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A Practical Application of LOTUS 1-2-3™

In Construction Management

by

KENNETH RACHKO

A research paper submitted in partial fulfillment  
of the requirements for the degree of

Master of Science

in

Civil Engineering

University of Washington

1985

Program Chairman and Advisor

Professor J. W. Hinze

T226804



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## ABSTRACT

With relatively inexpensive microcomputers available today, it behooves the business manager to become familiar with and knowledgeable in the use of these managerial assistants. This report reviews some of the capabilities of a popular microcomputer (IBM PC) coupled with a popular software package (LOTUS 1-2-3), as these can be easily tailored to various aspects of the construction industry. It can be used as a tool by the owner or project manager and the builder or contractor.

While each of these two major participants would be interested in some similar aspects of construction administration, their perspective and required data would necessarily be different. The report presents some uses for identifying, tracking and thereby controlling various aspects of the construction process. Examples are given using the spreadsheet and database capabilities of the LOTUS 1-2-3 program for managing project change orders, construction submittals and inventory control. Also included is a simple example of the graphics capability of LOTUS to illustrate the effectiveness of a pictorial representation of reported numbers.



## CHAPTER I

INTRODUCTION

As the largest single industry in this country, construction plays a significant role in the lives of a great many people. When one thinks of construction as an industry some of the images conjured up include designers at a drawing table, an equipment operator atop a giant dozer or scraper moving several yards of earth, an ironworker perched precariously on a steel frame 75 stories above the ground, an engineer reviewing a set of blueprints, etc. On a smaller scale are the carpenters framing a house or a local concrete finisher constructing a backyard patio. While the scope of work and dollars spent may vary with the size of the project, one thing these people have in common is that they are transforming the idea of someone into a physical reality.

## The Nature of Construction Projects

This industry, which accounts for more than \$200 billion of the United States' gross national product, is in some ways similar to other manufacturing businesses and in some ways similar to other service organizations <sup>(1)</sup>. For example, there are finished products, although they can be enormous in size, cost and complexity. There is also a tremendous labor intensive effort in the construction industry, although it is



usually quite varied.

Construction has many characteristics that make the industry unique. While it may be the single largest industry in the country, it is made up of hundreds of thousands of small businesses. Only about 15 percent of construction companies are incorporated. Few of these companies are large enough to be included on the "Fortune 500" list of top businesses, especially when measured in terms of assets rather than in volume of work completed. However, these corporations account for 70 percent of the total volume of construction work. The other 850,000 smaller contractors and subcontractors accomplish the balance of work (5).

Unlike mass-produced products manufactured in a plant, a construction project is a unique, custom-built facility. Even if constructed for a national chain organization, each building, which may appear similar, must be modified slightly and adapted to a particular location. In manufacturing, workers go to the same plant in the same place to produce a product, whereas in construction the workforce must travel to the jobsite, oftentimes in remote areas. The workforce itself is different as it consists of people engaged in several of the industry's 18 trades, not counting the many specialty type operations. The construction workforce is often hired on a seasonal basis instead of yearly and most can expect to be released to look for further employment upon completion of a project.

National economics also plays a significant role in the





construction industry. As the nation's money supply expands, more dollars are put into construction, especially in the housing and public sector areas. As the supply dwindles, so too does the market for construction. In addition, the requirement for construction is not evenly spread across the country to match construction resources, so there may be too much work in some areas and too little in others. Government competition for public funds to do construction accounts for only 20 to 30 percent of the total dollars spent, however, the impact of government involvement is more far-reaching in the industry but these implications will be discussed later.

The above traits help to describe the construction industry but do not explain its operation. "Construction is highly fragmented and sometimes divisive, yet in response to pressing national needs, such as a major war effort, few industries can mobilize resources more quickly. Each of its elements- designers, constructors, regulators, consumers, suppliers, crafts- can be highly skilled in its own area, yet there is little general perspective on how all the pieces fit together. There really is no central focus." (1)

### Problems in Controlling Construction Operations

One of the differing outlooks between the construction industry and most manufacturing or service industries is the perspective taken with regard to future development. While the construction industry is highly effective on practical or project matters, it is often ineffective on general or



program matters. For example, it has been stated that less than one percent of its gross revenues is spent on research and development which contrasts sharply with most other industries. The incentive-oriented outlook of the industry probably is the reason that there have been few advances in technology. Innovations in the construction business cannot usually be protected by patent laws and internal security. Therefore, new developments rapidly spread throughout the industry. Thus, there is little chance of obtaining a technological edge over competitors for very long.

Realizing this perspective exists, the industry must rely on advances in performance, productivity and technique rather than breakthroughs in product or equipment development. Effective management is the most likely avenue for increasing profits in this business whether it be from the owner's or contractor's viewpoint. Channelling the efforts of the planners, designers, and craftsmen requires a tremendous effort if a person is to see a new facility completed and functional.

The effective utilization of resources is the key to being a profitable entity. As stated by Halpin and Woodhead<sup>(4)</sup>, there are six basic types of resources relevant to most management situations. They include:

1. Manpower: Coordinating the people from the many construction trades involved.
2. Machines: Insuring timeliness and availability of both large pieces of equipment and small hand tools.
3. Materials: Providing the proper material at the





proper time is essential to any project.

4. Money: This includes the flow of cash to pay personnel and suppliers as well as the financing of the job.

5. Information: Monitoring project status and the necessary communication to initiate the flow of resources constitutes the information flow for a project.

6. Management Decisions and Orders: The successful manipulation of the first four resources based upon the correct interpretation of the fifth resource.

The managers of the various phases of construction must constantly monitor, evaluate and modify the construction operation to insure that the work proceeds in accordance with the overall plan.

### Streamlining the Control of Projects

As construction projects become more complex and the associated costs continue to rise, more effort is being required to manage the process. It has been reported by Dun and Bradstreet Inc. that the many failures reported in the construction industry can be attributed to neglect, fraud, disaster, and lack of experience. However, the largest single factor contributing to bankruptcy has been poor management. Incompetence, unbalanced experience and the lack of managerial ability have accounted for more than 80 percent of the failures (2). It is, therefore, imperative that today's construction manager be able to effectively use the resources available if the company is to survive, let alone



operate at a profit. In like fashion, the owner can benefit from an efficiently-controlled project.



## CHAPTER II

BACKGROUND

Effective management of the construction process is the primary means of controlling the expenditure of resources. The resources may vary when being viewed by either the contractor or the owner but they are instrumental for accomplishing any company objectives. To monitor usage and other administrative requirements, some type of control systems must be developed and employed.

## Administrative Requirements on Construction Projects

Based upon personal working experience with construction contracting offices of the U.S. Navy Civil Engineer Corps and the University of Washington Architect's Office and in conversations with contractor personnel, it has been concluded by this writer that there are many administrative controls and reports required to comply with contractual obligations and specific regulations of governmental agencies and public law. Among these "paper requirements" for each project are:

- Contract documents
- General correspondence
- Change orders
- Submittals





- Shop drawings
- Samples and catalog cuts
- Manufacturer's technical data
- Manufacturer's certifications and test data
- Safety reports
- Construction deficiencies
- Equal opportunity employment practices
- Minority businesses employed
- Women-owned businesses employed
- Subcontractors employed
- Primary suppliers
- Certified payrolls
- Weekly time sheets
- Daily inspection reports
- System testing and balancing reports
- Operations and maintenance manuals required
- Punch lists
- Claims

The above list is not necessarily an exhaustive list of reports as each contracting agency will have its own requirements. In addition, the size and complexity of the job will alter the type and amount of information to be communicated between the owner and contractor.

While some of the submissions would entail a one-time report, others constitute a continual occurrence throughout the life of the project. Change orders, for example, may occur at any time between contract award and project



completion. These generally involve compensation or time modifications and must be monitored very closely.

Complex projects generally involve several change orders, perhaps hundreds, that modify the original contract documents to produce a more workable facility. The evolution of a change order is a rather complex process. The initial concept for a change may be initiated by any party in the construction process, from a subcontractor or supplier to the prime contractor to the designer or even the owner. The idea for the change must then be evaluated by the owner and/or designer. Once a possible change has been identified, all appropriate people must review the potential change and submit information concerning its impact, particularly time and cost implications. The owner must then evaluate the need for the change, its cost, the method of construction required and the impact of the change on existing and scheduled work. After this lengthy process, which may take up to several months, a formal change order may be issued to modify the original contract. Since dozens of potential changes may be in varying stages of evolution, keeping track of the development of each potential change can be a significant undertaking, especially on a large, complex project. In addition, if several projects are being constructed concurrently, the management of these changes can be enormous. It is not uncommon on large projects for the owner and contractor to hire full-time personnel whose duties are



solely focused on monitoring or "tracking" changes.

Changes orders are but one part of the construction administrative process that must be properly managed. If attempted manually, the process of tracking and maintaining an accurate status is extremely difficult. When combined with all the other items of information that must be maintained, the task becomes nearly impossible. On larger jobs, the manager can become inundated with the report submissions instead of managing the job.

### High Technology and the Construction Industry

As stated earlier, very few technological breakthroughs have occurred in the construction industry. However, one major advance has been introduced from the business world. Various participants in the construction industry are beginning to reap the benefits derived from the use of advancing computer technology, especially in the inexpensive microcomputer arena. Software has been developed for a myriad of business applications and is expanding to include more and more construction applications as well. Several programs have been developed for planning construction, designing facilities, projecting usage, scheduling work and paying the workers. So far, little has been developed to identify, track and manage the "mountain of paper" that seems to accompany the construction project. While the paperwork is not a direct contribution to the construction evolution,





the lack of timely processing of some of this paperwork can have a significantly detrimental effect on construction progress.

A typical microcomputer system consists of five main components: 1) a central processing unit (CPU) with an eight to thirty-two bit processor, 2) a data storage unit, preferably with two disk drives, 3) a monitor, which can be monochrome although color adds much more impact to the graphics capability, 4) a printer, which if it contains a 14 inch carriage can print full size computer printouts and is much more flexible, and finally 5) software, which is most critical because it determines the overall application's capabilities of the system.

Computer capabilities are judged by the amount of RAM or random access memory they contain. Most current micro models contain anywhere from 64K to 640K bits of memory capacity. There are models however, that can be directly connected to "hard" disk drives versus the soft floppy disks that are most common today. Hard disks can increase the RAM to 40 megabytes. A larger memory capacity will permit the use of larger and more complex software programs to be used and more data to be manipulated. Along with the increase in capacity comes an increase in price. Prices can range from a few hundred dollars to over twenty thousand dollars, depending on requirements and desires.

The most popular software packages for business use are word processing packages used for correspondence and



electronic spreadsheets used for accounting and other managerial tasks. The more complex packages combine these capabilities into one program for convenience and add features like data base management and graphics capabilities. Again, as the capabilities increase, so do the prices. The price for these packages can range from a few dollars each to several thousand dollars. A careful evaluation of requirements and a comparison of software is essential so that the intended job can be accomplished easily but without wasting money on unnecessary features.



## CHAPTER III

METHODOLOGY

As stated earlier, if a company is to prosper in the construction industry, or if an owner is to optimize resources applied to capital investment, the project must be effectively and efficiently managed. Construction management can fall into three distinct levels 1) Mission Management, 2) Project Management, and 3) Field Management (7). Each level is concerned with different types of resources and their application.

Mission management is concerned with the overall construction program. It involves the coordination of several projects and the interaction of the participants, such as the owner, designer, contractor and contract administrator. This type of management requires knowledge in business as it relates to organizational, technical, legal, contractual, and financial matters.

Project management usually applies to a specific job or group of similar jobs. The effort at this level is in planning, organizing, monitoring and controlling the resources that support a particular project. Overall project success depends on this level of management.

Field management is a further breakdown of the management function. At the project level, the managers are involved with the technical details of construction





operations and the day-to-day planning and scheduling of the job.

While each level of management is important for success, the second echelon of management, at the project level, is critical because each job should be able to produce a profit independently. This paper will discuss management at that level.

### Project Management-Level Reporting

"Management-level reporting must provide a straightforward statement of the work accomplished, predict future accomplishments in terms of the project cost and schedule, and measure actual accomplishments against goals set forth in the plan. It should review current and potential problems and indicate management action underway to overcome the effects of the problems." (2) While the reporting systems are somewhat similar in use, they will vary in complexity.

It is unfortunate that many businesses, especially in the construction industry react to situations as they occur rather than anticipating opportunities before a problem occurs. Using an anticipatory approach and becoming aware of potential problems, before they become catastrophic enables the manager to better utilize available resources. Construction projects of any significant size require a great deal of paperwork in addition to actual "brick and



mortar" to complete. Managing this "mountain of paper", which includes contract and legal documents, payrolls, change orders, submittals and much more, places a tremendous burden on the project manager. This is true regardless of which side of the project, the owner's or contractor's, is being managed.

Based upon discussions with contractor personnel, owners, and contracting agents, coupled with this writer's own personal construction experience, most engineers and engineering managers would much rather build something than spend their time generating paperwork. Unfortunately, it seems that to accomplish the former, the latter, less glorious task must accompany all but the most simple projects. Managers must rely very heavily on status reports generated from accurate field information. However, in order that good decisions be made, the quantity, format, and timeliness of the information are also important. If a manager is overloaded with data, cannot quickly interpret the data, or receives it after a critical decision point has been passed, a proactive solution quickly becomes a reactive one, often with few and undesirable options. The good construction manager must then find ways to either reduce the information overload or control it and make it useful and effective.



## Development of an Information System

One of the ways to provide information for decision-making in a useful format is on a microcomputer. These inexpensive tools can greatly assist the manager in shifting from the reactive mode to the anticipatory mode and thus potentially earn a greater profit. However, any computerized system used to assist in the management effort must 1) be easy to use or be "user friendly", 2) actually reduce the workload, enhance or expand the output without interfering with current operations, 3) be relatively inexpensive to obtain and use, 4) be essentially maintenance free and 5) show an immediate reward or payback.

If any of the above five criteria is omitted or if the system is considered a burden by the personnel using it, there is no surer or faster way for a "management tool" to become one person's "expensive toy" or worse, a dust collector. In addition, getting the right capabilities through proper selection of hardware and software is tantamount to the acceptance of the new tool and successful implementation.

This report is not intended to endorse any particular product or system but describes one that was available to this writer for use and experimentation. There are literally hundreds of hardware system / software package combinations that can meet the requirements of a particular user.



The package used in this research effort consists of the popular IBM PC computer (IBM PC is a registered trademark of the International Business Machines Corporation) and the spreadsheet software package LOTUS 1-2-3 (LOTUS 1-2-3 is a registered trademark of the Lotus Development Corporation). Both are medium-priced but are near the upper range in capabilities for their respective costs.

The computer had been expanded to include 512K bits of RAM (random access memory) and contained two disk drives for 5.25 inch double sided, double density floppy diskettes. Rounding out the hardware package are a monochrome monitor, a 1.2 megabyte hard disk and an Epson 100, 14 inch wide, 144 character dot matrix printer. The hard disk is not an essential component for operating the computer and software, per se. However, when large amounts of data are to be entered and manipulated, the hard disk may be required. The dot matrix printer presents output in various print styles and sizes and it has considerable capabilities for graph plotting.

The "LOTUS" software package is a standard business spreadsheet from which various templates were developed through this research effort. The templates were developed for specific adaptation to construction management usage. These templates have been developed with people who actually use some of them in their everyday business. As will be seen, the perspective of both the contractor and owner have





been taken into account as the system is readily adaptable for use by either party.

The LOTUS 1-2-3 package consists essentially of an electronic spreadsheet with a multitude of ways to manipulate data. Spreadsheets are typically used by virtually all businesses to conduct financial transactions. The LOTUS spreadsheet is comprised of 256 columns labeled A, B, C, ... AA, AB, AC, ... IV and 2048 horizontal rows numbered 1, 2, 3, ... 2048. Each of the half million possible cell entries is identified by an alpha-numeric label and can contain an entry consisting of a number, a label or a formula. In addition to single cell entries and addresses, LOTUS allows the naming of portions of the worksheet and the manipulation of entire ranges of data as well. Combined with the capabilities of the IBM PC, this package becomes a powerful management tool<sup>(13)</sup>.

This paper is not intended to be a tutorial or user guide for the LOTUS 1-2-3 package, however, a basic description of the program is essential to understanding the various operations that will be described. For a more in-depth look at LOTUS 1-2-3, refer to either the manual that accompanies the program when purchased or other reference books that are readily available at bookstores and computer outlets.

The LOTUS program is menu-driven which means that, for every action to be taken, a listed choice of options is printed on the screen to guide the user through the



operation. Many of the capabilities of this spreadsheet package will be presented. Examples will be given to show how they can be adapted to the construction management process. When the program is inserted and turned on, or "booted up", the initial menu shown in Figure 1 greets the user. Of the six choices (1-2-3, File-Manager, Disk-Manager, PrintGraph, Translate, Exit) available, each has a sub menu to describe the capability within that choice. Whenever a selection is made by pressing the return key, either a new menu is displayed or a worksheet is available for further inputs. Figure 2 shows a blank spreadsheet where the user begins building a document that is tailored to a specific requirement.

As the data are entered, the user may wish to maneuver them or use them in some manner. Again, since the program is menu-driven, all that is required is to draw from the available menu choices to accomplish the desired action. Figure 3 is the next set of menu choices. Highlighted is the cursor while the second line contains a list of options for that highlighted choice. Figure 4 shows the descriptions of each of the eight first echelon menu options. Included are various capabilities in formatting the worksheet, defining a range, copying or moving cell contents, creating, using, printing or graphing files, manipulating data within files and finally quitting a 1-2-3 session.

As one becomes familiar with the available options and capabilities of this program, creative and illustrative



worksheets can be obtained quickly and efficiently. As with everything else "practice makes perfect." In the following chapter, examples of various worksheets will be presented illustrating the capabilities of LOTUS 1-2-3 and the potential applications within the construction management process as it applies to both owners and builders of construction projects.





Lotus Access System V.1A (C)1983 Lotus Development Corp.

MENU

-----  
2-3 File-Manager Disk-Manager PrintGraph Translate Exit  
Enter 1-2-3 -- Lotus Spreadsheet/Graphics/Database program  
=====

Wed 24-Jul-85  
4:01:06pm

Use the arrow keys to highlight command choice and press [Enter]  
Press [Esc] to cancel a choice; Press [F1] for information on command choices

Figure 1. Lotus System Menu



READY

A B C D E F G H

Figure 2. Lotus Blank Worksheet



Worksheet Range Copy Move File Print Graph Data Quit MENU  
Global, Insert, Delete, Column-Width, Erase, Titles, Window, Status  
A B C D E F G H

Figure 3. Lotus Worksheet Menu



|   |       |      |      |      |       |       |      |      |      |
|---|-------|------|------|------|-------|-------|------|------|------|
| Worksheet   | Range | Copy | Move | File | Print | Graph | Data | Quit | MENU |
| Format, Label-Prefix, Erase, Name, Justify, Protect, Unprotect, Input |       |      |      |      |       |       |      |      |      |
| A   | B     | C    |      | D    | E     | F     | G    | H    |      |
| MENU  |       |      |      |      |       |       |      |      |      |
| Worksheet   | Range | Copy | Move | File | Print | Graph | Data | Quit | MENU |
| Copy a cell or range of cells   |       |      |      |      |       |       |      |      |      |
| A   | B     | C    |      | D    | E     | F     | G    | H    |      |
| MENU  |       |      |      |      |       |       |      |      |      |
| Worksheet   | Range | Copy | Move | File | Print | Graph | Data | Quit | MENU |
| Copy a cell or range of cells   |       |      |      |      |       |       |      |      |      |
| A   | B     | C    |      | D    | E     | F     | G    | H    |      |
| MENU  |       |      |      |      |       |       |      |      |      |
| Worksheet   | Range | Copy | Move | File | Print | Graph | Data | Quit | MENU |
| Retrieve, Save, Combine, Xtract, Erase, List, Import, Directory       |       |      |      |      |       |       |      |      |      |
| A   | B     | C    |      | D    | E     | F     | G    | H    |      |
| MENU  |       |      |      |      |       |       |      |      |      |
| Worksheet   | Range | Copy | Move | File | Print | Graph | Data | Quit | MENU |
| Input a range to the printer or a print file                          |       |      |      |      |       |       |      |      |      |
| A   | B     | C    |      | D    | E     | F     | G    | H    |      |
| MENU  |       |      |      |      |       |       |      |      |      |
| Worksheet   | Range | Copy | Move | File | Print | Graph | Data | Quit | MENU |
| Create a graph  |       |      |      |      |       |       |      |      |      |
| A   | B     | C    |      | D    | E     | F     | G    | H    |      |
| MENU  |       |      |      |      |       |       |      |      |      |
| Worksheet   | Range | Copy | Move | File | Print | Graph | Data | Quit | MENU |
| 11, Table, Sort, Query, Distribution                                  |       |      |      |      |       |       |      |      |      |
| A   | B     | C    |      | D    | E     | F     | G    | H    |      |
| MENU  |       |      |      |      |       |       |      |      |      |
| Worksheet   | Range | Copy | Move | File | Print | Graph | Data | Quit | MENU |
| End 1-2-3 session (Have you saved your work ?)                        |       |      |      |      |       |       |      |      |      |
| A   | B     | C    |      | D    | E     | F     | G    | H    |      |

Figure 4. Lotus Menus





## CHAPTER IV

RESULTS

It is unfortunate that many businesses, especially in the construction industry, react to situations after they occur rather than anticipating problems prior to their occurrence. Using an anticipatory approach and becoming aware of potential problems before they become catastrophic enables the manager to better utilize available resources. Construction projects of any significant size require a great deal of paperwork, in addition to the actual physical effort required, in order to reach a smooth project completion. Managing the necessary periodic reports places a tremendous burden on the project manager. This is true for both contractors and owners as they manage their projects.

This research was conducted in three steps. First, a review of current techniques in the management of construction projects was made. Information was gathered from four sources: 1) literature regarding construction management, 2) interviews with local contractors currently involved in construction projects of varying scopes, 3) interviews with owners currently monitoring construction projects, and 4) personal experience of this writer in managing a variety of construction projects on behalf of the U.S. Navy. Second, possible alternative methods of construction monitoring had to be identified and reviewed for applicability. These alternative choices were obtained from the same general sources listed above. The better features of each method were



then taken and incorporated into a single construction management process. Finally, once a promising method was selected, it was further developed for implementation.

On all but the simplest projects, some control system is required. However, the system must be flexible enough to accommodate various types and sizes of projects. It must also be easy to use and its cost must be commensurate with the intended use. As Barrie states <sup>(1)</sup>, there has been considerably more sophistication in both the planning and control of construction projects with the advent of the computer. Computerized reports generating hundreds of pages of information are, in many cases, of little use to the line managers in charge and who are in a position to influence work. They become overwhelmed with information and have returned to fundamentals and continue to use their own rules of thumb, common sense, and individual methods and systems that have proven effective for them in the past. The use of detailed, computerized systems appears widespread on large, cost plus fee contracts. However, when a contractor's own money is at stake, as on lump sum contracts, the system chosen is simplified and is less elaborate. The construction industry has been slow to emulate the manufacturing industry because there has been little evidence to support the effective use of large computers in the planning and control of construction. This is beginning to change since the microcomputer has become available and popular. As the cost of the systems has come down and their use has gotten easier, construction managers are more able to justify the expenses for purchasing computers and hiring associated personnel. In addition, as computers become easier to



use and as report preparation and use is simplified, more managers may become more willing to experiment with them.

The microcomputer is an inexpensive tool that can greatly assist the manager in shifting from the reacting mode to the anticipatory mode and thus earning a potentially greater profit. Presented below are a few examples of how the computer can be of assistance. These represent recurring requirements that demand attention on essentially every job. Templates have been developed to provide a framework or structure to manage these items. Included are a change order log, a submittal log, a simple inventory control system and a simple, graphic cash flow projection model. While these examples are not meant to be all-inclusive, they illustrate both the flexibility and the adaptability of the program in easing the tasks performed by managers.



## Change Order Control Log Template

One of the basic premises of the construction industry is that almost no job is ever built completely as originally designed. Whether the change is caused by some unforeseen condition, the owner's changing requirements or the designer making an error or omission does not matter. Regardless of the reasons, some changes must be incorporated for a successful project and they must be included in a timely manner and with an equitable settlement for both the owner and contractor. Monitoring these changes and settlements and tracking the status of these changes through various review stages is essential for both the owner and contractor.

While most information would be similar in a log maintained to monitor construction changes, there are some data which would be applicable to only an owner and project manager or to a contractor. At the University of Washington Architect's Office, a system has been developed to monitor the numerous proposed changes on the construction contracts they award. The system is simple, which makes it easy to use, but it also has the capability of being expanded to meet requirements of almost any particular construction project.

As discussed earlier, a change can be identified by any party in the construction process from owner and designer to prime contractor and subcontractors to inspectors and even eventual occupants. Depending on the party to identify the requirement, the reason or justification for the change would vary. For example, eight possible reasons for instigating a





change order are listed below. They include:

-Unforeseen site conditions. These include changes associated with encountering unmarked obstacles such as underground utility lines or soil conditions that differ significantly from those depicted in the contract drawings. When these conditions occur, the contractor is often required to perform extra work or modify the originally-intended method of construction. This often delays construction progress. Because of these possible significant impacts, the contractor is usually entitled to additional compensation and/or time.

-Program changes for Owner. These changes are associated with new, different, or additional equipment the owner intends to install, or the owner may request a modification in the design of furnishings to better suit the eventual occupants.

-Program changes for Physical Plant or Public Works Department. These changes are associated with modifying the original design to facilitate maintenance and repair of installed equipment or the structure itself.

-Program changes for Occupant Coordination. These will occur primarily in remodeling projects where unique interfacing problems may arise with the occupants of an adjacent, currently-occupied building.

-Design Errors, Omissions, Corrections, and Clarifications. These changes are probably the most common. Greater complexity of projects entails more interfacing requirements by the various engineering disciplines which result in oversights and/or conflicts. Change orders resulting from this problem need



careful attention from the owner to determine potential liability against the designer.

-Regulatory Changes. On projects taking several years to complete, building codes and various other governmental regulations may be initiated or modified during the construction period thus requiring the contractor to make modifications to the new facility. While necessary for the building to meet all code requirements so that the owner can move into an acceptable facility, the contractor may be entitled to additional compensation.

-Value Engineering Improvements. These changes can be suggested by the owner or contractor as a less expensive and/or better way of accomplishing a project objective. The changes occasionally result in an overall net savings. These savings may be split between owner and contractor in some predetermined proportion.

-Project Coordination. These changes are required to coordinate utility outages arising from the need to connect the new facility to existing utility services or to disrupt traffic flows, pedestrian accessways or other interfaces. While necessary, these changes, when not previously identified, must be kept to a minimum as premium prices generally ensue.

These reasons may explain the cause for a potential change but they do not assist the construction manager in controlling the project. The manager needs a flexible monitoring system to help direct the job.

One of the easiest monitoring systems for potential changes



involves a two phase process. A number is used to uniquely describe each potential change. This number is assigned for tracking purposes in the early stage. A second number is assigned when the contract documents are formally revised or when a formal change order is issued. The contractor can then bill against the new line item that includes the cost of the change.

Once a change has been identified by any party, a Modification Proposal (MP) number and a brief description is assigned for tracking purposes. This number will accompany the MP until it becomes an official change order. Ideally, every time an MP is created, the designer will prepare a cost estimate prior to the time when the contractor is asked to prepare a cost proposal. In this way, the owner will have an idea of the costs associated with the change prior to making a commitment. If an optional change appears too costly, the owner can decide to abandon the proposal before significant amounts of effort are invested in preparing the change order. This dollar amount can also be used as a budgeting tool to track the status of any contingency funds that might be needed for the job. In addition, when the contractor's proposal is received, it can be evaluated more completely by having an independent estimate for comparison. The independent cost estimate can help identify differences in assumptions which will lead to more reasonable agreements and prevent later disputes (1).

Once the contractor's proposal is evaluated the price is either accepted, rejected or negotiated to a mutually-agreeable price. After an agreement is reached, a formal change order can be issued. Depending on the scope of the change and the dollar





amounts involved, the change can be approved by the project manager's office, a Change Order Approval Board, the owner or any appropriate level in the review process, depending on the scope of the change and the reviewing process of the owner's organization. Most changes are referred to a panel or review board to assess change orders and which makes a recommendation to the owner. The Board usually consists of representatives from the project manager's office including the director, the cost engineer, and the chief project inspector. The owner may also send representatives from finance, administration, or the ultimate using department. In addition, the designer sends the engineer or architect most familiar with the particular change to be discussed. Items discussed include: the necessity of the change, the methodology involved to construct the change and the actual cost to have the contractor implement the change. In addition, the impact of this modification on other already completed change orders or other pending MP's and the impact on the overall construction budget are discussed.

To assist not only members of the reviewing staff but also to assist in the day-to-day monitoring of job progress, a computerized log similar to Figure 5, could be developed. This log is tailored to the needs of the owner's staff. The title area can be applied to any of the pages and can be as long as deemed appropriate. Headings for data entries can be inserted for any information that requires monitoring. The headings in the template shown have been found to be the most useful. However, the headings can be changed to accommodate differing managerial needs. To keep the illustration simple, only the most important





CHANGE ORDER CONTROL LOG  
(OWNER'S PERSPECTIVE)

| CHANGE ORDER | DESCRIPTION | COST     |    | AMOUNT | APPROVED | JUST. | SPEC. | MBS | REVIEW | A/E | DATE | INITIATED | CONTRACTOR | RECEIVED | CHANGE |
|--------------|-------------|----------|----|--------|----------|-------|-------|-----|--------|-----|------|-----------|------------|----------|--------|
|              |             | ESTIMATE | BY |        |          |       |       |     |        |     |      |           |            |          |        |
|              |             |          |    |        |          |       |       |     |        |     |      |           |            |          |        |

Figure 5. Change Log (Owner - MP) : Headings



categories have been used, but the program is flexible enough to accommodate changes as necessary.

The log contains all modification proposals, whether they are additions, deductions, or no cost changes. Every time the contractor and owner agree that a particular item is outside of the scope of the original contract requirements, an MP is added. Figure 6 shows the initial entry into the log. Once the worksheet has been formatted, only data entries need be made as they occur. This sample Change Order Control Log shows the current status of each MP. Entries in the log will be made in the sequence that MP's are initiated. However, the information can be sorted differently by using other parameters.

Since the construction contract will include all change orders, the highest status of an MP is when it is transformed into a formal change order. Consequently, the log has been formatted to display the formal change order column first. Two columns of the log indicate whether an MP has been included in a change order or if it is still in the review stage. If a formal, negotiated change order has been issued, that number will appear in column A (CHANGE ORDER). If the MP is in any other stage of review, column A will be blank and column J (REVIEW STATUS), will contain an appropriate review status code.

Column B (MOD PROP) contains the modification proposal number. Assigned in numerical order, each potential change receives a number usually in the order that the problem was first discovered. It is followed by a brief description of the MP in column C (DESCRIPTION). The spreadsheet column-widths can be set at any spacing between 1 and 72 characters. By carefully



CHANGE ORDER CONTROL LOG  
(OWNER'S PERSPECTIVE)

| CHANGE ORDER NO | DESCRIPTION                     | COST            |                 | AMOUNT  | APPROVED JUST. SPEC. PRICE CODE | WRS  | REVIEW FEE | DATE INITIATED | RECEIVED PROPOSAL FROM CONTRACTOR | CHANGE BOARD APPROVAL DATE |
|-----------------|---------------------------------|-----------------|-----------------|---------|---------------------------------|------|------------|----------------|-----------------------------------|----------------------------|
|                 |                                 | ESTIMATE BY A-E | ESTIMATE BY R-C |         |                                 |      |            |                |                                   |                            |
| 1               | CHANGE SITE FENCE TO CHAIN LINK | \$2,000         |                 | \$2,000 | 7                               | 2444 | 4          | 04-Jan-84      |                                   |                            |

CHANGE ORDER CONTROL LOG  
(OWNER'S PERSPECTIVE)

| CHANGE ORDER NO | DESCRIPTION                     | COST            |                 | AMOUNT  | APPROVED JUST. SPEC. PRICE CODE | WRS  | REVIEW FEE | DATE INITIATED | RECEIVED PROPOSAL FROM CONTRACTOR | CHANGE BOARD APPROVAL DATE |
|-----------------|---------------------------------|-----------------|-----------------|---------|---------------------------------|------|------------|----------------|-----------------------------------|----------------------------|
|                 |                                 | ESTIMATE BY A-E | ESTIMATE BY R-C |         |                                 |      |            |                |                                   |                            |
| 1               | CHANGE SITE FENCE TO CHAIN LINK | \$2,000         | \$3,200         | \$3,200 | 7                               | 2444 | 3          | 04-Jan-84      | 18-Jan-84                         |                            |

Figure 6. Change Log (Owner - MP) : Initial Entry



adjusting the column-widths for each entry item, the user can optimize the information that can be shown on the screen and also on the hard copy. The user must be aware of the capabilities of the printer being used when column-widths are set.

Columns D, E, F, and G contain pricing information. As labelled, the first two columns, (COST ESTIMATE BY A/E and COST ESTIMATE BY CONTRACTOR), reflect the estimates of the designer and general contractor respectively. The next two columns are mainly for budgetting purposes. The AMOUNT PENDING column represents the higher of the A/E or Contractor estimates and is considered the worst case result or highest possible cost that will likely be charged to that MP. This price is used until the proposal has been negotiated and an agreeable price has been determined. At that time, the column F entry is removed and the approved price is inserted in the next column. This approved price is then used in the formal change. Only one of these two columns will contain an entry for each MP.

The following columns contain information that is useful in evaluating the overall effect of all the MP's. Column H contains the justification code or reason for the change. The codes range from 1 to 8 and correspond to the numbers given to the eight possible reasons a change may be initiated, as discussed earlier. Following that is a breakdown of the MP's by work breakdown structure (WBS). The work is segregated according to the Construction Specifications Institute (CSI) specification division and can be tracked by major groups. As will be seen later, by coding this information and inserting it into the log, a project manager can determine impacts of certain changes and





reasons for those changes.

The REVIEW STATUS column has been previously addressed. Status codes correspond to the stage of the review each MP is in. Example review status codes follow:

| <u>CODE</u> | <u>REVIEW STATUS</u>                               |
|-------------|--|
| blank       | MP has been approved and a change order issued     |
| 1           | MP being reviewed by owner                         |
| 2           | MP being reviewed by Change Order Review Board     |
| 3           | MP being reviewed by designer                      |
| 4           | MP price proposal not yet received from Contractor |

The following column (A/E FEE) is inserted for budgetary reasons. It indicates entitlement of payment to the designer for any new MP. Usually, if the proposed change has been due to a design oversight or error, no entitlement exists. However, if the owner requests additional work or wishes to modify the existing plans, the design agent is compensated.

Various milestone dates are also monitored, including the date an MP was initiated, the date a price proposal was received from the contractor, and the approval date by the review board or the date a formal change order was issued. These dates can be inserted as dates or numbers, as the LOTUS 1-2-3 program will convert them all to numbers. This ability is helpful for sorting and enables the computer to compare dates to provide information or indications when action on an MP is delayed or overdue.

As an MP progresses through the various stages enroute to becoming an official change order, additional information is



included in the log as it becomes available. Figure 7 contains seven more MP's as well as updated information on the first. Note, that as the modifications are approved and change orders are actually consummated, a change order number is included in the proper column. The change order numbers may not be in numerical order as the evaluation of an MP may take weeks or months. Change orders are issued periodically which combine all modifications that have been approved during that period, which is usually monthly. Thus, several MP's will be combined into a single change order. On a large job with a multitude of MP's, this procedure will tend to eliminate some paperwork. As more MP's are identified, they can easily be added to the end of the log. A blank, extra row for data entry is simply inserted at the end of the worksheet, just before the totals section, and the new entry is introduced.

The purpose of a spreadsheet is to be able to perform mathematical calculations on data. LOTUS does this like most other spreadsheet packages. Columns or rows can be totalled by inserting a formula identifying the addresses to be summed and the result can be inserted in any desired cell address. When additional entries are made that extend the worksheet, formulae are automatically adjusted to account for the corresponding increase in columns or rows and the totals are manually or automatically recalculated. Additional MP's have been included in Figure 8 to show the program's versatility.

With some exceptions, the needs of a contractor are similar to those of an owner. Figure 9 shows a log that might be more appropriate for a contractor. While parts of the log would be



CHANGE ORDER CONTROL LOG  
OWNER'S PERSPECTIVE

| CHANGE ORDER       | MOD PROP | DESCRIPTION  | COST ESTIMATE |               | AMOUNT   | APPROVED PRICE | JUST. CODE | SPEC. SECTION | UFG  | REVIEW | A E | DATE INITIATED | RECEIVED PROPOSAL FROM CONTRACTOR | CHANGE BOARD APPROVAL DATE |           |
|--------------------|----------|--|---------------|---------------|----------|----------------|------------|---------------|------|--------|-----|----------------|-----------------------------------|----------------------------|-----------|
|                    |          |  | BY AVE        | BY CONTRACTOR |          |                |            |               |      |        |     |                |                                   |                            |           |
| 1                  | 1        | CHANGE SITE FENCE TO CHAIN LINK                      | \$2,000       | \$7,000       |          | \$5,000        |            |               | 2444 |        |     | \$198          | 04 Jan-84                         | 19-Jan-84                  | 24-Mar-84 |
| 2                  |          | WOOD SUBSTATION FENCE IN LIEU OF CHAIN LINK          | \$4,500       | \$4,750       | \$4,950  |                |            |               | 414  | 2      |     | \$297          | 27-Jan-84                         | 10-Feb-84                  |           |
| 3                  | 1        | DEMOLITION OF CONCRETE ENCOUNTERED DURING EXCAVATION | \$5,500       | \$5,500       |          | \$5,500        |            |               | 2200 | 1      |     | \$0            | 07-Feb-84                         | 21-Feb-84                  | 24-Mar-84 |
| 4                  |          | REMOVE MECHANICAL SYSTEMS IN DR'S LOUNGE             | \$1,000       | \$1,100       | \$1,100  |                |            |               | 1500 | 3      |     | \$0            | 07-Feb-84                         | 21-Feb-84                  |           |
| 5                  |          | CONSTRUCT "HEALTH SCIENCES" BUS STOP                 | \$4,000       | \$3,500       | \$4,000  |                |            |               | 2513 | 3      |     | \$240          | 07-Feb-84                         | 21-Feb-84                  |           |
| 6                  |          | RELOCATE EXISTING X RAY 2 PANEL                      | \$1,000       | \$1,500       | \$1,500  |                |            |               | 1600 | 4      |     | \$0            | 17-Mar-84                         |                            |           |
| 7                  |          | LOWER FOOTINGS AT RE/68 AND BH/68                    | \$7,900       | \$7,000       | \$7,000  |                |            |               | 2200 | 4      |     | \$274          | 17-Mar-84                         |                            |           |
| 8                  |          | ADD SANITARY AND STORM SEWER LINES                   | \$18,000      | \$18,000      | \$18,000 |                |            |               | 2722 | 4      |     | \$0            | 17 Mar-84                         |                            |           |
| TOTALS             |          |  |               | \$7,850       | \$8,900  |                |            |               |      |        |     | \$969          |                                   |                            |           |
| CONSTRUCTION TOTAL |          |  |               | \$47,650      |          |                |            |               |      |        |     |                |                                   |                            | \$43,619  |

Figure 7. Change Log (Owner - MP) : Entries



CHANGE ORDER CONTROL LOG  
(OWNER'S PERSPECTIVE)

| CHANGE ORDER       | DESCRIPTION  | ESTIMATE  |               | AMOUNT BEHIND | APPROVED PRICE | JUST CODE | SPECT. SECTION | WBS   | PERCENT | DATE INITIATED | PROPOSAL FROM CONTRACTOR | CHANGE BOARD APPROVAL DATE |
|--------------------|--|-----------|---------------|---------------|----------------|-----------|----------------|-------|---------|----------------|--------------------------|----------------------------|
|                    |  | BY A/E    | BY CONTRACTOR |               |                |           |                |       |         |                |                          |                            |
| 1                  | CHANGE SITE FENCE TO CHAIN LINK                      | \$2,800   | \$7,300       |               | \$7,300        |           |                | 2444  |         | 04-Jan-84      | 18-Jan-84                | 24-Mar-84                  |
| 2                  | WOOD SUBSTITUTION FENCE IN LIEU OF CHAIN LINK        | \$4,500   | \$4,950       |               | \$4,950        |           |                | 2444  |         | 27-Jan-84      | 10-Feb-84                | 27-Jul-84                  |
| 3                  | DEMOLITION OF CONCRETE ENCOUNTERED DURING EXCAVATION | \$5,500   | \$5,500       |               | \$5,500        |           |                | 2200  |         | 07-Feb-84      | 21-Feb-84                | 24-Mar-84                  |
| 4                  | REMOVE MECHANICAL SYSTEMS IN DR'S LOUNGE             | \$1,000   | \$1,100       |               | \$1,100        |           |                | 15010 |         | 07-Feb-84      | 21-Feb-84                | 25-Aug-84                  |
| 5                  | CONSTRUCT "HEALTH SCIENCES" BUS STOP                 | \$4,000   | \$5,630       |               | \$5,630        |           |                | 2513  |         | 18-Feb-84      | 21-Feb-84                | 25-Apr-84                  |
| 6                  | RELOCATE EXISTING 1-6-1/2 PANEL                      | \$1,500   | \$2,130       |               | \$2,130        |           |                | 16020 |         | 17-Mar-84      | 31-Mar-84                | 25-Apr-84                  |
| 7                  | LOWER FOOTINGS AT RE/68 AND RH/68                    | \$5,700   | \$4,290       |               | \$4,290        |           |                | 2200  |         | 17-Mar-84      | 31-Mar-84                | 25-Apr-84                  |
| 8                  | ADD SANITARY AND STORP. SEWER LINES                  | \$18,000  | \$19,800      |               | \$19,800       |           |                | 2722  |         | 17-Mar-84      | 31-Mar-84                | 27-May-84                  |
| 9                  | DIMENSIONAL CHANGES IN TUBE STEEL & STAIR TONGUES    | NA        | \$750         |               | \$750          |           |                | 5560  |         | 17-Jun-84      | 03-Jul-84                | 27-Jul-84                  |
| 10                 | FLUMING FIXTURE SUBSTITUTIONS                        | \$5,200   | \$4,950       |               | \$4,950        |           |                | 15450 |         | 19-Jun-84      | 03-Jul-84                | 25-Aug-84                  |
| 11                 | ALTER FLOOR PLANS TO ACCOMMODATE DOOR SHOP DRAWINGS  | \$2,500   | \$4,250       |               | \$4,250        |           |                | 8305  |         | 17-Jun-84      | 03-Jul-84                | 29-Sep-84                  |
| 12                 | DEND AND REMOVE CONCRETE FOOTING AT AIR SHIRT        | \$2,000   | \$2,200       |               | \$2,200        |           |                | 2200  |         | 19-Jun-84      | 03-Jul-84                | 27-Jul-84                  |
| 13                 | RELOCATE 4" RAIN LEADER PER 00-5                     | \$500     | \$550         |               | \$550          |           |                | 15400 |         | 19-Jun-84      | 03-Jul-84                | 29-Sep-84                  |
| 14                 | DELETE MANHOLE, ETC PER REV. FIG. NO. 3              | (\$2,500) | (\$2,200)     |               | (\$2,200)      |           |                | 2722  |         | 19-Jun-84      | 03-Jul-84                | 25-Aug-84                  |
| 15                 | ADD ELEVATOR SILL ANGLES PER 50-37                   | \$1,000   | \$3,630       |               | \$3,630        |           |                | 5500  |         | 02-Aug-84      | 08-Aug-84                | 25-Aug-84                  |
| 16                 | PIPE SUBSTITUTIONS PER 40-78                         | \$1,500   | \$1,100       |               | \$1,100        |           |                | 15300 |         | 05-Aug-84      | 08-Aug-84                | 29-Sep-84                  |
| 17                 | REROUTE GROUND WIRE IN ME-2 PER ED-7                 | \$9,000   | \$2,900       |               | \$2,900        |           |                | 16010 |         | 06-Aug-84      | 20-Aug-84                | 25-Aug-84                  |
| 18                 | DIRECTED WORK STOPPAGE AT LOADING DOOR               | NA        | \$7,850       |               | \$7,850        |           |                | 1050  |         | 07-Aug-84      | 21-Aug-84                | 25-Aug-84                  |
| 19                 | ADD TWO 6" RIBBED SHELVES @ WATER MAIN               | \$500     | \$550         |               | \$550          |           |                | 2700  | 2       | 22-Oct-84      | 11-Nov-84                |                            |
| 20                 | INSTALL P-24 DRAIN 1" BELOW GRADE @ STAIR PER F0-41  | (\$2,200) | (\$2,000)     |               | (\$2,000)      |           |                | 15400 | 2       | 22-Oct-84      | 11-Nov-84                |                            |
| 21                 | RELOCATE SEWER MANHOLES AND 6" LINE (REV. FIG. 6)    | \$1       | \$4,200       |               | \$4,200        |           |                | 2722  | 1       | 22-Oct-84      | 22-Oct-84                |                            |
| 22                 | ADD DROP INLET AT MANHOLE 3 PER 50-19                | \$4,500   | \$4,950       |               | \$4,950        |           |                | 2722  | 2       | 13-Nov-84      | 15-Nov-84                |                            |
| 23                 | RELOCATE STEAM VENT LINE PER FIELD QUESTION ED-2     | \$0       | \$5,500       |               | \$5,500        |           |                | 15720 | 2       | 13-Nov-84      | 20-Nov-84                |                            |
| 24                 | ADD SUPER PLASTER/STIEF TO ELEVATOR CORE CONCRETE    | \$2,900   | \$1,100       |               | \$1,100        |           |                | 3310  | 3       | 13-Nov-84      | 25-Nov-84                |                            |
| 25                 | LOWER FOOTINGS AT RH 62 AND 65                       | \$3,200   | \$3,200       |               | \$3,200        |           |                | 2200  | 4       | 178            | 25-Nov-84                |                            |
| 26                 | RELOCATE 9' MORMON TREES                             | \$1,900   | \$1,900       |               | \$1,900        |           |                | 2110  | 4       | 114            | 07-Dec-84                |                            |
| 27                 | CHANGE STOREFRONT HARDWARE FINISH PER REV. FIG. 17   | \$4,500   | \$4,500       |               | \$4,500        |           |                | 8700  | 4       | 270            | 19-Dec-84                |                            |
| 28                 | STRUCTURAL REVISIONS PER REV. FIG 19                 | NA        |               |               |                |           |                | 5120  | 4       | 08-Jan-85      |                          |                            |
| 29                 | ADD BECK SUPPORT PER 50-46 (LEVEL -1S)               | \$2,000   | \$2,000       |               | \$2,000        |           |                | 5500  | 4       | 120            | 18-Jan-85                |                            |
| TOTALS             |  |           |               | \$26,700      | \$69,540       |           |                |       |         | \$2,720        |                          |                            |
| CONSTRUCTION TOTAL |  |           |               |               | \$96,540       |           |                |       |         |                |                          | \$99,260                   |

Figure 8. Change Log (Owner - MP) : Addl Entries





PROJECT NAME:

CHANGE ORDER CONTROL LOG  
(CONTRACTOR'S PERSPECTIVE)

CONTRACT NUMBER:

PROJECT LOCATION:

CONTRACT AGENCY:

| MOD CHANGE<br>PROP STATUS | MRS<br>(SPEC.)<br>SECTION | DESCRIPTION  | SUBS<br>AFFECTED | DATE<br>INITIATED | ESTIMATE<br>BY<br>SUR (CONTRACTOR) | TOTAL<br>COST<br>(ESTIMATE) | DATE<br>FROM<br>OWNER | DATE<br>TO<br>OWNER | NEXT<br>RESP<br>(S,C,O) | APPROVED<br>PRICE | TYPE<br>CHNG | REMARKS |
|---------------------------|---------------------------|--|------------------|-------------------|------------------------------------|-----------------------------|-----------------------|---------------------|-------------------------|-------------------|--------------|---------|
| 1                         | 1                         | CHANGE SITE FENCE TO CHAIN LINK                      | 1444 FINE FENCE  | 04-Jan-84         | \$2,000                            | \$2,000                     | 08-Jan-84             | 19-Jan-84           | 24-Mar-84               | \$2,300           |              |         |
| 2                         | 4                         | WOOD SUBSTATION FENCE IN LIEU OF CHAINLINK           | 2444 FIRE FENCE  | 07-Jan-84         | \$4,500                            | \$4,500                     | 09-Feb-84             | 10-Feb-84           | 27-Jul-84               | \$4,950           |              |         |
| 3                         | 1                         | DEMOLITION OF CONCRETE ENCOUNTERED DURING EXCAVATION | 2200             | 07-Feb-84         | \$5,500                            | \$5,500                     | 21-Feb-84             | 24-Mar-84           |                         | \$5,500           |              |         |
| 4                         | 5                         | REMOVE MECHANICAL SYSTEMS IN TR'S LOBBY              | 15010            | 07-Feb-84         | \$1,000                            | \$1,000                     | 18-Feb-84             | 21-Feb-84           | 25-Aug-84               | \$1,000           |              |         |
| 5                         | 2                         | CONSTRUCT "HEALTH SHELTERS" BUS STOP                 | 2507             | 07-Feb-84         | \$7,670                            | \$7,670                     | 21-Feb-84             | 25-Apr-84           |                         | \$7,670           |              |         |
| 6                         | 2                         | RELOCATE EXISTING X RAY 2 FARE                       | 16010            | 17-Mar-84         | \$1,500                            | \$1,500                     | 22-Mar-84             | 31-Mar-84           | 25-Apr-84               | \$2,000           |              |         |
| 7                         | 2                         | LOWER FOOTINGS AT BEYER AND RH 28                    | 2200             | 17-Mar-84         | \$4,200                            | \$4,200                     | 31-Mar-84             | 31-Mar-84           | 25-Apr-84               | \$4,000           |              |         |
| 8                         | 3                         | ADD SANITARY AND STORM SEWER LINES                   | 2722             | 17-Mar-84         | \$19,000                           | \$19,000                    | 24-Mar-84             | 31-Mar-84           | 27-Nov-84               | \$18,100          | TH           |         |
| 9                         | 5                         | RELOCATE MANHOLE, ADD TWO 15" ELEGAS                 | 2722             | 04-Jun-84         | \$3,900                            | \$3,900                     | 07-Jul-84             |                     |                         | \$380             |              |         |
| 10                        | 4                         | DIMENSIONAL CHANGES IN TUBE STEEL @ STAIR TOWERS     | 5500             | 17-Jun-84         | \$345                              | \$345                       | 27-Jun-84             | 02-Jul-84           | 27-Jul-84               | \$4,950           |              |         |
| 11                        | 5                         | PLUMBING FIXTURE SUBSTITUTIONS                       | 15450            | 19-Jun-84         | \$4,500                            | \$4,500                     | 30-Jun-84             | 03-Jul-84           | 29-Sep-84               | \$4,000           |              |         |
| 12                        | 6                         | ALTER FLOOR PLANS TO ACCOMMODATE OODP SHOP DRAWINGS  | 3705             | 19-Jun-84         | \$2,200                            | \$2,200                     | 03-Jul-84             | 03-Jul-84           | 27-Jul-84               | \$2,200           | TH           |         |
| 13                        | 4                         | DEMO AND REMOVE CONCRETE FOOTING AT AIR SHIRT        | 2200             | 19-Jun-84         |                                    |                             |                       |                     |                         |                   |              |         |
| 14                        | 5                         | ENLARGE SHOWER ROOM PIPE CHASE (REV. FIG. 12)        | 9215             | 19-Jun-84         | \$500                              | \$500                       | 03-Jul-84             | 03-Jul-84           | 29-Sep-84               | \$550             | C            |         |
| 15                        | 6                         | RELOCATE 4" RAIN LEADER PER 00-5                     | 15400            | 19-Jun-84         | \$3,000                            | \$3,000                     | 13-Nov-84             |                     |                         |                   | C            |         |
| 16                        | 5                         | FEWISE DIMENSION TO CORRESPOND TO STRUCTURAL DWGS    | 5500             | 19-Jun-84         | (\$2,200)                          | (\$2,200)                   | 27-Jun-84             | 03-Jul-84           | 25-Aug-84               | (\$2,200)         |              |         |
| 17                        | 5                         | DELETE MANHOLE, ETC PER REV. FIG. NO. 3              | 2740             | 19-Jun-84         | \$7,300                            | \$7,300                     | 04-Aug-84             | 08-Aug-84           | 25-Aug-84               | \$3,630           |              |         |
| 18                        | 5                         | ADD ELEVATOR SILL ANGLES PER 50-77                   | 5500             | 02-Aug-84         | \$1,000                            | \$1,000                     | 05-Aug-84             | 08-Aug-84           | 29-Sep-84               | \$1,100           |              |         |
| 19                        | 6                         | PIPE SUBSTITUTIONS PER 40-2                          | 5500             | 05-Aug-84         | \$9,000                            | \$9,000                     | 11-Aug-84             | 20-Aug-84           | 25-Aug-84               | \$9,000           |              |         |
| 20                        | 5                         | REROUTE GROUND WIRE IN RE 2 PER ED-7                 | 14010            | 06-Aug-84         |                                    |                             | 17-Aug-84             | 21-Aug-84           |                         | \$3,550           | LS           |         |
| 21                        | 5                         | DIRECTED WORK STORAGE AT LOADING DOCK                | 1500             | 06-Aug-84         | \$500                              | \$500                       | 04-Nov-84             | 11-Nov-84           |                         |                   | LS           |         |
| 22                        | A                         | ADD TWO 6" BLDG VALVES @ WATER MAIN                  | 2740             | 22-Oct-84         | (\$2,200)                          | (\$2,200)                   | 04-Nov-84             | 11-Nov-84           |                         |                   | LS           |         |
| 23                        | A                         | INSTALL P-24 OPAIN 1" BELOW GRADE @ STAIR PER 20-41  | 15400            | 22-Oct-84         | \$4,200                            | \$4,200                     | 22-Oct-84             | 22-Oct-84           |                         |                   | TH           |         |
| 24                        | C                         | RELOCATE SEWER MANHOLES AND 8" LINE                  | 2722             | 22-Oct-84         | \$4,500                            | \$4,500                     | 17-Nov-84             | 15-Nov-84           |                         |                   | TH           |         |
| 25                        | A                         | ADD OODP INLET AT MANHOLE 3 PER FD-19                | 2722             | 15-Nov-84         | \$5,000                            | \$5,000                     | 14-Nov-84             | 20-Nov-84           |                         |                   | TH           |         |
| 26                        | C                         | RELOCATE STEAM VENT LINE PER FIELD QUESTION PG-2     | 15720            | 15-Nov-84         | \$1,100                            | \$1,100                     | 25-Nov-84             | 25-Nov-84           |                         |                   | LS           |         |
| 27                        | A                         | ADD SUPER PLASTISIZER TO ELEVATOR CORE CONCRETE      | 3010             | 25-Nov-84         | \$1,500                            | \$1,500                     | 17-Dec-84             |                     |                         |                   | LS           |         |
| 28                        | A                         | LOWER FOOTINGS AT RH 52 AND 45                       | 2200             | 25-Nov-84         | \$1,500                            | \$1,500                     |                       |                     |                         |                   | LS           |         |
| 29                        | A                         | RELOCATE 9 DOGWOOD TREES                             | 2110             | 07-Dec-84         |                                    |                             |                       |                     |                         |                   | LS           |         |
| 30                        | A                         | CHANGE STIFFFRONT HARDWARE FINISH PER REV. FIG. 17   | 8700             | 19-Dec-84         |                                    |                             |                       |                     |                         |                   | LS           |         |
| 31                        | A                         | STRUCTURAL REVISIONS PER REVISION PACKAGE 19         | 5120             | 18-Jan-85         |                                    |                             |                       |                     |                         |                   | LS           |         |
| 32                        | A                         | ADD DECK SUPPORT PER 50-46 (LEVEL -15)               | 5500             | 18-Jan-85         |                                    |                             |                       |                     |                         |                   | LS           |         |

TOTALS \$62,845 \$87,700

\$69,640



the same, unique information of particular interest to the contractor could be inserted and extraneous information could be deleted. For example, information regarding subcontractors and suppliers has been added as well as dates of various stages of approval. The CHANGE STATUS column indicates whether an MP is active (A), a potential claim with the owner or subcontractor (C), a change only involving a subcontractor (S), or even a proposed MP that has been cancelled (X). Column L (NEXT RESP S,C,O) reminds the contractor who is to take the next step in pursuing a particular MP, the sub, the contractor, or the owner. A column has been inserted to indicate the type of change order an MP may result in, including lump sum (LS), time and materials (TM), or a claim (C). Again, the overall program is flexible enough to be adapted to suit nearly every owner or contractor.

This report is concerned more with the application of the microcomputer to the construction industry than with the style and format of the information generated. The sample figures contain formats that have been useful to both owners and contractors but can easily be modified to meet other specific needs.

One of the most useful capabilities of the LOTUS 1-2-3 package is its ability to sort information in a data base. This capability is not as sophisticated as many data base programs but it generally serves this purpose adequately. The effectiveness and flexibilities of LOTUS can be seen in Figures 10 and 11. These figures show the data management capability of the LOTUS 1-2-3 program. In these figures, the logs have been sorted by the change status. In addition, a line (beginning with MP, CO,



CHANGE ORDER CONTROL LOG  
 (OWNER'S PERSPECTIVE)

| CHANGE ORDER #     | DESCRIPTION  | COST ESTIMATE |               | AMOUNT REMAINING | APPROVED PRICE | JUST. COST | WFS. (SPEC. SECTION) | REVIEW DATE | INITIATED DATE | RECEIVED PROPOSAL FROM CONTRACTOR | CHANGE BOARD APPROVAL DATE |           |
|--------------------|--|---------------|---------------|------------------|----------------|------------|----------------------|-------------|----------------|-----------------------------------|----------------------------|-----------|
|                    |  | BY AVE        | BY CONTRACTOR |                  |                |            |                      |             |                |                                   |                            |           |
| 1                  | CHANGE SITE FENCE TO CHAIN LINK                      | \$2,800       | \$3,700       |                  | \$3,700        |            | 1                    | 2444        | \$178          | 04-Jan-84                         | 18-Jan-84                  | 24-Mar-84 |
| 1                  | DEMOLITION OF CONCRETE ENCOUNTERED DURING EXCAVATION | \$5,500       | \$5,500       |                  | \$5,500        |            | 1                    | 2219        | \$0            | 07-Feb-84                         | 21-Feb-84                  | 24-Mar-84 |
| 2                  | CONSTRUCT "HEALTH SCIENCES" BUS STOP                 | \$4,400       | \$7,520       |                  | \$7,520        |            | 2                    | 2513        | \$219          | 07-Feb-84                         | 21-Feb-84                  | 25-Apr-84 |
| 2                  | RELOCATE EXISTING X-RAY 2 PANEL                      | \$1,900       | \$3,000       |                  | \$3,000        |            | 5                    | 15010       | \$0            | 17-Mar-84                         | 11-Mar-84                  | 25-Apr-84 |
| 2                  | LOWER FOOTINGS AT BE/58 AND BH/58                    | \$7,000       | \$4,750       |                  | \$4,000        |            | 1                    | 2206        | \$40           | 17-Mar-84                         | 31-Mar-84                  | 25-Apr-84 |
| 3                  | ADD SANITARY AND STORM SEWER LINES                   | \$18,000      | \$17,800      |                  | \$18,100       |            | 5                    | 2722        | \$0            | 17-Mar-84                         | 31-Mar-84                  | 27-May-84 |
| 4                  | WOOD SUBSTATION FENCE IN LIEU OF CHAIN LINK          | \$4,700       | \$4,950       |                  | \$4,950        |            | 3                    | 2444        | \$277          | 27-Jan-84                         | 13-Feb-84                  | 27-Jul-84 |
| 4                  | DIMENSIONAL CHANGES IN TIRE STEEL & STAIR TOWERS     | NA            | \$720         |                  | \$730          |            | 5                    | 5500        | \$0            | 17-Jun-84                         | 03-Jul-84                  | 27-Jul-84 |
| 4                  | DEMO AND REPOVE CONCRETE FOOTING AT AIR SHAFT        | \$2,000       | \$2,200       |                  | \$2,200        |            | 1                    | 2209        | \$0            | 15-Jun-84                         | 03-Jul-84                  | 27-Jul-84 |
| 5                  | REMOVE MECHANICAL SYSTEMS IN OR'S LOUNGE             | \$1,000       | \$1,100       |                  | \$1,000        |            | 5                    | 15010       | \$0            | 07-Feb-84                         | 21-Feb-84                  | 25-Aug-84 |
| 5                  | PLUMBING FIXTURE SUBSTITUTIONS                       | \$5,200       | \$4,950       |                  | \$4,950        |            | 2                    | 15050       | \$277          | 19-Jun-84                         | 03-Jul-84                  | 25-Aug-84 |
| 5                  | DELETE MANHOLE, ETC PER REV FIG NO. 7                | (\$2,500)     | (\$2,200)     |                  | (\$2,200)      |            | 1                    | 2722        | \$0            | 19-Jun-84                         | 03-Jul-84                  | 25-Aug-84 |
| 5                  | ADD ELEVATOR SILL ANGLES PER 50-37                   | \$1,000       | \$7,820       |                  | \$3,620        |            | 5                    | 5500        | \$0            | 02-Aug-84                         | 08-Aug-84                  | 25-Aug-84 |
| 5                  | REROUTE GROUND WIRE IN DE-2 PER E0-7                 | \$7,000       | \$7,000       |                  | \$9,000        |            | 5                    | 18019       | \$0            | 06-Aug-84                         | 20-Aug-84                  | 25-Aug-84 |
| 5                  | DIRECTED WORK STOPPAGE AT LOADING DOCK               | NA            | \$7,350       |                  | \$7,550        |            | 2                    | 1050        | \$0            | 07-Aug-84                         | 21-Aug-84                  | 25-Aug-84 |
| 6                  | ALTER FLOOR PLANS TO ACCOMMODATE ODOF SHOP DRAWINGS  | \$3,000       | \$4,220       |                  | \$4,000        |            | 5                    | 8305        | \$0            | 19-Jun-84                         | 03-Jul-84                  | 29-Sep-84 |
| 6                  | RELOCATE 4" RAIN LEADER PER 60-5                     | \$50          | \$50          |                  | \$550          |            | 3                    | 15400       | \$33           | 19-Jun-84                         | 03-Jul-84                  | 29-Sep-84 |
| 6                  | PIPE SUBSTITUTIONS PER 40-58                         | \$1,500       | \$1,120       |                  | \$1,100        |            | 3                    | 15300       | \$0            | 05-Aug-84                         | 08-Aug-84                  | 29-Sep-84 |
| 22                 | ADD TWO 6" BLOCK VALVES & WATER MAIN                 | \$500         | \$550         |                  | \$550          |            | 3                    | 2700        | \$33           | 22-Oct-84                         | 11-Nov-84                  |           |
| 23                 | INSTALL P-24 DRAIN 1" BELOW GRADE @ STAIR PER 50-41  | (\$2,200)     | (\$2,000)     |                  | (\$2,000)      |            | 5                    | 15400       | \$0            | 22-Oct-84                         | 11-Nov-84                  |           |
| 24                 | RELOCATE SEWER MANHOLES AND 8" LINE (REV. FIG. 61)   | \$0           | \$4,200       |                  | \$4,200        |            | 1                    | 2722        | \$252          | 22-Oct-84                         | 22-Oct-84                  |           |
| 25                 | ADD DROP INLET AT MANHOLE 3 PER 60-19                | \$4,500       | \$4,950       |                  | \$4,950        |            | 5                    | 2722        | \$0            | 13-Nov-84                         | 15-Nov-84                  |           |
| 26                 | RELOCATE STEAM VENT LINE PER FIELD QUESTION 60-2     | \$0           | \$5,500       |                  | \$5,500        |            | 8                    | 15720       | \$720          | 13-Nov-84                         | 20-Nov-84                  |           |
| 27                 | ADD SUPER PLASTISIZER TO ELEVATOR CORE CONCRETE      | \$2,000       | \$1,100       |                  | \$2,000        |            | 8                    | 3010        | \$120          | 13-Nov-84                         | 25-Nov-84                  |           |
| 28                 | LOWER FOOTINGS AT BH 62 AND 65                       | \$3,200       | \$3,200       |                  | \$3,200        |            | 1                    | 2200        | \$198          | 25-Nov-84                         |                            |           |
| 27                 | RELOCATE 5 OUGHWOOD TREES                            | \$1,000       | \$1,000       |                  | \$1,000        |            | 4                    | 2110        | \$114          | 07-Dec-84                         |                            |           |
| 30                 | CHANGE STOREFRONT HARDWARE FINISH PER REV. FIG. 17   | \$4,500       | \$4,500       |                  | \$4,500        |            | 4                    | 8700        | \$279          | 19-Dec-84                         |                            |           |
| 31                 | STRUCTURAL REVISIONS PER REV FIG 19                  | NA            |               |                  | \$4,500        |            | 5                    | 5129        | \$0            | 08-Jan-85                         |                            |           |
| 32                 | ADD DECK SUPPORT PER 50-46 (LEVEL -1S)               | \$2,000       | \$2,000       |                  | \$2,000        |            | 5                    | 5500        | \$120          | 18-Jan-85                         |                            |           |
| TOTALS             |  |               |               |                  |                |            |                      |             |                | \$2,720                           |                            |           |
| CONSTRUCTION TOTAL |  |               |               |                  |                |            |                      |             |                | \$59,640                          |                            |           |
| GRAND TOTAL        |  |               |               |                  |                |            |                      |             |                | \$96,540                          |                            | \$99,260  |

Figure 10. Change Log (Owner - CO)





DESCRIPT, etc.) that was not printed in the previous figures, is shown in Figure 11, which simplifies the task of making various sorts. As can be seen below the title block but above all columns, is a word that describes the field below. During printout this field description is omitted. The program can sort the field in ascending or descending order. LOTUS 1-2-3 also provides for a secondary, simultaneous sub-sort, so that greater flexibility exists in data manipulation. The program will sort the primary field as directed and then re-sort according to a secondary field. These figures were first sorted by change order or change status and then by modification proposal number to ensure that those MP's not included in a formal change order will be in numerical order at the end of the log. Sorting can be done by either alpha or numeric characters, however, only the first letter of an alpha expression is recognized. That is, the computer would not recognize the difference between "ACME PLUMBING" and "ARNIE'S TREE SERVICE" if sorted together. The manipulation of data has many useful purposes. The need to know dollar amounts, subcontractors affected, and submission dates of change order responses are various ways that the computer could be used to assist in managing a construction project with the touch of a few keys.

Another interesting feature of the LOTUS 1-2-3 program, is its MACRO capability. This feature assigns a single keystroke to replace a set of preprogrammed instructions. If a sequence of instructions and data entries is used repetitively, a macro command would save the user time and ensure greater accuracy. If, for example, the contractor wanted to segregate the change order





PROJECT NAME: \_\_\_\_\_  
 PROJECT NUMBER: \_\_\_\_\_  
 PROJECT LOCATION: \_\_\_\_\_

CONTRACT NUMBER: \_\_\_\_\_  
 CONTRACT AGENCY: \_\_\_\_\_

| MR. CHARGE | PROF. STATUS | WBS (SPEC. SECTION) | DESCRIPTION  | M/S   | SUBS AFFECTED | DATE INITIATED | DATE COMPLETED | DATE FROM | DATE TO   | DATE FROM | DATE TO | OWNER | OWNER (S.C.O.) | APPROVED PRICE | APPROVED CHRG | REMARKS |  |
|------------|--------------|---------------------|--|-------|---------------|----------------|----------------|-----------|-----------|-----------|---------|-------|----------------|----------------|---------------|---------|--|
| 20         | A            | 2700                | ADD TWO 6" R/OCD VALVES & WATER MAIN                 | 2700  | ACHE PLUMBING | 22-Oct-84      |                | 04-Nov-84 | 11-Nov-84 |           |         |       |                |                |               |         |  |
| 21         | A            | 154                 | INSTALL P-24 DRAIN 1" BELOW GRADE & STAIR PER P0-41  | 154   | ACHE PLUMBING | 22-Oct-84      |                | 04-Nov-84 | 11-Nov-84 |           |         |       |                |                |               |         |  |
| 25         | A            | 2722                | ADD DROP INLET AT MANHOLE 2 PER P0-19                | 2722  | CITY SEWER    | 10-Nov-84      |                | 15-Nov-84 | 15-Nov-84 |           |         |       |                |                |               |         |  |
| 27         | A            | 3010                | ADD SUPER PLASTER TO ELEVATOR CORE CONCRETE          | 3010  |               | 17-Nov-84      |                | 25-Nov-84 | 25-Nov-84 |           |         |       |                |                |               |         |  |
| 28         | A            | 2230                | LOWER FOOTINGS AT B4-62 AND 65                       | 2230  |               | 25-Nov-84      |                |           |           |           |         |       |                |                |               |         |  |
| 29         | A            | 2110                | RELOCATE 9 DOGWOOD TREES                             | 2110  | LANDSCAPE     | 07-Dec-84      |                | 17-Dec-84 |           |           |         |       |                |                |               |         |  |
| 30         | A            | 8700                | CHANGE STOREFRONT HARDWARE FINISH PER REV. FIG. 17   | 8700  |               | 19-Dec-84      |                |           |           |           |         |       |                |                |               |         |  |
| 31         | A            | 5120                | STRUCTURAL REVISIONS PER REVISION PACKAGE 19         | 5120  |               | 02-Jan-85      |                |           |           |           |         |       |                |                |               |         |  |
| 32         | A            | 5500                | ADD DEED SUPPORT PER S0-46 (LEVEL -1S)               | 5500  |               | 18-Jan-85      |                |           |           |           |         |       |                |                |               |         |  |
| 24         | C            | 2722                | RELOCATE SEWER MANHOLES AND 8" LINE                  | 2722  | CITY SEWER    | 22-Oct-84      |                | 22-Oct-84 | 22-Oct-84 |           |         |       |                |                |               |         |  |
| 26         | C            | 15720               | RELOCATE STEAM VENT LINE PER FIELD QUESTION P0-2     | 15720 | ACHE PLUMBING | 17-Nov-84      |                | 14-Nov-84 | 20-Nov-84 |           |         |       |                |                |               |         |  |
| 9          | 5            | 2722                | FELOCATE MANHOLE, ADD TWO 15" ELBOWS                 | 2722  | CITY SEWER    | 04-Jun-84      |                | 07-Jul-84 |           |           |         |       |                |                |               |         |  |
| 14         | 5            | 5215                | ENLARGE SHOWER 400M PIPE CHASE (REV. FIG. 12)        | 5215  | ACHE PLUMBING | 19-Jan-84      |                | 13-Nov-84 |           |           |         |       |                |                |               |         |  |
| 16         | 5            | 5500                | REVISE DIMENSION TO CORRESPOND TO STRUCTURAL DWGS    | 5500  | STRONG STEEL  | 19-Jun-84      |                |           |           |           |         |       |                |                |               |         |  |
| 1          | 1            | 2444                | CHANGE SITE FENCE TO CHAIN LINK                      | 2444  | FINE FENCE    | 04-Jan-84      |                | 09-Jan-84 | 18-Jan-84 |           |         |       |                |                |               |         |  |
| 3          | 1            | 2517                | DEMOLITION OF CONCRETE ENCOUNTERED DURING EXCAVATION | 2517  |               | 07-Feb-84      |                |           | 21-Feb-84 |           |         |       |                |                |               |         |  |
| 5          | 2            | 2517                | CONSTRUCT "HEALTH SCIENCES" BOYS STOP                | 2517  |               | 07-Feb-84      |                |           | 21-Feb-84 |           |         |       |                |                |               |         |  |
| 6          | 2            | 16010               | RELOCATE EXISTING X-RAY 2 PANEL                      | 16010 | DOE ELECTRICS | 17-Mar-84      |                | 22-Mar-84 | 31-Mar-84 |           |         |       |                |                |               |         |  |
| 7          | 2            | 2200                | LOWER FOOTINGS AT BE-68 AND BE-68                    | 2200  |               | 17-Mar-84      |                |           | 31-Mar-84 |           |         |       |                |                |               |         |  |
| 8          | 3            | 2722                | ADD SANITARY AND STORM SEWER LINES                   | 2722  | CITY SEWER    | 17-Mar-84      |                | 24-Mar-84 | 31-Mar-84 |           |         |       |                |                |               |         |  |
| 2          | 4            | 2444                | WOOD SUBSTANTIATION FENCE IN LIEU OF CHARLIM         | 2444  | FINE FENCE    | 27-Jan-84      |                | 08-Feb-84 | 10-Feb-84 |           |         |       |                |                |               |         |  |
| 10         | 4            | 5500                | DIMENSIONAL CHANGES IN TUBE STEEL & STAIR TOWERS     | 5500  | STRONG STEEL  | 17-Jun-84      |                | 27-Jun-84 | 02-Jul-84 |           |         |       |                |                |               |         |  |
| 13         | 4            | 2200                | DEMO AND REMOVE CONCRETE FOOTING AT AIR SHAFT        | 2200  |               | 19-Jun-84      |                |           | 08-Jul-84 |           |         |       |                |                |               |         |  |
| 4          | 5            | 15010               | REMOVE MECHANICAL SYSTEMS IN DR'S LOUNGE             | 15010 | MIGHTY MECH   | 07-Feb-84      |                | 18-Feb-84 | 21-Feb-84 |           |         |       |                |                |               |         |  |
| 11         | 5            | 15050               | PLUMBING FIXTURE SUBSTITUTIONS                       | 15050 | ACHE PLUMBING | 10-Jun-84      |                | 30-Jun-84 | 03-Jul-84 |           |         |       |                |                |               |         |  |
| 17         | 5            | 2700                | DELETE MANHOLE, ETC PER REV. FIG. NO. 3              | 2700  | CITY SEWER    | 19-Jun-84      |                | 27-Jun-84 | 03-Jul-84 |           |         |       |                |                |               |         |  |
| 18         | 5            | 5500                | ADD ELEVATOR SILL ANGLES PER S0-57                   | 5500  | STRONG STEEL  | 02-Aug-84      |                | 04-Aug-84 | 08-Aug-84 |           |         |       |                |                |               |         |  |
| 20         | 5            | 16010               | REROUTE GROUND PIPE IN ME-2 PER ED-7                 | 16010 | DOE ELECTRIC  | 06-Aug-84      |                | 11-Aug-84 | 20-Aug-84 |           |         |       |                |                |               |         |  |
| 21         | 5            | 1050                | DIRECTED WORK STOPPAGE AT LOADING DOCK               | 1050  |               | 07-Aug-84      |                | 17-Aug-84 | 21-Aug-84 |           |         |       |                |                |               |         |  |
| 12         | 6            | 8705                | ALTER FLOOR PLANS TO ACCOMMODATE DOOR SHOP DRAWINGS  | 8705  |               | 19-Jun-84      |                | 03-Jul-84 | 03-Jul-84 |           |         |       |                |                |               |         |  |
| 15         | 6            | 15400               | RELOCATE 4" RAIN LEADER PER 00-5                     | 15400 | ACHE PLUMBING | 19-Jun-84      |                | 03-Jul-84 | 03-Jul-84 |           |         |       |                |                |               |         |  |
| 19         | 6            | 5500                | PIPE SUBSTITUTIONS PER 00-38                         | 5500  | STRONG STEEL  | 05-Aug-84      |                | 05-Aug-84 | 08-Aug-84 |           |         |       |                |                |               |         |  |

TOTALS \$62,645 \$87,300

Figure 11. Change Log (Contractor - Status)



log by change status groups, a macro would be very useful. By preprogramming the macro in combination with the "wildcard input" command, the contractor could insert several blank lines between different groupings and provide a subtotal for each category. The wildcard input would prompt the user for information regarding the number of lines to be totalled for each status group. As can be seen in Figure 12, subtotal lines have been inserted between each different status group and for each different change order. The subtotalling must be done after the column totals are calculated or the additional numbers would cause an erroneous total sum.

The use of macro commands is not always appropriate. However, the use of macros is suitable if any command sequence contains 10 or more keystrokes, if the same command sequence is used very often in creating the worksheet, or if complex formulae are used in creating the worksheet. They will not only reduce the time required to complete the task but will accomplish the task with greater accuracy.

Another capability of the LOTUS program is its ability to single out specific information. This extraction process can either call entire line entries or extract applicable parts of them. For example, Figure 13 is basically part of a summary sheet. In the figure, changes are broken down by the justification of each change. The breakdown in Figure 14 is by division of work most affected by the change.

In the former case the justification of each change is determined and inserted in the column labelled as "JUST CODE". The codes range from 1 to 8. In the second case the column



CHANGE ORDER CONTROL LOG  
 CONTRACTOR'S PERSPECTIVE

PROJECT NAME: \_\_\_\_\_ CONTRACT NUMBER: \_\_\_\_\_

PROJECT LOCATION: \_\_\_\_\_ CONTRACT AGENCY: \_\_\_\_\_

| ROW CHANGE<br>PROP STATUS | DESCRIPTION  | MRS<br>SPEC.<br>SECTION | SUBS<br>AFFECTED | DATE<br>INITIATED | ESTIMATE<br>BY | COST<br>ESTIMATE<br>BY | DATE<br>FROM | DATE<br>TO | DATE<br>FROM | DATE<br>TO | NEXT<br>RESP<br>(S.C.D) | APPROVED<br>PRICE | TYPE<br>OR<br>CMMG | REMARKS |                 |                 |
|---------------------------|--|-------------------------|------------------|-------------------|----------------|------------------------|--------------|------------|--------------|------------|-------------------------|-------------------|--------------------|---------|-----------------|-----------------|
|                           |  |                         |                  |                   |                |                        |              |            |              |            |                         |                   |                    |         | ESTIMATE<br>SUB | ESTIMATE<br>SUB |
| 22 A                      | ADD TWO 3" BLOCK VALVES @ WATER MAIN                 | 2100                    | ACME PLUMBING    | 22-OCT-84         | \$500          | \$550                  | 04-Nov-84    | 11-Nov-84  |              |            | 0                       |                   | LS                 |         |                 |                 |
| 25 A                      | INSTALL P-24 DRAIN 1" BELOW GRADE @ STAIR PER FD-41  | 15400                   | ACME PLUMBING    | 22-OCT-84         | (12,000)       | (12,000)               | 04-Nov-84    | 11-Nov-84  |              |            | 0                       |                   | LS                 |         |                 |                 |
| 25 A                      | ADD DROP INLET AT MANHOLE 7 PER FD 19                | 2122                    | CITY SEWER       | 17-Nov-84         | \$4,950        | \$4,950                | 17-Nov-84    | 15-Nov-84  |              |            | 0                       |                   | LS                 |         |                 |                 |
| 27 A                      | ADD SUPER PLASTICIZER TO ELEVATOR CORE CONCRETE      | 2110                    |                  | 12-Nov-84         | \$1,100        | \$1,100                | 25-Nov-84    |            |              |            | 0                       |                   | LS                 |         |                 |                 |
| 28 A                      | LOWER FOOTINGS AT BH 62 AND 55                       | 2200                    |                  | 25-Nov-84         |                |                        |              |            |              |            | 0                       |                   | LS                 |         |                 |                 |
| 29 A                      | RELOCATE 9 DOWNWOOD TREES                            | 2110                    | LANDSCAPE        | 07-Dec-84         | \$1,900        | \$1,900                | 17-Dec-84    |            |              |            | 0                       |                   | LS                 |         |                 |                 |
| 30 A                      | CHANGE STOPEFRONT HARDWARE FINISH PER REV. PKG. 10   | 8700                    |                  | 12-Dec-84         |                |                        |              |            |              |            | 0                       |                   | LS                 |         |                 |                 |
| 31 A                      | STRUCTURAL REVISIONS PER REVISION PACKAGE 19         | 5120                    |                  | 19-Jan-85         |                |                        |              |            |              |            | 0                       |                   | LS                 |         |                 |                 |
| 32 A                      | ADD DECY SUPPORT PER 30-46 (LEVEL 15)                | 5500                    |                  | 12-Jan-85         |                |                        |              |            |              |            | 0                       |                   | LS                 |         |                 |                 |
| SUBTOTAL                  |  |                         |                  |                   |                |                        |              |            |              |            |                         |                   | \$4,700            | \$4,650 |                 | \$0             |
| 24 C                      | RELOCATE SEWER MANHOLES AND 8" LINE                  | 2722                    | CITY SEWER       | 22-Oct-84         | \$4,200        | \$4,200                | 22-Oct-84    | 22-Oct-84  |              |            | 0                       |                   | TM                 |         |                 |                 |
| 26 C                      | RELOCATE STEAM VENT LINE PER FIELD QUESTION FD-2     | 15720                   | ACME PLUMBING    | 12-Nov-84         | \$5,000        | \$5,500                | 14-Nov-84    | 20-Nov-84  |              |            | 0                       |                   | TM                 |         |                 |                 |
| SUBTOTAL                  |  |                         |                  |                   |                |                        |              |            |              |            |                         |                   | \$9,200            | \$9,700 |                 | \$0             |
| 9 S                       | RELOCATE MANHOLE, ADD TWO 15" ELBOWS                 | 2722                    | CITY SEWER       | 04-Jun-84         | \$2,900        | \$4,200                | 07-Jul-84    |            |              |            |                         |                   | TM                 |         |                 |                 |
| 14 S                      | ENLARGE SHOWER ROOM PIPE CHASE (REV. FIG. 12)        | 5215                    | ACME PLUMBING    | 16-Jun-84         |                |                        |              |            |              |            | 0                       |                   | TM                 |         |                 |                 |
| 15 S                      | REVISE DIMENSION TO CORRESPOND TO STRUCTURAL DWGS    | 5500                    | STRONG STEEL     | 17-Jun-84         | \$3,000        | \$0                    | 12-Nov-84    |            |              |            | 0                       |                   | C                  |         |                 |                 |
| SUBTOTAL                  |  |                         |                  |                   |                |                        |              |            |              |            |                         |                   | \$6,900            | \$4,200 |                 | \$0             |
| 1 I                       | CHANGE SITE FENCE TO CHAIN LINK                      | 2444                    | FINE FENCE       | 04-Jan-84         | \$3,000        | \$3,000                | 08-Jan-84    | 18-Jan-84  | 24-Mar-84    |            |                         |                   |                    | \$3,300 |                 |                 |
| 3 I                       | DEMOLITION OF CONCRETE ENCOUNTERED DURING EXCAVATION | 2200                    |                  | 07-Feb-84         | \$5,500        | \$5,500                | 21-Feb-84    | 24-Mar-84  |              |            |                         |                   |                    | \$5,500 |                 |                 |
| SUBTOTAL                  |  |                         |                  |                   |                |                        |              |            |              |            |                         |                   | \$3,000            | \$8,800 |                 | \$8,800         |

Figure 12. Change Log (Contractor - Subtotal)



PROJECT NAME:  
 PROJECT NUMBER:  
 PROJECT LOCATION:

CHANGE ORDER CONTROL LOG  
 CONTRACTOR'S PERSPECTIVE

CONTRACT NUMBER:  
 CONTRACT AGENCY:

| MCO CHANGE<br>PROF STATUS | DESCRIPTION | WPS<br>(SECT.<br>SECTION) | SUBS<br>AFFECTED                               | DATE<br>INITIATED | ESTIMATE<br>BY | DATE<br>FROM | DATE<br>TO | OWNER     | DATE<br>FROM | NEXT<br>RESP<br>(S.C.O) | APPROVED<br>PRICE | TYPE<br>CHNG | REMARKS |
|---------------------------|-------------|---------------------------|--|-------------------|----------------|--------------|------------|-----------|--------------|-------------------------|-------------------|--------------|---------|
|                           |             |                           |  |                   |                |              |            |           |              |                         |                   |              |         |
| 5                         | 2           | 2513                      |  | 07-Feb-84         | \$1,630        | 21-Feb-84    | 25-Apr-84  |           |              |                         | \$3,670           |              |         |
| 6                         | 2           | 16050                     | DOE ELECTRIC                                   | 17-Mar-84         | \$1,900        | 22-Mar-84    | 25-Apr-84  |           |              |                         | \$2,400           |              |         |
| 7                         | 2           | 2200                      | LOWER FOOTINGS AT RE/AB AND CH/AB              | 17-Mar-84         | \$4,200        | 31-Mar-84    | 25-Apr-84  |           |              |                         | \$4,600           |              |         |
| SUBTOTAL                  |             |                           |  |                   | \$1,900        |              |            |           |              |                         | \$9,630           |              |         |
| 8                         | 7           | 222                       | CITY SEWER                                     | 17-Mar-84         | \$18,000       | 24-Mar-84    | 31-Mar-84  | 27-Mar-84 |              |                         | \$18,100          |              |         |
| SUBTOTAL                  |             |                           |  |                   | \$18,000       |              |            |           |              |                         | \$18,100          |              |         |
| 2                         | 4           | 2444                      | FINE FENCE                                     | 27-Jun-84         | \$4,500        | 08-Feb-84    | 10-Feb-84  | 27-Jul-84 |              |                         | \$4,950           |              |         |
| 10                        | 4           | 5500                      | WOOD SUBSTATION FENCE IN LIEU OF CHAINLINK     | 17-Jun-84         | \$345          | 27-Jun-84    | 03-Jul-84  | 27-Jul-84 |              |                         | \$300             |              |         |
| 13                        | 4           | 2200                      | DEMOS AND REMOVE CONCRETE FOOTING AT AIR SHAFT | 19-Jun-84         | \$2,200        | 05-Jul-84    | 27-Jul-84  |           |              |                         | \$2,200           |              |         |
| SUBTOTAL                  |             |                           |  |                   | \$4,845        |              |            |           |              |                         | \$7,530           |              |         |
| 4                         | 5           | 15010                     | REMOVE MECHANICAL SYSTEMS IN DR'S LOUNGE       | 07-Feb-84         | \$1,100        | 18-Feb-84    | 21-Feb-84  | 25-Aug-84 |              |                         | \$1,000           |              |         |
| 11                        | 5           | 15450                     | PLUMBING FIXTURE SUBSTITUTIONS                 | 15-Jun-84         | \$4,500        | 30-Jun-84    | 03-Jul-84  | 25-Aug-84 |              |                         | \$4,950           |              |         |
| 17                        | 5           | 2700                      | DELETE MANHOLE, ETC PER REV. FIG. NO. 3        | 19-Jun-84         | (\$2,200)      | 27-Jun-84    | 03-Jul-84  | 25-Aug-84 |              |                         | (\$2,200)         |              |         |
| 18                        | 5           | 5500                      | ADD ELEVATOR STILL ANGLES PER SD-37            | 02-Aug-84         | \$3,300        | 04-Aug-84    | 09-Aug-84  | 25-Aug-84 |              |                         | \$3,630           |              |         |
| 20                        | 5           | 16010                     | REFROUTE GROUND WIRE IN NE-2 PER EG-7          | 06-Aug-84         | \$9,000        | 11-Aug-84    | 20-Aug-84  | 25-Aug-84 |              |                         | \$9,000           |              |         |
| 21                        | 5           | 1050                      | DIRECTED WORK STOPPAGE AT LOADING DOCK         | 07-Aug-84         | \$7,850        | 17-Aug-84    | 21-Aug-84  | 25-Aug-84 |              |                         | \$3,550           |              |         |
| SUBTOTAL                  |             |                           |  |                   | \$15,600       |              |            |           |              |                         | \$19,930          |              |         |
| 12                        | 6           | 8205                      | ALTER FLOOR PLANS TO ACCOMMODATE DOOR DRAWINGS | 19-Jun-84         | \$4,200        |              | 03-Jul-84  | 29-Sep-84 |              |                         | \$4,000           |              |         |





CHANGE ORDER CONTROL LOG  
 CONTRACTOR'S PERSPECTIVE

PROJECT NAME: \_\_\_\_\_

PROJECT NUMBER: \_\_\_\_\_

ON PAC NUMBER: \_\_\_\_\_

PROJECT LOCATION: \_\_\_\_\_

CONTRACT AGENCY: \_\_\_\_\_

| NO. CHANGE<br>PROP. STATUS | DESCRIPTION | W/S<br>(SPEC.<br>SECTION) | SWS<br>AFFECTED              | DATE<br>INITIATED | DATE<br>FROM | DATE<br>TO | DATE<br>FROM | DATE<br>TO | NEXT<br>RESP<br>(S.C.O) | PRICE<br>APPROVED | TYPE<br>OF<br>CHNG | COST     |       | REMARKS  |  |
|----------------------------|-------------|---------------------------|------------------------------|-------------------|--------------|------------|--------------|------------|-------------------------|-------------------|--------------------|----------|-------|----------|--|
|                            |             |                           |                              |                   |              |            |              |            |                         |                   |                    | ESTIMATE | TOTAL |          |  |
| 15                         | 15400       | 15400                     | 4" CPE PIPE PER 100'-5       | 15 Jun 84         | 05-Jul-84    | 05-Jul-84  | 29-Sep-84    |            |                         | \$550             |                    |          |       |          |  |
| 17                         | 5500        | 5500                      | PIPE SUBSTITUTIONS PER AG-35 | 05-Aug-84         | 05-Aug-84    | 08-Aug-84  | 29-Sep-84    |            |                         | \$1,100           |                    |          |       |          |  |
|                            |             |                           |                              | SUBTOTAL          |              |            |              |            |                         | \$5,650           |                    |          |       |          |  |
| TOTALS                     |             |                           |                              |                   |              |            |              |            |                         | \$65,645          |                    | \$87,700 |       | \$65,640 |  |

Figure 12c.



| JUSTIFICATION                                       | AMOUNT   | PERCENT |
|---|----------|---------|
| 1. UN-RUN SITE CONDITIONS                           | \$17,000 | 17.6%   |
| 2. PROGRAM CHANGE FOR OWNER                         | \$2,150  | 2.2%    |
| 3. PROGRAM CHANGE FOR PHYSICAL PLANT                | \$7,950  | 8.2%    |
| 4. PROGRAM CHANGE FOR OCCUPANT COORDINATION         | \$0      | 0.0%    |
| 5. DESIGN OF DRAWING CORRECTIONS AND CLARIFICATIONS | \$44,160 | 45.7%   |
| 6. PERIOLATORY CHANGE                               | \$0      | 0.0%    |
| 7. VALUE ENGINEERING IMPROVEMENT                    | \$7,800  | 8.1%    |
| 8. PROJECT COORDINATION                             | \$7,500  | 7.8%    |
| TOTALS =  | \$98,540 | 100.0%  |

Figure 13. Summary by Justification

| DIVISION OF WORK                 | AMOUNT   | PERCENT |
|----------------------------------|----------|---------|
| CONDITIONS OF THE CONTRACT       | \$0      | 0.0%    |
| 1. GENERAL REQUIREMENTS          | \$3,550  | 3.7%    |
| 2. SITE WORK                     | \$54,300 | 56.7%   |
| 3. CONCRETE                      | \$2,000  | 2.1%    |
| 4. MASONRY                       | \$0      | 0.0%    |
| 5. METALS                        | \$6,010  | 6.2%    |
| 6. CARPENTRY                     | \$0      | 0.0%    |
| 7. THERMAL & MOISTURE PROTECTION | \$0      | 0.0%    |
| 8. DOORS, WINDOWS, GLASS         | \$8,500  | 8.8%    |
| 9. FINISHES                      | \$0      | 0.0%    |
| 10. SPECIALTIES                  | \$0      | 0.0%    |
| 11. EQUIPMENT                    | \$0      | 0.0%    |
| 12. FURNISHINGS                  | \$0      | 0.0%    |
| 13. SPECIAL CONSTRUCTION         | \$0      | 0.0%    |
| 14. CONVEYING SYSTEMS            | \$11,100 | 11.5%   |
| 15. MECHANICAL                   | \$11,000 | 11.4%   |
| 15. ELECTRICAL                   | \$0      | 0.0%    |
| TOTAL =                          | \$98,540 | 100.0%  |

Figure 14. Summary by Division of Work



labelled "WBS SPEC SECTION" contains the specification section or work breakdown structure that is most affected by a particular change. The computer in each case is then asked to search the data entries in the log to determine if any criteria that have been specifically defined match any of the data entries.

As was done with the data sort feature, the computer compares the column heading in the first case labelled "JUST" and then reads down the entire column extracting the information requested (in this case dollar amounts of approved or pending changes) for each item that meets the specified criteria. For example, "JUST" Code 1 represents changes caused by unforeseen site conditions. For each MP that has been justified by a Code 1, the computer will extract either an approved change order amount or a pending MP amount, and insert the total amount of all MP's justified by a Code 1 in the appropriate space of the summary. This type of information enables both the owner or the contractor to see immediately by dollar value, which subcontractors are incurring extra work. Knowing that particular subcontractors may be incurring additional work could enable the construction manager to predict whether or not delays may be encountered in certain areas.

Similarly, under WBS, if information for all electrical changes was required, any entry that pertained to the Division 16 section of the specifications would be extracted. The specified criteria would then extract information from entries that possessed a WBS Code between 16000 and 16999. As stated earlier, this type of information would be quite useful in determining where problems in work overload may arise.



Because change orders are prevalent in the construction industry, they were used as an example of a typical use of the spreadsheet. The other reason for managing change orders versus reacting to them is in the money that can be saved when an owner knows the financial impacts of requested changes or when a contractor can be assured that payment will be forthcoming in a timely manner. By knowing the location in the "system" of a potential change order, a contractor is more likely to initiate action on a change prior to actually receiving a formal document, thus speeding up the construction process.





## Submittal Control System Template

Immediately following the award of a construction contract, the contractor is required to submit a variety of forms, documents and other paperwork in order to satisfy contractual requirements. Among the important components in this paperwork process, are the requests for approval or acceptance of materials and equipment the contractor plans to install. Nearly every project has a requirement for a contractor to submit information regarding the products intended for use in meeting the contract specifications. The information required consists of: manufacturers' technical data, color and style samples, certifications and test data proving that the materials or products meet specific standards and shop drawings that provide specific installation information or connection details for items not fully described in the construction documents. Depending on the size and complexity of the job, there may be numerous submittal requirements. After receipt of each submittal, the designer or owner will make a determination as to the acceptability of the contractor's submittal.

Most specifications are generally vague as to a specific listing of all required submittals, but they give guidance as to what items require a submittal as well as what information is to be submitted. It also places a burden on the contractor by requiring timely submittals so that delays caused by the reviewing designer will not adversely impact the procurement, delivery and installation of the various components of the construction project. In general, review times can range between



20 and 30 days. It is therefore imperative, that the contractor plan submittal actions carefully and monitor progress to ensure delays are not caused by lack of timely performance. Contractors are required to 1) identify which items require submittals, 2) which subcontractor or supplier will provide the necessary documentation, 3) when, in the job sequence, that item is required so the submission, review and procurement of particular materials can be made in a timely manner, 4) cross reference submittal requirements to the technical specifications in case of questions or conflicts, and 5) identify any problems associated with each submission.

While the task of making submittals may not seem overly demanding, a contractor working concurrently on five or six projects, each requiring 50 to 100 submittals, has a compounded problem. Many of these submittals may be for the same items on different projects, so the contractor may inadvertently lose track of a single item until it becomes critical. For example, nearly every construction project will contain cement, sand, and aggregate in a specific gradation. The specifications of that job generally require a certification from the manufacturer stating that the materials meet the standards specified. When working concurrently on several projects requiring a similar certification, a contractor may think the submittal has been made when, in fact, it was made for a different project. Thus, a simple oversight may result in a costly delay. Here again is where a computer program for monitoring progress can be of assistance.

At the beginning of each job, the contractor should prepare



a list of all submittal requirements. This list should also be coordinated with the owner to ensure that no omissions have been made. Once this list has been agreed upon, a log will generally be prepared by both the contractor and the owner to monitor progress. Since the contractor has primary responsibility for the timeliness in making submittals, the contractor, in particular, would benefit by creating and employing some type of computerized log to monitor submittal progress.

Each submittal should be assigned a unique number to assist in its identification and to make it easier for the contractor and owner to discuss any questions concerning a particular submittal. Any numbering system can be used, however, a scheme should be devised to permit easy cross-referencing to the project, the area of work and possibly the crew or subcontractor involved. In addition, supporting information such as 1) description of item, 2) specification section and/or drawing page number for cross-referencing, 3) the scheduled date required on the job, 4) the subcontractor or supplier providing the material and information, 5) milestone dates in the review process and 6) approval action by the owner or designer (9). In addition, a method of modifying the submittal number should be utilized to enable the resubmission of a rejected submittal while maintaining continuity in the numbering scheme. The easiest way to accomplish this is to use the original submittal number with an added suffix indicating a revised submission. The suffix would provide a reference to the original submittal while indicating, at the same time, that it is a different submittal.

After discussing the problem of submittal tracking with





contractor personnel, a Submittal Control Log was devised to assist in monitoring the progress of submittals. Figure 15 shows a page of a sample Submittal Log. As can be seen, the first column contains the submittal number. The second column, labelled "REV", provides space for a suffix, if it becomes necessary. It allows the contractor to resubmit, after an initial rejection, a corrected submittal with a similar number, so that both contractor and owner know the resubmittal is just that, a resubmittal of a previous submission and not an entirely new proposal. This should accelerate the review process as the reviewer will know which aspect of the submittal should receive closer examination. A description of the submittal item is noted in column C. This is followed (column D) by the specification reference which required that submittal. The next column indicates the projected date that the material will be required on the job. This date can be based on the contractor's schedule and can assist in forecasting procurement. The next column identifies the subcontractor or supplier responsible for that item. Columns G, H, and I (DATE REC'D FM SUB/SUP, DATE SENT TO OWNER, and DATE REC'D FM OWNER), respectively, contain the dates the submittal was received from the sub, the date it was forwarded to the owner and the date it was returned from the owner or reviewer. An action code is inserted in the next column that indicates the acceptability of that material. Amplifying remarks can also be added as required.

As with the Change Control Log, in order for this log to be sorted by various criteria, field names have to be inserted above the data. The initial line entry after the title block





(beginning with SUBM, DESCRIPTION, SPEC, etc.) provides the column range names to indicate to the computer where to search for data. This can be seen in Figure 16, which also contains the initial entry into the log. This line is not usually printed in the log report. In Figure 17, four more submittals have been entered, as well as updated information for actions that have taken place during the period covered by the log. The log could either be developed as submittals are required on the job or all entries could be made at the beginning of the job and updated accordingly.

As mentioned earlier, the macro command capability of the LOTUS 1-2-3 program, can replace a lengthy command sequence with a single keystroke, thereby reducing time and ensuring greater accuracy. For example, in this log, should a submittal be rejected, a revision and a resubmittal would be required. If a totally new number is used, continuity would be lost. But, if the same submittal number is used without some modification, there would be much confusion. An easy way to solve that problem is to use a revision suffix similar to the one shown in submittal SUBM 1-04 R-1 (See Figure 18). Since the information contained in the first six columns will necessarily be the same, a macro command to cause the insertion of a blank line and the printing of the resubmittal data could be made automatically. Figure 18 shows the result of how a macro command can be used as an alternative to typing. After all nine submittals have been numbered and entered into the log, the manager would then go back to insert any updated information for any previous submissions. As can be seen SUBM1-01, 02, and 03 were reviewed and approved,



SUBMITTAL CONTROL LOG

PROJECT NAME: \_\_\_\_\_ CONTRACT NUMBER: \_\_\_\_\_  
 PROJECT NUMBER: \_\_\_\_\_ CONTRACT AGENCY: \_\_\_\_\_  
 PROJECT LOCATION: \_\_\_\_\_

SUBMITTAL NUMBER REV. DESCRIPTION (SPEC SECTION) ON PROJECT SUBCONTRACTOR/SUPPLIER DATE REC'D FM SUB/SUP TO OWNER DATE SENT FM OWNER DATE REC'D ACTION (A,CAN,R) REMARKS

Figure 15. Submittal Log : Headings

SUBMITTAL CONTROL LOG

PROJECT NAME: \_\_\_\_\_ CONTRACT NUMBER: \_\_\_\_\_  
 PROJECT NUMBER: \_\_\_\_\_ CONTRACT AGENCY: \_\_\_\_\_  
 PROJECT LOCATION: \_\_\_\_\_

AS OF: 1 MAR 1984

| SUBMITTAL NUMBER REV | DESCRIPTION                  | SPEC SECTION | DATE ON PROJECT | SUB/SUP SUPPLIER | DATE REC'D FM SUB/SUP TO OWNER | DATE SENT FM OWNER | DATE REC'D ACTION (A,CAN,R) | REMARKS |
|----------------------|------------------------------|--------------|-----------------|------------------|--------------------------------|--------------------|-----------------------------|---------|
| SUBM SUBM-01         | UNDERGROUND SPRINKLER SYSTEM | 2441         | 15-JUL-84       | ACHE PLUMBING    | DATEFMS 22-FEB-84              | DATEFO 29-FEB-84   | ACT                         | REMARKS |

Figure 16. Submittal Log : Initial Entry



SUBMITTAL CONTROL LOG  
 PROJECT NAME: .....  
 PROJECT NUMBER: ..... CONTRACT NUMBER: .....  
 PROJECT LOCATION: ..... CONTACT AGENCY: .....

AS OF: 1 APRIL 1984

| SUBMITTAL NUMBER | REV | DESCRIPTION                  | (SPEC SECTION) | SPED DATE ON PROJECT | SUBCONTRACTOR / SUPPLIER | DATE REC'D FM SUB/SUP | DATE SENT TO OWNER | DATE REC'D FM OWNER | ACTION (A, AM, R) | REMARKS                       |
|------------------|-----|------------------------------|----------------|----------------------|--------------------------|-----------------------|--------------------|---------------------|-------------------|-------------------------------|
| SUBMI-01         |     | UNDERGROUND SPRINKLER SYSTEM | 2441           | 15-Jul-84            | ACME PLUMBING            | 22-Feb-84             | 29-Feb-84          | 30-Mar-84           | A                 | OK SENT TO ACME 2 APR 84      |
| SUBMI-02         |     | METAL STAIRS                 | 5510           | 15-Aug-84            | STRONG STEEL             | 09-Mar-84             | 15-Mar-84          |                     |                   |                               |
| SUBMI-03         |     | PREFCAST CONCRETE SLAB UNITS | 3410           | 15-Aug-84            | CONCRETE SUPPLY CO       | 01-Mar-84             | 03-Mar-84          | 19-Mar-84           | A                 | OK SENT TO CONCRETE 22 MAR 84 |
| SUBMI-04         |     | ELECTRIC PANEL BOARDS        | 16300          | 14-Sep-84            | ELMO'S ELECTRIC          | 03-Mar-84             | 10-Mar-84          |                     |                   |                               |
| SUBMI-05         |     | LIGHTING FIXTURES FOR LOBBY  | 16500          | 04-Dec-84            | ELMO'S ELECTRIC          | 03-Mar-84             | 10-Mar-84          |                     |                   |                               |

Figure 17. Submittal Log : As of 1 April 1984



SUBMITTAL CONTROL LOG

PROJECT NAME: \_\_\_\_\_ CONTRACT NUMBER: \_\_\_\_\_  
 PROJECT NUMBER: \_\_\_\_\_ CONTRACT AGENCY: \_\_\_\_\_  
 PROJECT LOCATION: \_\_\_\_\_

AS OF: 1 MAY 1984

| SUBMITTAL NUMBER | REV | DESCRIPTION                  | (SPEC SECTION) ON PROJECT | SURCONTRACTOR/SUPPLIER | DATE REC'D FM SUP/SUP | DATE SENT TO OWNER | REC'D FM OWNER | ACTION (A, R, N, R) | REMARKS                       |
|------------------|-----|------------------------------|---------------------------|------------------------|-----------------------|--------------------|----------------|---------------------|-------------------------------|
| SUBMI-01         |     | UNDERGROUND SPRINKLER SYSTEM | 2441 15-Jul-84            | ACME PLUMBING          | 22-Feb-84             | 29-Feb-84          | 30-Mar-84      | A                   | OK SENT TO ACME 2 APR 84      |
| SUBMI-02         |     | METAL STAIRS                 | 5510 15-Aug-84            | STRONG STEEL           | 09-Mar-84             | 16-Mar-84          | 15-Apr-84      | A                   | OK SENT TO STRONG 22 APR 84   |
| SUBMI-03         |     | PRECAST CONCRETE SLAB UNITS  | 3410 15-Aug-84            | CONCRETE SUPPLY CO     | 08-Feb-84             | 18-Feb-84          | 19-Mar-84      | A                   | OK SENT TO CONCRETE 22 MAR 84 |
| SUBMI-04         |     | ELECTRIC PANEL BOARDS        | 16300 14-Sep-84           | ELMO'S ELECTRIC        | 03-Mar-84             | 10-Mar-84          | 09-Apr-84      | R                   | WRONG SIZE                    |
| SUBMI-04 R-1     |     | ELECTRIC PANEL BOARDS        | 16300 14-Sep-84           | ELMO'S ELECTRIC        | 29-Apr-84             |                    |                |                     |                               |
| SUBMI-05         |     | LIGHTING FIXTURES FOR LOBBY  | 16500 04-Dec-84           | ELMO'S ELECTRIC        | 03-Mar-84             | 10-Mar-84          | 10-Mar-84      |                     |                               |
| SUBMI-06         |     | FIRE ALARM                   | 16721 24-Oct-84           | ELMO'S ELECTRIC        | 05-Apr-84             | 15-Apr-84          |                |                     |                               |
| SUBMI-07         |     | PAINT FOR FIRST FLOOR LOBBY  | 9900 03-Jan-85            | PETER PAINTS           |                       |                    |                |                     |                               |
| SUBMI-08         |     | CLOCKS                       | 16770 13-Jan-85           | ELMO'S ELECTRIC        |                       |                    |                |                     |                               |
| SUBMI-09         |     | CARPETING                    | 9680 12-Feb-85            | CANDI'S CARPETS        |                       |                    |                |                     |                               |

Figure 18. Submittal Log : As of 1 May 1984





but SUBM1-04 was rejected. Rather than retyping the log or adding another line entry at the end of this log for a revised SUBM1-04, the user can invoke the macro command that has been prepared to insert space directly below the rejected submittal and simply copy the information from the rejected submittal that would not change, namely the base number, description, referenced specification section, the scheduled date required on the job and the subcontractor or supplier. New milestone dates would then be added as they occur.

The use of the "wildcard input" command adds convenience and flexibility to the program. The use of this command function will cause the computer to pause after copying the submittal number and prompt the user for a revision number. Once inserted, the computer will once again, take over and complete the remainder of the work of copying automatically.

Assuming that the project used in the example required only nine submittals the log shown would essentially be complete with the exception of the action dates and final approvals. Figure 19 is a copy of the log as it would appear on the first of September. Note, the updated information. Once again, SUBM1-04 (this time R-1), has been rejected along with SUBM1-05. In both cases, as the user is updating the information, the rejection would be entered in the ACTION column and the macro command invoked to insert a follow-on revised submission. The wildcard input prompts the operator to insert the new submittal revision number in the appropriate space.

A log or any application on a computer does not have to be difficult to be effective - quite the contrary. This log has



SUBMITTAL CONTROL LOG

PROJECT NAME: \_\_\_\_\_ CONTRACT NUMBER: \_\_\_\_\_  
 PROJECT NUMBER: \_\_\_\_\_ CONTRACT AGENCY: \_\_\_\_\_  
 PROJECT LOCATION: \_\_\_\_\_

AS OF: 1 SEPT 1984

| SUBMITTAL NUMBER | REV | DESCRIPTION                  | (SPEC SECTION) | SQYD DATE ON PROJECT | SUBCONTRACTOR/SUPPLIER | DATE SENT  |           | REC'D ACTION | REMARKS |                               |
|------------------|-----|------------------------------|----------------|----------------------|------------------------|------------|-----------|--------------|---------|-------------------------------|
|                  |     |                              |                |                      |                        | FM SUR/SUP | TO OWNER  |              |         |                               |
| SUBMI-01         |     | UNDERGROUND SPRINKLER SYSTEM | 2441           | 15-Jul-84            | ACME PLUMBING          | 22-Feb-84  | 29-Feb-84 | 30-Mar-84    | A       | OK SENT TO ACME 2 APR 84      |
| SUBMI-02         |     | METAL STAIRS                 | 5510           | 15-Aug-84            | STRONG STEEL           | 09-Mar-84  | 16-Mar-84 | 15-Apr-84    | A       | OK SENT TO STRONG 22 APR 84   |
| SUBMI-03         |     | PRECAST CONCRETE SLAB UNITS  | 3410           | 15-Aug-84            | CONCRETE SUPPLY CO     | 08-Feb-84  | 18-Feb-84 | 19-Mar-84    | A       | OK SENT TO CONCRETE 22 MAR 84 |
| SUBMI-04         |     | ELECTRIC PANEL BOARDS        | 16300          | 14-Sep-84            | ELMO'S ELECTRIC        | 03-Mar-84  | 10-Mar-84 | 09-Apr-84    | R       | WRONG SIZE                    |
| SUBMI-04 R-1     |     | ELECTRIC PANEL BOARDS        | 16300          | 14-Sep-84            | ELMO'S ELECTRIC        | 29-Apr-84  | 04-May-84 | 30-May-84    | P       | INSUFFICIENT SPARES           |
| SUBMI-04 R-2     |     | ELECTRIC PANEL BOARDS        | 16300          | 14-Sep-84            | ELMO'S ELECTRIC        | 09-Jun-84  | 16-Jun-84 | 06-Jul-84    | A       | OK SENT TO ELMO               |
| SUBMI-05         |     | LIGHTING FIXTURES FOR LOBBY  | 16500          | 04-Dec-84            | ELMO'S ELECTRIC        | 03-Mar-84  | 10-Mar-84 | 09-Apr-84    | R       | WRONG MAKE                    |
| SUBMI-05 R-1     |     | LIGHTING FIXTURES FOR LOBBY  | 16500          | 04-Dec-84            | ELMO'S ELECTRIC        | 19-May-84  | 26-May-84 | 25-Jun-84    | AGR     | OK SENT TO ELMO               |
| SUBMI-06         |     | FIRE ALARM                   | 16721          | 24-Oct-84            | ELMO'S ELECTRIC        | 05-Apr-84  | 15-Apr-84 | 15-May-84    | A       | OK SENT TO ELMO               |
| SUBMI-07         |     | PAINT FOR FIRST FLOOR LOBBY  | 9900           | 03-Jan-85            | PETER PAINTS           | 06-Aug-84  | 13-Aug-84 |              |         |                               |
| SUBMI-08         |     | CLOCKS                       | 16700          | 13-Jan-85            | ELMO'S ELECTRIC        | 14-Jul-84  | 24-Jul-84 | 23-Aug-84    |         |                               |
| SUBMI-09         |     | CARPETING                    | 9680           | 12-Feb-85            | CANDI'S CARPETS        |            |           |              |         |                               |

Figure 19. Submittal Log : As of 1 Sept 1984



been designed to be simple. There are no major formulae or calculations required, and the log is still able to provide accurate information regarding the status of any contract submittal. As this sample job nears completion and all submittals have been approved, a printout similar to Figure 20 would be obtained. If the contractor had correctly identified all required submittals in the log, there would no longer be a need to wonder if all paperwork was complete. The log indicates that all submittal action has been completed and provides a record as to which submittals had problems and which information from subcontractors or suppliers had difficulty meeting the owner's approval.

While this log was developed for tracking progress of submittal data, a log could be created for almost any purpose. Monitoring all correspondence, progress payments, labor reports, time sheets etc. could all be made simpler on a computer. Brick and mortar may be the fun part of the construction process, but the job can be adversely affected when the paperwork that accompanies these items is not completed properly and on time.



SUBMITTAL CONTROL LOG

PROJECT NAME: \_\_\_\_\_ CONTRACT NUMBER: \_\_\_\_\_

PROJECT NUMBER: \_\_\_\_\_ CONTRACT AGENCY: \_\_\_\_\_

PROJECT LOCATION: \_\_\_\_\_

AS OF: 1 MAR 1985

| SUBMITTAL NUMBER | REV | DESCRIPTION                  | (SPEC SECTION) | SCHED DATE ON PROJECT | SURCONTRACTOR/SUPPLIER | DATE REC'D FM SUB/SUP TO OWNER | DATE SENT TO OWNER | REC'D FM OWNER (A, AAN, R) | ACTION | REMARKS                       |
|------------------|-----|------------------------------|----------------|-----------------------|------------------------|--------------------------------|--------------------|----------------------------|--------|-------------------------------|
| SUBMI-01         |     | UNDERGROUND SPRINKLER SYSTEM | 2441           | 15-Jul-84             | ACME PLUMBING          | 22-Feb-84                      | 29-Feb-84          | 30-Mar-84                  | A      | OK SENT TO ACME 2 APR 84      |
| SUBMI-02         |     | METAL STAIRS                 | 5510           | 15-Aug-84             | STRONG STEEL           | 09-Mar-84                      | 16-Mar-84          | 15-Apr-84                  | A      | OK SENT TO STRONG 22 APR 84   |
| SUBMI-03         |     | PRECAST CONCRETE SLAB UNITS  | 3410           | 15-Aug-84             | CONCRETE SUPPLY CO     | 08-Feb-84                      | 18-Feb-84          | 19-Mar-84                  | A      | OK SENT TO CONCRETE 22 MAR 84 |
| SUBMI-04         |     | ELECTRIC PANEL BOARDS        | 16300          | 14-Sep-84             | ELMO'S ELECTRIC        | 03-Mar-84                      | 10-Mar-84          | 09-Apr-84                  | R      | WRONG SIZE                    |
| SUBMI-04 R-1     |     | ELECTRIC PANEL BOARDS        | 16300          | 14-Sep-84             | ELMO'S ELECTRIC        | 29-Apr-84                      | 04-May-84          | 30-May-84                  | R      | INSUFFICIENT SPARES           |
| SUBMI-04 R-2     |     | ELECTRIC PANEL BOARDS        | 16300          | 14-Sep-84             | ELMO'S ELECTRIC        | 09-Jun-84                      | 16-Jun-84          | 06-Jul-84                  | A      | OK SENT TO ELMO               |
| SUBMI-05         |     | LIGHTING FIXTURES FOR LOBBY  | 16500          | 04-Dec-84             | ELMO'S ELECTRIC        | 07-Mar-84                      | 10-Mar-84          | 09-Apr-84                  | R      | WRONG MAKE                    |
| SUBMI-05 R-1     |     | LIGHTING FIXTURES FOR LOBBY  | 16500          | 04-Dec-84             | ELMO'S ELECTRIC        | 19-May-84                      | 26-May-84          | 25-Jun-84                  | AAN    | OK SENT TO ELMO               |
| SUBMI-06         |     | FIRE ALARM                   | 16721          | 24-Oct-84             | ELMO'S ELECTRIC        | 05-Apr-84                      | 15-Apr-84          | 15-May-84                  | A      | OK SENT TO ELMO 22 MAY 84     |
| SUBMI-07         |     | PAINT FOR FIRST FLOOR LOBBY  | 9900           | 03-Jan-85             | PETER PAINTS           | 06-Aug-84                      | 13-Aug-84          | 12-Sep-84                  | R      | INSUFFICIENT COLOR SELECTION  |
| SUBMI-07 R-1     |     | PAINT FOR FIRST FLOOR LOBBY  | 9900           | 03-Jan-85             | PETER PAINTS           | 12-Oct-84                      | 15-Oct-84          | 09-Nov-84                  | A      | OK SENT TO PETER              |
| SUBMI-08         |     | CLOCKS                       | 16730          | 13-Jan-85             | ELMO'S ELECTRIC        | 14-Jul-84                      | 24-Jul-84          | 23-Aug-84                  | AAN    | OK SENT TO ELMO 27 AUG 84     |
| SUBMI-09         |     | CARPETING                    | 9680           | 12-Feb-85             | CANDI'S CARPETS        | 22-Oct-84                      | 01-Nov-84          | 01-Dec-84                  | R      | NOT HEAVY DUTY                |
| SUBMI-09 R-1     |     | CARPETING                    | 9680           | 12-Feb-85             | CANDI'S CARPETS        | 21-Dec-84                      | 28-Dec-84          | 19-Jan-85                  | P      | INSUFFICIENT COLOR SELECTION  |
| SUBMI-09 R-2     |     | CARPETING                    | 9680           | 12-Feb-85             | CANDI'S CARPETS        | 30-Jan-85                      | 02-Feb-85          | 12-Feb-85                  | A      | ORDER BUYCY - LATE!!          |

Figure 20. Submittal Log : As of 1 Mar 1985





## Inventory Control System Template

For most construction projects and most materials, procurement begins after the award of the contract and after a "Notice to Proceed" (NTP) has been issued. On jobs of any size, the identification, pricing, ordering, receiving and distributing of project materials can be an enormous task. Ensuring that the proper materials get to the correct jobsite on time is extremely important because misdelivered materials can often be "lost by inventory" or consumed on another job. In any case, these materials may no longer be available for reissue if, and when, the error is finally noticed. Items common to every job, such as cement, sand, nails, lumber, paints and reinforcing steel are especially susceptible to this occurrence. While the lead time for reorder is not usually very long, delays of a day or two can adversely impact any project.

To insure an adequate, ready supply of the most-used materials, many contractors establish a revolving stock inventory that is stored at a central warehouse or at the main office and yard area. Issues and receipts are made from this stock to particular projects. Although the materials are ordered for each job and charged against that job, they are first delivered to central stock for temporary storage and eventual distribution<sup>(6)</sup>. Managing this inventory and maintaining an adequate stock on hand can be greatly assisted by the computer.

An inventory control system, similar to the one shown in Figure 21, could be established to manage project materials. Again, the LOTUS 1-2-3 spreadsheet package provides many



capabilities for creating a database and manipulating the information into appropriate formats. Figure 21 shows the basic template of the system with typical headings. More sophisticated information could be used depending upon the needs of the user and any inventory system already in place. In this simple sample, the MAJOR MATERIAL GROUP represents the overall category into which the listed materials fall.

A COST CODE can be inserted, as shown in the second column, for tracking and accounting purposes. The type of system is not important as long as the user is consistent. However, the same classification system should be used throughout all project phases wherever possible as this eliminates the requirement to learn multiple systems. While the cost coding should be flexible and expandable it should also remain as simple as possible (5). Several construction organizations have developed cost coding systems and have published standard account charts, including the American Home Builders Association, American Road Builders Association, Associated General Contractors and the Construction Specifications Institute. Some construction firms have even developed their own systems (5,6,9). Again, the system should be consistent with the needs of the using organization and in any case the LOTUS program can easily be adapted to accommodate the coding requirements.

The next two columns in the template (MATERIAL DESCRIPTION, UNIT ISSUE) contain a noun description of the material and the unit of issue. The next five columns contain the basic stocking information, including the QUANTITY ON HAND (QOH), the amount of action during the last period, any amounts that have been ordered,



MATERIAL CONTROL LOG

AS OF: \_\_\_\_\_

| MAJOR MATERIAL GROUP | COST CODE | MATERIAL DESCRIPTION | UNIT ISSUE | QUANTITY ON HAND | + or - LAST PER. | QUANTITY ON ORDER | LOW LIMIT | HIGH LIMIT |
|----------------------|-----------|----------------------|------------|------------------|------------------|-------------------|-----------|------------|
|----------------------|-----------|----------------------|------------|------------------|------------------|-------------------|-----------|------------|

Figure 21. Material Control Log : Headings



and the LOW and HIGH LIMITS. These last two limits provide an indication to the material manager as to whether an item needs to be reordered or if a large surplus is building. For example, an item which is in "short" supply (below its low limit), may not be available for issue in the quantity required. Obviously this could cause a costly delay. On the other extreme, the purchaser could be tying up funds in excessive inventories.

Figure 22 shows the template with additional columns of information not shown in the previous template. The additional columns are where information is inserted or changed and then is updated when the user has LOTUS recalculate the numbers. The program automatically carries forward the BEGINNING OF MONTH INVENTORY from the QUANTITY ON HAND column. The inventory clerk then manually inserts the appropriate receipts and issues during the period. By inserting the proper formulae in the correct spaces, LOTUS will then total the receipts and issues and combine this total with the original inventory, giving the NEW QOH. When the new QOH falls below the desired low limit, LOTUS can extract those items and prepare another list of materials to order. This is made possible by defining each column, or field, and assigning a name to that field. Note, the row immediately below the title block contains these range names but is omitted during printout of the regular report for clarity. LOTUS can then compare established criteria with the information in each field and selectively highlight or copy entries to another section of the worksheet as will be discussed later.

A sample inventory has been created in Figure 23. The cost code in this example, is based on the Uniform Construction





MATERIAL CONTROL LOG

AS OF: \_\_\_\_\_

| MAJOR MATERIAL GROUP | COST CODE | MATERIAL DESCRIPTION | UNIT ISSUE | QUANTITY ON HAND | or LAST PER. | QUANTITY ON ORDER | LOW LIMIT | HIGH LIMIT | BEG. MO INVENT. | REC'D PERIOD | ISSUES PERIOD | TOTAL PERIOD | NEW GOH | TIME TO ORDER |
|----------------------|-----------|----------------------|------------|------------------|--------------|-------------------|-----------|------------|-----------------|--------------|---------------|--------------|---------|---------------|
| MAJMAT               | CC        | MATL                 | UI         | GOH              | PERIOD       | GOO               | LL        | HL         | BEGINV          | RECTS        | ISSUES        | TOTAL        | NEW     | TTO           |
|                      |           |                      |            |                  |              |                   |           |            |                 |              |               |              |         |               |

Figure 22. Material Control Log : Field Names



MATERIAL CONTROL LOG

AS OF:

| MAJOR MATERIAL GROUP | COST CODE  | MATERIAL DESCRIPTION           | UNIT ISSUE       | QUANTITY ON HAND | + or - LAST PER. | QUANTITY ON ORDER | LOW LIMIT | HIGH LIMIT |
|----------------------|------------|--------------------------------|------------------|------------------|------------------|-------------------|-----------|------------|
| CONCRETE MATERIALS   | 3.1 04-032 | CEMENT                         | BAG              | 75               | 0                | 0                 | 25        | 300        |
|                      | 3.1 05-580 | FORM OIL                       | GAL              | 50               | 0                | 0                 | 50        | 100        |
|                      | 3.3 01-040 | SAND, CLEAN                    | CU YD            | 50               | 0                | 0                 | 15        | 50         |
|                      | 3.3 08-020 | WELOED WIRE FABRIC 4X4         | ROLL             | 5                | 0                | 0                 | 5         | 20         |
|                      | 3.3 08-060 | WELOED WIRE FABRIC 6X6         | ROLL             | 10               | 0                | 0                 | 15        | 25         |
| LUMBER               | 6.1 19-265 | FINISHED, 2 X 4                | BF               | 2500             | 0                | 0                 | 1000      | 4000       |
|                      | 6.1 19-268 | FINISHED, 2 X 6                | BF               | 2000             | 0                | 0                 | 1000      | 4000       |
|                      | 6.1 19-270 | FINISHED, 2 X 8                | BF               | 1000             | 0                | 0                 | 1000      | 3000       |
|                      | 6.1 19-272 | FINISHED, 2 X 10               | BF               | 500              | 0                | 0                 | 500       | 1000       |
|                      | 6.1 70-002 | PLYWOOD, EXTERIOR GRADE 1/4 IN | SHT              | 18               | 0                | 0                 | 24        | 48         |
|                      | 6.1 70-005 | PLYWOOD, EXTERIOR GRADE 3/8 IN | SHT              | 22               | 0                | 0                 | 24        | 72         |
|                      | 6.1 70-010 | PLYWOOD, EXTERIOR GRADE 1/2 IN | SHT              | 78               | 0                | 0                 | 48        | 144        |
|                      | 6.1 70-020 | PLYWOOD, EXTERIOR GRADE 5/8 IN | SHT              | 44               | 0                | 0                 | 48        | 72         |
|                      | 6.1 70-030 | PLYWOOD, EXTERIOR GRADE 3/4 IN | SHT              | 35               | 0                | 0                 | 24        | 72         |
|                      | PAINTS     | 5.1 50-654                     | PRIMER, RED LEAD | GAL              | 20               | 0                 | 0         | 20         |
| 5.1 50-700           |            | PRIMER, ZINC CHROMATE          | GAL              | 40               | 0                | 0                 | 20        | 40         |
| 5.1 50-672           |            | COLOR, WHITE                   | GAL              | 15               | 0                | 0                 | 25        | 50         |
| STEEL                | 3.2 04-003 | REBAR, #3                      | EA               | 20               | 0                | 0                 | 20        | 75         |
|                      | 3.2 04-004 | REBAR, #4                      | EA               | 75               | 0                | 0                 | 50        | 250        |
|                      | 3.2 04-005 | REBAR, #5                      | EA               | 0                | 0                | 0                 | 50        | 100        |
|                      | 3.2 04-006 | REBAR, #6                      | EA               | 50               | 0                | 0                 | 30        | 150        |
|                      | 3.2 04-008 | REBAR, #8                      | EA               | 40               | 0                | 0                 | 20        | 100        |
|                      | 3.2 04-010 | REBAR, #10                     | EA               | 20               | 0                | 0                 | 20        | 50         |

Figure 23. Material Control Log : LIMITS



Industry chart (11). This figure would be the initial month's entry and so does not contain any entries for issues, receipts or orders. All information on the page would be inserted manually for this iteration. In Figure 24, the BEG MO INVENT column has been added by simply inserting the formula to carry the number in column F (QUANTITY ON HAND) forward to column K. After this formula has been entered once, the transfer will be done automatically after every recalculation simply by pressing the recalculation function key [F9] on the IBM PC. Figure 25 has been further expanded to include the RECEIPT and ISSUE for the period columns. Every month, or sooner if necessary, the clerk would enter appropriate data in these columns. In addition, ordering information would also be inserted by the clerk. The entire worksheet has been "protected" so that only these three columns will accept entries. This insures that no other numbers could be accidentally changed should an inexperienced person be required to enter data. All other entries requiring calculation or transfer of information would be done automatically by 1-2-3. This can be seen in Figure 26, where a NEW QOH, column O, has been added. The issues and receipts have been totalled and combined with the beginning inventory. The NEW QOH is then compared to the low limit, to determine whether additional stock should be reordered. If so, a "0" will be placed in column P (TIME TO ORDER), as can be seen in Figure 27. This is made possible by the application of one of LOTUS' logic functions. The function causes LOTUS to compare columns O and I, and if the new quantity on hand is less than the low limit, a "0" is placed in column P. If not, then a "1" is placed in the space.



MATERIAL CONTROL LOG

AS OF: .....

| MAJOR MATERIAL GROUP | COST CODE              | MATERIAL DESCRIPTION           | UNIT ISSUE       | QUANTITY ON HAND | % OF LAST PER. | QUANTITY ON ORDER | LOW LIMIT | HIGH LIMIT | REG. MO INVENT. |
|----------------------|------------------------|--------------------------------|------------------|------------------|----------------|-------------------|-----------|------------|-----------------|
| CONCRETE MATERIALS   | 3.3 04-032             | CEMENT                         | BAG              | 75               | 0              | 50                | 25        | 300        | 75              |
|                      | 3.1 05-589             | FOPH OIL                       | GAL              | 50               | 0              | 20                | 50        | 100        | 50              |
|                      | 3.3 01 040             | SAND, CLEAR                    | CU YD            | 50               | 0              | 30                | 15        | 50         | 50              |
|                      | 3.3 06-020             | WELDED WIRE FABRIC #14         | ROLL             | 5                | 0              | 5                 | 5         | 20         | 5               |
| 3.3 06-060           | WELDED WIRE FABRIC #16 | ROLL                           | 10               | 0                | 0              | 15                | 25        | 10         |                 |
| LUMBER               | 6.1 19-265             | FINISHED, 2 X 4                | BF               | 2500             | 0              | 1000              | 1000      | 4000       | 2500            |
|                      | 6.1 19-268             | FINISHED, 2 X 6                | BF               | 2000             | 0              | 0                 | 1000      | 4000       | 2000            |
|                      | 6.1 19-270             | FINISHED, 2 X 8                | BF               | 1000             | 0              | 500               | 1000      | 3000       | 1000            |
|                      | 6.1 19-272             | FINISHED, 2 X 10               | BF               | 500              | 0              | 0                 | 500       | 1000       | 500             |
|                      | 6.1 70-002             | PLYWOOD, EXTERIOR GRADE 1/4 IN | SHT              | 18               | 0              | 0                 | 24        | 48         | 18              |
|                      | 6.1 70-005             | PLYWOOD, EXTERIOR GRADE 3/8 IN | SHT              | 22               | 0              | 0                 | 24        | 72         | 22              |
|                      | 6.1 70-010             | PLYWOOD, EXTERIOR GRADE 1/2 IN | SHT              | 78               | 0              | 43                | 48        | 144        | 78              |
|                      | 6.1 70-020             | PLYWOOD, EXTERIOR GRADE 5/8 IN | SHT              | 44               | 0              | 48                | 48        | 72         | 44              |
|                      | 6.1 70-030             | PLYWOOD, EXTERIOR GRADE 3/4 IN | SHT              | 35               | 0              | 48                | 24        | 72         | 35              |
|                      | PAINTS                 | 5.1 50-654                     | PRIMER, RED LEAD | GAL              | 20             | 0                 | 0         | 20         | 40              |
| 5.1 50-700           |                        | PRIMER, ZINC CHROMATE          | GAL              | 40               | 0              | 0                 | 20        | 40         | 40              |
| 5.1 50-672           |                        | COLOR, WHITE                   | GAL              | 15               | 0              | 0                 | 25        | 50         | 15              |
| STEEL                | 3.2 04-003             | REBAR, #3                      | EA               | 20               | 0              | 40                | 20        | 75         | 20              |
|                      | 3.2 04-004             | REBAR, #4                      | EA               | 75               | 0              | 100               | 50        | 250        | 75              |
|                      | 3.2 04-005             | REBAR, #5                      | EA               | 0                | 0              | 50                | 50        | 100        | 0               |
|                      | 3.2 04-006             | REBAR, #6                      | EA               | 50               | 0              | 20                | 30        | 150        | 50              |
|                      | 3.2 04-008             | REBAR, #8                      | EA               | 40               | 0              | 0                 | 20        | 100        | 40              |
|                      | 3.2 04-010             | REBAR, #10                     | EA               | 20               | 0              | 0                 | 20        | 50         | 20              |

Figure 24. Material Control Log : BWT MO INV





MATERIAL CONTROL LOG

AS OF: \_\_\_\_\_

| MAJOR MATERIAL GROUP | COST CODE  | MATERIAL DESCRIPTION           | UNIT ISSUE       | QUANTITY ON HAND | LAST PER. | + or - | QUANTITY ON ORDER | LOW LIMIT | HIGH LIMIT | REG. MD INVENT. | REC'TS PERIOD | ISSUES PERIOD | TOTALS PERIOD |
|----------------------|------------|--------------------------------|------------------|------------------|-----------|--------|-------------------|-----------|------------|-----------------|---------------|---------------|---------------|
| CONCRETE MATERIALS   | 3.3 04-032 | CEMENT                         | BAG              | 75               |           | 0      | 50                | 25        | 300        | 75              | 50            | 100           | -50           |
|                      | 3.1 05-580 | FORM OIL                       | GAL              | 50               |           | 0      | 20                | 50        | 100        | 50              | 20            | 15            | 5             |
|                      | 3.3 01-040 | SAND, CLEAN                    | CU YD            | 50               |           | 0      | 30                | 15        | 50         | 50              | 30            | 10            | 20            |
|                      | 3.3 06-020 | WELDED WIRE FABRIC 4X4         | ROLL             | 5                |           | 0      | 5                 | 5         | 20         | 5               | 5             | 5             | 0             |
|                      | 3.3 06-060 | WELDED WIRE FABRIC 6X6         | ROLL             | 10               |           | 0      | 15                | 15        | 25         | 10              | 10            | 5             | -5            |
| LUMBER               | 6.1 19-265 | FINISHED, 2 X 4                | BF               | 2500             |           | 0      | 1000              | 1000      | 4000       | 2500            | 500           | 1000          | -500          |
|                      | 6.1 19-268 | FINISHED, 2 X 6                | BF               | 2000             |           | 0      | 1000              | 1000      | 4000       | 2000            | 500           | 500           | 500           |
|                      | 6.1 19-270 | FINISHED, 2 X 8                | BF               | 1000             |           | 0      | 500               | 1000      | 3000       | 1000            |               |               | 0             |
|                      | 6.1 19-272 | FINISHED, 2 X 10               | BF               | 500              |           | 0      | 500               | 500       | 1000       | 500             |               | 150           | -150          |
|                      | 6.1 70-002 | PLYWOOD, EXTERIOR GRADE 1/4 IN | SHT              | 10               |           | 0      | 24                | 24        | 48         | 10              | 24            | 10            | 14            |
|                      | 6.1 70-005 | PLYWOOD, EXTERIOR GRADE 3/8 IN | SHT              | 22               |           | 0      | 24                | 24        | 72         | 22              | 22            | 15            | -15           |
|                      | 6.1 70-010 | PLYWOOD, EXTERIOR GRADE 1/2 IN | SHT              | 78               |           | 0      | 48                | 48        | 144        | 78              | 48            | 48            | 0             |
|                      | 6.1 70-020 | PLYWOOD, EXTERIOR GRADE 5/8 IN | SHT              | 44               |           | 0      | 48                | 48        | 72         | 44              | 44            | 15            | -15           |
|                      | 6.1 70-030 | PLYWOOD, EXTERIOR GRADE 3/4 IN | SHT              | 35               |           | 0      | 48                | 24        | 72         | 35              | 35            | 24            | 24            |
|                      | PAINTS     | 5.1 50-654                     | PRIMER, RED LEAD | GAL              | 20        |        | 0                 | 20        | 20         | 40              | 20            |               |               |
| 5.1 50-700           |            | PRIMER, ZINC CHROMATE          | GAL              | 40               |           | 0      | 20                | 20        | 40         | 40              |               | 10            | -10           |
| 5.1 50-672           |            | COLOR, WHITE                   | GAL              | 15               |           | 0      | 25                | 25        | 50         | 15              | 25            | 25            | 25            |
| STEEL                | 3.2 04-003 | REBAR, #3                      | EA               | 20               |           | 0      | 40                | 20        | 75         | 20              | 20            | 30            | -10           |
|                      | 3.2 04-004 | REBAR, #4                      | EA               | 75               |           | 0      | 100               | 50        | 250        | 75              | 100           | 50            | 50            |
|                      | 3.2 04-005 | REBAR, #5                      | EA               | 0                |           | 0      | 50                | 50        | 100        | 0               | 50            | 25            | 25            |
|                      | 3.2 04-006 | REBAR, #6                      | EA               | 50               |           | 0      | 20                | 20        | 150        | 50              | 20            | 20            | 20            |
|                      | 3.2 04-008 | REBAR, #8                      | EA               | 40               |           | 0      |                   | 20        | 100        | 40              | 40            | 0             | 0             |
|                      | 3.2 04-010 | REBAR, #10                     | EA               | 20               |           | 0      |                   | 20        | 50         | 20              | 20            | 5             | -5            |

Figure 25. Material Control Log : TOTALS



MATERIAL CONTROL LOG

AS OF:

| MAJOR MATERIAL GROUP | COST CODE  | MATERIAL DESCRIPTION           | UNIT ISSUE       | QUANTITY ON HAND | + or - LAST PER. | QUANTITY ON ORDER | LOW LIMIT | HIGH LIMIT | REG. NO INVENT. | REC'D PERIOD | ISSUES PERIOD | TOTALS PERIOD | NEW QOH |
|----------------------|------------|--------------------------------|------------------|------------------|------------------|-------------------|-----------|------------|-----------------|--------------|---------------|---------------|---------|
| CONCRETE MATERIALS   | 3.3 04-032 | CEMENT                         | BAG              | 75               | 0                | 50                | 25        | 300        | 75              | 50           | 100           | -50           | 25      |
|                      | 3.1 05-580 | FORM OIL                       | GAL              | 50               | 0                | 20                | 50        | 100        | 50              | 20           | 15            | 5             | 55      |
|                      | 3.3 01-040 | SAND, CLEAN                    | CU YD            | 50               | 0                | 30                | 15        | 50         | 50              | 30           | 10            | 20            | 70      |
|                      | 3.3 06-020 | WELDED WIRE FABRIC 4X4         | ROLL             | 5                | 0                | 5                 | 5         | 20         | 5               | 5            | 0             | 0             | 5       |
|                      | 3.3 06-060 | WELDED WIRE FABRIC 6X6         | ROLL             | 10               | 0                | 15                | 15        | 25         | 10              | 5            | 5             | -5            | 5       |
| LUMBER               | 6.1 19-265 | FINISHED, 2 X 4                | BF               | 2500             | 0                | 1000              | 1000      | 4000       | 2500            | 500          | 1000          | -500          | 2000    |
|                      | 6.1 19-268 | FINISHED, 2 X 6                | BF               | 2000             | 0                | 1000              | 1000      | 4000       | 2000            | 500          | 500           | 500           | 2500    |
|                      | 6.1 19-270 | FINISHED, 2 X 8                | BF               | 1000             | 0                | 500               | 1000      | 3000       | 1000            | 0            | 0             | 0             | 1000    |
|                      | 6.1 19-272 | FINISHED, 2 X 10               | BF               | 500              | 0                | 0                 | 500       | 1000       | 500             | 0            | 150           | -150          | 350     |
|                      | 6.1 70-002 | PLYWOOD, EXTERIOR GRADE 1/4 IN | SHT              | 10               | 0                | 0                 | 24        | 48         | 10              | 24           | 10            | 14            | 24      |
|                      | 6.1 70-005 | PLYWOOD, EXTERIOR GRADE 3/8 IN | SHT              | 22               | 0                | 0                 | 24        | 72         | 22              | 48           | 15            | -15           | 7       |
|                      | 6.1 70-010 | PLYWOOD, EXTERIOR GRADE 1/2 IN | SHT              | 78               | 0                | 48                | 48        | 144        | 78              | 48           | 48            | 0             | 78      |
|                      | 6.1 70-020 | PLYWOOD, EXTERIOR GRADE 5/8 IN | SHT              | 44               | 0                | 48                | 48        | 72         | 44              | 44           | 15            | -15           | 29      |
|                      | 6.1 70-030 | PLYWOOD, EXTERIOR GRADE 3/4 IN | SHT              | 35               | 0                | 48                | 24        | 72         | 35              | 48           | 24            | 24            | 59      |
|                      | PAINTS     | 5.1 50-654                     | PRIMER, RED LEAD | GAL              | 20               | 0                 | 0         | 20         | 40              | 20           | 0             | 0             | 0       |
| 5.1 50-700           |            | PRIMER, ZINC CHROMATE          | GAL              | 40               | 0                | 0                 | 20        | 40         | 40              | 40           | 10            | -10           | 30      |
| 5.1 50-672           |            | COLOR, WHITE                   | GAL              | 15               | 0                | 0                 | 25        | 50         | 15              | 25           | 25            | 25            | 40      |
| STEEL                | 3.2 04-003 | REBAR, #3                      | EA               | 20               | 0                | 40                | 20        | 75         | 20              | 20           | 30            | -10           | 10      |
|                      | 3.2 04-004 | REBAR, #4                      | EA               | 75               | 0                | 100               | 50        | 250        | 75              | 100          | 50            | 50            | 125     |
|                      | 3.2 04-005 | REBAR, #5                      | EA               | 0                | 0                | 50                | 50        | 100        | 0               | 50           | 25            | 25            | 75      |
|                      | 3.2 04-006 | REBAR, #6                      | EA               | 50               | 0                | 20                | 30        | 150        | 50              | 20           | 20            | 20            | 70      |
|                      | 3.2 04-008 | REBAR, #8                      | EA               | 40               | 0                | 0                 | 20        | 100        | 40              | 0            | 0             | 0             | 40      |
|                      | 3.2 04-010 | REBAR, #10                     | EA               | 20               | 0                | 0                 | 20        | 50         | 20              | 20           | 5             | -5            | 15      |

Figure 26. Material Control Log : NEW QOH



MATERIAL CONTROL LOG

AS OF:

| MAJOR MATERIAL GROUP | COST CODE  | MATERIAL DESCRIPTION           | UNIT ISSUE       | QUANTITY ON HAND | LAST REP. | + | OR | -    | QUANTITY IN ORDER | LOW LIMIT | HIGH LIMIT | BEG. INVT. | NO. REC'D. | PERIOD | TOTALS PERIOD | NEW OOH | TIME TO ORDER |
|----------------------|------------|--------------------------------|------------------|------------------|-----------|---|----|------|-------------------|-----------|------------|------------|------------|--------|---------------|---------|---------------|
| CONCRETE MATERIALS   | 3.3 04-032 | CEMENT                         | 866              | 75               | 0         | 0 | 0  | 0    | 50                | 25        | 304        | 75         | 50         | 100    | -50           | 25      | 0             |
|                      | 3.1 05-580 | FORM OIL                       | GAL              | 50               | 0         | 0 | 0  | 0    | 20                | 50        | 100        | 50         | 20         | 15     | 5             | 55      | 1             |
|                      | 3.3 01-040 | SAND, CLEAN                    | CU YD            | 50               | 0         | 0 | 0  | 0    | 30                | 15        | 50         | 50         | 30         | 10     | 20            | 70      | 1             |
|                      | 3.3 06-020 | WELDED WIRE FABRIC #14         | ROLL             | 5                | 0         | 0 | 0  | 0    | 5                 | 5         | 20         | 5          | 5          | 0      | 0             | 5       | 0             |
|                      | 3.3 06-360 | WELDED WIRE FABRIC #16         | ROLL             | 10               | 0         | 0 | 0  | 0    | 10                | 15        | 35         | 10         | 10         | 5      | -5            | 5       | 0             |
| LUMBER               | 6.1 19-265 | FINISHED, 2 X 4                | BF               | 2500             | 0         | 0 | 0  | 1000 | 1000              | 4000      | 2500       | 2500       | 500        | 1000   | -500          | 2000    | 1             |
|                      | 6.1 19-268 | FINISHED, 2 X 6                | BF               | 2000             | 0         | 0 | 0  | 1000 | 1000              | 4000      | 2000       | 2000       | 500        | 500    | 500           | 2500    | 1             |
|                      | 6.1 19-270 | FINISHED, 2 X 8                | BF               | 1000             | 0         | 0 | 0  | 500  | 1000              | 3000      | 1000       | 1000       | 0          | 0      | 0             | 1000    | 0             |
|                      | 6.1 19-272 | FINISHED, 2 X 10               | BF               | 500              | 0         | 0 | 0  | 0    | 500               | 1000      | 500        | 500        | 150        | 150    | -150          | 350     | 0             |
|                      | 6.1 70-002 | PLYWOOD, EXTERIOR GRADE 1/4 IN | SHT              | 10               | 0         | 0 | 0  | 0    | 24                | 24        | 48         | 10         | 24         | 10     | 14            | 24      | 0             |
|                      | 6.1 70-005 | PLYWOOD, EXTERIOR GRADE 3/8 IN | SHT              | 22               | 0         | 0 | 0  | 0    | 24                | 24        | 72         | 22         | 22         | 15     | -15           | 7       | 0             |
|                      | 6.1 70-010 | PLYWOOD, EXTERIOR GRADE 1/2 IN | SHT              | 78               | 0         | 0 | 0  | 48   | 48                | 48        | 144        | 78         | 48         | 48     | 0             | 78      | 1             |
|                      | 6.1 70-020 | PLYWOOD, EXTERIOR GRADE 5/8 IN | SHT              | 44               | 0         | 0 | 0  | 48   | 48                | 48        | 72         | 44         | 44         | 15     | -15           | 29      | 0             |
|                      | 6.1 70-030 | PLYWOOD, EXTERIOR GRADE 3/4 IN | SHT              | 35               | 0         | 0 | 0  | 48   | 24                | 24        | 72         | 35         | 48         | 24     | 24            | 59      | 1             |
|                      | PAINTS     | 5.1 50-654                     | PRIMER, RED LEAD | GAL              | 20        | 0 | 0  | 0    | 0                 | 20        | 40         | 40         | 20         | 0      | 0             | 0       | 20            |
| 5.1 50-700           |            | PRIMER, ZINC CHROMATE          | GAL              | 40               | 0         | 0 | 0  | 0    | 20                | 40        | 40         | 40         | 0          | 10     | -10           | 30      | 1             |
| 5.1 50-672           |            | COLOR, WHITE                   | GAL              | 15               | 0         | 0 | 0  | 0    | 25                | 50        | 50         | 15         | 25         | 25     | 25            | 40      | 1             |
| STEEL                | 3.2 04-003 | REBAR, #3                      | EA               | 20               | 0         | 0 | 0  | 40   | 20                | 75        | 20         | 20         | 20         | 30     | -10           | 10      | 0             |
|                      | 3.2 04-004 | REBAR, #4                      | EA               | 75               | 0         | 0 | 0  | 100  | 50                | 250       | 75         | 100        | 50         | 50     | 50            | 125     | 1             |
|                      | 3.2 04-005 | REBAR, #5                      | EA               | 0                | 0         | 0 | 0  | 50   | 50                | 100       | 0          | 50         | 0          | 25     | 25            | 25      | 0             |
|                      | 3.2 04-006 | REBAR, #6                      | EA               | 50               | 0         | 0 | 0  | 20   | 30                | 150       | 50         | 50         | 20         | 20     | 20            | 70      | 1             |
|                      | 3.2 04-008 | REBAR, #8                      | EA               | 40               | 0         | 0 | 0  | 0    | 20                | 100       | 40         | 40         | 0          | 0      | 0             | 40      | 1             |
|                      | 3.2 04-010 | REBAR, #10                     | EA               | 20               | 0         | 0 | 0  | 0    | 20                | 20        | 50         | 20         | 0          | 5      | -5            | 15      | 0             |

Figure 27. Material Control Log : TIME TO ORDER



Figure 28 shows only the first three entries in the log but has been reformatted to show appropriate formulae where they are used. All number and label entries would be made manually while the numbers derived from equations would be updated by pressing the [F9] key. Again, for security reasons, only three columns should be left unprotected for necessary data entries.

If column P (TIME TO ORDER) contains a "0" after the comparison, the inventory clerk would be alerted to the need to initiate a requisition. To assist in the determination of which materials have to be ordered, 1-2-3 can be queried to search the data contained in this worksheet to see which entries have been earmarked for reorder by the "0" entry in column P. Finding the appropriate line entries can either be accomplished by highlighting them within the worksheet, one at a time or by copying all corresponding entries to a separate reorder worksheet as shown in Figure 29. The title block in this case is similar to that of the original worksheet, including the field names below the title. The order of the field names can be different as long as all named ranges are present. This "output range" must be of sufficient size to accept all flagged entries or an incomplete listing will result. Figure 30 shows all the materials in which the new quantity on hand is below the established low limit and therefore, should be reordered. Unfortunately, in order to extract the information from one record and print it in another area, the protection feature discussed earlier must be disengaged.

Once the materials to reorder have been identified, the clerk would then simply press [F9] to recalculate the new totals,





MATERIAL CONTROL LOG

AS OF:

| MAJOR MATERIAL GROUP | COST CODE  | MATERIAL DESCRIPTION | UNIT ISSUE | QUANTITY ON HAND | QUANTITY * or LAST PER. ON ORDER | LOW LIMIT | HIGH LIMIT | BEG. INVENT. | REC'D PERIOD | ISSUES PERIOD | TOTALS PERIOD | NEW DOH | TIME TO ORDER       |
|----------------------|------------|----------------------|------------|------------------|----------------------------------|-----------|------------|--------------|--------------|---------------|---------------|---------|---------------------|
| CONCRETE MATERIALS   | 3.7 04-072 | CEMENT               | BAG #017   | 4813             | 5                                | 25        | 500 #017   | 50           | 50           | 100           | 413-M12       | 413-M13 | 01F(+013-113)(,0,1) |
|                      | 3.1 05-580 | FORM OIL             | GAL #014   | 4814             | 20                               | 50        | 100 #014   | 20           | 20           | 15            | 414-M14       | 414-M14 | 01F(+014-114)(,0,1) |
|                      | 3.7 01-040 | SAND, CLEAN          | CU YD #015 | 4815             | 30                               | 15        | 50 #015    | 30           | 30           | 10            | 415-M15       | 415-M15 | 01F(+015-115)(,0,1) |

Figure 28. Material Control Log : Text Entries



MATERIAL CONTROL LOG MATERIALS TO ORDER

AS OF: -----

| MAJOR MATERIAL GROUP | COST CODE | MATERIAL DESCRIPTION | UNIT | QUANTITY ON HAND | + or - LAST PERI. | QUANTITY IN ORDER | LOW LIMIT | HIGH LIMIT | REG. NO | REG. PERIOD | ISSUES PERIOD | TOTALS PERIOD | NEW COH | TIME TO ORDER |
|----------------------|-----------|----------------------|------|------------------|-------------------|-------------------|-----------|------------|---------|-------------|---------------|---------------|---------|---------------|
|                      |           | MATL                 | BT   | COH              | PERIOD            | COO               | LL        | HL         | REGNO   | PERIOD      | ISSUES        | TOTAL         | NEW     | TTO           |
|                      |           |                      |      |                  |                   |                   |           |            |         |             |               |               |         |               |

Figure 29. Material to Order : Headings



MATERIAL CONTROL LOG MATERIALS TO ORDER

AS OF: -----

| MAJOR MATERIAL GROUP | COST CODE  | MATERIAL DESCRIPTION           | UNIT ISSUE | QUANTITY ON HAND | QUANTITY LAST PER. OR ORDER | LOW LIMIT | HIGH LIMIT | REG. INVENT. | REG. MO PERIOD | ISSUES PERIOD | TOTALS PERIOD | NEW BOH | TIME TO ORDER |
|----------------------|------------|--------------------------------|------------|------------------|-----------------------------|-----------|------------|--------------|----------------|---------------|---------------|---------|---------------|
| CONCRETE MATERIALS   | 3.1 04-032 | CEMENT                         | 646        | 75               | 0                           | 5         | 300        | 75           | 50             | 100           | -50           | 25      | 0             |
|                      | 3.1 06-020 | WELDED WIRE FABRIC 474         | ROLL       | 5                | 0                           | 5         | 20         | 5            | 5              |               | 0             | 5       | 0             |
|                      | 3.1 06-060 | WELDED WIRE FABRIC 676         | POLL       | 10               | 0                           | 15        | 25         | 10           | 5              | 5             | -5            | 5       | 0             |
|                      | 6.1 13-270 | FINISHED, 2 X 8                | BF         | 1000             | 0                           | 1000      | 3000       | 1000         |                |               | 0             | 1000    | 0             |
|                      | 6.1 19-272 | FINISHED, 2 X 10               | RF         | 500              | 0                           | 500       | 1000       | 500          |                | 150           | -150          | 350     | 0             |
|                      | 6.1 70-012 | PLYWOOD, EXTERIOR GRADE 1/4 IN | SHT        | 10               | 0                           | 24        | 48         | 10           | 24             | 10            | 14            | 24      | 0             |
|                      | 6.1 70-005 | PLYWOOD, EXTERIOR GRADE 3/8 IN | SHT        | 22               | 0                           | 24        | 72         | 22           |                | 15            | -15           | 7       | 0             |
|                      | 6.1 70-020 | PLYWOOD, EXTERIOR GRADE 5/8 IN | SHT        | 44               | 0                           | 48        | 72         | 44           |                | 15            | -15           | 29      | 0             |
| PAINTS               | 5.1 50-654 | PRIMER, RED LEAD               | GAL        | 20               | 0                           | 20        | 40         | 20           |                |               | 0             | 20      | 0             |
| STEEL                | 3.2 04-003 | REBAR, #3                      | EA         | 20               | 0                           | 20        | 75         | 20           | 20             | 30            | -10           | 10      | 0             |
|                      | 3.2 04-005 | REBAR, #5                      | EA         | 0                | 0                           | 50        | 100        | 0            | 50             | 25            | 25            | 25      | 0             |
|                      | 3.2 04-010 | REBAR, #10                     | EA         | 20               | 0                           | 20        | 50         | 20           |                | 5             | -5            | 15      | 0             |

Figure 30. Material to Order : Extracted Entries



as has been done in Figure 31. The NEW QOH would then be carried over to column F, QUANTITY ON HAND, and the totals would be reestablished so that the procedure could be repeated when required. At the beginning of the next reporting period, a macro command to erase the previous entries in columns H, L, and M (QUANTITY ON ORDER, REC'TS PERIOD, ISSUES PERIOD) respectively, would begin the process. New information regarding orders, receipts, and issues can be inserted again, as shown in Figure 32. As orders are made and receipts and issues are posted, the LOTUS 1-2-3 program would automatically update the inventory and create another Materials to Requisition list upon command.

By using the computer and a simple spreadsheet format, the contractor could obtain better control of material flows and inventory. This template has combined several features in database management to simplify the process and to reduce the chance for errors. Additional data or additional entries can be added with ease, so the material control log can grow with the inventory in stock. By automating the process, information is likely to be entered sooner, be more accurate and provide a more up-to-date listing of available materials resulting in savings of both time and money.





MATERIAL CONTROL LOG

AS OF:

| MAJOR MATERIAL GROUP | COST CODE  | MATERIAL DESCRIPTION           | UNIT ISSUE       | QUANTITY ON HAND | QUANTITY + or - LAST PER. | QUANTITY ON ORDER | LOW LIMIT | HIGH LIMIT | BES. MD INVENT. | ISSUES PERIOD | TOTALS PERIOD | NEW 90H | TIME TO ORDER |
|----------------------|------------|--------------------------------|------------------|------------------|---------------------------|-------------------|-----------|------------|-----------------|---------------|---------------|---------|---------------|
| CONCRETE MATERIALS   | 3.3 04-022 | CEMENT                         | BAG              | 25               | -50                       | 50                | 25        | 300        | 75              | 50            | 100           | -50     | 25            |
|                      | 3.1 05-580 | FORM DIL                       | GAL              | 55               | 5                         | 20                | 50        | 100        | 50              | 20            | 15            | 5       | 55            |
|                      | 3.3 01-040 | SAND, CLEAN                    | CU YD            | 70               | 20                        | 30                | 15        | 50         | 50              | 30            | 10            | 20      | 70            |
|                      | 3.3 06-020 | WELDED WIRE FABRIC 4X4         | POLL             | 5                | 0                         | 0                 | 5         | 20         | 5               | 0             | 0             | 0       | 5             |
|                      | 3.3 06-060 | WELDED WIRE FABRIC 6X6         | POLL             | 5                | 5                         | 0                 | 15        | 25         | 10              | 5             | 5             | -5      | 5             |
| LUMBER               | 6.1 19-265 | FINISHED, 2 X 4                | BF               | 2000             | -500                      | 1000              | 1000      | 4000       | 2500            | 500           | 1000          | -500    | 2000          |
|                      | 6.1 19-268 | FINISHED, 2 X 6                | BF               | 2500             | 500                       | 1000              | 1000      | 4000       | 2000            | 500           | 500           | 500     | 2500          |
|                      | 6.1 19-270 | FINISHED, 2 X 8                | BF               | 1000             | 0                         | 500               | 1000      | 3000       | 1000            | 0             | 0             | 0       | 1000          |
|                      | 6.1 19-272 | FINISHED, 2 X 10               | BF               | 350              | -150                      | 500               | 500       | 1000       | 500             | 150           | 150           | -150    | 350           |
|                      | 6.1 70-002 | PLYWOOD, EXTERIOR GRADE 1/4 IN | SHT              | 24               | 14                        | 24                | 24        | 48         | 10              | 24            | 10            | 14      | 24            |
|                      | 6.1 70-005 | PLYWOOD, EXTERIOR GRADE 3/8 IN | SHT              | 7                | -15                       | 24                | 24        | 72         | 22              | 15            | 15            | -15     | 7             |
|                      | 6.1 70-010 | PLYWOOD, EXTERIOR GRADE 1/2 IN | SHT              | 78               | 0                         | 48                | 48        | 144        | 78              | 43            | 48            | 0       | 78            |
|                      | 6.1 70-020 | PLYWOOD, EXTERIOR GRADE 5/8 IN | SHT              | 29               | -15                       | 43                | 48        | 72         | 44              | 15            | 15            | -15     | 29            |
|                      | 6.1 70-030 | PLYWOOD, EXTERIOR GRADE 3/4 IN | SHT              | 59               | 24                        | 48                | 24        | 72         | 30              | 48            | 24            | 24      | 59            |
|                      | PAINTS     | 5.1 50-654                     | PRIMER, RED LEAD | GAL              | 20                        | 0                 | 20        | 20         | 40              | 20            | 20            | 0       | 0             |
| 5.1 50-700           |            | PRIMER, ZINC CHROMATE          | GAL              | 30               | -10                       | 0                 | 20        | 40         | 40              | 10            | 10            | -10     | 30            |
| 5.1 50-672           |            | COLOR, WHITE                   | GAL              | 40               | 25                        | 0                 | 25        | 50         | 15              | 25            | 25            | 40      | 1             |
| STEEL                | 3.2 04-003 | REBAR, #3                      | EA               | 10               | -10                       | 40                | 20        | 75         | 20              | 20            | 30            | -10     | 10            |
|                      | 3.2 04-004 | REBAR, #4                      | EA               | 125              | 50                        | 100               | 50        | 250        | 75              | 100           | 50            | 50      | 125           |
|                      | 3.2 04-005 | REBAR, #5                      | EA               | 25               | 25                        | 50                | 50        | 100        | 0               | 50            | 25            | 25      | 0             |
|                      | 3.2 04-006 | REBAR, #6                      | EA               | 70               | 20                        | 20                | 30        | 150        | 50              | 20            | 20            | 20      | 70            |
|                      | 3.2 04-008 | REBAR, #8                      | EA               | 40               | 0                         | 0                 | 20        | 100        | 40              | 0             | 0             | 0       | 40            |
|                      | 3.2 04-010 | REBAR, #10                     | EA               | 15               | -5                        | 20                | 20        | 50         | 20              | 5             | 5             | -5      | 15            |

Figure 31. Material Control Log : Recalculated



ATERIAL CONTROL LOG

OF:

| MAJOR MATERIAL GROUP | COST CODE  | MATERIAL DESCRIPTION           | UNIT ISSUE       | QUANTITY ON HAND | + or - LAST PER. | QUANTITY ON ORDER | LOW LIMIT | HIGH LIMIT | REG. MO INVENT. | REC'TS PERIOD | ISSUES PERIOD | TOTALS PERIOD | NEW BOH | TIME TO ORDER |
|----------------------|------------|--------------------------------|------------------|------------------|------------------|-------------------|-----------|------------|-----------------|---------------|---------------|---------------|---------|---------------|
| CONCRETE MATERIALS   | 3.3 04-032 | CEMENT                         | BA6              | 25               | -50              |                   | 25        | 300        | 75              |               |               |               | 25      | 0             |
|                      | 3.1 05-580 | FORM OIL                       | GAL              | 55               | 5                |                   | 50        | 100        | 50              |               |               |               | 55      | 1             |
|                      | 3.3 01-040 | SAND, CLEAN                    | CU YD            | 70               | 20               |                   | 15        | 50         | 50              |               |               |               | 70      | 1             |
|                      | 3.3 06-020 | WELDED WIRE FABRIC 4X4         | ROLL             | 5                | 0                |                   | 5         | 20         | 5               |               |               |               | 5       | 0             |
|                      | 3.3 06-060 | WELDED WIRE FABRIC 6X6         | ROLL             | 5                | -5               |                   | 15        | 25         | 10              |               |               |               | 5       | 0             |
| LUMBER               | 6.1 19-265 | FINISHED, 2 X 4                | BF               | 2000             | -500             |                   | 1000      | 4000       | 2500            |               |               |               | 2000    | 1             |
|                      | 6.1 19-268 | FINISHED, 2 X 6                | BF               | 2500             | 500              |                   | 1000      | 4000       | 2000            |               |               |               | 2500    | 1             |
|                      | 6.1 19-270 | FINISHED, 2 X 8                | BF               | 1000             | 0                |                   | 1000      | 3000       | 1000            |               |               |               | 1000    | 0             |
|                      | 6.1 19-272 | FINISHED, 2 X 10               | BF               | 350              | -150             |                   | 500       | 1000       | 500             |               |               |               | 350     | 0             |
|                      | 6.1 70-002 | PLYWOOD, EXTERIOR GRADE 1/4 IN | SHT              | 24               | 14               |                   | 24        | 48         | 10              |               |               |               | 24      | 0             |
|                      | 6.1 70-005 | PLYWOOD, EXTERIOR GRADE 3/8 IN | SHT              | 7                | -15              |                   | 24        | 72         | 22              |               |               |               | 7       | 0             |
|                      | 6.1 70-010 | PLYWOOD, EXTERIOR GRADE 1/2 IN | SHT              | 78               | 0                |                   | 48        | 144        | 78              |               |               |               | 78      | 1             |
|                      | 6.1 70-020 | PLYWOOD, EXTERIOR GRADE 5/8 IN | SHT              | 29               | -15              |                   | 48        | 72         | 44              |               |               |               | 29      | 0             |
|                      | 6.1 70-030 | PLYWOOD, EXTERIOR GRADE 3/4 IN | SHT              | 50               | 24               |                   | 24        | 72         | 35              |               |               |               | 59      | 1             |
|                      | PAINTS     | 5.1 50-654                     | PRIMER, RED LEAD | GAL              | 20               | 0                 |           | 20         | 40              | 20            |               |               |         | 20            |
| 5.1 50-700           |            | PRIMER, ZINC CHROMATE          | GAL              | 30               | -10              |                   | 20        | 40         | 40              |               |               |               | 30      | 1             |
| 5.1 50-672           |            | COLOR, WHITE                   | GAL              | 40               | 25               |                   | 25        | 50         | 15              |               |               |               | 40      | 1             |
| STEEL                | 3.2 04-003 | REBAR, #3                      | EA               | 10               | -10              |                   | 20        | 75         | 20              |               |               |               | 10      | 0             |
|                      | 3.2 04-004 | REBAR, #4                      | EA               | 125              | 50               |                   | 50        | 250        | 75              |               |               |               | 125     | 1             |
|                      | 3.2 04-005 | REBAR, #5                      | EA               | 25               | 25               |                   | 50        | 100        | 0               |               |               |               | 25      | 0             |
|                      | 3.2 04-006 | REBAR, #6                      | EA               | 70               | 20               |                   | 30        | 150        | 50              |               |               |               | 70      | 1             |
|                      | 3.2 04-008 | REBAR, #8                      | EA               | 40               | 0                |                   | 20        | 100        | 40              |               |               |               | 40      | 1             |
|                      | 3.2 04-010 | REBAR, #10                     | EA               | 15               | -5               |                   | 20        | 50         | 20              |               |               |               | 15      | 0             |

Figure 32. Material Control Log : Ready for Entries



## Graphic Representations Template

Construction managers obtain data in order to forecast progress payments, predict delays caused by changes to the contract, ensure timely delivery of reports, monitor submittals, and a myriad of other uses. Many times, the manager represents owners that have little construction experience, but who control the finances of the job. While these owners may be good managers of manufacturing plants, hospitals, banks and the like, they lack the technical engineering background to understand the intricate details and interrelationships that exist on a major construction project. They acquire that expertise by hiring a construction manager.

Therefore, successful construction managers must first effectively and efficiently run the project. The goal is to complete the job for the lowest reasonable cost, with the highest possible quality and in the least amount of time. Meeting these constraints is difficult, at best, but when changes are required or schedules are shifted, the difficulty of the task increases enormously. Trying to explain these problems to an untrained owner may be even harder. Computer graphics may make that job easier.

"A picture is worth a thousand words." This old adage has general merits but is also true in the construction industry. One half of the construction contract documents is a set of plans that depict what the actual facility will look like. One of the ways to clarify an ambiguous



structural connection is with a fabricator's shop drawings. Catalog cuts showing types of materials and equipment to be used on a project often contain visual aids for the reviewer. The construction manager can also visually portray many of the reports generated to monitor construction progress. For example, by knowing how much money has been spent and by forecasting monthly cash flows based upon work in place, the project manager can assist the owner in financing the job. Knowing the impact of changes can alert the owner to potential problems before a final commitment is made. A project manager can provide this type of information in a format that an owner can readily understand and use in making decisions. One way this can be done is with graphs and charts. It is much easier to understand a picture showing the payments that are made to a contractor, then to wade through a table of numbers or reams of paper.

The LOTUS 1-2-3 program has the capability to do simple graphics displays. Line graphs, bar graphs, stacked bar graphs, pie charts and XY graphs can all be prepared using 1-2-3. Two examples will be shown to demonstrate this capability.

Figure 33 contains a cash flow summary that has been prepared from the contractor's construction schedule. Using the information provided by the contractor, this table has been developed to indicate the cumulative total of progress payments after each month of the job. This example follows the typical "S" curve, where the project billings start very slow, increase rapidly during the middle portion of the





## CASH FLOW SUMMARY

| PERIOD | MONTH | PROJECTED<br>EARLY<br>START | PROJECTED<br>LATE<br>START | ACTUAL  |
|--------|-------|-----------------------------|----------------------------|---------|
| 0      | JAN   | 0                           | 0                          | 0       |
| 1      | FEB   | 39220                       | 29220                      | 24220   |
| 2      | MAR   | 91165                       | 71165                      | 61165   |
| 3      | APR   | 155291                      | 125291                     | 110291  |
| 4      | MAY   | 240864                      | 190864                     | 135864  |
| 5      | JUN   | 336964                      | 266964                     | 291964  |
| 6      | JUL   | 452500                      | 352500                     | 412500  |
| 7      | AUG   | 576219                      | 446219                     | 546219  |
| 8      | SEP   | 705718                      | 546718                     | 681718  |
| 9      | OCT   | 842462                      | 652462                     | 922462  |
| 10     | NOV   | 981800                      | 771800                     | 911800  |
| 11     | DEC   | 1062982                     | 902982                     | 1087982 |
| 12     | JAN   | 1174182                     | 1034182                    | 1134182 |
| 13     | FEB   | 1283516                     | 1143516                    | 1203516 |
| 14     | MAR   | 1399062                     | 1289062                    | 1324062 |
| 15     | APR   | 1469911                     | 1399911                    | 1429911 |
| 16     | MAY   | 1487212                     | 1462212                    | 1474712 |
| 17     | JUN   | 1494292                     | 1484292                    | 1489292 |
| 18     | JUL   | 1500000                     | 1500000                    | 1500000 |
| 19     | AUG   |                             |                            |         |

Figure 33. Cash Flow Summary List



project and then taper off near the end. Period 18 represents the final month of the job when all actual billings are known. Using the graphics portion of the 1-2-3 package and assigning the month, early, late and actual cash payments to proper ranges, the LOTUS printgraph capability will develop a line graph that shows cumulative cash disbursements for this project (See Figure 34). If this graph were made available to the owner every month during construction, much more accurate projections of cash requirements could be made, which in the long run could save the owner money. Contractors could also use this information to assist in preparing cash flow analyses for necessary construction loans.

Figure 35 is similar to Figure 14. It contains the summary of change order costs to date, for this project broken down by division of work. The lower list contains the same information except that all divisions that were not effected have been eliminated. Figure 36 is a simple pie chart which is "sliced" by percentages of change orders per division of work. As the range is set with the values given in the table, 1-2-3 automatically calculates the percentage of the pie that should be allotted to each type of change. It also assigns the proper label to each segment and aligns it during the printout.

Having LOTUS translate tabular information into graphic form clearly indicates that the overwhelming area of change orders has occurred in sitework. What that can mean is that the subcontractor doing the sitework has had a significant



# CASH FLOW

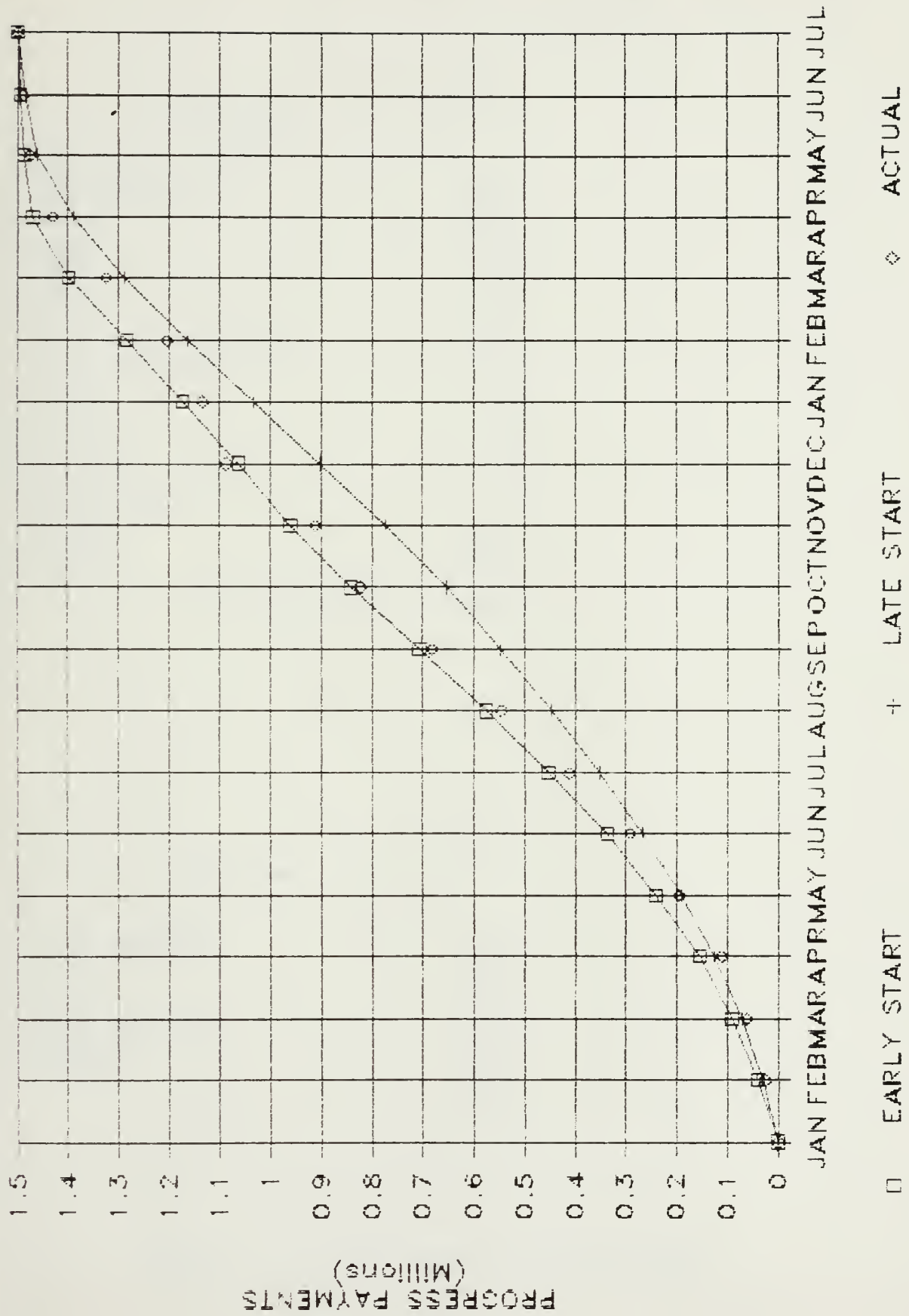


Figure 34. Cash Flow Diagram : Line Graph



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 DIVISION OF WORK
 

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| CONDITIONS OF THE CONTRACT       |          |
|----------------------------------|----------|
| 1. GENERAL REQUIREMENTS          | \$3,550  |
| 2. SITE WORK                     | \$39,480 |
| 3. CONCRETE                      | \$0      |
| 4. MASONRY                       | \$0      |
| 5. METALS                        | \$5,110  |
| 6. CARPENTRY                     | \$0      |
| 7. THERMAL & MOISTURE PROTECTION | \$0      |
| 8. DOORS, WINDOWS, GLASS         | \$4,000  |
| 9. FINISHES                      | \$0      |
| 10. SPECIALTIES                  | \$0      |
| 11. EQUIPMENT                    | \$0      |
| 12. FURNISHINGS                  | \$0      |
| 13. SPECIAL CONSTRUCTION         | \$0      |
| 14. CONVEYING SYSTEMS            | \$0      |
| 15. MECHANICAL                   | \$6,500  |
| 16. ELECTRICAL                   | \$11,000 |
| <hr/>                            |          |
| TOTAL BY SPEC DIVISION =         | \$69,640 |

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 DIVISION OF WORK
 

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|                          |          |
|--------------------------|----------|
| 1. GENERAL REQUIREMENTS  | \$3,550  |
| 2. SITE WORK             | \$39,480 |
| 5. METALS                | \$5,110  |
| 8. DOORS, WINDOWS, GLASS | \$4,000  |
| 15. MECHANICAL           | \$6,500  |
| 16. ELECTRICAL           | \$11,000 |
| <hr/>                    |          |
| TOTAL =                  | \$69,640 |

Figure 35. Summary by Division of Work





# BREAKDOWN BY

## DIVISION OF WORK

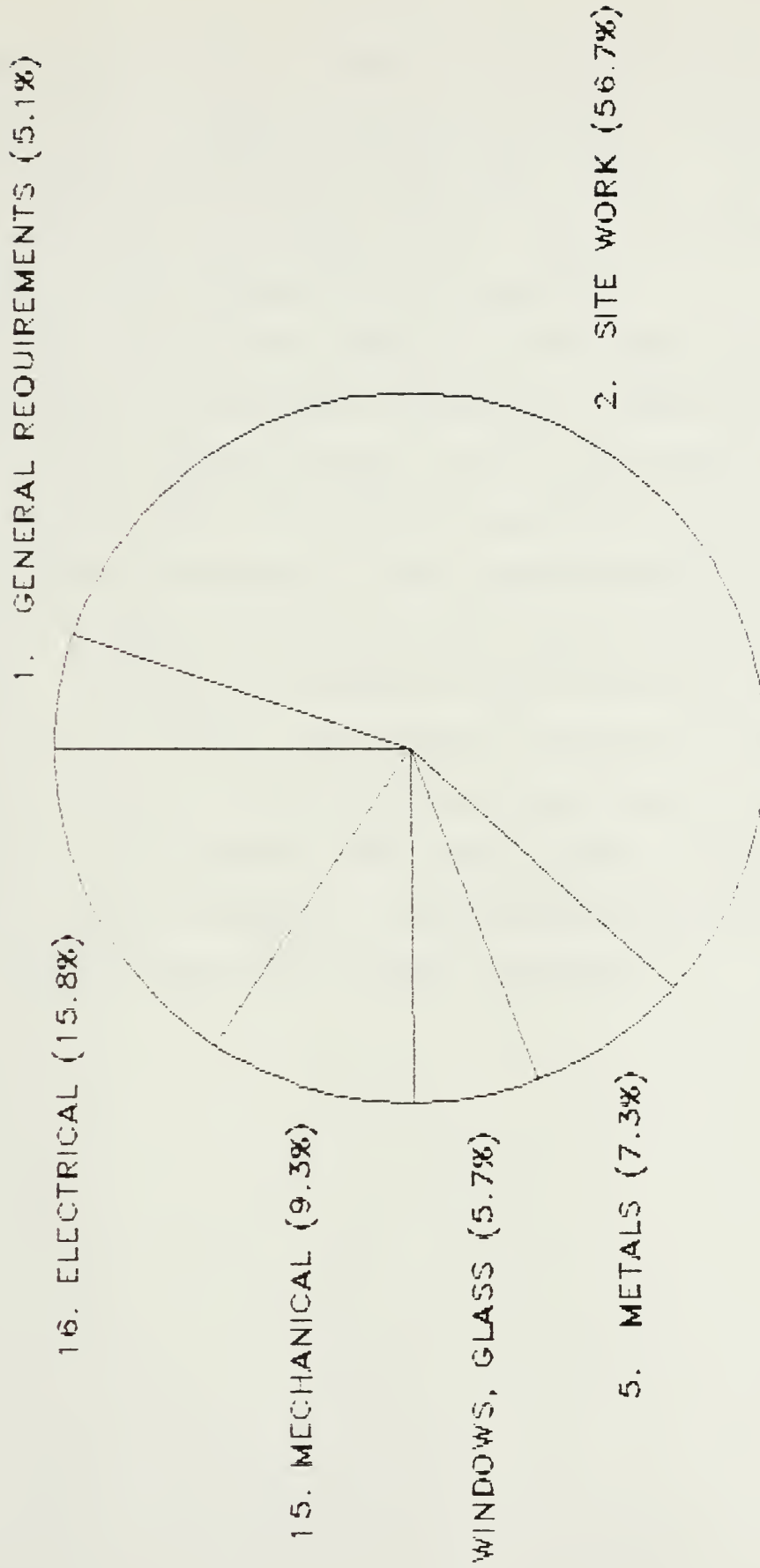


Figure 36. Pie Chart by Division of Work



amount of extra work. It may have delayed the project because other crafts were not able to begin on time or that some problems may exist with the site itself. In either case, the owner is now aware that a potential problem exists and that a time extension may be requested.

These are just two examples of how graphs can be used to illustrate information to someone not totally familiar with the construction process. As the LOTUS user becomes more familiar with the graphics capabilities, more complex drawings can be prepared. With a graphics monitor, the graphs developed can be seen on the screen without being printed. This allows the user to make corrections and adjustments quickly. Additionally, graphs can be made with various titles, in different colors and sizes and even in different orientations. While these capabilities make the graphing function complex it also enables the user to provide more impact and interest to reports.



## CHAPTER V

SUMMARY AND CONCLUSIONS

The computer is a tool that has greatly increased the effectiveness of management in organizing and running a company. Until very recently, much of the construction industry had not employed this management tool because many project engineers and contractors saw themselves as builders not business people, even if they ran successful operations. The nature of the construction industry, with its unique problems, has caused it to lag behind the rest of the business world in applying modern methods of project administration.

Inexpensive microcomputers are available to assist contractors and owners deal with the increasing administrative burdens which impact construction. The trend has been to move away from the large, multi-million dollar, mainframe computers, toward the smaller machines that are affordable and available to smaller businesses. In addition, there are several different programs available for general business purposes, such as word processing and accounting. There have also been recent innovations in software to assist the construction industry. Programs are available to help estimators prepare bid prices and to help cost engineers manage project finances. Construction managers can benefit from software developed for project scheduling, quality assurance, procurement, productivity, and project



administration.

This research effort attempted to identify methods of making construction managers more effective and efficient in the area of construction administration. By adapting "off the shelf" software for specific purposes, an inexpensive alternative to full software development was achieved. In addition to the availability and cost factors, ease of use was considered very important. Learning how to use the computer system and the development of the four templates took only a few months of part-time effort. As a construction manager, the investment in time, was well worth the effort in learning about computers. The templates can provide a significant payback by reducing errors and the time necessary to properly monitor construction projects. Using these templates, or ones similar, shows that inexpensive computers and software can be effective in reducing the drudgery of increasing administrative loads.





## CHAPTER VI

RECOMMENDATIONS

Computers have become, if not a household necessity, at least a business necessity. Managers, who just a few years ago, would not have considered their use, are now using them successfully in everyday business. The amount of information that bombards these managers must be reformatted in such a way as to make it readily available, easily understood, quickly analyzed, and can be rapidly applied to a problem. Today's small, inexpensive microcomputers can assist very well.

If contractors intend to prosper, they must be able to reduce waste and increase productivity in order to gain a competitive advantage. They do not have time to waste on the increasing administrative chores that accompany construction today. By automating that function, more time is available for what contractors do best - build. However, all paperwork will never disappear, so those managers equipped with skills in word processing and data manipulation will be able to job-site correspondence, estimating, and payment requests quickly and proficiently.

Owners can apply the computer to assist them in increasing productivity as well. Time saved by automating routine paperwork can be used in analyzing change orders and preparing cost estimates early in the review cycle. They can also more accurately monitor job progress and accelerate payments for completed work. These items tend not only to lower overall job



costs, but also decrease construction time, thus providing increased profits by earlier occupation of the new facility.

Software manufacturers should recognize the potential market available in this, the nation's largest industry. Developing user-friendly programs and template applications for construction administration and publicizing its availability, would not only assist the construction industry but provide a significant untapped market for the software industry.

Finally, academia must increase awareness of the uses and potential benefits that can be derived from applications of computer technology. A few schools, such as Dartmouth and Carnegie-Mellon University now require prospective students to indicate that they have a personal computer in their possession prior to being accepted. In addition to construction theory, (students must first understand the basics) schools should teach the fastest and most efficient ways to attack problems.

Computers are not a panacea for problem solving. There is always a requirement for a person to analyze a situation, develop alternatives, evaluate the choices and make the final decision. However, computers and programs like LOTUS 1-2-3 can enhance information and speed up the processing of that information. The microcomputer has lowered the cost of this management tool. "The motor car was a toy of the elite, a rich man's luxury, until the Model T made it accessible to every person and made a driver's license a socioeconomic necessity. The microprocessor has become the Model T of computers, and proficiency in its application in individual professional activities will be essential to the productivity and success of



future construction managers."(2)



ACKNOWLEDGEMENT

The writer wishes to acknowledge the contribution of Scott Rusch of the University of Washington Architect's Office, the Cost Engineer who was primarily responsible for modifying the basic Lotus 1-2-3 software in order to meet University reporting requirements. In addition, without his instruction, guidance, assistance and most important his patience, much of the information gathered for this paper would not have been available.





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