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Overview of PAVER Pavement Management System

M.Y. SHAHIN AND S.D. KOHN

A brief overview of the PAVER pavement management system and the capabilities it offers its users is presented. PAVER is designed for use by military installations, cities, and counties. The system capabilities discussed are data storage and retrieval, pavement network definition, pavement condition rating, project prioritization, inspection scheduling, determination of present and future network condition, determination of maintenance and repair needs, performance of economic analysis, and budget planning.

PAVER is a pavement management system designed for use by military installations, cities, and counties. The system was developed and tested over the past 10 years and is currently being implemented by several agencies, including Fort Eustis, the Great Lakes Naval Training Center, and the City of Mesa, Arizona. This system was developed by the U.S. Army Construction Engineering Research Laboratory under the auspices of the Office of the Chief of Engineers, U.S. Army Corps of Engineers. It has been extensively tested prior to its implementation. The objective of this paper is to provide an overview of PAVER with emphasis on what is available to system users. Details of the system's development and results of an economic analysis of its implementation have been documented in a paper by Shahin and Kohn (1) and a paper by Kohn and Shahin in this Record.

PAVER provides the engineer with a practical decisionmaking procedure for identifying cost-effective maintenance and repairs on roads and streets. The System 2000 is the data base manager. This system and other "interface" programs provide the user with report generation capability for critical information. This information allows objective input to the decisionmaking process.

PAVER provides its users with many important capabilities. These include data storage and retrieval, pavement network definition, pavement condition rating, project prioritization, inspection scheduling, determination of present and future network condition, determination of maintenance and repair (M&R) needs, performance of economic analysis, and budget planning. This paper describes these capabilities and presents example reports for each area.

DATA STORAGE AND RETRIEVAL

The PAVER data base is a custom-designed data structure defined on a commercially available computer data base manager called System 2000 (System 2000 is a registered trademark of the Intel Corporation).

The data structure consists of 12 data groups that are linked together to form a tree structure (see Figure 1). Storing the data in this structure enables the user to retrieve information based on its connection to other data in the data base. Space is available in each data group to store specific items related to that data group. The Pavement Structure data group shown in Figure 2 is an example.

The data can be stored and retrieved through special "interface" programs (FORTRAN or COBOL) or through the access language of the data base manager. Since these programs are interactive, the user has immediate access to the data base. The programs are designed to supply the information in useful format.

DEFINITION OF PAVEMENT NETWORK

An installation's (city's) pavement network consists of all surface areas that provide access ways for ground or air traffic (airfield pavements). This network must be divided and identified in order to use the data base. Networks are divided into branches, sections, and sample units, which can be briefly defined as follows:

1. A branch is any identifiable part of the network that is a single entity and has a distinct function, such as an individual street.
2. A section is a division of a branch that has consistent structural composition, construction history, and traffic volume.
3. A sample unit is the smallest unit of the network and is an area of the pavement section used during inspection.

The data base provides information on the pavement network through reports such as "lists" or "inventories". Figure 3 shows a typical output of the inventory report. This report provides general information about specific branches or sections, thus providing the user with overall inventory information.

PAVEMENT CONDITION RATING

A key component of any pavement management system is a condition rating procedure. The PAVER system uses the pavement condition index (PCI), a composite index of the structural integrity and operating condition of the pavement. It is a numerical index from 0 to 100, where 100 represents excellent condition. The PCI is determined based on quantity, severity, and type of distress, as shown in Figure 4. The PCI was developed to agree closely with the collective judgment of experienced pavement engineers.

The PCI has been divided into seven condition categories, ranging from "excellent" to "failed", as

shown in Figure 5. These categories are useful for developing maintenance policies and guidelines.

The PAVER data base uses reports such as PCI, Inspect, and Sample to provide PCI information. Figure 6 shows a typical output of the Inspect report, which provides the user with PCI and distress information. The report can be used to prepare desk estimates of repairs and to determine history of pavement condition.

PROJECT PRIORITIZATION

Project prioritization is an immediate payoff of pavement network definition and pavement condition rating. The PCI report can be used for this purpose. It lists pavement sections in an increasing order of PCI. Figure 7 shows an example report output. The information in the report can be sorted based on pavement surface type, pavement rank (functional class), traffic type and volume, PCI range, or a combination of factors. Therefore, the report can be used to prioritize projects based on the user's policy.

INSPECTION SCHEDULING

The Inspection Schedule report has been developed to maintain current condition data with efficient inspection level. This report produces a plot and list of the pavement sections to be surveyed for the next six years for any type of branch use (roadway, parking, etc.) and surface type (asphalt, portland cement, concrete, etc.).

The schedule is based on two criteria. One is the minimum PCI that a given pavement type is allowed to reach, and the second is the rate of deterioration (loss of PCI points per year). The user inputs the minimum PCI values and the years allowed between inspections for various deterioration rates. The PCI for the selected sections is then predicted by a straight-line extrapolation based on

Figure 1. PAVER data structure.

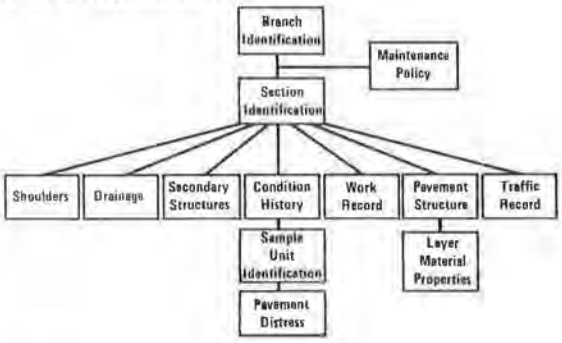


Figure 2. Pavement Structure data group.

```
2500*  PAVEMENT STRUCTURE (RG IN 1000)
  2501*  DATE CONSTRUCTED (DATE IN 2500)
  2502*  LAYER CATEGORY (NAME X(10) IN 2500)
  2503*  LAYER MATERIAL CODE (INTEGER NUMBER 999 IN 2500)
  2504*  LAYER MATERIAL (NAME X(20) IN 2500)
  2505*  LAYER THICKNESS (DECIMAL NUMBER 99.9 IN 2500)
  2506*  TYPE OF COATING (NAME X(10) IN 2500)
  2507*  LAYER COMMENTS (NON-KEY NAME X(39) IN 2500)
  2508*  PAVEMENT STRUCTURE UPDATE (NON-KEY DATE IN 2500)
  2509*  FACTOR 2509 (NON-KEY DECIMAL NUMBER 9(8).99 IN 2500)
  2510*  FACTOR 2510 (NON-KEY DECIMAL NUMBER 9(8).99 IN 2500)
  2511*  FACTOR 2511 (NON-KEY DECIMAL NUMBER 9(8).99 IN 2500)
  2512*  FACTOR 2512 (NON-KEY DECIMAL NUMBER 9(8).99 IN 2500)
  2513*  FACTOR 2513 (NON-KEY DECIMAL NUMBER 9(8).99 IN 2500)
  2514*  PSTR-CONCAT (NAME X(19) IN 2500)
  3100*  LAYER MATERIAL PROPERTIES (RG IN 2500)
    3101*  TEST DATE (DATE IN 3100)
    3102*  TEST TYPE (NAME X(31) IN 3100)
    3103*  TEST VALUE (DECIMAL NUMBER 9(5).9999 IN 3100)
    3104*  TEST UNIT (NON-KEY NAME X(13) IN 3100)
    3105*  FACTOR 3105 (NON-KEY DECIMAL NUMBER 9(8).99 IN 3100)
    3106*  FACTOR 3106 (NON-KEY DECIMAL NUMBER 9(8).99 IN 3100)
    3107*  FACTOR 3107 (NON-KEY DECIMAL NUMBER 9(8).99 IN 3100)
    3108*  FACTOR 3108 (NON-KEY DECIMAL NUMBER 9(8).99 IN 3100)
    3109*  FACTOR 3109 (NON-KEY DECIMAL NUMBER 9(8).99 IN 3100)
    3110*  LMAT-CONCAT (NAME X(26) IN 3100)
```

Figure 3. Example output of Inventory report.

```
REPORT DATE-  02/18/82

                          INVENTORY
                NON-FAMILY HOUSING PAVEMENTS

                                  SURF    BRANCH      PAVEMENT      AREA
                                  TYPE    USE         RANK          (SY)
----------
IWASN WASHINGTON NORTH
      SECTION 01                  AC      ROADWAY     PRIMARY       4007
      FROM- ROUTE 105
      TO-   CL MADISON AVE

      SECTION 02                  AC      ROADWAY     PRIMARY       6651
      FROM- CL MADISON AVE
      TO-   N'LY SIDE HINES CIR

      SECTION 03                  AC      ROADWAY     PRIMARY       4000
      FROM- S'LY SIDE HINES CIR
      TO-   CENTER OF SOMERVELL

      SECTION 04                  AC      ROADWAY     PRIMARY       6340
      FROM- CENTER OF SOMERVELL
      TO-   N'LY EDGE TAYLOR

      SECTION 05                  PCC     ROADWAY     SECONDARY     4453
      FROM- S'LY EDGE TAYLOR
      TO-   N'LY EDGE WILSON

                                          TOTAL BRANCH AREA         25451

  TOTAL AREA OF SELECTED NON-FAMILY HOUSING PAVEMENTS               25,451
```

Figure 4. Steps for determining PCI of a pavement section.

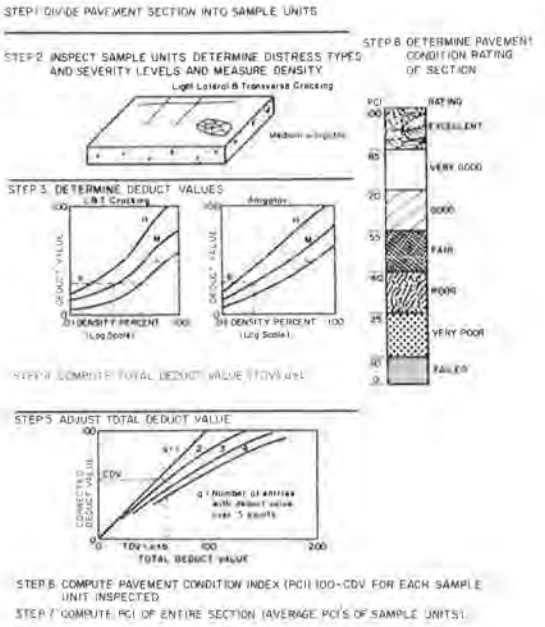


Figure 5. Correlation of M&R zones with PCI and condition rating for airfield pavements.

M&R ZONE	PCI		RATING
ROUTINE	100		EXCELLENT
	85		VERY GOOD
ROUTINE, MAJOR, OVERALL	70		GOOD
	55		FAIR
MAJOR, OVERALL	40		POOR
OVERALL	25		VERY POOR
	10		FAILED
	0		

Figure 6. Example output of Inspect report.

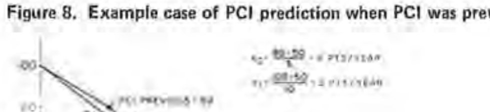
```
REPORT DATE-  09/28/81            PAVEMENT INSPECTION

BRANCH NAME -   WASHINGTON NORTH                    SECTION LENGTH -  2307 LF
BRANCH NUMBER -  IWASN                              SECTION WIDTH -   24 LF
SECTION NUMBER - 04                                 SECTION AREA -     6340 SY

INSPECTION DATE - 11/06/79     PCI= 76    RATING=  VERY GOOD
CONDITION- RIDING-C2  SAFETY-C1  DRAINAGE-C1  SHOULDERS-C1  OVERALL-C1

TOTAL NUMBER OF SAMPLES IN SECTION=                               24
NUMBER OF SAMPLES SURVEYED=                                       11
RECOMMENDED SAMPLES TO BE SURVEYED=                               17
STANDARD DEVIATION OF PCI BETWEEN RANDOM UNITS SURVEYED=        15.3

EXTRAPOLATED DISTRESS QUANTITIES FOR SECTION-
```

DISTRESS TYPE	SEVERITY	QUANITITY	DENSITY-PCT	DEDUCT-VALUE
ALLIGATOR CR	MEDIUM	592 SF	1.03	21.4
DEPRESSION	LOW	5 SF	0.00	4.0
EDGE CR	HIGH	8 LF	0.01	7.4
EDGE CR	LOW	13 LF	0.02	0.2
EDGE CR	MEDIUM	30 LF	0.05	4.0
JT REFLECT CR	HIGH	74 LF	0.12	2.6
JT REFLECT CR	LOW	128 LF	0.22	0.0
JT REFLECT CR	MEDIUM	278 LF	0.48	3.8
LANE/SHLDR DROP	LOW	49 LF	0.08	2.0
LANE/SHLDR DROP	MEDIUM	25 LF	0.04	4.0
LONG/TRANS CR	LOW	512 LF	0.89	1.6
PATCH/UTIL CUT	LOW	192 SF	0.33	0.8
RR CROSSING	LOW	270 SF	0.47	2.0
RUTTING	LOW	150 SF	0.26	2.0
RUTTING	MEDIUM	72 SF	0.12	4.6

Figure 7. Example output of PCI report.

```
REPORT DATE-  09/28/81                          PCI REPORT

BRANCH    BRANCH   SECTION                       SURFACE     SECTION   PAVEMENT
NUMBER     USE     NUMBER   PCI     RATING        TYPE      AREA/SY     RANK

PBENE     PARKING      01    10      FAILED        AC           440    SECONDARY
         12/04/79  [FROM] PARKING AREA            [TO]  BLDG 1002
PBENE     PARKING      03    10      FAILED        AC           440    SECONDARY
         12/04/79  [FROM] PARKING AREA NR BLD     [TO]  G 1001
PSTER     PARKING      03    13    VERY POOR       PCC          868    TERTIARY
         10/17/79  [FROM] PARKING LOT             [TO]  BLDG 515
PBENE     PARKING      02    18    VERY POOR       AC           440    SECONDARY
         12/04/79  [FROM] PARKING AREA NR BLD     [TO]  G 1004
IBACK     ROADWAY      01    21    VERY POOR       AC          5155    TERTIARY
         02/11/81  [FROM] E EDGE HARRISON RD      [TO]  W EDGE MULBRY IS RD
PBENE     PARKING      04    25    VERY POOR       AC           440    SECONDARY
         12/04/79  [FROM] PARKING AREA NR BLD     [TO]  G 1005
PCOND     PARKING      01    25    VERY POOR       PCC          550    SECONDARY
```

Figure 8. Example case of PCI prediction when PCI was previously determined.

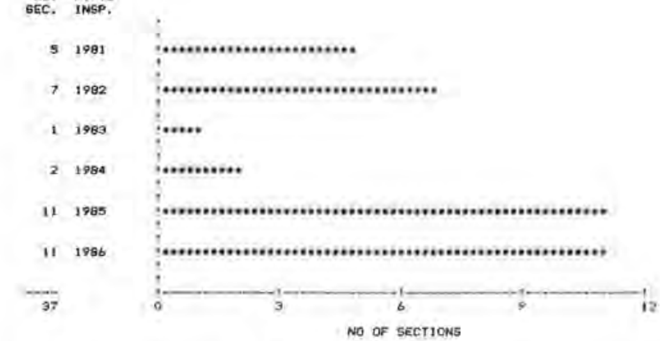


the maximum slope from either the last inspection or construction-overlay date (see Figure 8). Sections reaching the minimum PCI within six years of reaching the time limit based on the rate of deterioration are selected for inspection in the appropriate year.

Figure 9 shows a typical Inspection Schedule output with plot and list of cases. The example shown is for primary roadways with asphalt concrete surfaces. By using this report, the engineer can keep the pavement network data base up to date with minimal effort.

Figure 9. Example output of Inspection Schedule report.

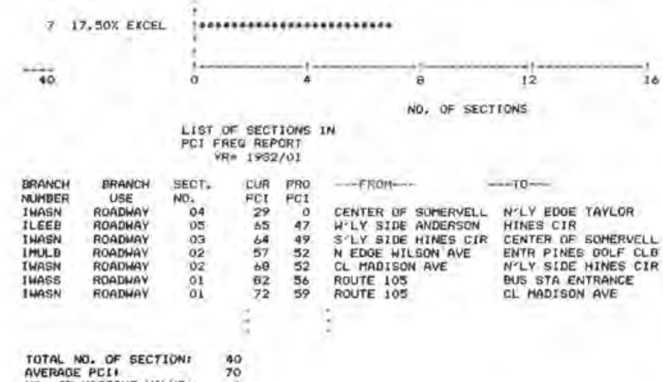
```
INSPECTION SCHEDULE REPORT
                                  REPORT DATE:  81/09/28.

BRANCH USE: ROADWAY
PAVEMENT RANK: P
SURFACE TYPE: AC
FAMILY HOUSING: B
```




```
                    LIST OF CASES IN
                INSPECTION SCHEDULE REPORT

        FY TO INSPECT : 1981   NO. OF SECTIONS :    5
BRANCH  BRANCH SECT.  PAVE.  SUT  SEC    FROM                 TO
NUMBER   USE    NO.   RANK        AREA
ILEEB  ROADWAY  05     P     AC   7698 W'LY SIDE ANDERSON   HINES CIR
IMULB  ROADWAY  02     P     AC  12551 N EDGE WILSON AVE    ENTR PINES GOLF CLB
IWASN  ROADWAY  02     P     AC   6651 CL MADISON AVE       N'LY SIDE HINES CIR
IWASN  ROADWAY  03     P     AC   4000 S'LY SIDE HINES CIR  CENTER OF SOMERVELL
IWASN  ROADWAY  04     P     AC   6340 CENTER OF SOMERVELL  N'LY EDGE TAYLOR

TOTAL NO. OF SECTION:       37
SECT. NOT NEEDING REPAIR:    0
NO. OF MISSING VALUE:        1
```

Figure 10. Example output of PCI Frequency report for January 1982.

```
PCI FREQUENCY REPORT
                              REPORT DATE:  81/09/28.

BRANCH USE: ROADWAY
PAVEMENT RANK: P
SURFACE TYPE: AC  PCC
FAMILY HOUSING: B

                   YR= 1982/01
```




```
               LIST OF SECTIONS IN
               PCI FREQ REPORT
                  YR= 1982/01

BRANCH   BRANCH   SECT.  CUR  PRO   ---FROM---            ---TO---
NUMBER    USE     NO.    PCI  PCI
IWASN   ROADWAY   04     29    0   CENTER OF SOMERVELL   N'LY EDGE TAYLOR
ILEEB   ROADWAY   05     65   47   W'LY SIDE ANDERSON    HINES CIR
IWASN   ROADWAY   03     64   49   S'LY SIDE HINES CIR   CENTER OF SOMERVELL
IMULB   ROADWAY   02     57   52   N EDGE WILSON AVE     ENTR PINES GOLF CLB
IWASN   ROADWAY   02     68   52   CL MADISON AVE        N'LY SIDE HINES CIR
IWASS   ROADWAY   01     82   56   ROUTE 105             BUS STA ENTRANCE
IWASN   ROADWAY   01     72   59   ROUTE 105             CL MADISON AVE

TOTAL NO. OF SECTION:   40
AVERAGE PCI:            70
NO. OF MISSING VALUE:    1
```

DETERMINATION OF PRESENT AND FUTURE NETWORK CONDITION

An overall PCI Frequency report has been developed to help plan future M&R and to inform management of

Figure 11. Example output of PCI Frequency report for January 1983.

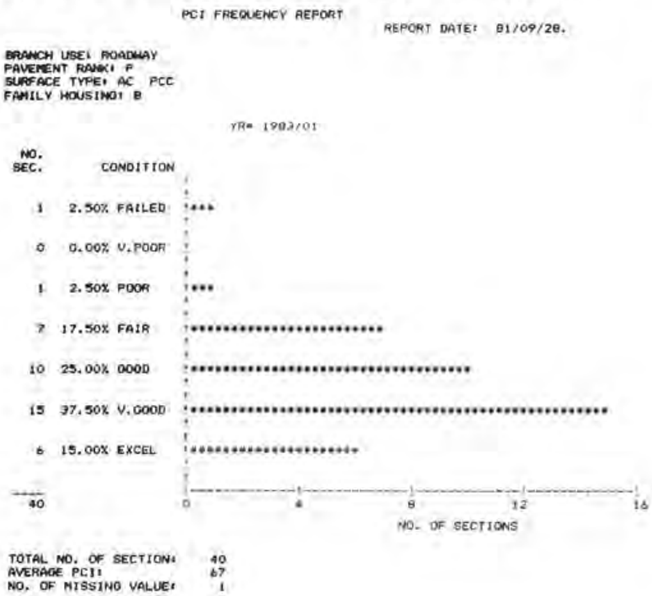
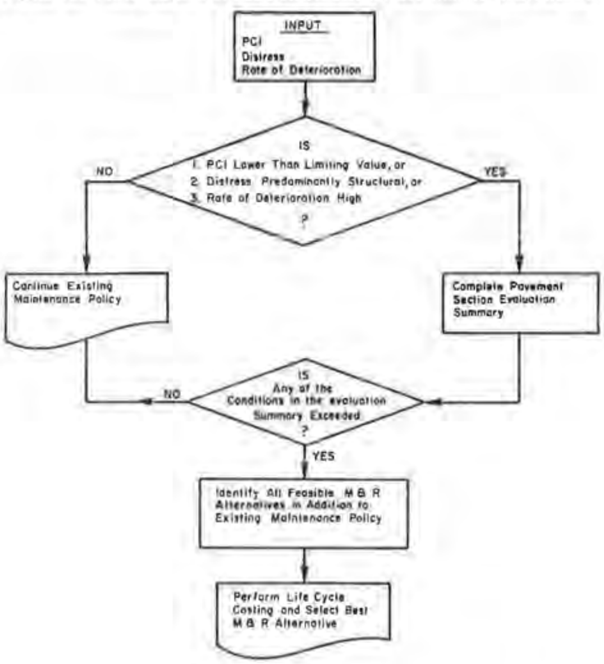


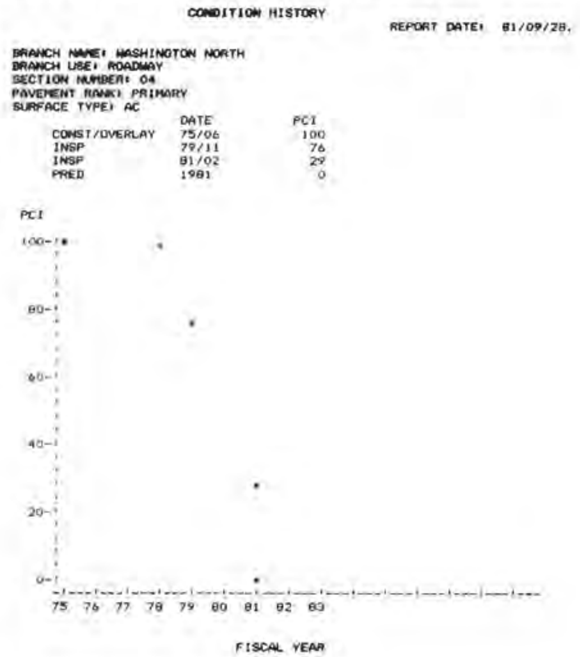
Figure 12. Flow diagram of decision process for determining M&R needs.



the network condition. The report shows an estimated frequency of condition (based on the PCI scale) for the year requested. The pavement sections included in the report can be selected based on branch use, pavement rank, and surface type.

The frequency is estimated as in the Inspection Schedule report by using a straight-line extrapolation of the PCI. Figures 10 and 11 show typical outputs of this report. These two figures show the estimated frequency of occurrence for the same set of pavement sections for two different years. The extrapolation presumes that no major repairs (such as slab replacement or overlay) have occurred between the last inspection and prediction dates. Thus, the impact of performing no major repairs can be seen.

Figure 13. Example output of Condition History report.



DETERMINATION OF M&R NEEDS

A decision process has been devised for determining the M&R needs of a pavement section. Figure 12 shows a flow diagram of this process. A first-level decision can be made, based on the PCI value, type of distress, and deterioration rate. PAVER provides reports such as PCI and Condition History to help the user make the first decision. The PCI report is an ordered listing of sections ranked by PCI (Figure 7). The Condition History report can be used to determine the rate of deterioration; the report plots the PCI over time for a given section. The plot shows the PCI at each inspection date and linearly extrapolates a point five years beyond the last inspection date. Figure 13 shows an example of this report. The type of distress can be determined from the inspect report, shown in Figure 6.

If a pavement section does not require further analysis, routine maintenance practices can be continued. Routine maintenance includes practices such as spall repair and crack filling. By using maintenance guidelines for specific distress types, such as those given in Table 1, the user can input a repair policy. This policy is used in a program called MRG (Maintenance and Repair Guidelines) to estimate the type and cost of routine repair to specific sections. The MRG report can also be used to compute the cost of overlay after distress repair. Figure 14 shows an output of the MRG report.

If a section requires further analysis, an evaluation summary is completed for the section. The evaluation is based on structural capacity, roughness, skid problems, and other relevant factors, as shown in the top half of Figure 15. Complete guidelines for performing the evaluation are presented elsewhere (1). Feasible M&R alternatives are identified based on the results of the evaluation, as shown in the bottom half of Figure 15. This figure is an output of the Evaluation Summary report that was developed based on input from many experiences (maintenance engineers). The output from the report is general. Therefore, the engineer needs to select specific alternatives and perform the design based on the user agency policy. This may include using nondestructive testing.

PERFORMANCE OF ECONOMIC ANALYSIS

Several repair (or construction) alternatives may be considered feasible for any given pavement section. To help select the appropriate alternative, an Economic Analysis program has been developed and added to the system. The program allows the user to input initial costs, periodic maintenance costs, and separate future maintenance costs. Figure 16 shows a typical input, and Figure 17 shows a corresponding

Table 1. Maintenance guidelines for asphalt pavement distresses.

	M&R Method									
Distress Type	Do Nothing	Crack Seal	Partial-Depth Patch	Full-Depth Patch	Skin Patch	Pothole Filling	Apply Heat and Roll Sand	Apply Surface Seal Emulsion	Apply Rejuvenation	Apply Aggregate Seal Coat
Alligator cracking			M,H					L	L	
Bleeding	L						L,M,H			
Block cracking	L	L,M,H							L	L,M
Bumps and sags	L		M,H	M,H	M,H					
Corrugation	L		M,H	M,H						
Depression	L		M,H	M,H	M,H					
Edge cracking[a]	L	L,M	M,H	M,H						
Joint reflective cracking	L	L,M,H	H							
Lane-shoulder drop-off[b]	L									
Longitudinal transverse cracking	L	L,M,H	H					L	L	L,M
Patching and utility cut	L	M	H[c]	H[c]						
Polished aggregate	A									A
Potholes			L	L,M,H		L,M,H				
Railroad crossing	L				L,M,H					
Rutting	L		L,M,H	M,H	L,M,H					
Shoving	L		M,H							
Slippage cracking	L	L	M,H							
Swell	L			M,H						
Weathering and raveling	L		H					L,M	L	M,H

Note: L = low severity; M = medium severity; H = high severity; and A = has only one level of severity.

[a] If predominant, apply shoulder seal, e.g., aggregate seal coat.
[b] If predominant, level off shoulder and apply aggregate seal coat.
[c] Replace patch.

Figure 14. Example output of MRG report.

```
REPORT DATE - 81/10/05.

                    MAINTENANCE AND REPAIR GUIDELINES

BRANCH NAME   - WASHINGTON NORTH                    SECTION LENGTH -   2307 LF
BRANCH NMBR   - IWASN                               SECTION WIDTH  -     24 LF
SECTION NMBR  - 04                                  SECTION AREA   -  6340 SY

INSPECTION DATE - 02/11/81                          SECTION PCI    -     29

DISTRESS      DIS  DIST-QTY  WORK          MATL LABOR LABOR MAT'L EQUIP TOTAL
TYPE          SEV  WORK-QTY  TYPE          CODE HOURS COST$ COST$ COST$ COST$
-------------------------------------------------------------------------------
ALLIGATOR CR   M   1682 SF
                   1682 SF   SHALLOW PATCH  120  941.0 10092   336  1867 13136
LONG/TRANS CR  M    975 LF
                    975 LF   CRACK FILLING  171    0.0     0     0     0   639
                             OVERLAY        120                             19028
-------------------------------------------------------------------------------
                                            TOTAL 941.0 10092   336  1867 32803
```

Figure 15. Example output of Evaluation Summary report.

```
CURRENT VALUES ARE AS FOLLOWS :=
 1  PCI :=  29
 2  LOCAL VARIATION(Y/N)          := N
 3  SYSTEMATIC VARIATION(Y,N) := N
 4  SHORT TERM RATE OF DETERIORATION(L,N,H):= L
 5  LONG TERM RATE OF DETERIORATION(L,N,H) := H
 6  MAJOR SOURCE OF DISTRESS(LOAD,CLIMATE) := L
 7  LOAD CARRYING DEFICIENCY(Y,N) := Y
 8  SURFACE ROUGHNESS(L,M,H)       := L
 9  SKID/HYDROPLANING PROBLEMS(L,M,H) := L
10  PREVIOUS MAINTENANCE(L,N,H)        := N
SELECT(A-D) :=
I>C

DATE := 10 FEB 82          FEASIBLE M&R ALTERNATIVES

BASE := M Y SHAHIN                    FEATID := WASH      PCI:=  29
FEATNM := WASHINGTON BLVD             M&R REPAIR ZONE := MAJOR-OVERALL

          ***** RECOMMENDED MAINTENANCE ALTERNATIVES *****

           1 :=  RECONSTRUCTION
           2 :=  OVERLAY STRUCTURAL AC
           4 :=  OVERLAY PCC
          11 :=  RECYCLE STRUCTURE

          *** END ***
```

Figure 16. Typical input to Economic Analysis program.

	M&R ACTIVITY DESC	YEAR	COST	TIME-SPACING
1	6 IN GRAN,$10/TON	1982	32630.00	0
2	PRIME ,$.27/SY	1982	3802.00	0
3	4 IN AC ,$30/TON	1982	38704.00	0
4	REP 2 %,1.5 INT COST	1987	3754.00	5
5	PATCH & MAINT,.05/SY	1988	704.00	1
6	SURF SEAL ,$.1/SY	1989	1408.00	0
7	SURF SEAL ,$.1/SY	1996	1408.00	0

Figure 17. Economic Analysis output for input shown in Figure 16.

```
DATE:=  82/02/18.        PROJECTED COST ANALYSIS              (DETAIL)

                      SECTION ID:=TW
ALTERNATIVE:= 4 IN AC/ 6 IN GRAN          SECTION AREA(S.Y.):=  14080.0
LIFE OF ALTERNATIVE:= 20 INTEREST RATE:= 10.0   INFLATION RATE:=    0.0
```

M&R ACTIVITY	YEAR	COST($)	PRESENT VALUE($)
6 IN GRAN,$10/TON	1982	32630.00	32630.00
PRIME,$.27/SY	1982	3802.00	3802.00
4 IN AC,$30/TON	1982	88704.00	88704.00
	TOTAL:=	125136.00	125136.00
REP 2%,1.5 INT COST	1987	3754.00	2330.94
PATCH & MAINT,.05/SY	1988	704.00	397.39
PATCH & MAINT,.05/SY	1989	704.00	361.26
SURF SEAL,$.1/SY	1989	1408.00	722.53
	TOTAL:=	2112.00	1083.79
PATCH & MAINT,.05/SY	1990	704.00	328.42
PATCH & MAINT,.05/SY	1991	704.00	298.56
REP 2%,1.5 INT COST	1992	3754.00	1447.33
PATCH & MAINT,.05/SY	1992	704.00	271.42
	TOTAL:=	4458.00	1718.75
PATCH & MAINT,.05/SY	1993	704.00	246.75
PATCH & MAINT,.05/SY	1994	704.00	224.32
PATCH & MAINT,.05/SY	1995	704.00	203.92
PATCH & MAINT,.05/SY	1996	704.00	185.39
SURF SEAL,$.1/SY	1996	1408.00	370.77
	TOTAL:=	2112.00	556.16
REP 2%,1.5 INT COST	1997	3754.00	898.68
PATCH & MAINT,.05/SY	1997	704.00	168.53
	TOTAL:=	4458.00	1067.21
PATCH & MAINT,.05/SY	1998	704.00	153.21
PATCH & MAINT,.05/SY	1999	704.00	139.28
PATCH & MAINT,.05/SY	2000	704.00	126.62
PATCH & MAINT,.05/SY	2001	704.00	115.11

```
INITIAL COST($):=                              125136.00
PRESENT VALUE($):=                             134126.43
EQUIVALENT UNIFORM ANNUAL COST($):=             15754.44
EUAC PER SQ. YD. ($):=                              1.12
              ------------ END OF REPORT ------------
```

output. As shown, the user is provided with the initial cost, present value, equivalent uniform annual cost, and equivalent uniform annual cost per square yard. The Economic Analysis program allows the user to vary interest rates, inflation rates, repair costs, and timing so that their effect on alternatives can be easily analyzed.

BUDGET PLANNING

A budget planning report was developed to provide an estimate of the rehabilitation dollars required over a 10-year period for a given level of condition. The report is based on the user's input of minimum PCI levels for various branch uses and pavement rank. The user also inputs unit repair costs based on pavement surface type and the PCI scale; i.e., the cost of repair can be varied, depending on the PCI value. Thus, the increased cost of differing rehabilitation can be anticipated. The program also takes into account the inflation rate. Figure 18 shows an example output of this report.

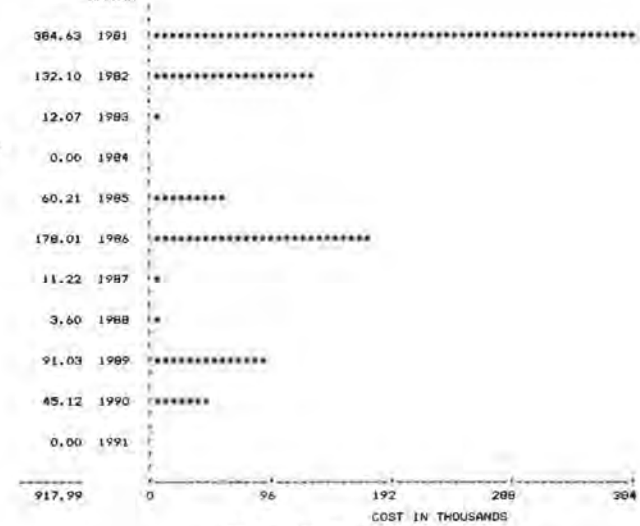
This program predicts, for each pavement section, the year in which the minimum PCI is reached and calculates the cost of repair. The prediction is the straight-line prediction procedure explained in the Inspection Schedule report.

SUMMARY

This paper has presented a brief overview of PAVER, a pavement management system for military installations, cities, and counties. PAVER assists engineers and planners with pavement management by providing the data base and computational capabilities. These capabilities are data storage and retrieval, pavement network definition, pavement condition rating, project prioritization, inspection scheduling, determination of present and future network condition, determination of M&R needs, performance of economic analysis, and budget planning.

Figure 18. Example output of Budget Planning report.

```
                  BUDGET PLANNING REPORT
                                         REPORT DATE:  81/09/28.

BRANCH USE: ROADWAY
PAVEMENT RANK: P
SURFACE TYPE: AC
INFLATION RATE:  10.00
FAMILY HOUSING: B
```



LIST OF CASES IN
BUD PLANNING REPORT

FY TO REPAIR	BRANCH NUMBER	BRANCH USE	SECT. NO.	PAVE. RANK	SUT	SEC AREA	COST TO REPAIR($1000'S)
1981	ILEEB	ROADWAY	05	P	AC	7698	55.74
1981	IMULB	ROADWAY	02	P	AC	12551	96.02
1981	IPERS	ROADWAY	03	P	AC	1917	13.80
1981	IWASN	ROADWAY	01	P	AC	4007	26.45
1981	IWASN	ROADWAY	02	P	AC	6651	47.22
1981	IWASN	ROADWAY	03	P	AC	4000	29.20
1981	IWASN	ROADWAY	04	P	AC	6340	64.03

```
TOTAL NO. OF SECTION:         20
SECT. NOT NEEDING REPAIR:      9
NO. OF MISSING VALUE:          1

            MINIMUM PCI TABLE

          P
ROADWAY  65

            SUT UNIT COST TABLE
      SUT       $ COST/SQYD
            PCI 0-20  21-40  41-60  61-80  81-100
      AC       12.00  10.00   8.00   7.00   5.00
```

ACKNOWLEDGMENT

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REFERENCE

1. M.Y. Shahin and S.D. Kohn. Pavement Maintenance Management for Roads and Parking Lots. U.S. Army Construction Engineering Research Laboratory, Champaign, IL, Tech. Rept. M-294, Dec. 1981.

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