New Jersey Department of Transportation Automated Construction Estimate System

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In this paper, the New Jersey Department of Transportation's computerized construction estimate program is described from the user's perspective. This personal computer–based system is used by resident engineers for inputting daily inspection data, information on materials received, and field personnel data. From these data the program produces various documents, including daily reports, weekly reports, item and materials status reports, and monthly progress estimates.

Construction record keeping is a complicated task that is vital to the efficient management of New Jersey Department of Transportation (NJDOT) highway and bridge projects. These record-keeping responsibilities rest are entrusted to the resident engineer and the inspection staff assigned to the particular construction project.

In 1984, at the request of the Division of Construction and Maintenance, computer programmers assigned to the Department of Transportation from the Office of Telecommunications and Information Systems (OTIS) of the New Jersey Department of Treasury assisted construction personnel in the development of a personal computer (PC) data base management system. This system, known as the Automated Construction Estimate System (ACES), has been specifically tailored to meet existing NJDOT procedures for construction documentation and estimate preparation. The field-based system was initially installed December 1985 on the I-195 project in Trenton.

PROJECT DOCUMENTATION: GENERAL INFORMATION

Forms DC-29-A, B, C and D (Figures 1–4) are the source documents that are prepared and submitted by the field inspector. These forms contain specific information about a contract item work activity, progress or as-built quantities, the contractor's work force and equipment, and weather conditions. The field inspector's signature is required on the DC-29 document package. Under the New Jersey Department of Transportation Project Documentation and Estimate System, information from the DC-29 reports is entered on daily reports, weekly reports, item summary reports, and monthly estimates (Figure 5).

Currently, the computerized system is being used on nine projects. The present policy is to provide personal computers and related equipment for projects with budgets of $16,000,000 or greater. Eventually, it is expected that virtually every project will use the computer-based system.

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SYSTEM

The system employs a IBM personal computer (IBM PC) and a Bernoulli box with two 10-megabyte drives. ACES is written in dBASE III, compiled with Clipper. The dBASE III software, 92 dBASE III programs, and the data base files are maintained on one 10-megabyte Bernoulli cartridge. The report files are maintained on another 10-megabyte Bernoulli cartridge. Various programs written in dBASE III produce input panels that allow the user to enter data on the screen for daily construction quantities, materials received on site, and personnel data. The system stores the input information and uses it to produce various reports, including item quantity summaries, materials received reports, daily reports, weekly reports, and monthly progress estimates.

INSTALLATION

The computer and related hardware are included as part of the equipment required for the field office specified in the contract. The contractor is responsible for supplying and installing the computer system at the resident engineer's field office site. At the end of the project, the equipment remains the property of the contractor. The Bernoulli cartridges containing the ACES programs and data bases become the property of NJDOT. The following is a sample specification:

105.15 Field Office

The contractor shall supply the field office with a computer configuration as follows:

Hardware

1 IBM/PC or IBM/XT with two 360K disk drives and 256K memory (without hard disk)
1 Quadram board with 384K memory
1 Hayes 1200-baud modem without Smartcom
1 Princeton Graphics color RGB monitor or equivalent
1 graphics monitor adapter
1 Epson LQ-1000 printer or equivalent with tractor feed
1 printer cable
1 printer stand

NEW JERSEY DEPARTMENT OF TRANSPORTATION
DAILY INSPECTOR'S REPORT

Form DC-29(a) 4/80

(h) AS-BUILT QUANTITY

(a) Route _____ Section _____ Structure _____ Day and Date _____

(b) Item No. _____ Item _____ (e) Inspector Worked: _____ A.M. to _____ P.M.

(c) Plan Sheet No. _____ (d) Inspector's Signature(s) _____ Man Hours This Item →

(f) Location (Station to Station) (Structure – Description)	(g) Offset	(h) Quantity	(i) Concrete Req.	(i) Concrete Used	(j) Contractor Worked AM to PM (k) Labor & Equipment	(l) Hrs.

Weather and Air Temperature

(m) REMARKS: (Ground conditions, materials used, etc.):

(n) Use reverse side for sketches and calculations

FIGURE 1 Form DC-29-A.

Form DC-29 (b) 4/80

NEW JERSEY DEPARTMENT OF TRANSPORTATION

DAILY INSPECTOR'S REPORT – BITUMINOUS CONCRETE PAVEMENT

(a) Route _____ Section _____ Day and Date _____

(b) Item No. _____ Item _____ (e) Inspector Worked: _____ A.M. to _____ P.M.

(c) Plan Sheet Nos. _____ (d) Inspector's Signature(s) _____ Total Man Hours This Item →

Mix No (f)	Lot No (g)	Location Baseline & Station to Station (h)	Lane (i)	Lift (j)	Thickness (k)	Pounds Received (l)	Pounds Laid (m)	S.Y. Laid (n)	Lbs S.Y. (o)

(p) Progress Quantity → _____ Tons or _____ S.Y.

(q) Producer of Material

Weather & Temperatures

(t) Remarks (Base Conditions, etc.)

Mixture Temperature (r)	Mix No	Highest	Lowest	Ave for Day
		°F	°F	°F
		°F	°F	°F

(s) Contractor Worked AM to PM

(s) Labor & Equipment	(s) Hours

Type of Automatic Controls Used

(u) Use Reverse Side for Sketches, Calculations and Additional Remarks

FIGURE 2 Form DC-29-B.

Form DC-29 (c) 4/80

NEW JERSEY DEPARTMENT OF TRANSPORTATION

DAILY INSPECTOR'S REPORT – APPLICATION OF BITUMINOUS MATERIALS

(a) Route _____ Section _____ Day and Date _____

(b) Item No. _____ Item _____ (e) Inspector Worked: _____ A.M. to _____ P.M.

(c) Plan Sheet Nos. _____ (d) Inspector's Signature _____ Man Hours This Item →

(f) Grade of Material Applied _____ (g) Producer and Location (h) Hauler and Location

(i) Location Station to Station	Lane or Side (j)	Lot No (k)	Tank No (l)	Date Material Inspt. (m)	Delivery Slip No. (n)	Truck No (o)	Gauge on Truck Start (p)	Gauge on Truck Finish (q)	Temp. of Mat'l. (r)	Conversion Factor (s)	GALLONS APPLIED Gross (t)	GALLONS APPLIED @60° F (u)	Number of S Y Covered (v)	Rate G/S.Y. @ 60° F (w)

(x) Specified Temperature range of material ° F to ° F

(x) Specified rate of application G/S.Y to G/S.Y.

Weather and Air Temperature

(z) Remarks (Base Condition, Stability, etc.)

(y) Contractor Worked _____ AM to _____ PM

(y) Labor and Equipment Used | Hours

USE REVERSE SIDE FOR SKETCHES, CALCULATIONS, AND ADDITIONAL REMARKS.

FIGURE 3 Form DC-29-C.

1 Iomega Bernoulli box with two 10-MEG drives; the driver will be IDRIVE 4.11 and the board will be PC2B, self-booting

Software

1 DOS Version 3. 1
1 Multimate
1 Lotus 1-2-3

Accessories and Supplies

1 surge protector with a minimum of six outlets
1 surge protector for the modem phone line
1 static mat—floor type, 4′ × 5′
1 desk or work station to set computer on
15 cartridges for the Bernoulli box
48 cartons of paper (9½ × 11″, 1 part, blank, approximately 3,000 sheets per carton, medium weight)
10 printer ribbons
4 boxes diskettes (10 per box)
1 diskette holder (holds 50 diskettes), dust covers for Bernoulli box, PC CPU, keyboard, monitor, and printer
1 Bernoulli box head cleaner kit

Any accessories for the computer must be able to be used with the computer.

The contractor will not be permitted to use this computer equipment at any time as it is being supplied for the Department's use.

The contractor shall forward all manuals, instructions, or literature received with the computer package to the engineer. The contractor is also responsible to keep the computer equipment in good working condition and is also responsible for all maintenance and repairs.

The contractor is responsible to install the computer system at the field office site. At the time of setup, the contractor shall ensure that the system is in operating condition. In addition, the computer system shall be removed and shall become the property of the contractor when no longer required. The Bernoulli cartridges containing the ACES programs and data bases shall become the property of the State.

A designated OTIS representative is responsible for loading the operating system and data base files onto the Bernoulli cartridges. The data for item numbers, item descriptions, quantities, and bid prices are downloaded from the NJDOT mainframe data base file, so the resident engineer's staff need not input this information.

OPERATING THE SYSTEM

ACES is written so that the user does not need much knowledge of or experience with the IBM PC or dBASE III to operate the system. An office worker or secretary assigned to the project is responsible for entering data.

To start up the system, the program and data base file Bernoulli cartridge is inserted into the Bernoulli box C drive, and the report file cartridge is inserted into the Bernoulli box D drive. When the computer is turned on, the program is automatically loaded into memory.

Form DC–29 (d) 4/80

NEW JERSEY DEPARTMENT OF TRANSPORTATION
DAILY INSPECTORS - REPORT - PILE DRIVING

DAILY INSPECTOR'S REPORT – PILE DRIVING

Route	Section	Structure	Location	Day and Date

Type Hammer	Blows/Min.	Inspector's Signature	Inspector Worked AM to PM	Man hours This item

Pile * No	Order Length	Actual Length	Timber Pile Dia Tip	Timber Pile Dia Butt	Splice Data Length	Splice Data From	Penetration **	Cutoff **	Blows Last 5 Feet 5	4	3	2	1	Blows Last Inch	NOTES

Weather & Air Temperature:

REMARKS:

Contractor Worked AM to PM

Labor & Equipment	Hours

ITEM NO.	DESCRIPTION	QUANTITY

* See Pile Numbering on Pile Plan
** Indicate (A) for Actual Length or (E) for Estimated Length to be Corrected later

FIGURE 4 Form DC-29-D.

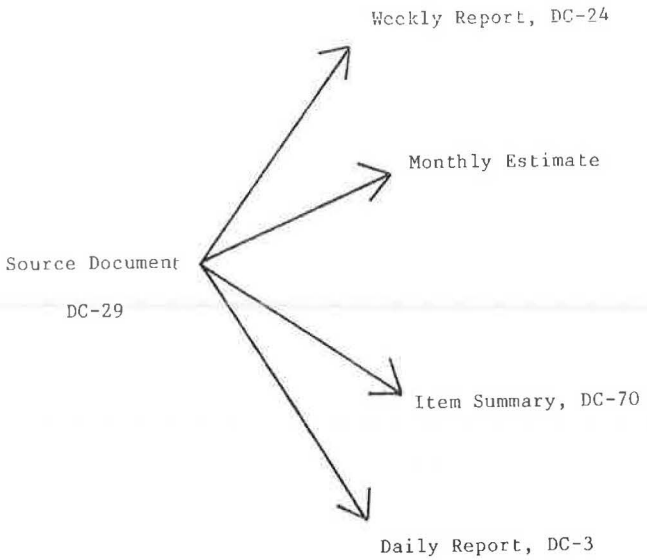

FIGURE 5 Reports produced from the information supplied by the DC-29 forms.

ACES is menu driven. An option is chosen from a menu by simply typing the number or letter that corresponds to the option. The user does not have to press any other key. The system provides a main menu and several submenus that are accessible from the main menu. Submenu selections allow the user to modify display colors, reset the system clock, and change personnel data, in addition to operating the data entry and report functions.

Main Menu

The Main Menu (Figure 6) allows the user to enter the rest of the menus in the system or to exit the system. Options are as follows:

Selection 0: Exit the Program Return to DOS.

Selection 1: Input Inspection Data Display the Inspection Menu (Figure 7). This submenu, from which daily inspection information is entered, is the most frequently used.

Selection 2: Generate Reports to Disk Allow the user to write various reports to disk.

Selection 3: View Reports on Disk Allow the user to view or print the reports written to disk.

Selection 4: Project Setup Program Enable the user to enter or change various particulars, such as project description, completion dates, personnel information, and human resources data for the project.

Selection 5: Disk Utilities Display the utilities submenu so that the user may perform various utilities functions (backup of the current data files is one of the most important).

Selection 6: Send Reports Over the Phone Lines Permit the user to send reports already on the cartridge to another PC or allow the user to receive reports from another PC to the user's PC through the telephone lines.

Inspection Menu

This submenu (Figure 7) provides the following options:

Selection 0: Return to Main Menu

Selections 1–4: Input Inspection Data Permit entry of progress quantities and related information reported by inspectors on the daily inspection report (DC-29-A, -B, -C, or -D).

Selection 5: DC-12-A Allow entry of change order data into the system.

Selection 6: Manpower Input Provide opportunity to input or change data on personnel work hours.

Selection 7: DC-70 Materials Received Input Permit logging of materials received.

Selection 8: Materials on Jobsite Input Allow user to input or change the data on the materials on the job site.

Selection 9: DC-29 Edit Existing Data Permit user opportunity to edit data previously entered from the daily inspection report.

```
PMEMAIN          06/04/86          NJDOT CONSTRUCTION                09:54:00
                              RESIDENT ENGINEER FORMS AND REPORTS
                                        MAIN MENU

          SELECTION          DESCRIPTION
              0              EXIT PROGRAM

              1              INPUT INSPECTION DATA

              2              GENERATE REPORTS TO DISK

              3              VIEW REPORTS ON DISK

              4              PROJECT SET-UP PROGRAMS

              5              DISK UTILITIES

              6              SEND REPORTS OVER PHONE LINE

                        CHOOSE A SELECTION BY NUMBER

            *
          [1] <======
```

FIGURE 6 ACES Main Menu. Number in brackets is entered by user.

```
PMEINSP        06/04/86          NJDOT CONSTRUCTION              12:24:00
                              RESIDENT ENGINEER FORMS AND REPORTS
                                      INSPECTION MENU

     SELECTION              DESCRIPTION
         0       EXIT       RETURN TO MAIN MENU

         1       DC-29-A    DAILY INSPECTIONS REPORT (QUANTITIES)
         2       DC-29-B    DAILY INSPECTIONS REPORT (PAVING)
         3       DC-29-C    DAILY INSPECTIONS REPORT (OIL)
         4       DC-29-D    DAILY INSPECTIONS REPORT (PILES)

         5       DC-12-A    CHANGE ORDER
         6                  MANPOWER INPUT
         7       DC-70      MATERIAL RECEIVED INPUT
         8                  MATERIALS ON JOB SITE INPUT
         9       DC-29      EDIT EXISTING DATA

                 CHOOSE A SELECTION BY NUMBER

     [1] <======
```

FIGURE 7 ACES Inspection Menu. Number in brackets is entered by user.

PRINCIPAL FEATURES

Inspection Data Input

Daily inspection reports DC-29-AD are used as source documents for reporting progress quantities and related information. Pertinent details, including inspection date, item number, item description, location of work, weather, progress quantity, or as-built quantity, are provided on these inspection documents. To input these data, the user chooses Selection 1 on the Main Menu, followed by selection 1, 2, 3, or 4 on the Inspection Menu to reach the new data input screen for item number and inspection date (Figure 8). The "page down" (PGDN) key is used to move to the next screen, allowing entry of the weather conditions, location, and pay quantity or as-built quantity (Figure 9).

```
PMEITEM        06/04/86          NJDOT CONSTRUCTION              12:25:00
                              RESIDENT ENGINEER FORMS AND REPORTS
                               ITEM NUMBER AND DATE FOR NEW DATA

                    ENTER ITEM NUMBER TO ADD DATA FOR: [103]*

                     ENTER DATE TO ADD DATA FOR: [06/04/86]

    USE ARROW KEYS TO MOVE AROUND ON SCREEN

    PRESS THE "PGDN" KEY TO MOVE TO THE NEXT SCREEN
```

FIGURE 8 Input screen for contract item number and date. Items in brackets are entered by user.

```
PME29A_2       06/04/86          NJDOT CONSTRUCTION              12:26:00
                              RESIDENT ENGINEER FORMS AND REPORTS
                              DAILY INSPECTOR REPORT ON QUANTITIES

      RETURN TO MAIN MENU (Y/N)   [N]    RECORD NUMBER 3277

      ITEM NO.:103                INSPECTION DATE:06/04/86
      DESCRIPTION: 15" REINFORCED CONCRETE CULVERT PIPE STRUCTURE:
      WEATHER:[SUNNY]             TEMPERATURE AM:     [66]       PM:     [80]
          LOCATION                                PAY QUANTITY   AS-BUILT QUANTITY
           FROM RELOC. ARENA DR.                    [20.00]          [0.00]


       * TO ENTER DATA - PRESS ENTER KEY, THEN ENTER DATA
       * TO STOP ENTERING DATA - PRESS THE "PGDN" KEY
       * TO CANCEL THIS ENTRY - MOVE CURSOR UP TO TOP
            OF SCREEN AND TYPE "Y" AND PRESS THE "PGDN' KEY
```

FIGURE 9 Input screen for daily inspector's report data. Items in brackets are entered by user.

Material Received Input

From the Material Received Menu (Figure 10), the user can

Selection 0: Exit to Inspection Menu
Selection 1: Add New Material Description
Selection 2: Change Existing Material Description
Selection 3: Add Material Delivery Record That is, add the actual dates of delivery to the project.

To input material received, the user chooses selection 1 on the Main Menu, then Selection 7 on the Inspection Menu, then Selection 3 on the Material Received Menu. The appropriate record is obtained by inputting the item number for the material (Figure 11). Information entered includes the description of the material, quantity, source of supply, date of inspection or certification, and date that the material was received at the project site.

Supplementary Items and Changes to Existing Item Quantities

Screens are provided for adding supplementary item data, including item number, item description, quantity, and price. A screen is also provided for changing contract quantities of existing items (Figure 12).

Personnel Information

The system maintains data on each employee. Each day, the employee work hours are charged to specific activities by using the input screen shown in Figure 13. The source document for the information is the DC-29 Daily Inspector's Report. This human resources information is used by the NJDOT Construction Engineering Manpower Management (CEMM) System.

The CEMM System provides the estimated human resources needs for the project before construction. Actual human resources usage is later compared with the original estimate. The comparison provides a means for adjusting the human resources factors for future projects, if necessary.

Reports

One of the powerful features of ACES is its capacity to produce the many reports required on a construction project. The menu for printing reports is given in Figure 14. As an example

```
PMEMATIN        06/04/86          NJDOT CONSTRUCTION                12:58:00
                              RESIDENT ENGINEER FORMS AND REPORTS
                                    MATERIAL RECEIVED MENU


                    SELECTION        DESCRIPTION
              0     EXIT         EXIT TO INSPECTION MENU

              1     ADD          ADD NEW MATERIAL DESCRIPTION
              2     CHANGE       CHANGE EXISTING MATERIAL DESCRIPTION
              3     DETAIL       ADD MATERIAL DELIVERY RECORD


                        CHOOSE A SELECTION BY NUMBER

          [3]<======
```

FIGURE 10 Material Received Menu. Number in brackets is entered by user.

```
PREMATDL        06/04/86          NJDOT CONSTRUCTION                13:05:57
                              RESIDENT ENGINEER FORMS AND REPORTS
                                 ADD MATERIAL DELIVERY RECORD

                              MATERIAL NUMBER:  01

     MATERIAL DESCRIPTION: POROUS FILL (A)      ITEM NUMBER: [345]   UNITS: CY

  SOURCE OF SUPPLY #1: TELFORD SOIL      DATE QUESTIONNAIRE SUBMITTED: 03/29/86

  RECORD NUMBER: 255

  MATERIAL      REC'D      CERTIFICATION      INSPECTION REPORT
  RECEIVE       QUANT
  DATE          TODAY     DATE    QUANT   DATE       QUANT   RSLT FORM   REMARKS
  [06/04/86]   [30.00]    /  /    0.00  [06/04/86]  [30.00]


   ARE YOU FINISHED ENTERING DATA ON THIS SCREEN?  (Y/N): [Y]

                    USE ARROW KEYS TO MOVE AROUND ON SCREEN
```

FIGURE 11 Input screen for material delivery. Items in brackets are entered by user.

```
PME12A_2        06/04/86          NJDOT CONSTRUCTION                12:48:00
(CHANGE)                  RESIDENT ENGINEER FORMS AND REPORTS
                            CHANGE TOTAL CONTRACT QUANTITY

   CHANGE ORDER NUMBER: [003]
   DATE INITIATED: [04/12/86]
   APPROVAL DATE : 05/01/86
   ITEM NO.: [063]
   ITEM DESCRIPTION: BORROW EXCAVATION, BRIDGE FOUNDATION ROAD OR BRIDGE
   UNIT OF MEASURE: CY              UNIT PRICE: 10.00
   CURRENT CONTRACT QUANTITY:   24510.00
   ADD OR SUBTRACT          :    [10.00]
   NEW CONTRACT QUANTITY        24520.00

   IS THIS QUANTITY OK (Y OR N) ?  [Y]
   USE ARROW KEYS TO MOVE AROUND ON THE SCREEN

   PRESS THE "PGDN" KEY TO MOVE TO THE NEXT SCREEN
```

FIGURE 12 Input screen for changing contract quantities. Items in brackets are entered by user.

```
PMEMANIX        06/04/86          NJDOT CONSTRUCTION                12:55:00
                          RESIDENT ENGINEER FORMS AND REPORTS
                            DAILY MANPOWER DATA - INDIVIDUAL

NAME: FALVO, S.            TITLE: SENIOR ENGINEER            DATE: [06/04/86]

REGULAR    OVERTIME                          OTHER TIME
 [8.0]       0.0  RESIDENT ENGINEER             0.0  VACATION
  0.0        0.0  NON RESIDENT ENGINEER         0.0  SICK
  0.0        0.0  OFFICE WORK                   0.0  ADMINISTRATION
  0.0        0.0  AS-BUILT                      0.0  OTHER LEAVE
  0.0        0.0  GENERAL                       0.0  WITHOUT PAY
  0.0        0.0  EARTH                         0.0  WITH PAY
  0.0        0.0  DRAINAGE                      0.0  TRAINING OFF PROJ
  0.0        0.0  AGGREGATES                    0.0  LOANED OFF PROJ
  0.0        0.0  CURB & S WALK
  0.0        0.0  PAVING
  0.0        0.0  STRUCTURES
  0.0        0.0  UTILITIES
  0.0        0.0  ELECTRICAL
  0.0        0.0  MISCELLANEOUS
  0.0        0.0  SPECIAL CATEGORY

                    PRESS THE "PGDN" KEY TO CONTINUE
```

FIGURE 13 Input screen for daily human resources data. Items in brackets are entered by user.

```
PMEREPT         06/04/86          NJDOT CONSTRUCTION                13:38:20
                          RESIDENT ENGINEER FORMS AND REPORTS
                              GENERATE REPORT TO DISK MENU

     SELECTION            DESCRIPTION
         0       EXIT     RETURN TO MAIN MENU

         1       DC-3B    PRINT QUANTITIES OF WORK BY ITEM
         2       DC-70    PRINT ITEM BOOK PAGE
         3                PRINT CONTRACT SUMMARY
         4                PRINT CHANGE ORDER HISTORY BY ITEM

         5       DC-24    PRINT WEEKLY ESTIMATE
         6                PRINT MONTHLY ESTIMATE
         7       DC-70    PRINT MATERIALS RECEIVED
         8                PRINT ITEMS OVER SPECIFIED CONTRACT LIMIT
         9                PRINT MATERIAL ON JOB SITE EXCEEDING 85% CONTRACT
                          AMOUNT
         A                PRINT WEEKLY DETAIL TIME REPORT

               CHOOSE A SELECTION BY NUMBER

     [1]<======
```

FIGURE 14 Menu for printing reports. Number in brackets is entered by user.

of ACES output, a weekly report is presented in Figures 15 and 16.

ADVANTAGE OF THE ACES SYSTEM

The calculation and report production capabilities of ACES are a great improvement over the manual system in terms of time saved. Table 1 presents the average times required to produce various reports for a manual system versus the time needed for use of ACES.

TRAINING

Training personnel to use ACES is extremely important to the success of the program. After a project has been selected to use the system, the resident engineer and staff receive 3 days of training. A Bureau of Construction liaison is available to assist with additional training and to help throughout the duration of the project.

The trainees are provided with a user's manual that includes detailed instructions for using the system. As stated previously, the system menus and input screens are designed to

PME24PR
DC-24

NJDOT - AUTOMATED CONSTRUCTION ESTIMATE SYSTEM
WEEKLY PROGRESS REPORT
PRELIMINARY RUN

SHEET 1
REPORT NO. 175

MAN HOURS USED BY ACTIVITY GROUP	SAT	SUN	MON	TUE	WED	THU	FRI	WEEKLY USE TODATE	TOTAL USED	TOTAL PLANNED MAN HOURS
RESIDENT ENGINEER	0.0	0.0	8.0	8.0	8.0	8.0	8.0	40.0	5913.5	5792
NON RESIDENT FIELD SUPERVISION	0.0	0.0	1.0	7.0	3.0	5.0	7.0	23.0	5380.5	5106
FIELD INSPECTION	0.0	0.0	47.0	41.0	41.0	19.0	9.0	157.0	35178.5	30450
OFFICE WORK - EED	0.0	0.0	8.0	8.0	8.0	8.0	0.0	32.0	10113.0	8977
AS-BUILTS	0.0	0.0	0.0	0.0	0.0	24.0	32.0	56.0	4933.5	4164
GENERAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1563.0	2615
PROJECT TOTALS	0.0	0.0	64.0	64.0	60.0	64.0	56.0	308.0	63088.0	57104
INSPECTION ACTIVITIES										
EARTH WORK	0.0	0.0	0.0	0.0	0.0	16.0	8.0	24.0	9084.5	9141
DRAINAGE	0.0	0.0	16.0	14.0	16.0	0.0	0.0	46.0	4687.5	2372
AGGREGATES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2326.0	1373
CURB & SIDEWALK	0.0	0.0	0.0	2.0	0.0	0.0	0.0	2.0	1780.0	834
PAVING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2259.5	2074
STRUCTURES	0.0	0.0	12.0	8.0	8.0	2.0	0.0	30.0	11288.0	9446
UTILITIES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	935.0	1152
ELECTRICAL	0.0	0.0	2.0	0.0	0.0	0.0	0.0	2.0	201.0	872
MISCELLANEOUS	0.0	0.0	16.0	16.0	16.0	0.0	0.0	48.0	1980.0	998
SPECIAL	0.0	0.0	1.0	1.0	1.0	1.0	1.0	5.0	637.0	2188
INSPECTION SUBTOTAL	0.0	0.0	47.0	41.0	41.0	19.0	9.0	157.0	35178.5	30450

NUMBER OF EMPLOYEES ASSIGNED TO THIS PROJECT

PROJ ENGR	0.0	ASST. ENGR (INCL CET)	0.0	HWY INSP	2.0
PRIN ENGR	1.0	PRIN INSP	0.0	CLERICAL (INCL CO-OP'S)	1.0
SR ENGR	2.0	SR INSP	3.0	OTHER (INCL SUMMERHELP)	0.0

PERCENTAGE OF MANPOWER USAGE
(MUST BE COMPLETED BY ALL PROJECTS)

TOTAL PROJECT = 63088.0 / 57104 = 110 .%

FIELD INSPECT = 35178.5 / 30450 = 116 .%

STATE EMPLOYEES & TITLE	DEPT CAR	THIS WEEK	NEXT WEEK	HOURS WORKED	OVERTIME WORKED	LEAVE TIME
ABATTO, A. SR INSP	-			40.0	0.0	0.0
DAMIANO, J. CLERICAL	-			32.0	0.0	0.0
DOLCI, W. SR INSP	-			40.0	0.0	0.0
FALVO, S. PRIN ENGR	TD-918			40.0	0.0	0.0
GALLO, P. HWY INSP	-			40.0	0.0	0.0
KAFER, W. SR ENGR	-			40.0	0.0	0.0
LOGAN, D. HWY INSP	-			40.0	0.0	0.0
MISNER, E. SR ENGR	TD-396			36.0	0.0	4.0
THOMPSON, F. SR INSP	-			0.0	0.0	40.0
			TOTALS	308.0	0.0	44.0

WORK PLANNED BY CONTRACTOR NEXT WEEK OR OTHER APPLICABLE REMARKS INCLUDING MANPOWER NEEDS AND EXCESSES.
CONTRACTOR PLANS TO CONTINUE WORKING ON LANDSCAPE ITEMS AND CORRECTIVE ACTION LIST.

BY:FRED THOMPSON / SR. HWY INSPECTOR /_____
PRINT NAME PRINT TITLE SIGNATURE

FIGURE 15 Sample of ACES output: a weekly progress report (page 1).

TABLE 1 AVERAGE TIME TO PRODUCE REPORTS

Report	Time to Produce Report	
	Manual System	ACES
Daily report, DC-3	1.5 hr	10 min
Weekly report, DC-24	1.5 hr	15 min
Monthly estimate	4.0 hr	20 min

provide instructions to the new user. Directions in clear, plain English are included at the bottom of each screen to guide the user through the system. Constant reference to the user's manual is therefore not necessary.

IMPLEMENTATION AND SYSTEM IMPROVEMENT

A coordinating team has been established to handle all aspects of implementation and improvement to the system. The ACES Coordinating Team consists of two members from each of the four regional construction offices plus three members from the Bureau of Construction. One of the Bureau of Construction team members serves as team leader. Representatives of OTIS also attend each of the team meetings, which are held every 2 months. Before each meeting, an agenda is prepared and distributed to each member:

ACES MEETING AGENDA—JUNE 29, 1987

I. Current Status of ACES System at the Field Office's New Site—Route 38, Mount Holly
II. Technical Update
   A. Communications between Field Offices and Regional Office, Discuss BITCOM
   B. Hardware—OTIS will begin testing ACES on other brands of microcomputers once the current version is completed
III. Priority List Review
   A. Third Priority List—Currently Being Programmed
      1. Progress Report on Items 19

PME24PR NJDOT - AUTOMATED CONSTRUCTION ESTIMATE SYSTEM SHEET 1
DC-24 WEEKLY PROGRESS REPORT REPORT NO. 175
WEEK ENDING : 08/28/87
ROUTE: 195 SECTION: 1A, 1E, 10D FEDERAL PROJ : I-195-8(14)60 REGION NO: III
LOCAL NAME : ROUTE 195 SECTION 1A,1E & 10D, FROM EAST OF WATSON CREEK TO EAST OF DP FILE NO: 752
CONTRACTOR : HESS BROTHERS, INC. PROJ ENGINEER : LOUIS PAPP RES ENGINEER : SANTE FALVO

ITM NO.	ITEM DESCRIPTION	22 SAT	23 SUN	24 MON	25 TUE	26 WED	27 THU	28 FRI	TOTAL	UNIT PRICE	AMOUNT THIS WEEK ($)
003	TRAFFIC DIRECT	0.00	0.00	6.00	0.00	0.00	0.00	0.00	6.00 MH	14.00	84.00
072	RIPRAP SLOPE P	0.00	0.00	0.00	52.40	0.00	0.00	0.00	52.40 SY	15.00	786.00
171	CONCRETE SIDEW	0.00	0.00	0.00	2.70	0.00	0.00	0.00	2.70 SY	19.00	51.30
181	24" CORRUGATED	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00 U	130.00	130.00
231	1.5 INCH RIGID	0.00	0.00	88.00	0.00	0.00	0.00	0.00	88.00 LF	8.50	748.00
238	18 IN X 36 IN	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00 U	625.00	625.00
271	4 INCH TOPSOIL	0.00	0.00	0.00	0.00	0.00	0.00	6021.00	6021.00 SY	0.80	4816.80
273	FERTILIZING AN	0.00	0.00	0.00	0.00	0.00	0.00	13919.00	13919.00 SY	0.25	3479.75
277	STRAW MULCHING	0.00	0.00	0.00	0.00	0.00	0.00	13919.00	13919.00 SY	0.25	3479.75
319	CORE STONE	0.00	0.00	0.00	81.00	0.00	0.00	0.00	81.00 CY	45.00	3645.00

(B) AMOUNT OF WORK COMPLETED THIS WEEK 17845.60

CALCULATION OF COMPLETION PERCENTAGES. NOTE: ALL PERCENTAGES WERE CALCULATED USING LATEST ADJUSTED CONTRACT AMOUNTS.

CO# 1 TO 030 EXCEPT

(A) AMOUNT PREVIOUS $ 25,449,402.73
(B) AMOUNT THIS WEEK $ 17,845.60
(C) AMOUNT TO DATE $ 25,467,248.33

ORIGINAL CONTRACT AMOUNT $ 25,978,212.98
TOTAL EXTRAS & SUPPLEMENTALS $ 1,665,501.94
TOTAL REDUCTIONS $ 1,903,676.43
ADJUSTED CONTRACT AMOUNT $ 25,740,038.49

$$\%\ \text{TO DATE} = \frac{(C)}{\text{ADJUSTED CONTRACT AMOUNT}} = \frac{\$\ 25,467,248.33}{\$\ 25,740,038.49} = 99.\%$$

$$= \frac{\text{TIME USED}}{\text{TIME ALLOWED}} = \frac{1223}{1193} = 103.\%$$

ENGINEERS' ESTIMATE OF PROJECT COMPLETION DATE = 07/29/87

ESTIMATED PROJECT FULL OPENING DATE = 08/15/87

DAILY AVERAGE NUMBER OF CONTRACTOR EMPLOYEES 27
DAILY AVERAGE NUMBER OF CONTRACTOR ACTIVITIES 6

ASBUILT WORK COMPLETED TO DATE 30.

FIGURE 16 Sample weekly progress report (page 2).

2. Handouts for Change Orders and Fuel Price Adjustments
B. Fourth Priority List
1. Review the Two Items
2. Discuss Any Proposed Items
IV. Miscellaneous Discussion, New Topics
V. Visit to the Microcomputer Store at OTIS Central, Bear Tavern Road

ACES Team meeting discussions are divided into four areas:

- *Discussion of Current Sites* Projects using ACES are discussed. Any problems that have occurred are examined, along with the status of each site.
- *Technical Updates* Items such as new hardware or software are either demonstrated or discussed. The team may vote on any choices that are presented. Normally, OTIS personnel have the responsibility of recommending changes in hardware.
- *Review of the Priority Lists* Additions to the ACES software are discussed. Proposed additions are ranked and placed on a priority list. The higher-priority items are placed on the higher-priority lists. As of August 1987, the First and Second priority lists had been completed, and OTIS was working on the Third Priority List. The Fourth Priority List was still pending. During this portion of the meeting, OTIS also demonstrates the programs that are in progress. The team reviews the work and either accepts it or recommends changes to it. All new programs must be accepted by a majority vote of the team before being included in the ACES program.
- *Miscellaneous Discussion* Computer applications outside of ACES are discussed, along with other topics of general interest.

IN THE FUTURE

There are plans to include automatic change order generation among the menu selections. The ACES team is exploring the use of electronic signatures for monthly estimate approvals. Currently, estimates produced by the system must be processed manually because approval signatures are required. An electronic signature system would speed the processing of estimates and payment to the contractor considerably.

CONCLUSIONS

ACES has proven to be a valuable tool for the NJDOT field forces. Resident engineers have always complained about the volume of paperwork generated by construction projects and the time required to produce it. ACES substantially reduces the time needed to produce reports and related documents. The system is flexible, and additional features can be added without a complete redesign. Its ease of use has converted the noncomputer users into computer enthusiasts.

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