COST TRACKING AND PRODUCTIVITY REPORTING

by

David Edward Husson

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COST TRACKING AND PRODUCTIVITY REPORTING

by

David Edward Husson

Committee Chairman: Michael C. Vorster
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.

I wish also to thank Professor Yvan Beliveau for providing me the opportunity to meet the challenge of graduate school.

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
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.

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.
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.

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:

\[
\begin{align*}
BCWS &= \text{percent complete} \times \text{estimated cost} \\
BCWP &= \text{actual manhours} \times \text{budgeted hourly costs} \\
ACWP &= \text{actual manhours} \times \text{actual hourly costs}
\end{align*}
\]

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.

\[
\text{Cost Variance} = \text{BCWP} - \text{ACWP} \\
\text{Schedule/Performance Variance} = \text{BCWP} - \text{BCWS}
\]

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.

\[
\text{Cost Performance Index} = \text{CPI} = \frac{\text{BCWP}}{\text{ACWP}}
\]
Schedule Performance Index = SPI = \( \frac{BCWP}{BCWS} \)

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.

These values are plotted against each other in figure 1. 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.

\[ \text{Revised CPI} = \frac{ACWP}{BCWP} \]
Cost/schedule cumulative performance index
CPI = BCWP/ACWP
SPI = BCWP/BCWS

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.
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
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Grand Total: $79000 | $12120 | $10,642 | $256,680 | $11748

---

Schedule/Performance Variance = BCMP - BOS
Cost Variance = ACP - ACP

---

Page 1

Figure 3
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:

\[
\text{Est Hours to Date} = \text{Act Units} \times \text{Est Man-hours per Unit}
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<td>25.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>FOUR SIDEWALK</td>
<td>012</td>
<td>LF 18.0</td>
<td>20</td>
<td>3.6</td>
<td>200</td>
<td>36</td>
<td>40</td>
<td>10.0</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>CUT GRASS</td>
<td>013</td>
<td>LS 0.0</td>
<td>1</td>
<td>0.0</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>30.0</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>
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:

<table>
<thead>
<tr>
<th>Name</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>ENAME2</td>
</tr>
<tr>
<td>Labor Types</td>
<td>LTYPE2</td>
</tr>
<tr>
<td>Percent Complete</td>
<td>%C</td>
</tr>
<tr>
<td>Estimated Work</td>
<td>EW1</td>
</tr>
<tr>
<td>Actual Work</td>
<td>AW1</td>
</tr>
<tr>
<td>Timecard Input</td>
<td>TI2</td>
</tr>
</tbody>
</table>
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.
ON-SITE COST CONTROL SYSTEM

LTYPE

ENAME

INPUT

TIMECARD

TIMECARD INFO FOR PAYROLL

RAW DATA HIST DATA

% COMP

ACTUAL WORK FILE

EST WORK

REPORTS

Indicates automatic interaction
Indicates batch transaction

Figure 5
<table>
<thead>
<tr>
<th>Command:</th>
</tr>
</thead>
</table>

**File: LTYPE2 Window: 1**

**Page: 1 Rec: 1 (1) Act: V**

---

**Figure 6**
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 CV

EST UNITS 100

UNIT COST 100.00

EST HRS 500.0

EST OT HRS 200.0

Figure 8
TIMECARD INPUT

INITIAL & LAST NAME: D HUSSEN

WIGCODE: 001

FIRST NAME: DAVID
EMP NUM: 22913
LTYPE: IW1

REGULAR HOURS: 40.00
OVERTIME HOURS: 20.00

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.
EMP NUM 22913
INIT L LAST NAME D HUSDON
FIRST NAME DAVID
DEPCODE 001
ILTYPE IW1
RHRS 40.00
OTHRS 20.00
ICLASS L1
HR COST 10.00
OT COST 11.00
EXT FCOST 400.00
EXT OCOST 220.00
TOTAL COST 620.00
HRD R COST 12.00
HRD OT COST 13.00
INCWP 740
DATE 07/09/97
OPERATOR DEH

Command:

File: T12 Window: 1

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

Figure 11
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>% Comp</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>Concrete Footings</td>
<td>9.0</td>
</tr>
</tbody>
</table>

| Unit | CY               |

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Estimated</th>
<th>BCWS</th>
<th>BCWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours</td>
<td>80.0</td>
<td>500.0</td>
<td>900</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>102.0</td>
<td>700</td>
<td></td>
<td>1456</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Estimated</th>
<th>Forecast</th>
<th>To Comp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>1000</td>
<td></td>
<td></td>
<td>12659</td>
</tr>
<tr>
<td>Total</td>
<td>1252</td>
<td>10000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACWP</td>
<td></td>
<td></td>
<td>PROJECTED</td>
<td>GAIN OR</td>
</tr>
<tr>
<td>Loss</td>
<td></td>
<td>100.0</td>
<td>LOSS</td>
<td>-3911</td>
</tr>
<tr>
<td>Units</td>
<td>9.0</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 bar charts 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.
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>MACCE</th>
<th>COMP UNIT</th>
<th>EST COST</th>
<th>RCMP</th>
<th>BCMP</th>
<th>ACP</th>
<th>FORECAST</th>
<th>SAVIN</th>
<th>EST UNIT</th>
<th>ACT UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONCRETE FOOTINGS</td>
<td>001</td>
<td>CY</td>
<td>$1000</td>
<td>$1300</td>
<td>$1110</td>
<td></td>
<td>$8,901</td>
<td>$121</td>
<td>$100.0</td>
<td>$102.3</td>
</tr>
<tr>
<td>PLACE REBAR - MALL</td>
<td>002</td>
<td>TON</td>
<td>$5900</td>
<td>$2150</td>
<td>$1550</td>
<td></td>
<td>$1,770</td>
<td>$2,346</td>
<td>$100.0</td>
<td>$82.3</td>
</tr>
<tr>
<td>GRADE LOT</td>
<td>003</td>
<td>LS</td>
<td>$1500</td>
<td>$800</td>
<td>$595</td>
<td></td>
<td>$1,070</td>
<td>$713</td>
<td>$1283</td>
<td>$1500.0</td>
</tr>
<tr>
<td>CURTAIN WALL</td>
<td>004</td>
<td>LF</td>
<td>$1500</td>
<td>$2550</td>
<td>$1480</td>
<td></td>
<td>$1,720</td>
<td>$8,400</td>
<td>$4880</td>
<td>$30.0</td>
</tr>
<tr>
<td>EXCAVATING FOUNDATION</td>
<td>005</td>
<td>CY</td>
<td>$1200</td>
<td>$250</td>
<td>$560</td>
<td></td>
<td>$600</td>
<td>$2,126</td>
<td>$1263</td>
<td>$5.0</td>
</tr>
<tr>
<td>ELECTRICAL INSTALLATION</td>
<td>006</td>
<td>LS</td>
<td>$1500</td>
<td>$250</td>
<td>$1701</td>
<td></td>
<td>$2,077</td>
<td>$8,380</td>
<td>$4515</td>
<td>$1500.0</td>
</tr>
<tr>
<td>INSTALL DOORS &amp; WINDOWS</td>
<td>007</td>
<td>EA</td>
<td>$3000</td>
<td>$0</td>
<td>$0</td>
<td></td>
<td>$0</td>
<td>$0</td>
<td>$150.0</td>
<td>$9.0</td>
</tr>
<tr>
<td>ROOF TRUSHER</td>
<td>008</td>
<td>EA</td>
<td>$5000</td>
<td>$800</td>
<td>$630</td>
<td></td>
<td>$1,700</td>
<td>$4,075</td>
<td>$1,125</td>
<td>$250.0</td>
</tr>
<tr>
<td>ROOFING</td>
<td>009</td>
<td>SY</td>
<td>$6000</td>
<td>$1000</td>
<td>$475</td>
<td></td>
<td>$565</td>
<td>$2,273</td>
<td>$2862</td>
<td>$20.0</td>
</tr>
<tr>
<td>INTERIOR FINISH</td>
<td>010</td>
<td>LS</td>
<td>$12000</td>
<td>$0</td>
<td>$0</td>
<td></td>
<td>$0</td>
<td>$12,000</td>
<td>$0</td>
<td>$2200.0</td>
</tr>
<tr>
<td>PLANT GRASS</td>
<td>011</td>
<td>EA</td>
<td>$500</td>
<td>$0</td>
<td>$0</td>
<td></td>
<td>$0</td>
<td>$500</td>
<td>$0</td>
<td>$500.0</td>
</tr>
<tr>
<td>ROCK SIDEWALK</td>
<td>012</td>
<td>LF</td>
<td>$3000</td>
<td>$550</td>
<td>$600</td>
<td></td>
<td>$1,460</td>
<td>$3,098</td>
<td>$1778</td>
<td>$18.9</td>
</tr>
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<td>DOT GRASS</td>
<td>013</td>
<td>LS</td>
<td>$500</td>
<td>$0</td>
<td>$289</td>
<td></td>
<td>$0</td>
<td>$500</td>
<td>$0</td>
<td>$0.0</td>
</tr>
</tbody>
</table>

Grand Total $70000 $12120 $10090 $10,612 $56,640 $11740

---

Schedule/Performance Variance = BCMP - ECPB
Cost Variance = BCMP - ACP

Figure 13
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>WACODE</th>
<th>UNIT</th>
<th>COMP</th>
<th>EST UNITS</th>
<th>ACT UNITS</th>
<th>EST HOURS</th>
<th>ACT HOURS</th>
<th>EST MHRS PER UNIT</th>
<th>ACT MHRS PER UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONCRETE FOOTINGS</td>
<td>001</td>
<td>CY</td>
<td>13.0</td>
<td>100</td>
<td>13.0</td>
<td>700</td>
<td>91</td>
<td>70.0</td>
<td>7.0</td>
</tr>
<tr>
<td>PLACE REPAIR - WALL</td>
<td>002</td>
<td>TON</td>
<td>45.0</td>
<td>50</td>
<td>21.5</td>
<td>275</td>
<td>118</td>
<td>100.0</td>
<td>5.5</td>
</tr>
<tr>
<td>GRADE LOT</td>
<td>003</td>
<td>LS</td>
<td>60.0</td>
<td>1</td>
<td>0.6</td>
<td>70</td>
<td>42</td>
<td>45</td>
<td>70.0</td>
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<tr>
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<td>LF</td>
<td>17.0</td>
<td>500</td>
<td>85.0</td>
<td>720</td>
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<td>CY</td>
<td>22.0</td>
<td>500</td>
<td>110.0</td>
<td>150</td>
<td>29</td>
<td>40</td>
<td>0.3</td>
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<td>LS</td>
<td>15.0</td>
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<td>8.2</td>
<td>950</td>
<td>143</td>
<td>144.0</td>
<td>450.0</td>
</tr>
<tr>
<td>INSTALL DOORS &amp; WINDOWS</td>
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<td>EA</td>
<td>0.0</td>
<td>20</td>
<td>0.0</td>
<td>170</td>
<td>0</td>
<td>0</td>
<td>8.5</td>
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<tr>
<td>ROOF TRUSSES</td>
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<td>EA</td>
<td>16.0</td>
<td>20</td>
<td>3.2</td>
<td>200</td>
<td>45</td>
<td>40</td>
<td>150.0</td>
</tr>
<tr>
<td>ROOFING</td>
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<tr>
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<td>6.0</td>
<td>600</td>
<td>0</td>
<td>0</td>
<td>800.0</td>
</tr>
<tr>
<td>PLANT GRASS</td>
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<td>EA</td>
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<td>0.6</td>
<td>75</td>
<td>0</td>
<td>0</td>
<td>32.0</td>
</tr>
<tr>
<td>POUR SIDEWALK</td>
<td>012</td>
<td>LF</td>
<td>18.0</td>
<td>20</td>
<td>3.6</td>
<td>700</td>
<td>34</td>
<td>40</td>
<td>10.0</td>
</tr>
<tr>
<td>CUT GRASS</td>
<td>013</td>
<td>LS</td>
<td>0.0</td>
<td>1</td>
<td>0.0</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>30.0</td>
</tr>
</tbody>
</table>
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.
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.
CONSTRUCTION COST CONTROL
MAIN MENU

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
Y EXIT

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

OPERATOR'S INITIALS DEH

Command:

File: TIP  Window: 1  
Page: 1  Rec: 1  (1)  Act: N

Figure 16
EMPLOYEE - EQUIPMENT

MENU

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

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

Figure 17
COST CODE - CHANGE ORDER

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

Select for X3 (use space bar)
F10 Finished '2 Cancel
File: (none) Window: 1

Figure 18
Figure 20

VIEW FILES MENU

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

Select for %5 (use space bar)
F10 Finished  ^Z Cancel
File: (none)  Window: 1
<table>
<thead>
<tr>
<th>Command:</th>
</tr>
</thead>
<tbody>
<tr>
<td>File: EHI Window: 1</td>
</tr>
<tr>
<td>Pages: 1 Rec: 1 (1) Act: Y</td>
</tr>
</tbody>
</table>

**Window 1**

MACODE 001 DESCRIPTION CONCRETE FOOTINGS

UNIT CY

**ESTIMATED VALUES**

- REG HOURS: 505.0
- OT HOURS: 220.0
- TOTAL COST: 10000
- NUM OF UNITS: 100
- UNIT CUST

Figure 21
Window 1

MACODE 001           DATE 07/07/87           OPERATOR DEH

INIT & LAST NAME D HUSSON       FIRST NAME DAVID

HRS 40.00               LTYPE IWI
OTHRS 20.00             CLASS L1

<table>
<thead>
<tr>
<th>VALUES</th>
<th>EXTENSION</th>
</tr>
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<tbody>
<tr>
<td>REG COST 10.00</td>
<td>400.00</td>
</tr>
<tr>
<td>QT COST 11.00</td>
<td>220.00</td>
</tr>
<tr>
<td>TOTAL COST</td>
<td>620.00</td>
</tr>
</tbody>
</table>

BID REG COST 12.00
BID QT COST 13.00

File: T12          Windows: 1
Page: 1           Rect: 1 (1) Act: N

Figure 22
REPORT MENU

A PRODUCTIVITY  
B COSTS  
C RETURN TO MAIN MENU

Select for 14 (use space bar)  
F10 Finished  "Z Cancel  
File: (none)  Window: }

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 Emenul
24 : Elseif %1="E"
25 : Jump COmenul
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
Repaint off
split horizontal 17 2
goto file TI2 screen INPUT
goto window 2
goto file ENAME2 screen standard
order key [1]
lookup load ENAME2
goto window 1
REPAINT ON
enter
Call Wait2
REPAINT OFF
lookup remove ENAME2
close
save TI2
Jump MM

------------------------------

COMMENT - This procedure is for percent complete input, it is not done with the Enter. The Update command is used to change the percent complete for previously entered cost codes.

Label Percent
goto file %C screen INPUT
Repaint on
update
Call Wait1
Repaint off
Jump MM

------------------------------

COMMENT - This procedure transacts all the input files and the Estimated work file to the Actual work file.

Label Compile
Call Wait3
Repaint off
split vertical 2 20
load AW1 screen standard
order key [1]
goto window 2
split vertical 2 40
goto file TI2 screen standard
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: transactions predefined %C-AW1 no-audit
102: transactions predefined EW1-AW1 no-audit
103: transactions predefined TI2-AW1 no-audit
104: unload file AW1
105: unload file EW1
106: close window 4
107: close window 3
108: close window 2
109: Beep 3
110: Jump MM
111: 
112: ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
113: 
114: COMMENT - This procedure generates the employee and equipment
115: menu. Following the menu are the sub-routines required
116: to add new employees and to update employee
117: information.
118: 
119: 
120: Label Emenu
121: load LTYPE2 screen standard
122: Label Emenu
123: input-screen load EMENU
124: If %2 = "A"
125: Jump Newemp
126: Elself %2 = "B"
127: Jump Updatemp
128: Elself %2 = "C"
129: Jump NewLT
130: Elself %2 = "D"
131: Jump UpdateLT
132: Elself %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 UpdateLT
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 : COMMENT - This Procedure generates the cost code-change
197 : order menu and subroutines.
198 :
199 :
200 :
201 :
202 : Label COMenu
203 : load %C screen standard
204 : load AW1 screen standard
205 : load EW1 screen EWEDIT
206 :
207 : Label COMenu
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 COMenu
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 COMenu
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 COMenu
243 :
244 :
245 :
246 : 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 Viewl
266 : input-screen load VIEW
267 : If %S="A"
268 : Jump Aw
269 : Elself %S="B"
270 : Jump Ew
271 : Elself %S="C"
272 : Jump Ti
273 : Elself %S="D"
274 : Unload file AW1
275 : Unload file EW1
276 : Jump MM
277 : Else Jump View!
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 Viewl
287 :
288 :
289 : Label Ew
290 : repaint on
291 : goto file EW1 screen VIEW
292 : scroll next 1
293 :
294 : repaint off
295 : Jump Viewl
296 : Label Ti
297 : repaint on
298 : goto file T12 screen VIEW
299 : scroll next 1
300 : repaint off
301 : Jump View1
302 :
303 :
304 :
305 :
306 :
307 :
308 :
309 : Label Rmenu
310 : load AW1 screen standard
311 : KEY UPDATE
312 : Label Rmenu
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 Rmenu
329 :
330 : Label Costs
331 : Call Print
332 : report print JOBCOST printer
333 : Jump Rmenu
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 : 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 die for his country."
357 : MENU Print 11 11 0 6 General George S. Patton
358 : 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 Program
370 : MENU Print 5 5 10 0 Virginia Polytechnic Institute and State 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 OTHRHS

Field 22 [G/L] =
IF [%COMP]<0
THEN 0
ELSE [EST COST]−([FORECAST]+[ACWP])
### Field No Field Title Type Length Key Total Status

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<thead>
<tr>
<th>Field No</th>
<th>Field Title</th>
<th>Type</th>
<th>Length</th>
<th>Key</th>
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<th>Key</th>
<th>Total</th>
<th>Status</th>
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### Window 1

**MACODE 001**

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**UNIT CY**

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


LOAD - opens a database file and prepares it for processing

---

### Window 1

**MACODE 001**

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**UNIT CY**

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


AW1 Screens

Figure 24
### EW1 File Specifications

#### Calculated Field Equations

No calculated fields

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<tr>
<th>Field No</th>
<th>Field Title</th>
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<th>Total</th>
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</table>
EWI Screens

Figure 25
Calculated Field Equations

Field 11 [EXT RCOST] = [RHRS]*(R COST)

Field 12 [EXT OTCOST] = [OTHS]*(OT COST)

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

Field 16 [BCWP] = [RHRS]*(BID R COST)+[OTHS]*(BID OT COST)

Field 17 [DATE] = TODAY
### TI2 File Specifications (cont.)

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<td>N2C</td>
<td>10</td>
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<tr>
<td>13</td>
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<td>3</td>
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</table>
T12 Screens

Figure 26
### Window 1

**OPERATOR'S INITIALS DEH**

---

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

File: T12  Window: 1  
Page: 1  Rec: 1  (1)  Act: Y

---

#### MACODE: DATE 08/19/87  OPERATOR DEH

<table>
<thead>
<tr>
<th>INIT &amp; LAST NAME</th>
<th>FIRST NAME</th>
<th>EMP NUM</th>
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</table>

<table>
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<th>LTYPE</th>
<th>CLASS</th>
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<th>EXTENSION</th>
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<tr>
<td>REG COST</td>
<td>0.00</td>
</tr>
<tr>
<td>OT COST</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**TOTAL COST: 0.00**

---

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

File: T12  Window: 1  
Page: 1  Rec: 1  (1)  Act: Y

---

**TI2 Screens (cont.)**

**Figure 27**
%C File Specifications

Calculated Field Equations

No calculated fields

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<td>N</td>
<td>N</td>
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\textbf{Window 1}

\begin{center}
\texttt{WACODE 001}
\texttt{XCOMP 13.0}
\end{center}

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

File: \texttt{SC} Window: 1
Page: 1 Rec: 1 (1) Act: Y

\textbf{Window 1}

\begin{center}
\textbf{PERCENT COMPLETE}
\end{center}

\begin{center}
\texttt{WACODE 001}
\texttt{XCOMP 13.0}
\end{center}

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

File: \texttt{SC} Window: 1
Page: 1 Rec: 1 (1) Act: Y

\textbf{SC Screens}

\textbf{Figure 28}
ENAME2 File Specifications

Calculated Field Equations

No calculated fields

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</table>
ENAME2 Screen

Figure 29
LTYPE2 File Specifications

Calculated Field Equations

No calculated fields

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</table>
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 shows the Cost Code-Change Order menu and the New Cost Code screen.

Figure 33 shows the View Files and the Report menus.
CONSTRUCTION COST CONTROL
MAIN MENU

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
H EXIT

Select for %1 (use space bar)
F10 Finished "2 Cancel
Files (none) Window: 1

EMPLOYEE - EQUIPMENT
MENU

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

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

Figure 31
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


2. ibid., p. 4.

3. ibid., p. 4.

4. ibid., p. 4.

5. ibid., p. 221.


8. ibid., p. 144.

9. ibid., p. 151.

10. ibid., p. 151.

11. ibid., p. 162.
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Construction Management Institute, 1979, *An Introduction to Site Cost Control*, Cape Town, South Africa, The Graduate School of Business, University of South Africa.


