, and first, second, and third floors, respectively. The average height of the attic is 7.5 ft. The cost of the building was $115,100.

1. Compute the cost per cubic foot based on the total volume of the building in cubic feet.

2. Compute the cost per cubic foot, allowing 60 percent for the basement, full value for the three stories, and 50 percent for the attic.

Solution 1: Cubical contents:	Approximate Estimates Cubic feet
Basement = 40 x 60 x 8.5	20,400
First floor = 40 x 60 x 10	24,000
Second floor = 40 x 60 x 9	21,600
Third floor = 40 x 60 x 9	21,600
Attic = 40 x 60 x 7.5	18,600
Total	105,600

Cost per cubic foot = $115,100/105,600 = $1.10

Solution 2: Equivalent cubical contents:	Cubic feet
Basement = 40 x 60 x 8.5 x 0.60	12,240
First floot = 40 x 60 x 10	24,000
Second floor = 40 x 60 x 9	21,600
Third floor = 40 x 60 x 9	21,600
Attic = 40 x 60 x 7.5 x 0.50	9,000
Total equivalent	88,440

$$\text{Cost per cubic foot} = \frac{\$115{,}100}{88{,}440} = \$1.30$$

Solution 2:

	Approximate Estimates Sq ft
Basement area, equivalent = 2,300 x 0.60	1,440
First floor	2,400
Second floor	2,400
Third floor	2,400
Attic floor, equivalent = 2,400 x 0.40	960
Roof, equivalent = 2,400 x 0.50	1,200
Total equivalent area	10,800

Cost per square foot, first, second floors
= $115,100/10,800 = $10.66
Cost per square foot, basement = $10.66 x 0.60 = 6.40
Cost per square foot, attic = $10.66 x 0.40 = 4.26
Cost per square foot, roof = $10.66 x 0.50 = 5.33

Solution 3:

	Sq ft
First floor, equivalent = 2,400 x 1.60	3,840
Second floor	2,400
Third floor, equivalent = 2,400 x 1.90	4,560
Total equivalent	10,800

Cost per square foot, second floor = $115,100/10,800 = $10.66
Cost per square foot, first floor = $10.66 x 1.60 = 17.06
Cost per square foot, third floor = $10.66 x 1.90 = 20.25

Solution 4

	Sq ft
First floor area	2.400
Second-floor area	2,400
Third-floor area	2,400
Total area, three floors	7,200

Cost per square foot = $115,100/7,200 = $16.00

APPENDIX 3
SQUARE FOOT ESTIMATE

Illustrative estimate. A certain building is 40 by 60 ft in size and consists of a basement; first, second, and third floors; and attic. The cost of the building was $115,100.

Compute the cost per square foot of the building:

1. Based on total area of three floors, basement, attic, and roof.
2. Based on total area of three floors, basement, and roof, assuming basement to cost 60 percent of the cost of the first floor, attic floor to cost 40 percent of the cost of the first floor, roof to cost 50 percent of the cost of the first floor, and first, second, and third floors to have equal costs.
3. Based on area of the three floors, assuming the cost of the first floor to include cost of basement and to be 1.60 times the cost of the second floor, and assuming the cost of the third floor to include cost of attic floor and roof and to be 1.90 times the cost of the second floor.
4. Based on total area of the three floors only.

Solution 1:	Sq ft
Basement area	2,400
First-floor area	2,400
Second-floor area	2,400
Third-floor area	2,400
Attic-floor area	2,400
Roof (horizontal) area	2,400
Total	14,400

$$\text{Cost per square foot} = \frac{\$115,110}{14,400} = \$8.00$$

APPENDIX 2
PROCESS PLANT COST RATIO
FROM INDIVIDUAL EQUIPMENT

Equipment	Factor
Blender	2.0
Blowers and fans	2.5
Centrifuges	2.0
Compressors:	
Centrifugals, motor driven	2.0
Steam turbine	2.0
Reciprocating, steam and gas	2.3
Motor driven	2.3
Ejectors	2.5
Furnaces	2.0
Heat Exchangers	4.8
Instruments	4.15
Motors, electric	8.5
Pumps:	
Centrifugal (motor driven--less motor)	7.0
Steam turbine (includes turbin)	6.5
Positive displacement (less motor)	5.0
Reactors--factor as approximate equivalent type of equipment	
Refrigeration	2.5
Tanks:	
Process	4.1
Storage	3.5
Fabricated and field erected	2.0
Towers	4.0

From W. F. Worth, "Factors in Cost Estimation."
* Factor multiplied by purchase price to obtain installation cost.

APPENDIX 1
TYPICAL EQUIPMENT INSTALLATION FACTORS

Item	Installation Cost (%)
Belt Conveyors	20-25
Bucket Elevators	25-40
Centrifugals, disk or bowl	5-6
Top suspended	30-40
Continuous	10-25
Crystallizers	30-50
Dryers, continuous drum	100+
Vacuum Rotary	150-200+
Rotary	50-100
Dust Collectors, wet	200-450+
Dry	10-200+
Electrostatic Precipitators	33-100+
Electric Motors Plus Controls	60
Filters	25-45
Gas Producers	45-250
Instruments	6-300
Ion Exchangers	30-275+
Towers	25-50
Turbine Generators	10-30

(+ includes accessories)

Adapted from F. C. Jelen (ed.), Cost and Optimization Engineering.

expanding its uses (scheduling, accounting, etc.) as forecasted by the company;

4) Go with the hardware package recommended by the software company;

5) If a software package cannot by purchased, it should be developed before purchasing a complete computer system. The hardware purchased should be capable of any anticipated future company uses.

Finally, by involving the company users in the development of a computerized estimating system, the transition will be easier and smoother. The users will have a system they are familiar with and so they will utilize all the computer's capabilities within a relatively short period of time. The entire company will feel the benefits of computerized estimating because more timely and accurate bids mean more work and profit.

Today computer estimating systems are state-of-the-art tools for estimating. A competitive construction company should begin gearing its estimating department towards using computers and, eventually, adopt a computerized estimating system. The construction company will benefit in savings of both time and money by utilizing a computer system. Estimating is the hinge to a contractor's success. Keeping this hinge in the most up-to-date working order opens the door to prosperity for a contractor. Good estimating means good business and computerized estimating means better bu. ess.

7.2 Recommendations

Eighty percent of all costs in cost estimating are repetitive for most construction companies. A good cost data base and sufficient software programming will increase the accuracy of this portion of the estimate. The remaining twenty percent is dependent upon unforeseen circumstances that must be accounted for by the estimator. His judgment, knowledge, and experience aid him in producing an accurate cost for this portion of the estimate. With this in mind, it is obvious that the estimating department that is up to date in its use of technology aided estimating (the computer estimating system), and one that has an adequate training program to develop potential estimators will produce the most accurate estimates as compared to actual construction costs.

The training plans of the estimating department may vary but it is imperative that the department get involved in adopting a computer system to aid them. The recommended steps to get started in computerized estimating are:

1) The company should review available software packages and select the five top packages;

2) From these top five, rank them as per their capabilities to assist the user;

3) Ask these software companies what hardware is best for the company. Insure that the hardware system is capable of

sufficiently estimate the projects as desired by the company. Hubbard will continue to review available packages but, to date, the consensus is to write their own program to insure the results are what they need. The conclusion reached in this area of construction is that the software must be developed by the company. There are too many variables that the packaged software cannot account for because they are geared more towards repetitive type construction.

4) Desk-top computerized estimating is no longer a thing of the future; rather, it is a thing of today. Before purchasing a computer, a company should be sure the software for the system is capable of outputting desired results. It is best to purchase software before buying the computer system.

5) Computers do reduce the human error element of an estimate. The more precise the estimate, the better chances of winning the contract award.

6) Computerized estimating does not stop at the cost output. It can be used to assist in job scheduling, quality control, and other phases of the construction industry.

either be purchased as a complete package or developed by the company to insure it produces the desired output.

The question of choosing computer software is the most important for a company. From the case studies reviewed and material researched, there are some basic conclusions that can be drawn:

1) If the company is involved in repetitive construction projects (i.e., building standard model homes), there are various software packages available on the market today. The company is tasked with reviewing the available packages and choosing the one that best fits its needs. One such package is the IBM software package used by Akira Wood and Building Works Incorporated for housing estimates.

2) Smaller construction companies, such as Restoration Specialists, whose work is that of small rehabilitation jobs, can write or buy a program without having an outside agency insure the package fits their needs. It is not a large financial investment project to purchase adequate software to perform the estimating.

3) Highway and heavy construction companies are faced with developing sufficient software to perform the needed functions to arrive at an actual cost estimate. There are attempts by computer companies to package similar software, as exemplified in Appendix 5, but the results are not positive. Hubbard Construction Company was experimenting with this particular package, but they felt it would not

THE HISTORY WINDOW

```
                                  BID ITEM                          (C)MC)1984
 Bid Id: SAMP
           SAMPLE BUILDING                                   as of---) 11 24 23
                                  ZDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD7
 Item:00100 General Requirements  3                 - History -                3
                          Bid     3 No. T Comments                   C   Amount 3
  L-Labor......       120,000     3   1 L ORIGINAL ESTIMATE          X  120,000 3
                                  3   2 M ORIGINAL ESTIMATE          X   85,000 3
  M-Material....       85,000     3   3 E CRANE #2                   X   20,000 3
                                  3   4 L OUR FORCES                 C  120,000 3
  E-Equipment...       20,000     3   5 M OUR FORCES                 C   85,000 3
                                  3   6 E OUR FORCES                 C   20,000 3
  S-Subcontract.                  3   7 E CRANE #2                   C   20,000 3
                                  3   8 E CRANE #2                   C   20,000 3
    Total.......      225,000     3   9 E CRANE #2                   C   20,000 3
                                  3                                             3
ZDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD3                                             3
3  T                    AMT.      3                                             3
3                                 3  Enter Line No.000                          3
@DDDDDDDJDDDDDDDDDDDDDDDDDDDDDDDD@DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD Y
  L-Labor              X-Estimate *     W-Wild guess  *   O-OTHER
  M-Material           F-Firm Est.      R-Replaces all    2-USER CODE 2
  E-Equipment          Q-Quote(firm)    B-Quote (bond)    3-USER CODE 3
  S-Subcontract        C-Company forces H-History only    4-USER CODE 4
```

The MC2 PC BIDDAY System keeps a history of all quotes received for each bid item. Simply pressing a function key on your PC "opens" this window and allows you to view the history of an item while judging the validity of a particular quote. By pressing a single function key, you may also select any quote in the history to replace the current quote on the bid item.

THE BID ANALYSIS PHASE

Bid Analysis is designed to give you more control and security in determining your risks and fees for a project. All risks and fees may be instantly updated using the screen shown below.

Bid Id: SAMP   Management Computer Controls, Inc.   (C)MC2 1984

SAMPLE BUILDING

Contractor's Fee Calculation Methods

1 - % of Gross   3 - % of Total Bid
2 - % of L,M,E&S   4 - Fixed Amount

Method	%/$/Labor	Material	Equipment	Subcontract
2	10.0000	8.0000	3.0000	2.0000

F1-Return to Analysis, F7-Return to Menu

If the ratio of work done by your own forces is disproportionate to the amount of subcontract work, you may want to adjust your fees accordingly. This screen gives you that option and is accessible from any of the Analysis screens.

Bid Id. SAMP — Management Computer Controls, Inc. — (C)MC2 1984

BID ANALYSIS I — 11 25 33

SAMPLE BUILDING

CODE	DESCRIPTION	RAW COST	%	TOTAL COST	%
X	ESTIMATE	588,500	45.0	600,390	40.3
Q	FIRM QUOTE	48,500	3.7	49,224	3.3
C	OUR FORCES	587,500	44.8	661,819	44.4
B	QUOTE BOND	65,000	5.0	67,290	4.5
	Undefined	20,000	1.5	20,299	1.4

Totals...........	1,309,500	100.0	1,398,522	93.9
Overhead..............................			90,689	6.1
Contractor's Fee......................				
Bid Total.............................			1,489,211	100.0

F3-Base/Alt Id F4-Change Fee F5-Next Analysis F7-Return to Menu F9-Roll

Bid Id: SAMP — Management Computer Controls, Inc. — (C)MC2 1984

BID ANALYSIS II — 11 29 36

SAMPLE BUILDING

	Amount	% of Bid	Amt of Load	% of Raw
Raw Labor	207,500	13.3	47,489	22.9
" Material	385,000	24.6	29,950	7.7
" Equipment	65,000	4.2	1,013	1.5
" Subcontract	652,000	41.7	11,484	1.7
Loaded Labor	254,989	16.3		
" Material	414,950	26.5		
" Equipment	66,013	4.2		
" Subcontract	663,484	42.5		
			Bid Total	1,562,934
Indirect Expenses	21,480	1.4		
Overhead	90,689	5.8	Estimate	1,348,500
Fee	72,809	4.7	% of Bid	86.3

F3-Base/Alt Id F4-Change Fee F5-Next Analysis F7-Return to Menu

Bid Id. SAMP — Management Computer Controls, Inc. — (C)MC2 1984

BID ANALYSIS III — 11 27 01

SAMPLE BUILDING

CODE	DESCRIPTION		RAW COST	%	TOTAL COST	%
X	ESTIMATE	Mat	30,000	2.3	33,890	2.4
X	ESTIMATE	Sub	518,500	39.7	526,582	33.7
X	ESTIMATE	Eqp	20,000	1.5	20,312	1.3
Q	FIRM QUOTE	Sub	48,500	3.7	49,256	3.2
C	OUR FORCES	Lab	207,500	15.8	254,989	16.3
C	OUR FORCES	Mat	335,000	25.6	361,061	23.1
C	OUR FORCES	Eqp	45,000	3.4	45,701	2.9
B	QUOTE BOND	Sub	65,000	5.0	67,333	4.3
	Undefined	Sub	20,000	1.5	20,312	1.3

Totals	1,309,500	100.0	1,399,436	89.5
Overhead			90,689	5.8
Contractor's Fee.......................			72,809	4.7
Bid Total			1,562,934	100.0

[illegible]/Alt Id F4-Change Fee F5-Next Analysis F7-Return to Menu F9-Roll

APPENDIX 6
RESTORATION SPECIALISTS COMPUTER PRINTOUT

RESTORATION SPECIALIST
1950 NE 23RD AVE
GAINESVILLE, FL 32601
904-377-2153

JOHN GREEN

QUANTITY MATERIALS	UNIT PRICE	MATERIALS TOTAL	MAN HOURS	PRICE PER HOUR	TOTAL LABOR	TOTAL
1 REPLACE 25 SQ YDS CARPET 25 SQ YD	15.50	387.50	4.0	14.50	58.00	445.50
		387.50				
5% SALES TAX		19.37				
SUBTOTALS		406.87	4.0		58.00	464.87

TOTALS	464.87
10% OVERHEAD AND 10% PROFIT	92.97
GRAND TOTAL	557.85

THANK YOU FOR CALLING US

APPENDIX 7
INTERVIEW WITH RICHARD GOODMAN AND MARY GREEN
FROM RESTORATION SPECIALISTS OF GAINESVILLE

- Company began April, 1984
- Work is generally Rehabilitation, after fire, storm, water, etc., damage--insurance claims
- Owner involved in ths type work since early 1960's
- New construction work is limited
- Jobs usually range from cost of $100 to $10,000 each
- Jobs mostly kitchen repairs, plumbing, room restorations
- Estimating originally done manually
- Advice of accountant went to computerized estimating
- Software was written by company
- The Commador Computer was then purchased
- The program is very basic
  - input data are: a) unit costs
    b) quantity take-off
  - the computer output is per line item
  - markup and profit are added in at the end of the computer run
- Appendix 6 is a copy of the output
- Estimates are accurate and done very timely
- Customers like the detailed output--list all costs
- Future potential of company is undecided
- The computer applications to the business are increasing
- The users like its user-friendliness and are happy with the output results.

APPENDIX 8
INTERVIEW WITH VICKI WELSH
FROM BARRY RUTTENBERG HOMES OF GAINESVILLE

- The company has been in operation since 1973.
- They specialize in residential single and attached family housing.
- The units they build are all similar with very few custom homes.
- Because of the repetitive construction projects the estimating they do is relatively simple.
- The builders can predict the costs of the units within 5-10% of actual cost--a guesstimate.
- The computer they use is a Texas Instrument and is used for word processing, job scheduling, etc., but it is only used by the estimator for a cost data base.
- Similar projects reduce the need to expand the computer's application.
- They are building more custom homes, and if this trend continues their use of computerized estimating will also increase.
- Until this is certain, expanding the use of the computer would only benefit the estimator and not be cost efficient for the company to expand it.
- The estimator of the company, Vicki Welsh, feels computers are the estimating tool of today.
- The data base reduces her work load and increases the accuracy of the estimate.
- Vicki Welsh feels they will increase the estimating office to include computerized estimating as their projects diversity.

APPENDIX 9
INTERVIEW WITH TERRY RUGGER
FROM AKIRA WOOD AND BUILDING INCORPORATED
OF GAINESVILLE

- This company specializes in both cabinet/mill work and housing construction; cabinet/mill work being two-thirds of their work, and housing construction the other one third.
- Terry Rugger is an estimator with the company, estimating both cost of cabinet fabrication and housing construction costs.
- The housing construction projects are estimated differently than the cabinet/mill work (shop work).
- The shop work is estimated by updating a cost data base. This data base is used to determine estimated costs to fabricate cabinets. This reduces extensive paper work and gives the supervisor a basis for monitoring shop output.
- This is set up on the Lotus spread sheet listing all cost materials, and labor needed to construct pieces in the shop.
- The housing projects are estimated both manually and by computer. They use the IBM pcx computer.
- They use a package software program produced by IBM, The input to run the program, quantity take-offs, are manually calculated.
- The program retrieves cost data, as per wall type input and calculates the estimated costs.
- The form of output is flexible (e.g., floor areas, item by item, phase by phase, etc.
- Overhead and markup are added in by multiplying a percent by total estimated cost.
- The program is good but the estimators are unfamiliar with it, therefore its use is limited.
- The estimations done by the computer are accurate, but because of the lack of confidence in the system, the results are checked against manually calculated costs.
- The company sees great potential in the system, and its uses will increase in the future.
- The only problems with the system is that the hardware was purchased first and they are working out the bugs in the software to make it compatible to their needs.

APPENDIX 10
INTERVIEW WITH LARRY ENLOW AND THOMAS McCELLAND FROM HUBBARD CONSTRUCTION COMPANY OF ORLANDO

- Mr. Enlow is Vice-President of operations.
- Mr. McCelland is Assistant Vice-President of Estimating.
- The company involved with construction from the ground level down (highways, large foundations).
- They specialize in heavy highway construction.
- Costs range from hundreds of thousands to millions of dollars.
- Projects are not similar as is the case for houses. Each job has to be evaluated individually.
- Because they need individual detailed estimates for each job, the estimating department has gone to some lengths to improve their estimates.
- They purchased a software package "MC^2" but it does not meet their needs.
- They are presently developing a catalog of items in a cost data base to include all possible phases of their construction project. Also a symphony spread sheet to do the entire estimate is prepared.
- To date the spread sheet is used but is limited in its use because the cost data base is not sufficient for all projects.
- They are very much impressed with the computer's capabilities and its potential in bettering their estimates.
- They also use the IBM to assist them in preparing quantity take-offs for excavation work. It is as time-consuming as manually calculating the quantities but there are no mathematical errors in determining quantities. Printouts from this program are precise on cut and fill quantities and give two-dimensional sketches of cross sections.

APPENDIX 11

USBI SRB/AFT FACILITY
KENNEDY SPACE CENTER

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PROJECT NAME	USBI SRB/AFT FACILITY			
LOCATION	KENNEDY SPACE CENTER			
BID DATE	12-19-1984 3:00pm			
ESTIMATOR	TMM			
LABOR OVERHEAD	10.60%	PROFIT	10.00%	
EQUIPMENT OVERHEAD	4.60%	PROFIT	10.00%	TOTAL OVERHEAD $60,275.79
MATERIAL OVERHEAD	5.80%	PROFIT	10.00%	TOTAL PROFIT $83,815.84
SUB CONTRACTOR OVERHEAD	4.80%	PROFIT	10.00%	

TOTAL GENERAL CONDITIONS	$158,583.61
TOTAL SITE PREPERATION	$253,783.84
TOTAL ORGANIC SANDS REMOVAL	$143,461.60
TOTAL TEMPORARY WATER	$19,301.35
TOTAL POTABLE WATER	$45,306.45
TOTAL FIRE LINE WATER	$187,171.38
TOTAL SANITARY SEWER	$81,145.17
TOTAL STORM DRAINAGE	$63,932.31
TOTAL MISCELLANEOUS CONST.	$35,205.27
TOTAL BID PRICE	$987,884.29

BID ITEM BID	DTL.	DESCRIPTION	QUANT.	UNIT	LABOR & BURDEN UNIT PRICE	LABOR & BURDEN AMOUNT	EQUIPMENT UNIT PRICE	EQUIPMENT AMOUNT	MATERIAL (open) UNIT PRICE	MATERIAL (open) AMOUNT	MATERIAL (closed) UNIT PRICE	MATERIAL (closed) AMOUNT	SUBCONTRACTOR UNIT PRICE	SUBCONTRACTOR AMOUNT	BID ITEM	BID PRICE UNIT PRICE	BID PRICE AMOUNT
1.00		GENERAL CONDITIONS	1	LS	$97,320.00	$97,320.00	$26,350.00	$26,350.00	$0.00	$0.00	$220.00	$220.00	$8,100.00	$8,100.00	1.00	$158,583.61	$158,583.61
2.00		SITE PREPERATION				$0.00		$0.00	$0.00	$0.00		$0.00		$0.00	2.00	$0.00	$0.00
2.01		CLEAR AND GRUB	3200	SY	$0.30	$960.00	$0.21	$672.00	$0.00	$0.00		$0.00	$0.21	$672.00	2.01	$0.85	$2,720.00
2.02		EMBANKMENT (ON SITE)	790	CY	$0.77	$608.30	$1.40	$1,106.00	$0.00	$0.00		$0.00		$0.00	2.02	$2.55	$2,014.50
2.03		EMBANKMENT (IMPORT)	29364	CY	$1.42	$41,696.88	$1.44	$42,284.16	$0.00	$0.00		$0.00	$3.47	$101,893.08	2.03	$7.39	$216,999.96
2.04		SITE SEEDING	87100	SY	$0.12	$10,452.00	$0.10	$8,710.00	$0.00	$0.00		$0.00		$0.00	2.04	$0.26	$22,646.00
2.05		SLAB GRADING	16000	SY	$0.18	$2,880.00	$0.15	$2,400.00	$0.00	$0.00		$0.00		$0.00	2.05	$0.39	$6,240.00
2.06		STRIPINGS	425	CY	$0.38	$161.50	$0.68	$289.00	$0.00	$0.00		$0.00		$0.00	2.06	$1.25	$531.25
2.07		PROOF ROLLING (4 PASS)	1	LS	$670.00	$670.00	$740.00	$740.00	$0.00	$0.00		$0.00		$0.00	2.07	$1,900.23	$1,900.23
2.08		PROOF ROLLING (8 PASS)	1	LS	$250.00	$250.00	$360.00	$360.00	$0.00	$0.00		$0.00		$0.00	2.08	$731.90	$731.90
3.00		ORGANIC SANDS REMOVAL				$0.00		$0.00	$0.00	$0.00		$0.00		$0.00	3.00	$0.00	$0.00
3.01		OVERBURDEN EXCAVATION	8900	CY	$0.89	$7,921.00	$0.80	$7,120.00	$0.00	$0.00	$0.04	$356.00		$0.00	3.01	$2.05	$18,245.00
3.02		ORGANIC SANDS EXCAVATION	6600	CY	$1.08	$7,128.00	$0.96	$6,336.00	$0.00	$0.00	$0.06	$396.00	$3.51	$23,166.00	3.02	$6.54	$43,164.00
3.03		BACKFILL (ON SITE)	6700	CY	$0.88	$5,896.00	$0.91	$6,097.00	$0.00	$0.00		$0.00		$0.00	3.03	$2.12	$14,204.00
3.04		BACKFILL (IMPORT)	8800	CY	$1.57	$13,816.00	$1.56	$13,728.00	$0.00	$0.00		$0.00	$3.47	$30,536.00	3.04	$7.71	$67,848.00
4.00		TEMPORARY WATER				$0.00		$0.00	$0.00	$0.00		$0.00		$0.00	4.00	$0.00	$0.00
4.01		CONNECT TO MAIN	1	EA	$323.00	$323.00	$194.00	$194.00	$0.00	$0.00	$250.00	$250.00		$0.00	4.01	$908.27	$908.27
4.02	1.010	1" PVC SCH. 40	750	LF	$1.90	$1,425.00	$0.97	$727.50	$0.27	$204.75		$0.00		$0.00	4.02	$3.75	$2,812.50
4.03	1.020	2" PVC SDR 26	20	LF	$2.07	$41.40	$1.06	$21.20	$0.31	$6.15		$0.00		$0.00	4.03	$4.10	$82.00
4.04	1.050	3" PVC SDR 26	2600	LF	$2.29	$5,954.00	$1.16	$3,016.00	$0.71	$1,838.55		$0.00		$0.00	4.04	$4.95	$12,870.00
4.05	1.060	6" PVC SDR 26	43	LF	$3.82	$164.26	$2.65	$113.15	$10.08	$433.30		$0.00		$0.00	4.05	$18.75	$806.25
4.06	1.070	1" SERVICE	10	EA	$52.00	$520.00	$23.00	$230.00	$12.60	$126.00		$0.00		$0.00	4.06	$104.56	$1,045.60
4.07	1.080	3" SERVICE	4	EA	$70.00	$280.00	$34.00	$136.00	$57.65	$239.40		$0.00		$0.00	4.07	$194.16	$776.64
5.00		POTABLE WATER				$0.00		$0.00	$0.00	$0.00		$0.00		$0.00	5.00	$0.00	$0.00
5.01	1.240	6" PVC C-900	130	LF	$6.08	$790.40	$3.97	$516.10	$7.45	$968.65	$2.72	$353.60		$0.00	5.01	$23.82	$3,096.60
5.02	1.250	6" PVC C-900	1725	LF	$5.12	$8,832.60	$3.39	$5,847.75	$3.29	$5,671.60	$1.50	$2,587.50		$0.00	5.02	$15.72	$27,117.00
5.03	1.040	2.5" PVC SDR 26	34	LF	$2.86	$97.24	$1.57	$53.38	$0.43	$14.64		$0.00		$0.00	5.03	$5.80	$197.20
5.04	1.030	2" PVC SDR 26	1330	LF	$2.50	$3,325.00	$1.30	$1,729.00	$0.31	$409.24	$0.03	$39.90		$0.00	5.04	$4.94	$6,570.20
5.05	1.030	1.5" PVC SCH. 60	50	LF	$2.86	$143.00	$1.57	$78.50	$0.57	$28.48		$0.00		$0.00	5.05	$5.96	$298.00
5.06	1.340	8"GATE VALVE AND BOX	1	EA	$88.00	$88.00	$43.00	$43.00	$346.50	$346.50		$0.00		$0.00	5.06	$560.08	$560.08
5.07	1.350	6"GATE VALVE AND BOX	6	EA	$70.00	$420.00	$34.00	$204.00	$231.00	$1,386.00		$0.00		$0.00	5.07	$393.35	$2,360.10
5.08	1.360	2.5"GATE VALVE AND BOX	2	EA	$62.00	$124.00	$30.00	$60.00	$91.35	$182.70		$0.00		$0.00	5.08	$216.46	$432.92
5.09	1.370	2 GATE VALVE AND BOX	3	EA	$53.00	$159.00	$25.00	$75.00	$68.25	$204.75		$0.00		$0.00	5.09	$172.85	$518.55
5.10	1.365	1.5"GATE VALVE AND BOX	1	EA	$53.00	$53.00	$25.00	$25.00	$56.18	$56.18		$0.00		$0.00	5.10	$158.79	$158.79
5.11	1.710	TEMPORARY PLUGS	7	EA	$25.00	$175.00	$15.00	$105.00	$6.30	$44.10		$0.00		$0.00	5.11	$55.09	$385.63
5.12		TEST POTABLE WATER SYSTEM	1	EA	$1,925.00	$1,925.00	$850.00	$850.00	$0.00	$0.00	$240.00	$240.00		$0.00	5.12	$3,605.38	$3,605.33
6.00		FIRE LINE WATER				$0.00		$0.00	$0.00	$0.00		$0.00		$0.00	6.00	$0.00	$0.00
6.01	1.210	14" CIP CL51	1562	LF	$6.08	$9,496.96	$3.87	$6,044.94	$18.38	$28,716.93	$1.81	$2,827.22		$0.00	6.01	$35.37	$55,247.94
6.02	1.220	12" PVC C-900	2412	LF	$5.86	$14,134.32	$3.76	$9,069.12	$10.83	$26,119.38	$1.67	$4,028.04		$0.00	6.02	$26.02	$62,760.24
6.03	1.230	10" PVC C-900	25	LF	$6.08	$152.00	$3.87	$96.75	$6.81	$170.36	$1.50	$37.50		$0.00	6.03	$21.55	$538.75
6.04	1.240	8" PVC C-900	34	LF	$6.08	$206.72	$3.87	$131.58	$7.45	$253.34	$2.72	$92.48		$0.00	6.04	$23.71	$806.14
6.05	1.250	6" PVC C-900	165	LF	$9.90	$1,633.50	$5.92	$976.80	$3.29	$542.52	$1.77	$292.05		$0.00	6.05	$24.78	$4,088.70
6.06	1.395	14" POST INDICATOR VALVE	2	EA	$157.00	$314.00	$81.00	$162.00	$1,983.45	$3,966.90		$0.00		$0.00	6.06	$2,593.07	$5,186.14
6.07	1.400	12" POST INDICATOR VALVE	7	EA	$138.00	$966.00	$71.00	$497.00	$1,076.25	$7,533.75		$0.00		$0.00	6.07	$1,502.58	$10,518.06
6.08	1.410	10" POST INDICATOR VALVE	1	EA	$110.00	$110.00	$59.00	$59.00	$766.50	$766.50		$0.00		$0.00	6.08	$1,094.14	$1,094.14
6.09	1.420	8" POST INDICATOR VALVE	2	EA	$83.00	$166.00	$41.00	$82.00	$564.50	$1,129.00		$0.00		$0.00	6.09	$805.86	$1,611.72
6.10	1.430	6" POST INDICATOR VALVE	1	EA	$50.00	$50.00	$25.00	$25.00	$439.53	$439.53		$0.00		$0.00	6.10	$601.29	$601.29
6.11	1.???	12" GATE VALVE AND BOX	3	EA	$155.00	$465.00	$79.00	$237.00	$651.50	$1,954.50		$0.00		$0.00	6.11	$1,049.84	$3,149.52

6.12	1.340	15" GATE VALVE AND BOX	0 EA	$116.00	$0.00	$56.00	$0.00	$346.50	$0.00		$0.00		$0.00	6.12	$613.94	$0.00
6.13	1.440	FIRE HYDRANT ASS'Y	7 EA	$331.00	$2,317.00	$172.00	$1,204.00	$998.45	$6,975.15	$67.00	$469.00		$0.00	6.13	$1,839.35	$12,875.45
6.14	1.450	BACK FLOW PREVENTOR	1 LS	$1,150.00	$1,150.00	$580.00	$580.00	$17,010.00	$17,010.00	$1,345.00	$1,345.00		$0.00	6.14	$23,431.79	$23,431.79
6.15	1.220	TEMPORARY PLUGS	10 EA	$25.00	$250.00	$15.00	$150.00	$44.10	$441.00		$0.00		$0.00	6.15	$99.09	$990.90
6.16		TEST FIREWATER SYSTEM	1 EA	$2,310.00	$2,310.00	$1,020.00	$1,020.00	$0.00	$0.00	$240.00	$240.00		$0.00	6.16	$4,270.60	$4,270.60
7.00		SANITARY SEWER			$0.00		$0.00	$0.00	$0.00		$0.00		$0.00	7.00	$0.00	$0.00
7.01		LIFT STATION	1 LS	$3,771.00	$3,771.00	$2,619.00	$2,619.00	$0.00	$0.00	$10,390.00	$10,390.00	$725.00	$725.00	7.01	$20,542.94	$20,542.94
7.02	1.120	12" PVC FORCE MAIN	1110 LF	$2.50	$2,775.00	$1.30	$1,443.00	$0.31	$341.55	$0.03	$33.30		$0.00	7.02	$4.94	$5,483.40
7.03	1.150	4" PVC SDR 35 (0'-6')	100 LF	$7.53	$753.00	$5.24	$524.00	$0.63	$63.00	$1.53	$153.00		$0.00	7.03	$17.73	$1,773.00
7.04	1.160	6" PVC SDR 35 (0'-6')	70 LF	$8.01	$560.70	$5.51	$387.80	$1.13	$79.38	$1.50	$105.00		$0.00	7.04	$19.21	$1,344.70
7.05	1.170	8" PVC SDR 35 (0'-6')	1200 LF	$8.01	$9,612.00	$5.54	$6,648.00	$2.00	$2,394.00	$1.50	$1,800.00		$0.00	7.05	$20.22	$24,264.00
7.06	1.170	8" PVC SDR 35 (6'-8')	480 LF	$8.92	$4,281.60	$6.19	$2,971.20	$2.00	$957.60	$1.75	$840.00		$0.00	7.06	$22.37	$10,737.60
7.07	1.180	WYES	5 EA	$29.00	$145.00	$21.00	$105.00	$15.75	$78.75		$0.00		$0.00	7.07	$77.88	$369.40
7.08	1.200	TEMPORARY PLUGS	10 EA	$15.00	$150.00	$11.00	$110.00	$2.42	$24.15		$0.00		$0.00	7.08	$33.77	$337.70
7.09	1.190	CLEAN OUTS (4")	1 EA	$77.00	$77.00	$34.00	$34.00	$27.30	$27.30		$0.00		$0.00	7.09	$164.81	$164.81
7.10		TEST SANITARY SYSTEM	1 EA	$963.00	$963.00	$425.00	$425.00	$0.00	$0.00	$25.00	$25.00		$0.00	7.10	$1,692.74	$1,692.74
7.11		SANITARY MANHOLE (0'-6')	6 EA	$456.00	$2,736.00	$301.00	$1,806.00	$0.00	$0.00	$530.00	$3,180.00		$0.00	7.11	$1,519.58	$9,117.48
7.12		SANITARY MANHOLE (6'-8')	3 EA	$571.00	$1,713.00	$393.00	$1,179.00	$0.00	$0.00	$530.00	$1,590.00		$0.00	7.12	$1,765.80	$5,297.40
8.00		STORM DRAINAGE			$0.00		$0.00	$0.00	$0.00		$0.00		$0.00	8.00	$0.00	$0.00
8.01		18" RCP	150 LF	$9.33	$1,399.50	$6.53	$979.50	$0.00	$0.00	$10.21	$1,531.50		$0.00	8.01	$30.78	$4,617.00
8.02		19" x 30" ERCP	100 LF	$10.91	$1,091.00	$7.56	$756.00	$0.00	$0.00	$19.20	$1,920.00		$0.00	8.02	$44.36	$4,436.00
8.03		24" CMP	135 LF	$5.72	$772.20	$2.90	$391.50	$0.00	$0.00	$10.42	$1,406.70		$0.00	8.03	$22.44	$3,029.40
8.04		18" FLARED END SECTION	4 EA	$173.00	$692.00	$123.00	$492.00	$0.00	$0.00	$231.00	$924.00		$0.00	8.04	$621.48	$2,485.92
8.05		19" x 30" FLARED END SECTION	4 EA	$230.00	$920.00	$164.00	$656.00	$0.00	$0.00	$285.00	$1,140.00		$0.00	8.05	$801.07	$3,204.28
8.06		TRENCH DRAIN #1	1 LS	$1,858.00	$1,858.00	$675.00	$675.00	$0.00	$0.00	$1,407.00	$1,407.00		$0.00	8.06	$4,680.14	$4,680.14
8.07		TRENCH DRAIN #2	1 LS	$1,858.00	$1,858.00	$675.00	$675.00	$0.00	$0.00	$1,407.00	$1,407.00		$0.00	8.07	$4,680.14	$4,680.14
8.08		TRENCH DRAIN #3	1 LS	$1,858.00	$1,858.00	$675.00	$675.00	$0.00	$0.00	$1,407.00	$1,407.00		$0.00	8.08	$4,680.14	$4,680.14
8.09		TRENCH DRAIN #4	1 LS	$1,858.00	$1,858.00	$675.00	$675.00	$0.00	$0.00	$1,407.00	$1,407.00		$0.00	8.09	$4,680.14	$4,680.14
8.10		TRENCH DRAIN #5	1 LS	$2,441.00	$2,441.00	$687.00	$687.00	$0.00	$0.00	$2,471.00	$2,471.00		$0.00	8.10	$6,873.37	$6,873.37
8.11		TRENCH DRAIN #6	1 LS	$1,858.00	$1,858.00	$675.00	$675.00	$0.00	$0.00	$1,407.00	$1,407.00		$0.00	8.11	$4,680.14	$4,680.14
8.12		TRENCH DRAIN #7	1 LS	$1,858.00	$1,858.00	$675.00	$675.00	$0.00	$0.00	$1,407.00	$1,407.00		$0.00	8.12	$4,680.14	$4,680.14
8.13		TRENCH DRAIN #8	1 LS	$1,858.00	$1,858.00	$675.00	$675.00	$0.00	$0.00	$1,407.00	$1,407.00		$0.00	8.13	$4,680.14	$4,680.14
8.14		TRENCH DRAIN APRONS	4 EA	$207.00	$828.00	$91.00	$364.00	$0.00	$0.00	$78.00	$312.00	$25.00	$100.00	8.14	$476.79	$1,907.16
8.15		SWALE GRADING	4100 SY	$0.50	$2,050.00	$0.31	$1,271.00	$0.00	$0.00		$0.00		$0.00	8.15	$0.97	$3,977.00
8.16		PLUG EXISTING CULVERTS	8 EA	$43.00	$344.00	$17.00	$136.00	$0.00	$0.00	$7.00	$56.00		$0.00	8.16	$80.15	$641.20
9.00		MISCELLANEOUS CONST.			$0.00		$0.00	$0.00	$0.00		$0.00		$0.00	9.00	$0.00	$0.00
9.01		SODDING	9150 SY	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1.05	$9,607.50	9.01	$1.21	$11,071.50
9.02		PRE-TEST TOFOS	1 LS		$0.00		$0.00	$0.00	$0.00		$0.00	$2,070.00	$2,070.00	9.02	$2,386.30	$2,386.30
9.03		TRUCK WASH RACK	1 EA	$1,138.00	$1,138.00	$484.00	$484.00	$0.00	$0.00	$1,008.00	$1,008.00	$235.00	$235.00	9.03	$3,388.97	$3,388.97
9.04		6" SHELL STAGING AREA	2650 SY	$0.50	$1,325.00	$0.48	$1,272.00	$0.00	$0.00	$2.10	$5,565.00		$0.00	9.04	$3.61	$9,566.50
9.05		2 & 6 BERM AND STOCKPL AREA	31400 SY	$0.12	$3,768.00	$0.11	$3,454.00	$0.00	$0.00	$0.01	$314.00		$0.00	9.05	$0.28	$8,792.00
9.06					$0.00		$0.00	$0.00	$0.00		$0.00		$0.00	9.06	$0.00	$0.00
9.07					$0.00		$0.00	$0.00	$0.00		$0.00		$0.00	9.07	$0.00	$0.00
9.08					$0.00		$0.00	$0.00	$0.00		$0.00		$0.00	9.08	$0.00	$0.00
9.09					$0.00		$0.00	$0.00	$0.00		$0.00		$0.00	9.09	$0.00	$0.00
9.10					$0.00		$0.00	$0.00	$0.00		$0.00		$0.00	9.10	$0.00	$0.00
		TOTAL			$305,642.48		$184,846.93		$112,176.58		$58,387.79		$177,104.58			$987,884.29

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APPENDIX 12

OPEN MATERIAL COST

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SUB. ITEM	ITEM DESCRIPTION	QTY. UNIT	SUPP LIER: DO NOT USE THIS AREA UNIT PR.	TOTAL	SUPP LIER: UNDERGROUND SUPPLY UNIT PR.	TOTAL	SUPP LIER: SENS UNIT PR.	TOTAL	SUPP LIER: CLOW UNIT PR.	TOTAL	SUPP LIER: UNDERGROUND SUPPLY UNIT PR.	TOTAL	SUPP LIER: HUGHES UNIT PR.	TOTAL	SUPP LIER: B & H UNIT PR.	TOTAL
			$0.00	$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00
1.010	1" PVC SCH. 40	750 LF	$0.27	$204.75	$0.26	$195.00	$0.24	$180.00	$0.26	$195.00	$0.26	$195.00		$0.00		$0.00
1.020	2" PVC SDR 26	2460 LF	$0.31	$755.95	$0.29	$713.40	$0.34	$836.40	$0.29	$713.40	$0.29	$713.40		$0.00		$0.00
1.030	1.5" PVC SCH 80	50 LF	$0.57	$28.48	$0.48	$24.00	$0.60	$30.00	$0.60	$30.00	$0.48	$24.00		$0.00		$0.00
1.040	2.5" PVC SDR 26	34 LF	$0.43	$14.64	$0.41	$13.94	$0.45	$15.30	$0.45	$15.30	$0.41	$13.94		$0.00		$0.00
1.050	3" PVC SDR 26	2600 LF	$0.71	$1,838.55	$0.65	$1,690.00	$0.62	$1,612.00	$0.50	$1,300.00	$0.65	$1,690.00		$0.00		$0.00
1.060	6" PVC SDR 26	43 LF	$10.08	$433.30	$1.69	$72.67	$2.10	$90.30	$1.60	$68.80	$1.69	$72.67		$0.00		$0.00
1.070	1" SERVICE	10 EA	$12.60	$126.00	$12.00	$120.00	$65.00	$650.00	$20.00	$200.00	$12.00	$120.00		$0.00		$0.00
1.080	3" SERVICE	4 EA	$59.85	$239.40	$57.00	$228.00	$79.00	$316.00	$79.00	$316.00	$57.00	$228.00		$0.00		$0.00
1.090	1" FITTINGS PVC	1 LS		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		$0.00		$0.00
1.100	2" FITTINGS PVC	4 EA		$0.00	$7.50	$30.00	$9.50	$38.00	$34.00	$136.00	$7.50	$30.00		$0.00		$0.00
1.110	1.5" FITTINGS PVC	1 LS		$0.00	$3.12	$3.12	$0.00	$0.00	$3.20	$3.20	$3.12	$3.12		$0.00		$0.00
1.120	2.5" FITTINGS PVC	1 LS		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		$0.00		$0.00
1.130	3" FITTINGS PVC	1 LS		$0.00	$61.00	$61.00	$66.00	$66.00	$260.00	$260.00	$61.00	$61.00		$0.00		$0.00
1.140	6" FITTINGS PVC	1 LS		$0.00	$340.00	$340.00	$290.00	$290.00	$294.00	$294.00	$340.00	$340.00		$0.00		$0.00
1.150	4" PVC SDR 35	100 LF	$0.63	$63.00	$0.60	$60.00	$0.54	$54.00	$0.49	$49.00	$0.60	$60.00		$0.00		$0.00
1.160	6" PVC SDR 35	50 LF	$1.13	$56.70	$1.08	$54.00	$1.06	$53.00	$1.10	$55.00	$1.08	$54.00		$0.00		$0.00
1.170	8" PVC SDR 35	1680 LF	$2.00	$3,351.60	$1.90	$3,192.00	$1.79	$3,007.20	$1.89	$3,175.20	$1.90	$3,192.00		$0.00		$0.00
1.180	WYES	5 EA	$15.75	$78.75	$15.00	$75.00	$15.00	$75.00	$15.50	$77.50	$15.00	$75.00		$0.00		$0.00
1.190	CLEAN OUTS	1 EA	$27.30	$27.30	$26.00	$26.00	$10.00	$10.00	$9.50	$9.50	$26.00	$26.00		$0.00		$0.00
1.200	PVC PLUGS	10 EA	$2.42	$24.15	$2.30	$23.00	$7.00	$70.00	$1.20	$12.00	$2.30	$23.00		$0.00		$0.00
1.210	14" DIP CL. 51	1562 EA	$18.38	$28,716.93	$15.33	$23,945.46	$15.33	$23,945.46	$14.91	$23,289.42	$15.33	$23,945.46		$0.00		$0.00
1.220	12" PVC C-900	2412 EA	$10.83	$26,119.38	$9.05	$21,828.60	$9.17	$22,118.04	$8.95	$21,567.40	$9.05	$21,828.60		$0.00		$0.00
1.230	10" PVC C-900	25 EA	$6.81	$170.36	$6.49	$162.25	$6.45	$161.25	$5.28	$157.00	$6.49	$162.25		$0.00		$0.00
1.240	8" PVC C-900	164 EA	$7.45	$1,221.59	$4.20	$688.80	$4.27	$700.28	$4.16	$682.24	$4.20	$688.80		$0.00		$0.00
1.250	6" PVC C-900	1890 EA	$3.29	$6,214.32	$2.46	$4,649.40	$2.57	$4,857.30	$2.44	$4,611.60	$2.46	$4,649.40		$0.00		$0.00
1.260	14" FITTINGS DIP	1 LS		$0.00	$3,404.00	$3,404.00	$2,850.00	$2,850.00	$3,340.00	$3,340.00	$3,404.00	$3,404.00		$0.00		$0.00
1.270	12" FITTINGS DIP	1 LS		$0.00	$3,047.00	$3,047.00	$2,967.00	$2,967.00	$2,497.00	$2,497.00	$3,047.00	$3,047.00		$0.00		$0.00
1.280	10" FITTINGS DIP	1 LS		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		$0.00		$0.00
1.290	8" FITTINGS DIP	1 LS		$0.00	$475.00	$475.00	$480.00	$480.00	$441.00	$441.00	$475.00	$475.00		$0.00		$0.00
1.300	6" FITTINGS DIP	1 LS		$0.00	$1,269.00	$1,269.00	$760.00	$760.00	$760.00	$760.00	$1,269.00	$1,269.00		$0.00		$0.00
1.310	PLUGS POTABLE WATER	7 EA	$6.30	$44.10	$6.00	$42.00	$8.50	$59.50	$6.00	$42.00	$6.00	$42.00		$0.00		$0.00
1.320	PLUGS FIREWATER	10 EA	$44.10	$441.00	$42.00	$420.00	$48.00	$480.00	$47.00	$470.00	$42.00	$420.00		$0.00		$0.00
1.330	12" GATE VALVE & BOX	3 EA	$661.50	$1,984.50	$630.00	$1,890.00	$618.00	$1,854.00	$884.00	$2,652.00	$630.00	$1,890.00		$0.00		$0.00
1.340	8" GATE VALVE & BOX	2 EA	$346.50	$693.00	$330.00	$660.00	$321.00	$642.00	$384.00	$768.00	$330.00	$660.00		$0.00		$0.00
1.350	6" GATE VALVE & BOX	8 EA	$231.00	$1,848.00	$220.00	$1,760.00	$215.00	$1,720.00	$254.00	$2,032.00	$220.00	$1,760.00		$0.00		$0.00
1.360	2.5" GATE VALVE & BOX	1 EA	$91.35	$91.35	$87.00	$87.00	$129.00	$129.00	$153.00	$153.00	$87.00	$87.00		$0.00		$0.00
1.370	2" GATE VALVE & BOX	2 EA	$68.25	$136.50	$65.00	$130.00	$71.00	$142.00	$135.00	$270.00	$65.00	$130.00		$0.00		$0.00
1.385	1.5" GATE VALVE & BOX	1 EA	$56.18	$56.18	$53.50	$53.50	$69.00	$69.00	$77.00	$77.00	$53.50	$53.50		$0.00		$0.00
1.395	14" POST INDICATOR VALVE	2 EA	$1,983.45	$3,966.90	$1,889.00	$3,778.00	$1,705.69	$3,411.38	$1,600.00	$3,200.00	$1,889.00	$3,778.00		$0.00		$0.00
1.400	12" POST INDICATOR VALVE	9 EA	$1,076.25	$9,686.25	$1,025.00	$9,225.00	$1,352.16	$12,169.44	$1,059.00	$9,531.00	$1,025.00	$9,225.00		$0.00		$0.00
1.410	10" POST INDICATOR VALVE	1 EA	$766.50	$766.50	$730.00	$730.00	$941.64	$941.64	$752.00	$752.00	$730.00	$730.00		$0.00		$0.00
1.420	8" POST INDICATOR VALVE	1 EA	$564.90	$564.90	$538.00	$538.00	$685.61	$685.61	$556.00	$556.00	$538.00	$538.00		$0.00		$0.00
1.430	6" POST INDICATOR VALVE	1 EA	$439.53	$439.53	$418.60	$418.60	$522.34	$522.34	$429.00	$429.00	$418.60	$418.60		$0.00		$0.00
1.440	FIRE HYDRANT ASSEMBLY	7 EA	$996.45	$6,975.15	$949.00	$6,643.00	$945.00	$6,615.00	$917.00	$6,419.00	$949.00	$6,643.00		$0.00		$0.00
1.450	BACKFLOW PREVENTION ASS'Y	1 LS	$17,010.00	$17,010.00	$16,200.00	$16,200.00	$21,025.00	$21,025.00	$16,160.00	$16,160.00	$16,200.00	$16,200.00		$0.00		$0.00
			$0.00	$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00
			$0.00	$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00
			$0.00	$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00
			$0.00	$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00
			$0.00	$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00
			$0.00	$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00
			$0.00	$0.00		$0.00		$0.00		$0.00		$0.00		$0.00		$0.00
	TOTALS			$114,253.40		$108,965.74		$116,698.44		$107,726.56		$108,965.74		$0.00		$0.00

APPENDIX 13

A NEW RETAIL FACILITY-SAN (D 1)

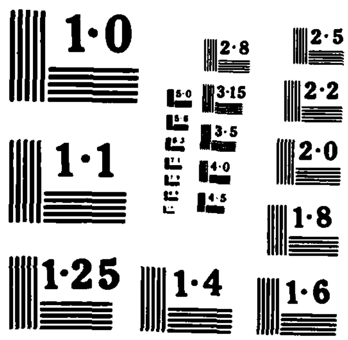
AD-A158 055 USE AND APPLICATION OF COMPUTERS IN CONSTRUCTION ESTIMATING(U) FLORIDA UNIV GAINESVILLE T R HUXEL 1985 N66314-72-A-3029 2/2

UNCLASSIFIED F/G 9/2 NL

END

FILMED

DTIC



NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

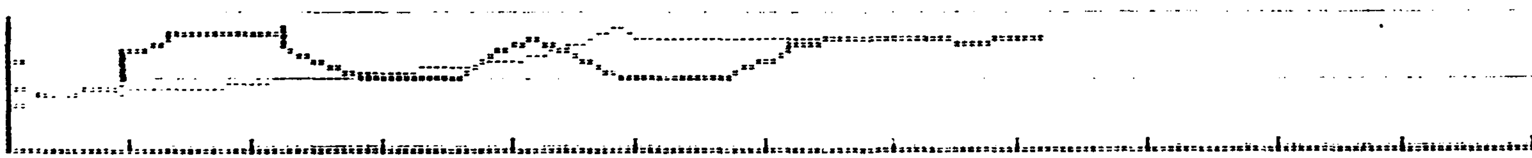
SITE NAME: A NEW RETAIL FACILITY-SAN (D 1)

BUILDER:

DATE: 12/10/1984

X SECT (L-R)

A NEW RETAIL FACILITY-SAN (D 1)



40 : Y = 374   ELEV = 43 + 2 /DIV   HORIZ = 200 /DIV

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APPENDIX 14

DESIGN SURFACE

DESIGN SURFACE	AREA SQ FT	EARTH VOLUME, CU YDS PRECOMPACT	CUT MOVED	FILL REQ'D	EXPT(IMPT)	VOL CHANGE PER 0.1 FT
	10249	190	0	1000	(1000)	43
SUB TOTAL	10249	190	0	1000	(1000)	43
ACC-DEC LANE	14964	277	0	335	(335)	62
SUB TOTAL	14964	277	0	335	(335)	62
AREA 1	60861	1127	0	3610	(3610)	254
SUB TOTAL	60861	1127	0	3610	(3610)	254
CONC CURB 1	10754	199	0	1098	(1098)	45
CONC DOCK	2572	0	236	0	236	10
CONC SIDEWAL	18831	349	0	883	(883)	78
SUB TOTAL	32158	548	236	1981	(1745)	133
HEAVY D. P.	312316	9692	2735	10095	(7360)	1249
SUB TOTAL	312316	9692	2735	10095	(7360)	1249
J BYRONS	44216	819	0	2291	(2291)	184
SUB TOTAL	44216	819	0	2291	(2291)	184
LIGHT D. P.	579124	1707	19172	2461	16711	2190
SUB TOTAL	579124	1707	19172	2461	16711	2190
LOCAL 3.6K S	3883	72	0	327	(327)	16
LOCAL 5.4K S	5760	107	0	237	(237)	24
LOCAL 6.4K S	6370	118	0	376	(376)	27
LOCAL 8.8K S	9100	170	0	1000	(1000)	38
LOCAL SHOPS	24854	460	0	2612	(2612)	104
LOCAL SHOPS	28183	521	0	1039	(1039)	117
SUB TOTAL	78187	1448	0	5642	(5642)	326
PUBLIX MRKT	41836	775	0	5020	(5020)	174
SUB TOTAL	41836	775	0	5020	(5020)	174
STORM BASIN	35062	20	3323	25	3297	130
STORM BASIN	28347	4	3539	2	3537	105
STORM BASIN	37833	0	4700	0	4700	140
STORM BASIN	75300	1	12047	0	12046	279
STORM BASIN	96872	91	9333	159	9174	361
SUB TOTAL	273502	115	33750	186	33564	1016
WAL MART	82583	1529	0	5400	(5400)	344
SUB TOTAL	82583	1529	0	5400	(5400)	344
SPEC TOTAL	1522997	12306	55093	38908	16991	6774
UNSPEC'D	406077	0	0	0	0	1000
SITE TOTAL	2016074	12306	55093	38908	16991	7775

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APPENDIX 15

BALANCE PARAMETERS

BALANCE PARAMETERS

A NEW RETAIL FACILITY-SAN (D 1)

STRIPPING LOSS: 1 FT / 56667 CU YDS

		SECT	COMPACT-%		PRECOMP=FT		AREA, SQ FT		RAW VOL, CU YDS	
#	SURFACE	FT	NAT'L	DESGN	CUT	FILL	CUT	FILL	CUT	FILL
1	LOCAL 3.6K S	0.50	80.0	90.0	0.0	0.5	0	3883	0	283
2	PUBLIX MRKT	0.50	80.0	90.0	0.0	0.5	0	41836	0	4376
3		0.00	80.0	90.0	0.0	0.5	0	10249	0	1650
4	LOCAL SHOPS	0.50	80.0	90.0	0.0	0.5	0	24854	0	2271
5	LOCAL 8.8K S	0.50	80.0	90.0	0.0	0.5	0	9180	0	870
6	WAL MART	0.50	80.0	90.0	0.0	0.5	0	82583	0	4630
7	LOCAL 6.4K S	0.50	80.0	90.0	0.0	0.5	0	6378	0	321
8	J BYRONS	0.50	80.0	90.0	0.0	0.5	0	44216	0	1946
9	LOCAL 5.4K S	0.50	80.0	90.0	0.0	0.5	0	5760	0	243
10	LOCAL SHOPS	0.50	80.0	90.0	0.0	0.5	0	28133	0	866
11	LIGTH D. P.	0.63	80.0	90.0	0.0	0.5	482640	96484	19172	1909
12	HEAVY D. P.	0.83	80.0	90.0	0.0	0.5	112973	199343	2785	8564
13	ACC-DEC LANE	1.06	80.0	90.0	0.0	0.5	17	14947	0	267
14	STORM BASIN	0.00	80.0	90.0	0.0	0.5	33969	1093	3323	20
15	STORM BASIN	0.00	80.0	90.0	0.0	0.5	28152	195	3539	1
16	STORM BASIN	0.00	80.0	90.0	0.0	0.5	37833	0	4708	0
17	STORM BASIN	0.00	80.0	90.0	0.0	0.5	75352	36	12847	0
18	STORM BASIN	0.00	80.0	90.0	0.0	0.5	91974	4898	9333	131
19	CONC CURB 1	0.00	80.0	90.0	0.0	0.5	0	10754	0	954
20	CONC SIDEWAL	0.00	80.0	90.0	0.0	0.5	0	18831	0	746
21	AREA 1	0.00	80.0	90.0	0.0	0.5	0	60061	0	3084
22	CONC DOCK	0.83	80.0	90.0	0.0	0.5	2572	0	236	0
							865482	664516	55873	33818

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2.2 Preliminary Estimating

The preliminary estimate is requested at some point in the initial evaluation stages, and/or early design stage of a project. "It is usually requested at the time when the overall scope and the conceptual design has evolved to the point where the estimator has a reasonable idea of the requirements of the owner and the implementation program of the design" (1). A preliminary estimate is used to check the owner's budget against the design concept and evaluate possible design alternatives to keep the project within the proposed budget. It can also be used by the owner to aid in budgeting cash flow needs throughout the project and evaluate bids (2).

The preliminary estimate has limited accuracy, but if the estimator possesses estimating skills, the estimate should be reasonably accurate, within twenty percent. The basic skills that good preliminary estimators possess are:

1) Knowledge of construction materials;
2) Understanding of building design;
3) Ability to conceive design details;
4) Knowledge of construction trades; and
5) Acquaintances with construction labor productivity. (1)

The magnitude of the use of these skills when preparing a preliminary estimate vary with type of construction and method of preliminary estimating. The various methods of preliminary estimating will be reviewed next.

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