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**COST TRACKING AND PRODUCTIVITY REPORTING**

by

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in

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# COST TRACKING AND PRODUCTIVITY REPORTING

by

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Civil Engineering

## (ABSTRACT)

The objective of this report is to examine the need for an on-site computerized cost control system in the construction industry. The background of the construction industry leading to the need for such a system is discussed. The report then covers the technologies available for cost tracking and productivity reporting. Finally, a solution to the problem involving the reports and information required for the compilation of the reports as well as a model cost tracking and productivity reporting system are discussed.

I would like to thank Professor Mike Vorster for his invaluable assistance and guidance during the compilation of this report.

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Finally, I wish to thank my parents, Ed and Eleanor for their never ending support and encouragement through my many years of education.

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## INTRODUCTION

This report explores the problem of labor cost control in the construction industry. The causes of the problem which are rooted in the way most construction firms come into being are discussed. Cost tracking and productivity reporting, the technologies used for labor cost control are explored. Once the problem has been defined and the tools used to solve it have been covered, an on-site cost tracking and productivity reporting model will be advanced as a possible solution.

Most systems require that the accounting department control the process. This interdepartmental dependency causes a considerable delay in the reporting of pertinent information. By the time an on-site manager learns of a cost overrun through this type of process, it is quite likely that the activity has been completed or is in another phase of construction and nothing can be done about the overrun. The on-site manager does not need numbers at accounting levels of accuracy. He does, however, need a rough idea of costs and productivity in a timely fashion. This enables him to stop problems before they can become serious. By eliminating the interdepartmental process for reporting to on-site

personnel, the manager gains a tremendous advantage in time.

The construction industry is unique in the U.S. Nowhere is controlling costs more important or more difficult. James Adrian states:

Successful construction contracting is in great part, the ability to forecast correctly and control costs efficiently. 1

The construction manager must control costs in a situation which is anything but controlled. Projects are often very spread out with men and materials scattered all about, creating a very difficult situation to control. Furthermore, construction projects are generally operated on a fixed budget or bid price. The firm's cost must remain under this price in order for it to make a profit.

The project must be monitored in order to be controlled. Monitoring a construction activity requires that inspectors or managers be kept abreast of both the physical and the financial aspects of the work under their control. Adrian mentions that construction firms are often understaffed, leaving the manager with inadequate means to supervise all activities on the job all of the

time. 2 This causes managers to limit the amount of time they spend on each work activity on a project. They must be able to allocate their time efficiently. To do this the managers need to know which work activities are on or near budget and which are not. They can then concentrate their time and effort on trouble spots. Monitoring and locating trouble areas are each a part of cost control. And cost control is in great part accounting. 3

Small or young construction firms are notorious for neglecting the accounting function. The reason for this is described quite accurately by Adrian:

The construction firm tends to be small, often owned and operated by a single proprietor. In many instances this is an individual who was employed as a craftsman and who has found the way to ownership through marketing efforts. In the proprietor's earlier years as an employee, accounting skills were of little or no value. The result is a slow recognition of the need for an essential management function -- accounting. 4

While firms may recognize the need for an effective accounting function, they may not be able to afford it.

There is a tremendous amount of information gathering and processing required to describe the status of an activity. A personal computer is well suited to perform these tasks. This being the case, why have computers not been more widely utilized in construction? Adrian gives four basic reasons for this:

1. Computer vendors have not designed software to meet the needs of the construction industry.
2. Computer vendors have not communicated the benefits of computer utilization to the construction industry.
3. The weak financial position of the construction firm prevents it from making the expenditure needed for computer utilization.
4. The construction firm tends to be set in its way and slow to react to change. 5

The fourth reason states that construction firms are "slow to react to change", but they do eventually react. And their reaction is to acknowledge that a computer can

indeed aid their operation. Now with the price of personal computers so low, the firms only need good software for daily on-site cost control. Unfortunately most programs give either too much information or take too much work to enter the required data. Either case would result in the computer not being used.

The advent of personal computers has given the on-site manager a powerful tool in managing his job. The personal computer is capable of processing the daily or weekly time card information into cost and productivity reports on-site. This enables the manager to immediately spot trouble areas and to take action to correct them.

Labor and equipment control are dealt with in this report. Labor and equipment are resources which are controlled in essentially the same manner, therefore when labor is mentioned, equipment is also implied.

Labor is considered the most important element in controlling and reducing costs on job sites. Labor costs are the largest contributing factor to the price of a project in most types of construction. A system which enables the monitoring of labor costs and productivity allows managers to control the costs which may well

determine if the job is going to make the company a profit or lose money for them.

The control of materials, while being very important, is secondary to labor and equipment control. The opportunity to waste materials is much more limited than the opportunity to waste labor. The amount of material required for an activity, including waste, is generally well known and will not change to any great degree. However, the labor and equipment hours required for a job can, for any number of reasons, vary from the estimate.

The total unit costs, including material, will be developed by the accounting function at a later date. This delay in receiving total unit cost will not be crucial due to the small opportunity for material cost to exceed the bid cost of those materials. When material is purchased, the purchasing agent will immediately know of any irregularity in the cost and can report it.

How to easily and inexpensively monitor activities and thereby begin to control costs is a problem that most of the construction industry faces. Construction firms need a computerized system to quickly and efficiently report the status of a project's activities without overburdening

the on-site staff with a lot of required input.

The remainder of this report will look at the technologies of cost tracking and productivity reporting. Then a possible solution to the problem of on-site monitoring and reporting will be covered. Finally, the cost tracking and productivity reporting model will be discussed.

## COST TRACKING

A major concern in controlling a construction project is determining where money has been spent compared to where it should have been spent. A cost tracking system must enable managers to see what the status of their project is in a timely manner. The most widely accepted way to report cost information is variance analysis. The format used in reporting is usually dependent upon the individual manager's preference.

Variance analysis compares costs actually incurred to standard costs at any given level of activity. Smith et al state:

The use of standards gives better assurance to managers that:(1) the operation is being properly controlled when variances are zero or insignificant, and(2) a significant variance means that the operation is out of control, warranting the time and cost of an investigation. 6

It should be noted that the authors refer to standards as being industry standards. In the construction industry, the standard employed is a company standard which is used

to prepare the estimate or bid. It should also be noted that in the construction industry variances of plus or minus ten percent are expected.

Variance analysis is quite effective for construction cost tracking. The particular style of variance analysis is called the three-column analysis. The three columns are:

Column 1 = budgeted quantities x budgeted costs

Column 2 = actual quantities x budgeted costs

Column 3 = actual quantities x actual costs

These three columns are combined in the following manner:

Cost Variance = Column 2 - Column 3

Quantity Variance = Column 2 - Column 1

These two variances are reported to the manager. They tell the manager whether the gain or loss on an activity is due to changes in price(cost) or quantity. These variances can be used for equipment, materials or labor. Some managers use a percent variance to describe the magnitude of the variance. The percent variance is equal to the variance divided by the budgeted cost. This method

of reporting gives the origin of the variance and relative magnitude of the variance for that activity.

Another more progressive method is presented by Moder, Phillips and Davis. They use the terms Actual Cost of Work Performed (ACWP), Budgeted Cost of Work Performed (BCWP), and Budgeted Cost of Work Scheduled (BCWS). 7

These terms are the authors' titles for the columns in the three column variance analysis. They add, however, that these are the actual and budgeted costs within a specified time period. When used in this report, the time scale is not used and the Budgeted Cost of Work Scheduled is actually a straight line approximation of the cost of work in place to date. Therefore:

BCWS =       percent complete x estimated cost  
 BCWP =       actual manhours x budgeted hourly costs  
 ACWP =       actual manhours x actual hourly costs

It should be noted that the summation is by work activity, irregardless of labor category. Moder et al give the values for BCWS, BCWP and ACWP as primary pieces of information that they wish to report. The price and

quantity variances are secondary information. This allows the manager to see in what scale or context a variance should be seen. From these terms, the manager can quickly tell what the cost variance or performance variance is in context with the actual and budgeted costs. This method of cost reporting does not require a percent variance to give the magnitude of a variance and it also allows the derivation of the cost and quantity variances and the performance indices which will be discussed next.

Moder et al give the equations for the variances using their terms as follows.

$$\text{Cost Variance} = \text{BCWP} - \text{ACWP}$$

$$\text{Schedule/Performance Variance} = \text{BCWP} - \text{BCWS}$$

8

The term Schedule/Performance Variance is used when describing labor, while Quantity Variance is used when describing materials.

The authors also advance the idea of a cost performance index and a schedule performance index.

$$\text{Cost Performance Index} = \text{CPI} = \frac{\text{BCWP}}{\text{ACWP}}$$

$$\text{Schedule Performance Index} = \text{SPI} = \frac{\text{BCWP}}{\text{BCWS}} \quad 9$$

The authors describe these values by saying:

Values of the CPI greater than 1.0 indicate costs below budget.

and also:

Values of the SPI greater than 1.0 indicate completions ahead of schedule. 10

These values are plotted against each other in figure 1. 11  
 The resulting graph gives the status of the activity or project in terms such as favorable, marginal and unfavorable. These terms are vague and the graph requires that management be trained to understand the indices. In addition to the graph being difficult to comprehend, the CPI describes being under budget as when the value of CPI is greater than one. This is not readily comprehended.

A method, which is more easily understood is to invert the formula for the Cost Performance Index.

$$\text{Revised CPI} = \frac{\text{ACWP}}{\text{BCWP}}$$

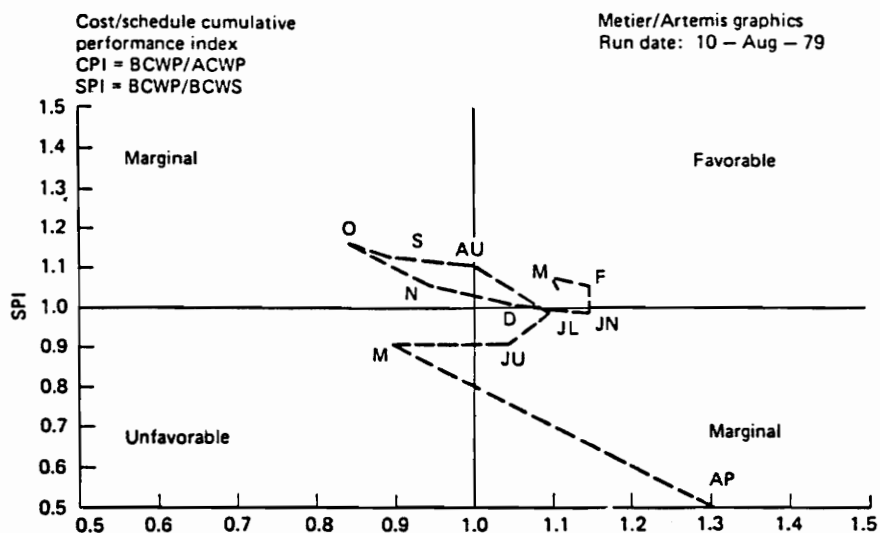
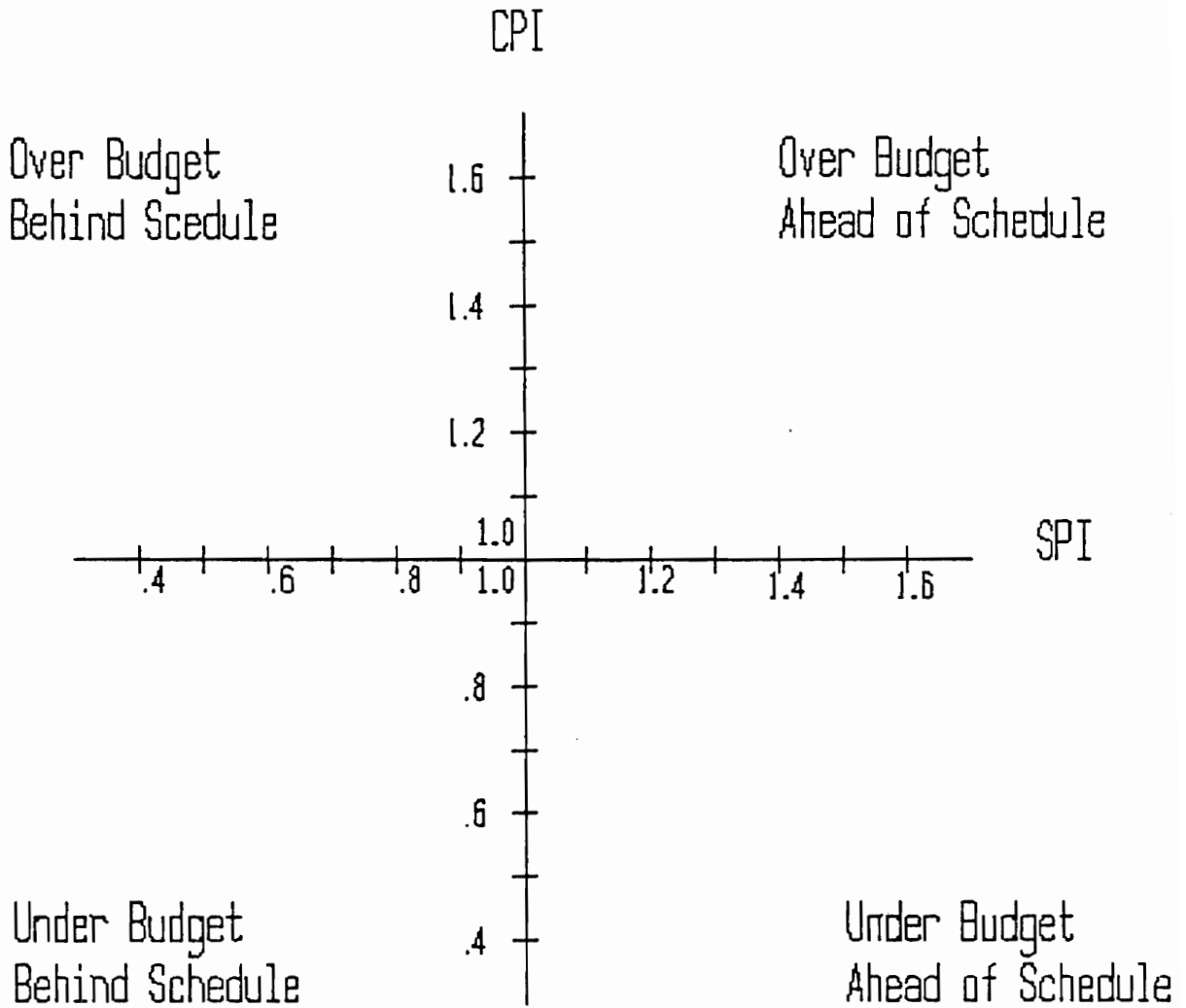


Figure 1

This value describes the activity or project as being under budget when the value is less than one. The reason for this change is apparent when the values are plotted as in figure 2.

This graph uses more easily understood terms. The axes intersect at (1,1). The SPI is the X axis and the Revised CPI is the Y axis. This results in values of the CPI greater than one describing an activity which is over budget. This is plotted above the X axis. Under budget ( $CPI < 1$ ) is plotted below the X axis. The SPI, if greater than one, is plotted to the right of the Y axis, indicating that the activity is ahead of schedule. SPI values less than one indicate that the activity is behind schedule and are plotted to the left of the Y axis. The resulting quadrants are then described using over budget and ahead of schedule, over budget and behind schedule, under budget and ahead of schedule, and finally, under budget and behind schedule.

This method combines easily understood descriptions with easily interpreted graphics. This will allow the manager to make his own decision about the status of the activity.



<p>CPI - Cost Performance Index SPI - Schedule Performance Index</p>
--

Figure 2

The manner in which construction projects are managed limit or eliminate the effect of the price variance. This is due to the practice of setting labor rates for the length of the contract. This leaves schedule/performance variances as the continual concern of construction managers.

## PRODUCTIVITY REPORTING

The productivity reports are important to the on-site construction managers. They are the ones who must spot areas where the work is not moving along according to the schedule and then take steps to improve the production.

The information in this report is in physical terms rather than financial terms. It is reported in easily understood terms and in basic units of measure. Since the information is not in monetary terms, it is not subject to inflation or economic factors. These characteristics of productivity reports make the information of more use after the project is completed.

The information needed to detect trouble areas is easily collected. It includes some measure of completed work and the amount of labor used. From these two items the production rates can be calculated.

The production rates describe how efficiently the labor is working. Production rates in construction involve man-hours and units of completed work. Generally the production rate is man-hours per unit. In industrial applications, where many units are produced per man-hour, the value used is units per man-hour. Either method is

acceptable if all persons using the reports are comfortable with and understand the value used.

Productivity reports are presented to all field personnel involved with the management of labor. The supervisors need to be informed of poor productivity to enable them to make corrections.

## SOLUTION TO PROBLEM

A reporting system must have all the cost and productivity reporting capabilities presented in the two previous sections and, in addition, must be able to produce reports when needed. The desired attributes of such a system would include easily understood reports, ease of operation, and a minimum of daily input. The reports are the end product of the entire process and a fitting place to begin the derivation of the system.

Different levels of management wish to see different types of information, therefore, the reporting system must be able to produce at least these two types of reports, a labor cost report and a productivity report. The construction manager will want the labor cost report for use in reporting to the project or business manager. The construction manager will also want the productivity report to use in planning the weekly or monthly work schedule with his supervisors. These two reports cover the most useful information about labor.

The labor cost report is presented as an example in figure 3. It shows non-monetary and monetary information about each cost code. The former includes the name or a short description of each activity, the work activity code, the

## CONSTRUCTION COMPANY

## LABOR COST REPORT

August 19, 1987

DESCRIPTION	WACODE	% COMP	UNIT	EST COST	BCWS	BCWP	ACWP	FORECAST TO COMP.	GAIN (LOSS)	EST UNIT COST	ACT UNIT COST
CONCRETE FOOTINGS	001	13.0%	CY	\$10000	\$1300	\$1110	\$1,330	\$8,901	\$(231)	\$100.0	\$102.3
PLACE REBAR - WALL	002	43.0%	TON	\$5000	\$2150	\$1550	\$1,770	\$2,346	\$884	\$100.0	\$82.3
GRADE LOT	003	60.0%	LS	\$1500	\$900	\$995	\$1,070	\$713	\$(283)	\$1500.0	\$1783.3
CURTAIN WALL	004	17.0%	LF	\$15000	\$2550	\$1480	\$1,720	\$8,400	\$4880	\$30.0	\$20.2
EXCAVATING FOUNDATION	005	22.0%	CY	\$2500	\$550	\$560	\$600	\$2,126	\$(226)	\$5.0	\$5.5
ELECTRICAL INSTALLATION	006	15.0%	LS	\$15000	\$2250	\$1701	\$2,097	\$8,388	\$4515	\$15000.0	\$10485.0
INSTALL DOORS & WINDOWS	007	0.0%	EA	\$3000	\$0	\$0	\$0	\$3,000	\$0	\$150.0	\$0.0
ROOF TRUSSES	008	16.0%	EA	\$5000	\$800	\$1330	\$780	\$4,095	\$125	\$250.0	\$243.8
ROOFING	009	18.0%	SY	\$6000	\$1080	\$475	\$565	\$2,573	\$2862	\$20.0	\$10.5
INTERIOR FINISH	010	0.0%	LS	\$12000	\$0	\$0	\$0	\$12,000	\$0	\$12000.0	\$0.0
PLANT GRASS	011	0.0%	EA	\$500	\$0	\$0	\$0	\$500	\$0	\$500.0	\$0.0
POUR SIDEWALK	012	18.0%	LF	\$3000	\$540	\$600	\$680	\$3,098	\$(778)		\$188.9
CUT GRASS	015	0.0%	LS	\$500	\$0	\$289	\$0	\$500	\$0		\$0.0
<b>Grand Total</b>				<b>\$79000</b>	<b>\$12120</b>	<b>\$10090</b>	<b>\$10,612</b>	<b>\$56,640</b>	<b>\$11748</b>		

SCHEDULE/PERFORMANCE VARIANCE = BCWP - BCWS  
 COST VARIANCE = BCWP - ACWP

percent complete of that activity and also the units in which the activity is measured. The latter information includes the total estimated cost, the BCWS, the BCWP, the ACWP, the forecast cost to complete, the projected gain or loss on the activity, the estimated unit cost and the actual unit cost.

The total estimated cost gives the manager the bottom line that labor costs cannot exceed. It is prepared by the estimators and used in making the project budget.

The derivations of BCWS, BCWP, and ACWP were covered previously. The BCWS tells the manager how much money should have been spent for the amount of work completed. The BCWP is presented to allow the manager to quickly get an idea of the price and performance variance. The ACWP gives the actual cost of the activity to date.

The Forecast Cost to Complete is a straight line extension of what the expected cost will be at the current production rate and unit cost. Its formula is:

$$\text{Forecast Cost} = (\text{Est Units} - \text{Act Units}) \times \text{Act Unit Cost}$$

Where the abbreviations are as follows:

$$\text{Est Units} = \text{Estimated Number of Units}$$

Act Units = Actual Number of Units to Date

Act Unit Cost = Current Actual Unit Cost

The formula for the Actual Unit Cost is:

$$\text{Act Unit Cost} = \frac{\text{ACWP}}{\text{Act Units}}$$

The Projected Gain or Loss on the activity gives the manager the extension of all the variances and trends. It tells him what might happen if changes are not made. Its formula is:

$$\text{Gain(Loss)} = \text{Est Cost} - (\text{Forecast Cost} + \text{ACWP})$$

This value is, again, a straight line forecast of current values. The Projected Gain or Loss and the Forecasted Cost to Complete give ball park figures. The manager must know that spending curves for different activities will have different characteristics and that at any point in time these two values will be high or low of the final cost. They are presented to the manager that he may apply his experience to the values and have a competent base from which he can make a decision.

The last two items on the cost report are the Estimated Unit Cost and the Actual Unit Cost. The Estimated Unit Cost is prepared by the estimators and is presumed to be correct. The Actual Unit Cost is presented with the Estimated Unit Cost so that it can be compared to a correct value.

The productivity report (figure 4) includes the same initial information as the cost report. The title of the activity, the work activity code, the percent complete of the activity and the units used in measuring the activity. the rest of the items are the Estimated Units, the Actual Units, the Estimated Hours, the Estimated Hours to Date, the Actual Hours, the Estimated Man-hours per Unit and the Actual Man-hours per Unit.

The Estimated Units and Actual Units were covered earlier. The Estimated Hours is the total number of man-hours expected, regardless of labor type. The Estimated Hours to Date is the number of hours that should have been expended for the amount of work completed. Its formula is:

$$\begin{array}{l} \text{Est Hours} \\ \text{to Date} = \text{Act Units} \times \text{Est Man-hours per Unit} \end{array}$$

## CONSTRUCTION COMPANY

## PRODUCTIVITY REPORT

August 19, 1987

DESCRIPTION	WACODE	UNIT	% COMP	EST UNITS	ACT UNITS	EST HOURS	EST TO DATE	ACT HOURS	EST MNRS PER UNIT	ACT MNRS PER UNIT
CONCRETE FOOTINGS	001	CY	13.0	100	13.0	700	91	90	7.0	6.9
PLACE REBAR - WALL	002	TON	43.0	50	21.5	275	118	100	5.5	4.7
GRADE LOT	003	LS	60.0	1	0.6	70	42	45	70.0	75.0
CURTAIN WALL	004	LF	17.0	500	85.0	750	128	120	1.5	1.4
EXCAVATING FOUNDATION	005	CY	22.0	500	110.0	130	29	40	0.3	0.4
ELECTRICAL INSTALLATION	006	LS	15.0	1	0.2	950	143	144	950.0	720.0
INSTALL DOORS & WINDOWS	007	EA	0.0	20	0.0	170	0	0	8.5	0.0
ROOF TRUSSES	008	EA	16.0	20	3.2	300	48	60	15.0	18.8
ROOFING	009	SY	18.0	300	54.0	320	58	45	1.1	0.8
INTERIOR FINISH	010	LS	0.0	1	0.0	800	0	0	800.0	0.0
PLANT GRASS	011	EA	0.0	1	0.0	35	0	0	35.0	0.0
POUR SIDEWALK	012	LF	18.0	20	3.6	200	36	40	10.0	11.1
CUT GRASS	015	LS	0.0	1	0.0	30	0	0	30.0	0.0

The Actual Hours is the sum of the man-hours expended, regardless of labor type and whether the hours were regular time or overtime. This distinction will be explained shortly.

The two last items are the production rates. Estimated Man-hours per Unit and Actual Man-hours per Unit. These are the values explained in a previous section. The Estimated Man-hours per Unit is prepared by the estimators, while the Actual Man-hours per Unit is calculated by the following formula:

$$\text{Actual Man-hours per Unit} = \frac{\text{Act Hours}}{\text{Act Units}}$$

The reason for using total man-hours is that this value tells how much labor has been used and how effective it has been. If the activity's man-hours and production rate are near the estimated values, but the actual cost is too high, the manager can see that the problem is not with labor but with management. This situation would indicate that the wrong labor mix or too much overtime was being used. Upon seeing this type of comparison, the manager can look into the matter further and determine the cause.

## Cost Tracking and Productivity Reporting Model

This cost control model demonstrates the feasibility of an on-site labor cost control computer program which produces both a labor cost report and a productivity report. It can produce up to date reports when needed and requires only a small amount of daily input.

The program was developed using the Smart Software System from Innovative Software Incorporated. The cost control model was developed in the Smart Database Manager and uses the Smart Project Processing feature to make a menu driven program. The complexity of the interactions between the database files made it necessary to give the program menus.

The program uses six database files. They are:

<u>Name</u>	<u>Abbreviation</u>
Employees	ENAME2
Labor Types	LTYPE2
Percent Complete	%C
Estimated Work	EW1
Actual Work	AW1
Timecard Input	TI2

The interaction of the files is illustrated in the flowchart in figure 5.

The labor type file, LTYPE2 (figure 6), contains the costs associated with each labor type. It has fields for bid regular cost and bid overtime costs. These are the averages for each labor type that the estimators developed and used in the preparation of the bid. This file also has fields for the regular and overtime costs in effect when the job starts. The Ltype field is the four digit alpha-numeric code which identifies the labor types. This file is initialized at the start of the project.

The employee file, ENAME2 (figure 7), contains information pertaining to all employees and equipment on the job. The employee's first initial and last name or an identifying name for a piece of equipment are entered in field 1. This is the information that will be used for daily input. field 2 contains the employee's first name. Field 3 is the employee or equipment number. It is a five digit alpha-numeric code identifying the employee or equipment. The remaining fields are the same as those in the labor type file. Once the employee's labor type is entered, the program automatically searches the labor type file for that labor type and then fills in the remaining fields.



```
Window 1  
LTYPE IW1  
CLASS L1  
R COST 10.00  
OT COST 11.00  
BID R COST 12.00  
BID OT COST 13.00
```

Command:

File: LTYPE2 Window: 1

Page: 1 Rec: 1 ( 1 ) Act: Y

Figure 6

```
Window 1  
INIT & LAST NAME D HUSSON  
FIRST NAME DAVID  
EMP NUM 22913  
LTYPE IW1  
CLASS L1  
R COST 10.00  
GT COST 11.00  
BID R COST 12.00  
BID GT COST 13.00
```

Command:

File: ENAME2 Window: 1

Page: 1 Rec: 1 ( 1 ) Act: Y

Figure 7

If an employee's cost is not the amount listed for that labor type, it can now be changed to the employee's actual cost.

The estimated work file, EW1, contains basic information about each activity. The fields can be seen in figure 8. They are the work activity code, activity description, estimated cost, unit used to measure the activity, number of units, estimated regular hours and the estimated overtime hours.

The percent complete file, %C (figure 9), is used to enter the percent complete of each activity. This information is used in calculations in the actual work file.

The timecard input file, TI2, is the file used to enter the daily timecard information. The information can be seen in figure 10. The employee's first initial and last name are entered. The computer then searches the employee file for a match. It then enters the employee's first name, employee number and labor type in the small box on the right side of the screen. This is read-only information used to insure that the hours are credited to the correct name. Next the work activity code is entered and, finally, the hours worked are entered. Figure 10 is

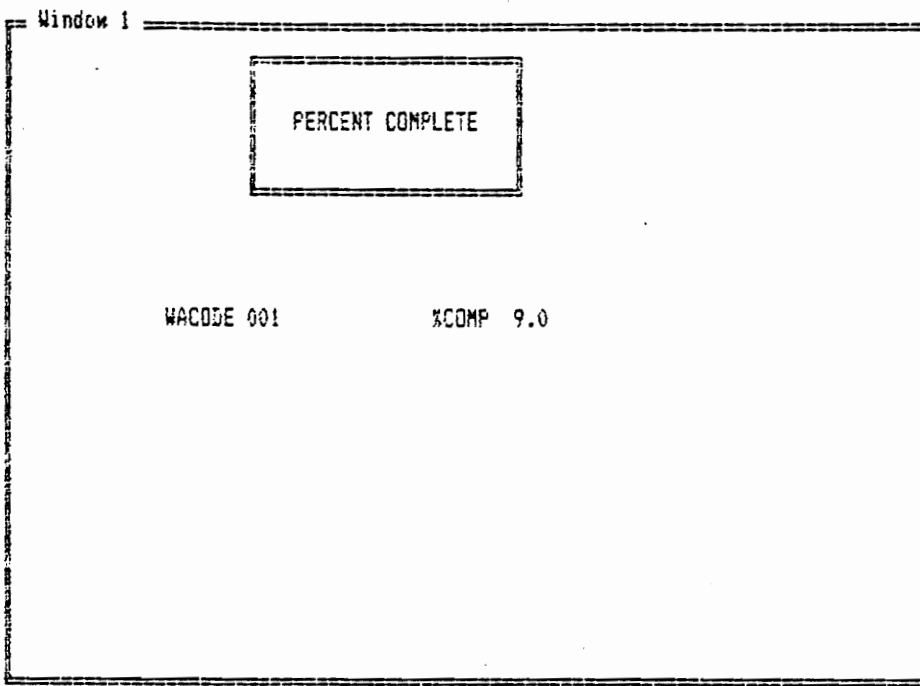
```
Window 1  
WACODE 001  
DESCRIPTION: CONCRETE FOOTINGS  
EST COST      10000  
UNIT CY  
EST UNITS     100  
UNIT COST     100.00  
EST RHRS      500.0  
EST OTHRS     200.0
```

Command:

File: EWI Window: 1

Page: 1 Rec: 1 ( 1 ) Act: Y

Figure 8



Command:

File: %C Window: 1

Page: 1 Rec: 1 ( 1 ) Act: Y

Figure 9

Window 1

TIMECARD INPUT	
INITIAL & LAST NAME D HUSSON	FIRST NAME DAVID
WACODE 001	EMP NUM22913
	LTYPE IW1
REGULAR HOURS 40.00	OVERTIME HOURS 20.00

Command:

File: T12 Window: 1

Page: 1 Rec: 1 ( 1 ) Act: N

Figure 10

the input screen for TI2. Not all of the information contained in TI2 is shown here. Figure 11 shows the entire file. It includes all the cost information for that employee from the employee file. It also contains the date of entry of the information.

Some calculations are done in the file TI2. The contribution of this employee's hours to the ACWP and the BCWP for that activity are calculated. These values are transferred to the actual work file for summation by work activity. The operator field is for the operator's initials. This field is filled only at the beginning of each entry session. This enables the managers to follow up any problems that might occur by letting them know who entered that day's information.

The last file in the system is the actual work file, AW1. This file contains all the information contained in the other files. This information is transacted to the actual work file during compilation. The information can be seen in figure 12. The calculations for these values were covered in previous sections.

```
Window 1
EMP NUM 22913
INIT & LAST NAME D HUSSON
FIRST NAME DAVID
WACODE 001
LTYPE IW1
RHRS 40.00
OTHR 20.00
CLASS L1
R COST 10.00
OT COST 11.00
EXT RCOST 400.00
EXT OTCOST 220.00
TOTAL COST 620.00
BID R COST 12.00
BID OT COST 13.00
BCWP 740
DATE 07/09/87
OPERATOR DEH
```

Command:

File: TI2 Window: 1

Page: 1 Rec: 1 ( 1 ) Act: N

Figure 11

Window 1				
WACODE 001		DESCRIPTION CONCRETE FOOTINGS		%COMP 9.0
UNIT CY				
	ACTUAL	ESTIMATED		
REG HOURS	80.0	500.0	BCWS	900
OT HOURS	22.0	200.0		
TOTAL HOURS	102.0	700	BCWP	1456
REG COST	1000		FORECAST	
OT COST	252		TO COMP.	12559
TOTAL COST	1252	10000		
(ACWP)			PROJECTED	
UNIT COST	139.11	100.00	GAIN OR	
NUM OF UNITS	9.0	100	LOSS	-3911

Command:

File: AW1 Window: 1

Page: 1 Rec: 1 ( 1 ) Act: Y

Figure 12

The output of the program is the labor cost report and the productivity report which were covered in an earlier section and shown in figures 13 and 14 respectively. These reports place pertinent information together in an easy to read form.

No graphs are produced by the program. The Smart Software System is not capable of producing a graph like that in figure 2. If barcharts or histograms are desired, they can be done manually in Smart. Since managers' preferences as to the information they wish to see graphically is so varied, it was not practical to design a single format.

## CONSTRUCTION COMPANY

## LABOR COST REPORT

August 19, 1987

DESCRIPTION	WACODE	% COMP	UNIT	EST COST	BCWS	BCWP	ACWP	FORECAST TO COMP.	GAIN (LOSS)	EST UNIT COST	ACT UNIT COST
CONCRETE FOOTINGS	001	13.0%	CY	\$10000	\$1300	\$1110	\$1,330	\$8,901	\$(231)	\$100.0	\$102.3
PLACE REBAR - WALL	002	43.0%	TDN	\$5000	\$2150	\$1550	\$1,770	\$2,346	\$884	\$100.0	\$82.3
GRADE LOT	003	60.0%	LS	\$1500	\$900	\$995	\$1,070	\$713	\$(283)	\$1500.0	\$1783.3
CURTAIN WALL	004	17.0%	LF	\$15000	\$2550	\$1480	\$1,720	\$8,400	\$4880	\$30.0	\$20.2
EXCAVATING FOUNDATION	005	22.0%	CY	\$2500	\$550	\$560	\$600	\$2,126	\$(226)	\$5.0	\$5.5
ELECTRICAL INSTALLATION	006	15.0%	LS	\$15000	\$2250	\$1701	\$2,097	\$8,388	\$4515	\$15000.0	\$10485.0
INSTALL DOORS & WINDOWS	007	0.0%	EA	\$3000	\$0	\$0	\$0	\$3,000	\$0	\$150.0	\$0.0
ROOF TRUSSES	008	16.0%	EA	\$5000	\$800	\$1330	\$780	\$4,095	\$125	\$250.0	\$243.8
ROOFING	009	18.0%	SY	\$6000	\$1080	\$475	\$565	\$2,573	\$2862	\$20.0	\$10.5
INTERIOR FINISH	010	0.0%	LS	\$12000	\$0	\$0	\$0	\$12,000	\$0	\$12000.0	\$0.0
PLANT GRASS	011	0.0%	EA	\$500	\$0	\$0	\$0	\$500	\$0	\$500.0	\$0.0
POUR SIDEWALK	012	18.0%	LF	\$3000	\$540	\$600	\$680	\$3,098	\$(778)		\$188.9
CUT GRASS	015	0.0%	LS	\$500	\$0	\$289	\$0	\$500	\$0		\$0.0
<b>Grand Total</b>				<b>\$79000</b>	<b>\$12120</b>	<b>\$10090</b>	<b>\$10,612</b>	<b>\$56,640</b>	<b>\$11748</b>		

SCHEDULE/PERFORMANCE VARIANCE = BCWP - BCWS  
 COST VARIANCE = BCWP - ACWP

## CONSTRUCTION COMPANY

## PRODUCTIVITY REPORT

August 19, 1987

DESCRIPTION	WACODE	UNIT	% COMP	EST UNITS	ACT UNITS	EST HOURS	EST TO DATE	ACT HOURS	EST MNRS PER UNIT	ACT MNRS PER UNIT
CONCRETE FOOTINGS	001	CY	13.0	100	13.0	700	91	90	7.0	6.9
PLACE REBAR - WALL	002	TON	43.0	50	21.5	275	118	100	5.5	4.7
GRADE LOT	003	LS	60.0	1	0.6	70	42	45	70.0	75.0
CURTAIN WALL	004	LF	17.0	500	85.0	750	128	120	1.5	1.4
EXCAVATING FOUNDATION	005	CY	22.0	500	110.0	130	29	40	0.3	0.4
ELECTRICAL INSTALLATION	006	LS	15.0	1	0.2	950	143	144	950.0	720.0
INSTALL DOORS & WINDOWS	007	EA	0.0	20	0.0	170	0	0	8.5	0.0
ROOF TRUSSES	008	EA	16.0	20	3.2	300	48	60	15.0	18.8
ROOFING	009	SY	18.0	300	54.0	320	58	45	1.1	0.8
INTERIOR FINISH	010	LS	0.0	1	0.0	800	0	0	800.0	0.0
PLANT GRASS	011	EA	0.0	1	0.0	35	0	0	35.0	0.0
POUR SIDEWALK	012	LF	18.0	20	3.6	200	36	40	10.0	11.1
CUT GRASS	015	LS	0.0	1	0.0	30	0	0	30.0	0.0

## CONCLUSIONS

The purpose of this report was to investigate the technologies of cost tracking and productivity reporting. During the collection of information, it became clear that a majority of the construction industry has been slow in utilizing computer technology and accounting procedures for construction management. This report and program illustrate that costs and productivity can be monitored and reported using a relatively inexpensive personal computer.

This program is only a model of a system that would be required to run a job site. Features that were not added to the system due to their complexity include a subroutine for the creation of archival files . These archival files would be a picture of the project at certain points in time. The system does not store the raw data for historical files, which would be used for estimating future jobs. The last two items which were not included are the ability to handle material costs, thus enabling the reporting of total unit cost, and to perform the entire payroll function. All of these features would be good enhancements to this program.

It is hoped that this report will focus the awareness of

people in the construction industry on the benefits that a personal computer can give to the on-site managers.

APPENDIX A

COSTTRAK USER'S MANUAL

COSTTRAK: A computer program designed to be used on construction sites to monitor both costs and productivity.

## INTRODUCTION

This program was developed using the Smart Software System, version 3.0, from Innovative Software Incorporated. It is designed to run on a personal computer with a hard disk drive. A dot matrix printer is also required, since the reports are printed in compressed mode.

## INITIALIZATION

Before COSTTRAK can be used on a regular basis, the files must be initialized. These files include ENAME2, LTYPE2, %C, EW1, and AW1. The initialization can be done entirely in COSTTRAK. The directions here will give the general outline of the steps. The user should then follow the directions under each section heading.

After start-up:

1. ADD NEW LABOR TYPE (EMPLOYEE - EQUIPMENT MENU)
2. ENTER NEW COST CODE - CHANGE ORDER (COST CODE - CHANGE ORDER MENU)
3. ADD NEW EMPLOYEE OR EQUIPMENT (EMPLOYEE-EQUIPMENT MENU)

This three step procedure will initialize the five files mentioned above. Now the program can be used on a regular basis.

## START-UP

1. Access Smart's data-manager.
2. Select the EXECUTE command on command list 5.
3. Select COSTTRAK.

The program now loads and organizes the files and displays the main menu (figure 15).

Each selection on the main menu will be covered in order.

### A INPUT TIMECARD

This selection is used for the input of the timecard information. Figure 16 shows the first screen which appears. It is used to record the computer operator's initials. Once filled in, press F10.

The next screen is the TIMECARD INPUT SCREEN, shown in figure 10. Press F10 when finished filling in the information. The program now returns to the main menu.

### B INPUT PERCENT COMPLETE

This selection calls up the file, %C, for entering the percent complete of each activity. The screen is shown in

figure 9. Press F10 or answer yes, when asked by the computer if you are finished. The program now returns to the main menu.

#### C COMPILE WEEKLY DATA

This selection compiles the timecard information and percent complete information. This should be done before producing reports. The program returns to the main menu when compilation is complete.

#### D EMPLOYEE/EQUIPMENT MENU

This selection calls up the EMPLOYEE/EQUIPMENT MENU, which can be seen in figure 17. This menu enables the user to add to or edit the employee or labor type files. Press F10 when completed and the program returns to the EMPLOYEE/EQUIPMENT MENU.

#### E CHANGE ORDER/COST CODE MENU

This selection calls up the CHANGE ORDER/COST CODE MENU, shown in figure 18. When a new cost code is entered, choice A, the program generates an entry screen for the cost code itself, shown in figure 19. Press F10 when finished. The program then gives a screen like that in figure 8, but without any information in it. Press F10

when done entering the information and the program returns to the CHANGE ORDER/COST CODE MENU.

Choice B calls up the entire estimated work file, EW1, for editing.

#### F VIEW FILES MENU

The VIEW FILES MENU can be seen in figure 20. This menu allows the user to view three files in an easy to read format. The files scroll through their contents at a user defined rate. The scrolling can be halted in order to print the screen. The screen for the actual work file, AW1, is figure 12, estimated work file, EW1, is figure 21, and the timecard file, TI2, is figure 22. The percent complete file can be viewed by selecting INPUT PERCENT COMPLETE.

#### G REPORT MENU

This selection calls up the REPORT MENU, shown in figure 23. Before reports are produced, the latest information should be compiled. When either report is selected, a screen prompting the user to ready the printer is generated. Once printing is complete, the program returns to the REPORT MENU.

X EXIT

This selection will return the computer to Smart's command level. It is important that the program be exited with this selection and not by turning off the computer. The reason being that all of the latest information will be saved when the EXIT selection is made.

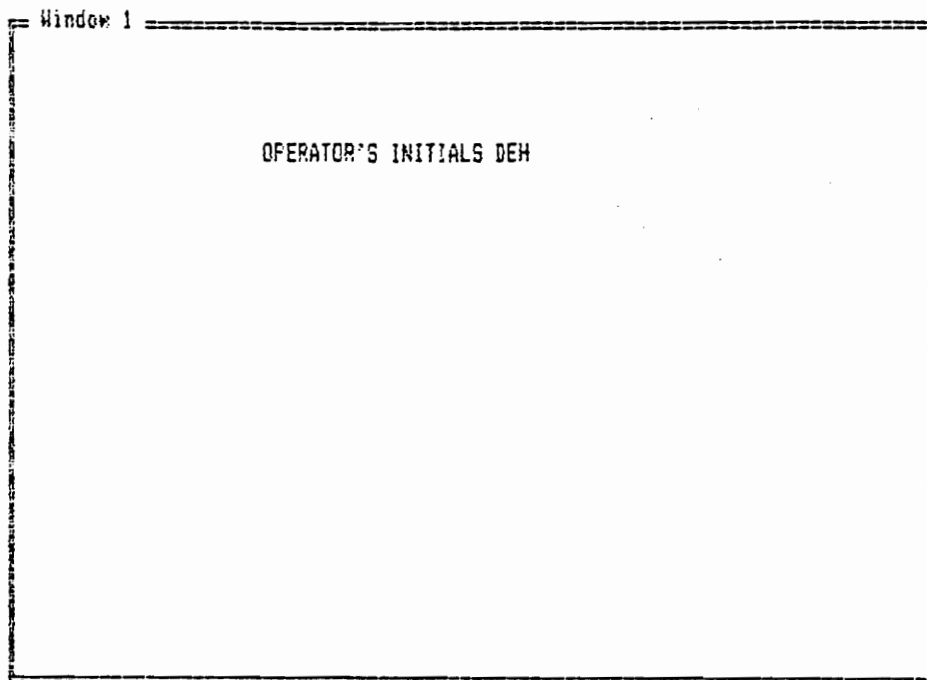
<p>CONSTRUCTION COST CONTROL MAIN MENU</p> <p>A INPUT TIMECARD B INPUT PERCENT COMPLETE C COMPILE WEEKLY DATA D EMPLOYEE/EQUIPMENT MENU E CHANGE ORDER/COST CODE MENU F VIEW FILES MENU G REPORT MENU X EXIT</p>
--

Select for X1 (use space bar)

F10 Finished ^Z Cancel

File: (none) Window: 1

Figure 15

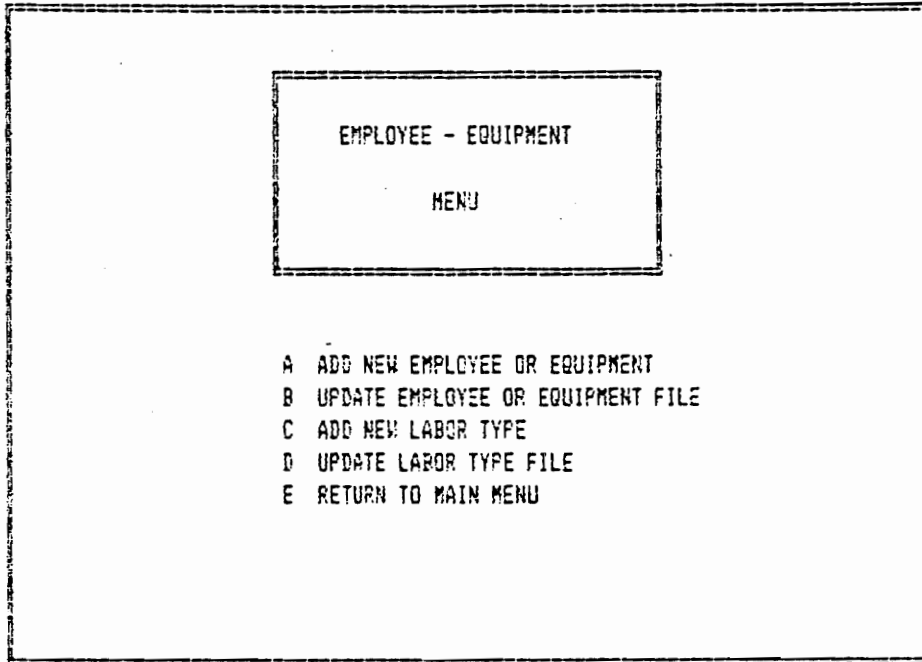


Command:

File: TIP Window: 1

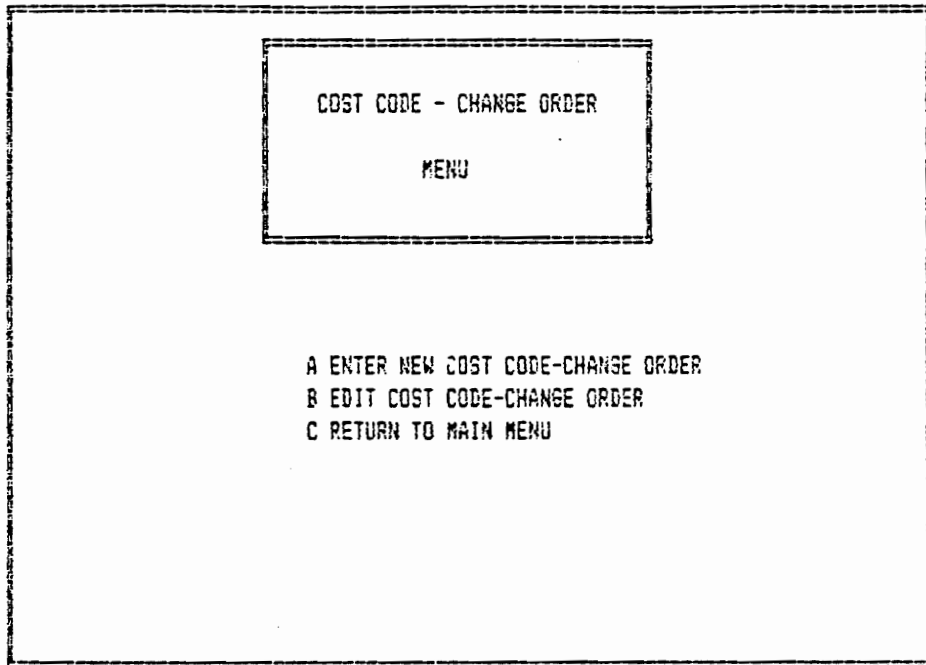
Page: 1 Rec: 1 ( 1 ) Act: N

Figure 16



Select for %2 (use space bar)  
F10 Finished ^Z Cancel  
File: (none) Window: 1

Figure 17



Select for X3 (use space bar)  
F10 Finished ^Z Cancel  
File: (none) Window: 1

Figure 18

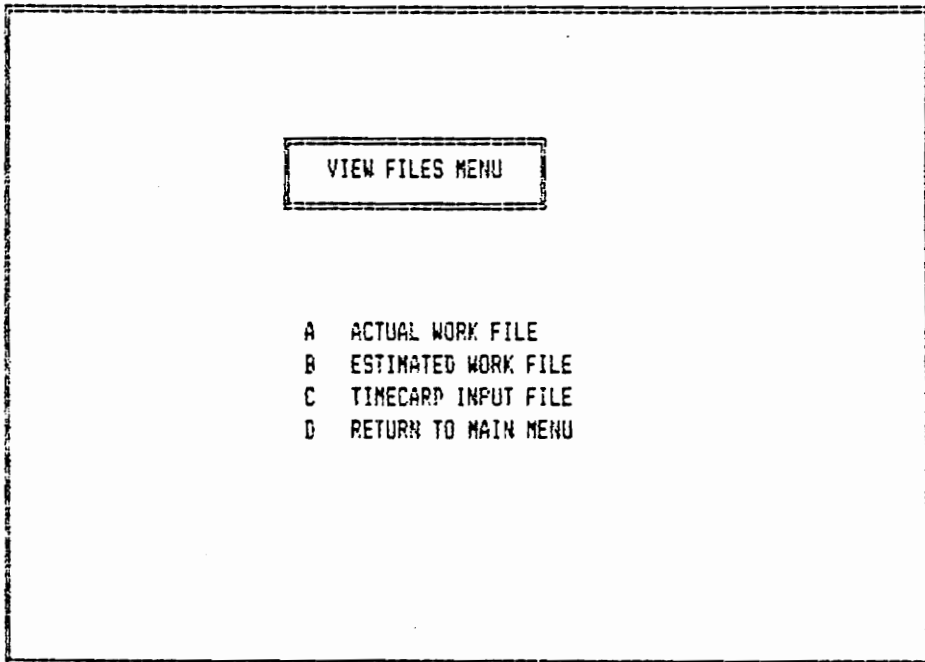
NEW COST CODE OR CHANGE ORDER

ENTER NEW COST CODE(CHANGE ORDER)

XXXXXXX

Enter data for text!  
F10 Finished ^Z Cancel  
File: (none) Window: 1

Figure 19



Select for %5 (use space bar)

F10 Finished ^Z Cancel

File: (none) Window: 1

Figure 20

Window 1

MACODE 001	DESCRIPTION CONCRETE FOOTINGS
UNIT CY	
	ESTIMATED VALUES
REG HOURS	500.0
TOT HOURS	200.0
TOTAL COST	10000
NUM OF UNITS	100
UNIT COST	

Command:

File: EWI Window: 1

Page: 1 Rec: 1 ( 1 ) Act: Y

Figure 21

```

Window 1
-----
WACODE 001          DATE 07/09/87          OPERATOR DEH

INIT & LAST NAME D HUSSON          FIRST NAME DAVID

                                  EMP NUM 22913

RHRS 40.00          LTYPE IW1
OTHR 20.00          CLASS L1

          VALUES          EXTENSION
          ==              ==
REG COST    10.00          400.00
OT COST     11.00          220.00

          TOTAL COST          620.00

BID REG COST 12.00
BID OT COST  13.00

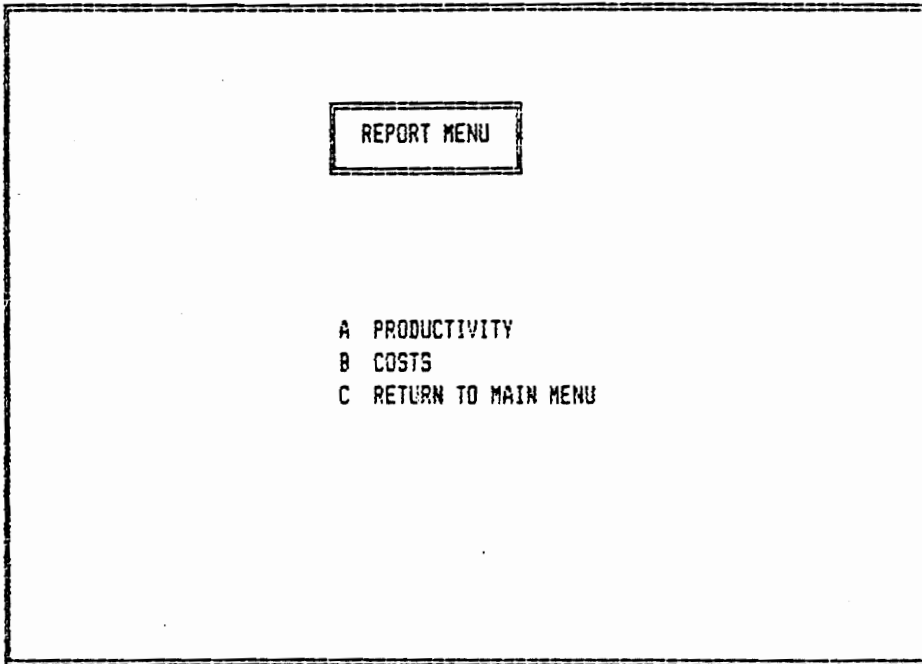
```

Command:

File: T12 Window: 1

Page: 1 Rec: 1 ( 1 ) Act: N

Figure 22



Select for %4 (use space bar)  
F10 Finished ^Z Cancel  
File: (none) Window: 1

Figure 23

APPENDIX B

COSTTRAK Program Printout

COSTTRAK Project Processor Program

```

1 : QUIET ON
2 : SINGLESTEP OFF
3 : COMMENT - This procedure generates the main menu.
4 :
5 : Call Wait4
6 : Repaint off
7 :
8 : LABEL MM1
9 : load %C screen INPUT
10 : load ENAME2 screen standard
11 : load TI2 screen INPUT
12 : load TI2 screen OPERATOR
13 : load TI2 screen standard
14 : Label MM
15 : input-screen load CCMAIN
16 : If %1="A"
17 :                               Jump TI
18 : Elseif %1="B"
19 :                               Jump Percent
20 : Elseif %1="C"
21 :                               Jump Compile
22 : Elseif %1="D"
23 :                               Jump Emenu1
24 : Elseif %1="E"
25 :                               Jump CMenu1
26 : Elseif %1="F"
27 :                               Jump View
28 : Elseif %1="G"
29 :                               Jump Rmenu
30 : Elseif %1="X"
31 :                               Jump Exit
32 : Else Jump MM
33 : Endif
34 :
35 :
36 :
37 : ~~~~~
38 : COMMENT - This Procedure is for Timecard Input.
39 :
40 :
41 : Label TI
42 : goto file TI2 screen OPERATOR
43 : Repaint on
44 : enter
45 : Call Wait1

```

```
46 : Repaint off
47 : split horizontal 17 2
48 : goto file TI2 screen INPUT
49 : goto window 2
50 : goto file ENAME2 screen standard
51 : order key [1]
52 : lookup load ENAME2
53 : goto window 1
54 : REPAINT ON
55 : enter
56 : Call Wait2
57 : REPAINT OFF
58 : lookup remove ENAME2
59 : close
60 : save TI2
61 :
62 : Jump MM
63 :
64 : ~~~~~
65 :
66 : COMMENT - This procedure is for percent complete input, it is not
67 :           not done with the Enter. The Update command is used to
68 :           change the percent complete for previously entered
69 :           cost codes.
70 :
71 : Label Percent
72 : goto file %C screen INPUT
73 : Repaint on
74 : update
75 : Call Wait1
76 : Repaint off
77 : Jump MM
78 :
79 : ~~~~~
80 :
81 : COMMENT - This procedure transacts all the input files
82 :           and the Estimated work file to the Actual work
83 :           file.
84 :
85 :
86 : Label Compile
87 : Call Wait3
88 : Repaint off
89 : split vertical 2 20
90 : load AW1 screen standard
91 : order key [1]
92 : goto window 2
93 : split vertical 2 40
94 : goto file TI2 screen standard
95 : goto window 3
```

```
96 : split vertical 2 60
97 : load EW1 screen standard
98 : goto window 4
99 : goto file %C screen INPUT
100 : goto window 1
101 :
102 : transactions predefined %C-AW1 no-audit
103 : transactions predefined EW1-AW1 no-audit
104 : transactions predefined TI2-AW1 no-audit
105 :
106 : unload file AW1
107 : unload file EW1
108 : close window 4
109 : close window 3
110 : close window 2
111 : Beep 3
112 : Jump MM
113 :
114 : ~~~~~
115 :
116 : COMMENT - This procedure generates the employee and equipment
117 :           menu. Following the menu are the sub-routines required
118 :           to add new employees and to update employee
119 :           information.
120 : Label Emenu1
121 : load LTYPE2 screen standard
122 : Label Emenu
123 : input-screen load EMENU
124 : If %2 = "A"
125 :                               Jump Newemp
126 : Elseif %2 = "B"
127 :                               Jump Updatemp
128 : Elseif %2 = "C"
129 :                               Jump NewLT
130 : Elseif %2 = "D"
131 :                               Jump UpdateLT
132 : Elseif %2 = "E"
133 :                               Jump Return
134 : Else Jump Emenu
135 : Endif
136 :
137 :
138 :
139 : Label Newemp
140 :
141 : Repaint off
142 : goto file ENAME2 screen standard
143 : split vertical 2 40
144 : goto window 2
145 : goto file LTYPE2 screen standard
```

```
146 : order key [1]
147 : goto window 1
148 : lookup load LTYPE2
149 : repaint on
150 : enter
151 : Call Wait1
152 : Repaint off
153 : key update
154 : lookup remove LTYPE2
155 : close
156 : Jump Emenu
157 :
158 :
159 :
160 : Label Updatemp
161 : goto file ENAME2 screen standard
162 : order key [1]
163 : Repaint on
164 : update
165 : Call Wait1
166 : Repaint off
167 : Jump Emenu
168 :
169 :
170 :
171 : Label NewLT
172 : goto file LTYPE2 screen standard
173 : Repaint on
174 : enter
175 : Call Wait1
176 : Repaint off
177 : Jump Emenu
178 :
179 :
180 :
181 : Label UpdateLT
182 : goto file LTYPE2 screen standard
183 : Repaint on
184 : update
185 : Call Wait1
186 : Repaint off
187 : Jump Emenu
188 :
189 :
190 : Label Return
191 : key update
192 : unload file LTYPE2
193 : Jump MM
194 :
195 : ~~~~~
```

```
196 :  
197 : COMMENT - This Procedure generates the cost code-change  
198 :           order menu and subroutines.  
199 :  
200 :  
201 :  
202 : Label CMenu1  
203 : load %C screen standard  
204 : load AW1 screen standard  
205 : load EW1 screen EWEDIT  
206 :  
207 : Label CMenu  
208 : input-screen load COMENU  
209 : If %3 = "A"  
210 :                               Jump Newcc  
211 : Elseif %3 = "B"  
212 :                               Jump Editcc  
213 : Elseif %3 = "C"  
214 :                               Jump ExitCO  
215 : Else Jump CMenu  
216 : Endif  
217 :  
218 :  
219 : Label Newcc  
220 : input-screen load ADDCC  
221 : repaint OFF  
222 : goto file AW1 screen standard  
223 : Call AddCC  
224 : goto file %C screen standard  
225 : Call AddCC  
226 : goto file EW1 screen EWEDIT  
227 : Call AddCC  
228 : Repaint on  
229 : update only-one  
230 : Call Wait1  
231 : Repaint off  
232 : key update  
233 : Jump CMenu  
234 :  
235 : Label Editcc  
236 : goto file EW1 screen EWEDIT  
237 : repaint on  
238 : update  
239 : Call Wait1  
240 : Repaint off  
241 : key update  
242 : Jump CMenu  
243 :  
244 :  
245 :
```

```
246 :
247 : Label ExitCO
248 : goto file AW1 screen standard
249 : key update
250 : unload file AW1
251 : goto file %C screen INPUT
252 : key update
253 : goto file EW1 screen EWEDIT
254 : key update
255 : unload file EW1
256 : Jump MM
257 :
258 :
259 :
260 : Label View
261 : load AW1 screen VIEW
262 : Load EW1 screen VIEW
263 : Load TI2 screen VIEW
264 :
265 : Label View1
266 : input-screen load VIEW
267 : If %5="A"
268 :             Jump Aw
269 : Elseif %5="B"
270 :             Jump Ew
271 : Elseif %5="C"
272 :             Jump Ti
273 : Elseif %5="D"
274 :             Unload file AW1
275 :             Unload file EW1
276 :             Jump MM
277 : Else Jump View1
278 : Endif
279 :
280 :
281 : Label Aw
282 : repaint on
283 : goto file AW1 screen VIEW
284 : scroll next 1
285 : repaint off
286 : Jump View1
287 :
288 :
289 : Label Ew
290 : repaint on
291 : goto file EW1 screen VIEW
292 : scroll next 1
293 :
294 : repaint off
295 : Jump View1
```

```
296 :
297 : Label Ti
298 : repaint on
299 : goto file TI2 screen VIEW
300 : scroll next 1
301 : repaint off
302 : Jump View1
303 :
304 :
305 :
306 :
307 :
308 :
309 : Label Rmenu
310 : load AW1 screen standard
311 : KEY UPDATE
312 : Label Rmenu1
313 : input-screen load RMENU
314 : If %4="A"
315 :                               Jump Prod
316 : Elseif %4="B"
317 :                               Jump Costs
318 : Elseif %4="C"
319 :                               unload file AW1
320 :                               Jump MM
321 : Else Jump Rmenu
322 : Endif
323 :
324 :
325 : Label Prod
326 : Call Print
327 : report print PROD printer
328 : Jump Rmenu1
329 :
330 : Label Costs
331 : Call Print
332 : report print JOBCOST printer
333 : Jump Rmenu1
334 :
335 :
336 :
337 :
338 :
339 : Label Exit
340 : unload all
341 : Stop
342 :
343 :
344 : COMMENT - These Procedures calls up a screen while the
345 :           operator is waiting.
```

```
346 :  
347 : Procedure Wait1  
348 : MENU Clear 4 14  
349 : MENU Print 10 20 4 14 Working.....  
350 : Return  
351 :  
352 :  
353 :Procedure Wait2  
354 :MENU Clear 0 6  
355 :MENU Print 7 10 0 6 "Nobody ever won a war by dying for his country.  
356 :MENU Print 9 11 0 6 You win a war by making the other poor bastard  
357 :MENU Print 11 11 0 6 die for his country."  
358 :MENU Print 13 40 0 6 General George S. Patton  
359 :Return  
360 :  
361 :  
362 : Procedure Wait3  
363 : MENU Clear 0 4  
364 : MENU Print 10 20 0 4 Compiling.....  
365 : Return  
366 :  
367 : Procedure Wait4  
368 : MENU Clear 10 0 no-border  
369 : MENU Print 3 5 10 0 Cost Tracking and Productivity Reporting  
370 : Program  
371 : MENU Print 5 5 10 0 Virginia Polytechnic Institute and State  
372 : University  
373 : MENU Print 7 5 10 0 1987  
374 : Return  
375 :  
376 : Procedure AddCC  
377 : enter blank  
378 : LET [WACODE]=TEXT1  
379 : Return  
380 :  
381 :  
382 : Procedure Print  
383 : MENU Clear 7 8  
384 : MENU Print 10 10 7 8 Align printer head with top of paper.  
385 : MENU Print 12 10 7 8 Press any key when ready.  
386 : Message  
387 : Return
```

## AW1 File Specifications

## Calculated Field Equations

Field 7 [TOTAL HRS] =  
[ACT RHRS]+[ACT OTHRS]

Field 16 [ACT UNITS] =  
[%COMP]\*[EST UNITS]/100

Field 17 [A UNIT COST] =  
[ACWP]/[ACT UNITS]

Field 18 [FORECAST] =  
IF [A UNIT COST]<=0  
THEN [EST COST]  
ELSE ([EST UNITS]-[ACT UNITS])\*[A UNIT COST]

## Calculated Field Equations

Field 19 [BCWS] =  
[EST COST]\*[%COMP]/100

Field 21 [TOTAL EST HRS] =  
[EST RHRS]+[EST OTHRS]

Field 22 [G/L] =  
IF [%COMP]<=0  
THEN 0  
ELSE [EST COST]-([FORECAST]+[ACWP])

## AW1 File Specifications (cont.)

Field No	Field Title	Type	Length	Key	Total	Status
1	WACODE	A	6	Y		N
2	DESCRIPTION	A	25	N		N
3	%COMP	N1	4	N	N	N
4	UNIT	A	3	N		N
5	ACT RHRS	N1	8	N	N	N
6	ACT OTHRS	N1	8	N	N	N
7	TOTAL HRS	N1C	8	N	N	N
8	ACT RCOST	NO	10	N	N	N
9	ACT OTCOST	NO	10	N	N	N
10	ACWP	NO	10	N	N	N
11	EST RHRS	N1	8	N	N	N
12	EST OTHRS	N1	8	N	N	N
13	EST COST	NO	10	N	N	N
14	E UNIT COST	N2	10	N	N	N
15	EST UNITS	NO	6	N	N	N

Field No	Field Title	Type	Length	Key	Total	Status
16	ACT UNITS	N1C	7	N	N	N
17	A UNIT COST	N2C	10	N	N	N
18	FORECAST	NOC	10	N	N	N
19	BCWS	NOC	10	N	N	N
20	BCWP	NO	10	N	N	N
21	TOTAL EST HRS	NOC	8	N	N	N
22	G/L	NOC	10	N	N	N

```

Window 1
WACODE 001
DESCRIPTION CONCRETE FOOTINGS
%COMP 13.0
UNIT CY
ACT RHRS      80.0
ACT OTHRS     10.0
TOTAL HRS     90.0
ACT RCOST     1160
ACT OTCOST    170
ACWP          1330
EST RHRS     500.0
EST OTHRS    200.0
EST COST     10000
E UNIT COST  100.00
EST UNITS    100
ACT UNITS     13.0
A UNIT COST  102.31
FORECAST     8901
BCWS         1300

```

Command list 4: Activate Directory File Index Load Read Save Unload  
Write

File: AW1 Window: 1 Page: 1 Rec: 1 ( 1 ) Act: Y  
LOAD - opens a database file and prepares it for processing

```

Window 1
WACODE 001      DESCRIPTION CONCRETE FOOTINGS      %COMP 13.0
UNIT CY
          ACTUAL          ESTIMATED
REG HOURS      80.0          500.0
OT HOURS       10.0          200.0
TOTAL HOURS    90.0          700
REG COST       1160
OT COST        170
TOTAL COST     1330          10000
(ACWP)
UNIT COST      102.31          100.00
NUM OF UNITS   13.0          100
          BCWS          1300
          BCWP          1110
          FORECAST
          TO COMP.      8901
          PROJECTED
          GAIN OR
          LOSS          -231

```

Command list 4: Activate Directory File Index Load Read Save Unload  
Write

File: AW1 Window: 1 Page: 1 Rec: 1 ( 1 ) Act: Y

### AW1 Screens

Figure 24

## EW1 File Specifications

## Calculated Field Equations

No calculated fields

Field No	Field Title	Type	Length	Key	Total	Status
1	WACODE	A	6	Y		N
2	DESCRIPTION	A	25	N		N
3	EST COST	NO	10	N	N	N
4	UNIT	A	3	N		N
5	EST UNITS	NO	6	N	N	N
6	UNIT COST	N2	10	N	N	N
7	EST RHRS	N1	8	N	N	N
8	EST OTHRS	N1	8	N	N	N

```

- Window 1
WACODE 001
DESCRIPTION CONCRETE FOOTINGS
EST COST      10000
UNIT CY
EST UNITS     100
UNIT COST     100.00
EST RHRS      500.0
EST OTHRS     200.0

Command list 4: Activate Directory File Index Load Read Save Unload
                Write
File: EW1 Window: 1 Page: 1 Rec: 1 ( 1 ) Act: Y

```

```

- Window 1
WACODE 001 DESCRIPTION CONCRETE FOOTINGS
UNIT CY

ESTIMATED VALUES
-----
REG HOURS      500.0
OT HOURS       200.0
TOTAL COST     10000

NUM OF UNITS   100
UNIT COST

Command list 4: Activate Directory File Index Load Read Save Unload
                Write
File: EW1 Window: 1 Page: 1 Rec: 1 ( 1 ) Act: Y

```

EW1 Screens

Figure 25

## TI2 File Specifications

## Calculated Field Equations

Field 11 [EXT RCOST] =  
[RHRS]\*[R COST]

Field 12 [EXT OTCOST] =  
[OTHRS]\*[OT COST]

Field 13 [TOTAL COST] =  
[EXT RCOST]+[EXT OTCOST]

Field 16 [BCWP] =  
[RHRS]\*[BID R COST]+[OTHRS]\*[BID OT COST]

Field 17 [DATE] =  
TODAY

## TI2 File Specifications (cont.)

Field No	Field Title	Type	Length	Key	Total	Status
1	EMP NUM	A	5	N		N
2	INIT & LAST NAME	I	20	N		N
3	FIRST NAME	A	10	N		N
4	WACODE	A	6	Y		N
5	LTYPE	A	4	N		N
6	RHRS	N2	5	N	N	N
7	OTHR	N2	5	N	N	N
8	CLASS	A	4	N		N
9	R COST	N2	6	N	N	N
10	OT COST	N2	6	N	N	N
11	EXT RCOST	N2C	10	N	N	N
12	EXT OTCOST	N2C	10	N	N	N
13	TOTAL COST	N2C	10	N	N	N
14	BID R COST	N2	6	N	N	N
15	BID OT COST	N2	6	N	N	N

Field No	Field Title	Type	Length	Key	Total	Status
16	BCWP	NOC	10	N	N	N
17	DATE	D C	8	N		N
18	OPERATOR	A	3	N		N

```

Window 1
EMP NUM 22913
INIT & LAST NAME D HUSSON
FIRST NAME DAVID
WACODE 001
LTYPE IH1
RHRS 40.00
OTHRS 10.00
CLASS L1
R COST 12.00
OT COST 17.00
EXT RCOST 480.00
EXT OTCOST 170.00
TOTAL COST 650.00
BID R COST 10.00
BID OT COST 15.00
BCWP 550
DATE 08/19/87
OPERATOR

```

Command list 4: Activate Directory File Index Load Read Save Unload  
Write

File: T12 Window: 1

Page: 1 Rec: 3 ( 3 ) Act: N

```

Window 1
TIMECARD INPUT

INITIAL & LAST NAME
WACODE

REGULAR HOURS          OVERTIME HOURS

FIRST NAME
EMP NUM
LTYPE

```

Command list 4: Activate Directory File Index Load Read Save Unload  
Write

File: T12 Window: 1

Page: 1 Rec: 1 ( 1 ) Act: Y

T12 Screens

Figure 26

Window 1

OPERATOR'S INITIALS DEH

Command list 4: Activate Directory File Index Load Read Save Unload  
Write

File: TI2 Window: 1 Page: 1 Rec: 1 ( 1 ) Act: Y

Window 1

WACODE	DATE 08/19/87	OPERATOR DEH
INIT & LAST NAME		FIRST NAME
		EMP NUM
RHRS		LTYPE
OTHR		CLASS
	<u>VALUES</u>	<u>EXTENSION</u>
REG COST		0.00
OT COST		0.00
	TOTAL COST	0.00
BID REG COST		
BID OT COST		

Command list 4: Activate Directory File Index Load Read Save Unload  
Write

File: TI2 Window: 1 Page: 1 Rec: 1 ( 1 ) Act: Y

TI2 Screens (cont.)

Figure 27

## %C File Specifications

## Calculated Field Equations

No calculated fields

Field No	Field Title	Type	Length	Key	Total	Status
1	WACODE	A	6	Y		N
2	%COMP	N1	4	N	N	N

```
Window 1  
WACODE 001  
%COMP 13.0
```

Command list 4: Activate Directory File Index Load Read Save Unload  
Write  
File: %C Window: 1 Page: 1 Rec: 1 ( 1 ) Act: Y

```
Window 1
```

PERCENT COMPLETE

```
WACODE 001          %COMP 13.0
```

Command list 4: Activate Directory File Index Load Read Save Unload  
Write  
File: %C Window: 1 Page: 1 Rec: 1 ( 1 ) Act: Y

%C Screens

Figure 28

## ENAME2 File Specifications

## Calculated Field Equations

No calculated fields

Field No	Field Title	Type	Length	Key	Total	Status
1	INIT & LAST NAME	I	26	Y		N
2	FIRST NAME	A	12	N		N
3	EMP NUM	A	5	N		N
4	LTYPE	A	4	N		N
5	CLASS	A	4	N		N
6	R COST	N2	6	N	N	N
7	OT COST	N2	6	N	N	N
8	BID R COST	N2	6	N	N	N
9	BID OT COST	N2	6	N	N	N

```
Window 1
INIT & LAST NAME D HUSSON
FIRST NAME DAVID
EMP NUM 22913
LTYPE IW1
CLASS L1
R COST 12.00
OT COST 17.00
BID R COST 10.00
BID OT COST 15.00
```

Command list 4: Activate Directory File Index Load Read Save Unload  
Write

File: ENAME2 Window: 1

Page: 1 Rec: 1 ( 1 ) Act: Y

ENAME2 Screen

Figure 29

## LTYPE2 File Specifications

## Calculated Field Equations

No calculated fields

Field No	Field Title	Type	Length	Key	Total	Status
1	LTYPE	A	4	Y		N
2	CLASS	A	4	N		N
3	R COST	N2	6	N	N	N
4	OT COST	N2	6	N	N	N
5	BID R COST	N2	6	N	N	N
6	BID OT COST	N2	6	N	N	N

```
Window 1
LTYPE IW1
CLASS L1
R COST 15.00
OT COST 22.00
BID R COST 12.00
BID OT COST 18.00
```

Command list 4: Activate Directory File Index Load Read Save Unload  
Write  
File: LTYPE2 Window: 1 Page: 1 Rec: 1 ( 1 ) Act: Y

LTYPE2 Screen

Figure 30

## MENUS

The following figures contain the menus. The menus were created using Smart's Input-screen command.

Figure 31 shows the Main Menu and the Employee-Equipment menu.

Figure 32 show the Cost Code-Change Order menu and the New Cost Code screen.

Figure 33 shows the View Files and the Report menus.

<p style="text-align: center;">CONSTRUCTION COST CONTROL MAIN MENU</p> <p>A INPUT TIMECARD B INPUT PERCENT COMPLETE C COMPILE WEEKLY DATA D EMPLOYEE/EQUIPMENT MENU E CHANGE ORDER/COST CODE MENU F VIEW FILES MENU G REPORT MENU X EXIT</p>
--

Select for %1 (use space bar)  
F10 Finished ^Z Cancel  
File: (none) Window: 1

<p style="text-align: center;">EMPLOYEE - EQUIPMENT MENU</p> <p>A ADD NEW EMPLOYEE OR EQUIPMENT B UPDATE EMPLOYEE OR EQUIPMENT FILE C ADD NEW LABOR TYPE D UPDATE LABOR TYPE FILE E RETURN TO MAIN MENU</p>
---

Select for %2 (use space bar)  
F10 Finished ^Z Cancel

Figure 31

COST CODE - CHANGE ORDER  
MENU

A ENTER NEW COST CODE-CHANGE ORDER  
B EDIT COST CODE-CHANGE ORDER  
C RETURN TO MAIN MENU

Select for %3 (use space bar)  
F10 Finished ^Z Cancel

NEW COST CODE OR CHANGE ORDER

ENTER NEW COST CODE(CHANGE ORDER)  
XXXXXX

Enter data for text1  
F10 Finished ^Z Cancel

Figure 32

VIEW FILES MENU

A ACTUAL WORK FILE  
B ESTIMATED WORK FILE  
C TIMECARD INPUT FILE  
D RETURN TO MAIN MENU

Select for %5 (use space bar)  
F10 Finished ^Z Cancel

REPORT MENU

A PRODUCTIVITY  
B COSTS  
C RETURN TO MAIN MENU

Select for %4 (use space bar)  
F10 Finished ^Z Cancel

Figure 33

## REFERENCES

1. James J. Adrian, 1979, Construction Accounting, Reston, Va., Reston Publishing Company, Inc., Preface p. xi.
2. ibid., p. 4.
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5. ibid., p. 221.
  
6. Jack Smith, Robert Keith and William Stephens, 1986, Accounting Principles, second edition, U.S.A., McGraw-Hill, Inc., p. 961.
  
7. Joseph Moder, Cecil Phillips and Edward Davis, 1983, Project Management with CPM, PERT and Precedence Diagramming, third edition, New York, Van Nostrand Reinhold Company Inc., pp. 143 - 144.
  
8. ibid., p. 144.
9. ibid., p. 151.
10. ibid., p. 151.
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