Abridgment

Integration of Personal Computers with Mainframe Computer Maintenance Management Systems

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Maintenance management systems have been in existence for 20 years. Connecticut's is old technology developed in 1972. At a low cost, Connecticut integrated personal computers with the existing mainframe system. This has helped Connecticut gain greater independence and flexibility in the field and has significantly reduced data entry errors.

Connecticut is one of the smallest states in the nation, ranking 48th in area. However, the state ranks fourth in population density. Approximately 3.1 million persons occupy 5,009 mi^2. Connecticut has 169 towns and 8 counties.

The Connecticut Department of Transportation maintains approximately 4,900 two-lane mi of roadway, of which approximately 900 mi is Interstate. To maintain these roads, the state is divided into four districts, each district being administered by a district maintenance manager. The districts are further divided into three sections; each section is administered by an operational superintendent. Three districts have their sections divided into four areas (a maintenance garage and associated area of responsibility), and one district has its sections divided into five areas. Two operational superintendents of each district are responsible for one of two specialty crews (signs and markings and electrical) for that district. In addition, two operational superintendents are responsible for maintenance of bridges, each superintendent being responsible for two districts. The total complement of personnel, staff, and field is approximately 2,200.

Maintenance management consists of planning, scheduling, and controlling work on the basis of desired levels of service. Maintenance management systems are comprehensive approaches to effect maintenance management. The objectives of Connecticut's maintenance management system are to

- Define work activities and measurement units in terms that are significant for planning work and measuring performance;
- Establish desired levels of maintenance service;
- Provide an objective basis for establishing annual work programs;
- Use labor, equipment, material, and financial resources in the most efficient and economical manner; and
- Provide the means for management to evaluate performance in terms of performance standards and work programs.

To accomplish the objectives, maintenance activities were divided into 10 functional categories: pavement and shoulders, drainage, structures, traffic services (signs, markings, illumination, etc.), extraordinary maintenance (accident, storm damage, etc.), work for other state agencies, snow and ice control, roadside (mowing, etc.), betterments, and overhead (training, vacation, sick leave, etc.). Work activities associated with each category were identified and described. To date Connecticut has defined 154 maintenance work activities.

For each work activity, standards were developed for performance, quantity, and quality. Actual work performance can be compared with the performance standards to monitor productivity and efficiency. Both planned and actual maintenance activities are developed and evaluated within the defined levels of service.

Connecticut's maintenance management system is a mainframe computer application and was developed in 1972. Although Connecticut's maintenance management system can be considered old technology, Connecticut integrated personal computers with the mainframe computers to increase efficiency, accessibility, and independence inexpensively.

The original information flow and data entry procedures consisted of field personnel completing code sheets on planned activities and work accomplished. The code sheets were forwarded to the district office and district personnel keypunched cards and entered the data by means of the cards. These procedures were prone to error and delay and were not responsive to users. On receipt, the report was reviewed for coding and keypunch errors. Errors were recorded, the data were reprocessed, and another report was generated. The recycling continued until the information for the month was correct. On the average, final reports were 2 to 3 months late.

To reduce dependence on this process, the Office of Maintenance developed a turnkey system using personal computers to enter data and generate reports. The system consists of three elements: data entry and validation, uploading information to the mainframe, and report generation.

For the first element, a user-friendly application was developed to check the validity of information being entered into the personal computer. The personal computer program was developed to identify data that violated the parameters of the maintenance management system master file in the main-

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frame and correct the data at the time of entry into the personal computer. During the input phase, a data entry person fills in the blanks on a screen (see Figure 1). The program will not accept invalid data.

The second element is a menu option for uploading records to the mainframe (see Figure 2). All that is required of the user is to enter the option letter. When the user selects the option to upload records, the system first checks to see if there is a floppy disk in drive A. If there is no disk, the system prompts the user to insert one. If there is one, the system compares the size of the file on the hard disk with the amount of space available on the floppy disk. If there is sufficient space, the system proceeds to the next phase; otherwise, the system prompts the user to insert a new floppy disk. Next, the system converts the dBase III data file on the C drive to an ASCII file and transfers program control to the Sperry Terminal Emulator Program (STEP). The STEP program logs onto the mainframe, copies the records from the personal computer to the mainframe maintenance management system master file, logs off the mainframe, and returns program control to the personal computer. The personal computer application then asks the user if the uploading was successful. If

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                    MAINT. MANAGEMENT SYSTEM
            START RECORD #: 2023  ADDING RECORD #: 2023

ACTIVITY            9999 To exit

CREW SIZE

DATE

AREA CODE

R/T HOURS

O/T HOURS

ACCOMP.
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FIGURE 1 Input phase.

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                    MAINT. MANAGEMENT SYSTEM

                  ========== MAINT.IO ==========
                        A->   INPUT
                        B->   PRINT
                        C->   UPDATE
                        D->   DELETE
                        E->   UPLOAD
                  ========== PLANNED ==========
                        F->   INPUT
                        G->   PRINT
                        H->   UPDATE
                        I->   DELETE
                        J->   UPLOAD
                  ==============================
                        K->   REPORT
                        X->   EXIT

                    INPUT WEEKLY MAINT. IO
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FIGURE 2 Menu option for uploading to mainframe.

the answer is affirmative, the system copies the file from the hard disk to the floppy disk and then erases the file on the hard disk. This ensures a backup copy of the records. If the answer is negative, the system asks the user if the user wishes to try again.

The third element consists of generating reports. The user selects the option for reports, and the system then prompts the user to enter the report parameters (beginning and ending dates of the report requested). The interfacing with the mainframe is similar to that for uploading.

By integrating personal computers with the mainframe, the Office of Maintenance has gained significant independence and flexibility in the field. District personnel now have more control over data entry and generation of needed reports.

The cost to accomplish the interfacing was minimal. Each district office had personal computers (NCR PC6s, which had been purchased previously for $3,220). The only hardware expense was the purchase of four Sperry STEP boards at a cost of $150 each. The programming was done by maintenance personnel and took approximately 1 month.

The major features of Connecticut's current stand-alone maintenance management system are the documentation of work hours and accomplishments annually and the ability to compare performance for each maintenance activity against a standard. The shortcomings of the system are as follows: it is not flexible; it is not integrated with equipment, budget, or material data; it does not provide information at a low-enough level to be used in the field; and it does not provide equipment or manpower scheduling capabilities.

Pennsylvania's Maintenance Operations Resources Information System (MORIS) is more sophisticated than the system used in Connecticut. Pennsylvania has integrated several systems with its maintenance management system, and the scheduling module as described appears to be most beneficial. Connecticut currently uses manual methods for scheduling similar to those Pennsylvania used before MORIS. Deficiencies are identified in the field, and work, materials, and equipment are scheduled at biweekly meetings.

The advantages in MORIS's scheduling module are apparent, and it was the next logical step in the evolution of Pennsylvania's maintenance management system. The integration of financial, equipment, material, and scheduling functions can relieve administrators of many hours of monitoring and controlling maintenance functions. However, in Connecticut the technological development of the maintenance management system has not progressed beyond the stand-alone system developed in 1972.

In summary, Pennsylvania should be commended for furthering the development of maintenance management system concepts. As are most technical advances, its advance was built on the merging of previous experience, a need for improvement, and innovation.