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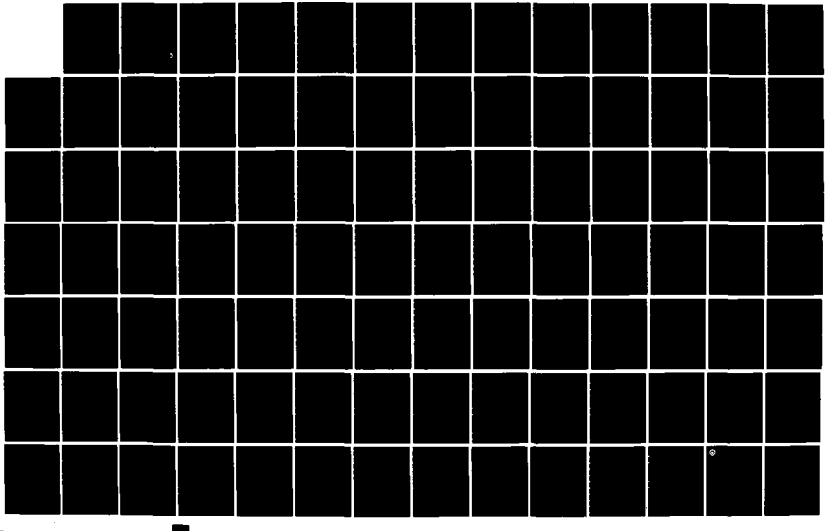

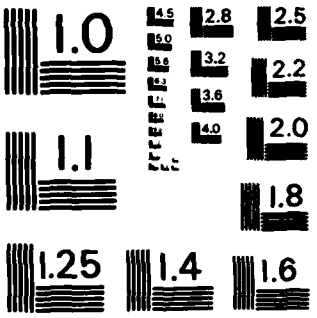

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IMPROVING PAVER IMPLEMENTATION

THESIS

Timothy R. McLean
Captain, USAF

AFIT/GEM/LSM/84S-12

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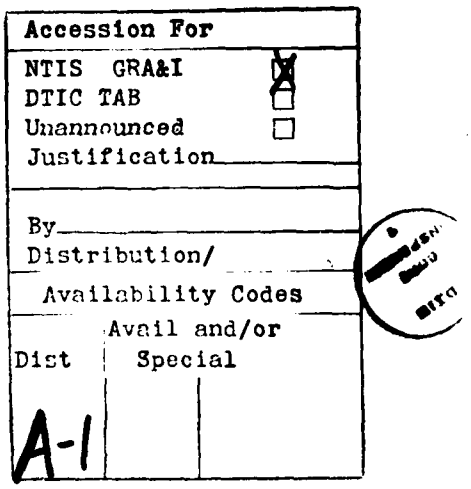

AFIT/GEM/LSM/84S-12

IMPROVING PAVER IMPLEMENTATION

THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Engineering Management

Timothy R. McLean, B.S.C.E.

Captain, USAF

September 1984

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Timothy R. McLean
Captain, USAF

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Abstract

PAVER is a state-of-the-art pavement management system that can be operated either manually or by computer and is designed to optimize the funds allocated for pavement maintenance, repair, or reconstruction. Much has already been written about the benefits of PAVER. The intent of this report is not to detract from any of those writings, but rather to supplement them. Problem areas affecting PAVER implementation are addressed so that current or future users might benefit from the lessons others have learned. Problems which were uncovered for which there are currently no solutions can now be researched and resolved. The information necessary to identify and analyze potential PAVER implementation problems was gathered through surveys sent to current and future users, through a literature review, and through telephone and personal interviews. Fourteen potential problem areas were identified, with five of them being most likely to affect PAVER implementation. These five areas are training, manpower, equipment, top management support, and user commitment. Recommended solutions are included.

IMPROVING PAVER IMPLEMENTATION

I. Introduction

A. General Issue

Airfield pavement maintenance is a key factor in supporting the Air Force's "fly and fight" mission. Without proper maintenance of the airfield, aircraft tires are damaged, snowplow blades are bent or broken, and the potential for Foreign Object Damage (FOD) is increased. This potential is especially important since FOD can result in damage to aircraft engines and windshields, ground vehicles, and support equipment. Further, it can result in injury to aircrews or ground personnel.

Maintenance of airfield pavements is the responsibility of the Base Civil Engineer (BCE). Major General William D. Gilbert, former Director of Engineering and Services, Headquarters Air Force (HQ USAF), emphasized how essential the BCE's role is:

> We consider the installation to be an integral part of our capability to launch and recover our weapon systems and it is, therefore, important to the Air Force to ensure that its facilities are well maintained [13:80].

In order for the BCE to maintain the airfield pavements (or any other Air Force facilities), he must first understand the extent of the task. In the Air Force alone, airfield pavements encompass over 247 million square yards (3:1)—the equivalent of a ten lane highway from Maine to California. Based on a recent 74,300 square yard replacement

project costing $2.94 million at Pease AFB, NH (11), this equates to about a $10 BILLION replacement value across the Air Force. Hence, the pavements represent an extremely valuable asset in themselves and, for this reason alone, warrant proper and timely maintenance.

The task of maintaining this immense pavement inventory is further complicated by the fact that the pavements are generally in a state of disrepair. Two key factors, age and neglect, have led to this deteriorated condition. The age factor is exemplified by the fact that many of the airfield pavement systems are nearing the end of their designed service (or useful) life of 25 years (18:381). In fact, over 90% of today's pavements were built prior to 1960, as indicated in Figure 1. With respect to the neglect factor, the following quotation, written about roads on a Navy station applies equally well to airfield pavements on an Air Force base:

> Pavement maintenance management typically consists of spending just enough money to repair potholes and, maybe, do some patching and crack filling. Then, when the station roads deteriorate enough, a special project is submitted for major repairs, usually consisting of an overlay of some given thickness [22:12].

For all of these reasons, an effective and efficient pavement management system (PMS) is essential to the BCE. Toward this end, the Air Force has developed and progressed through a series of pavement inspection and, to some extent, maintenance management systems since 1970. These efforts have resulted in a true pavement management system called (PAVER) (not an acronym), which has come of age for Air Force-wide implementation.

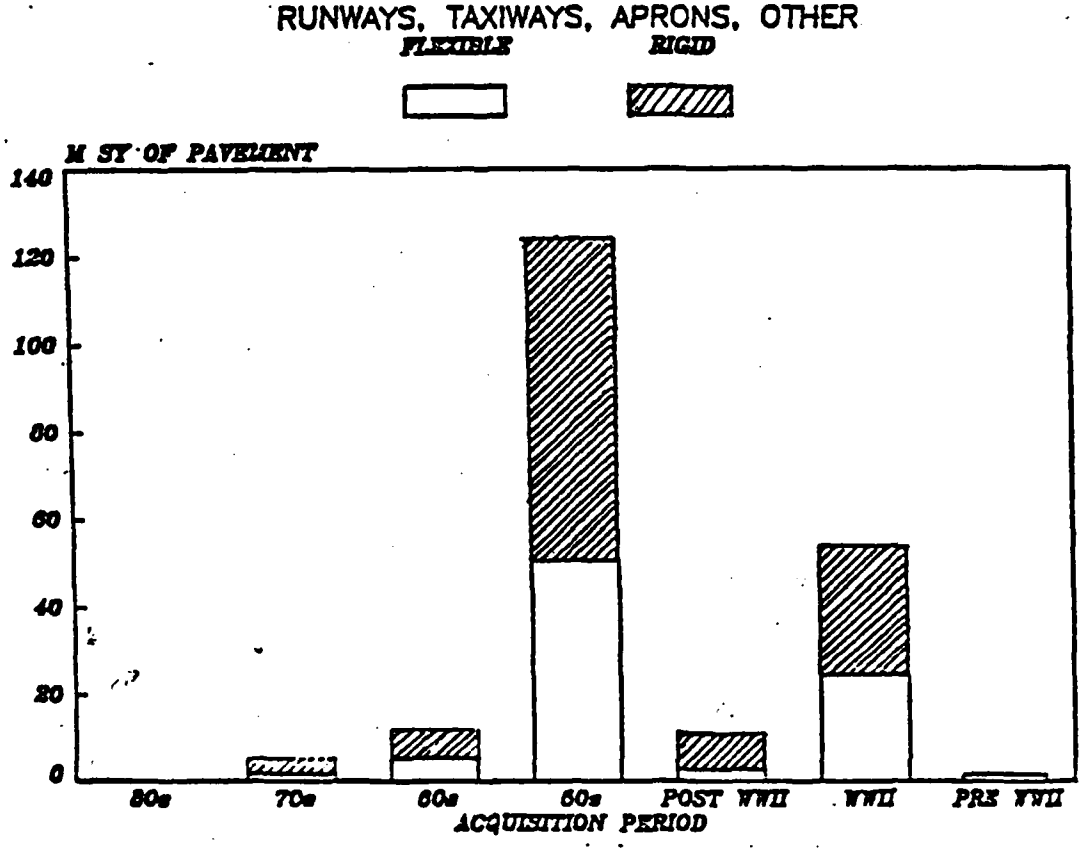


Figure 1. Worldwide Airfield Pavements (19)

B. Explanation of PAVER

PAVER is a state-of-the-art pavement management system that the the Army Construction Engineering Research Laboratory (CERL) has developed and extensively tested over the past 10 years through sponsorship and funding by the Air Force Engineering and Services Center (HQ AFESC). However, HQ AFESC and CERL are not the only agencies to appreciate the importance of having a good PMS:

> Many city and state highway departments have recognized the benefits of implementing a pavement maintenance management system, and consequently, many systems have evolved. Most are generally tailored for the user's specific needs [22:12].

Because PAVER is both centrally-based and generic in its design, it can be used by any city or military installation. For this reason, the American Public Works Association (APWA) has worked in conjunction and cooperation with CERL in the final development and testing phases of PAVER. Similarly, the Navy has assisted in the development and testing of PAVER for use at military installations.

The PAVER PMS consists of a large data base, a decision-making program, and a report generation capability, all of which can be manipulated manually or by computer. Within the PAVER data base, the pavement network is divided into manageable sections and each is given an identifying label. For each of these sections, the pavement condition survey data and rating are recorded, based on the pavement condition index (PCI) inspection methodology that has been in use by the Air Force for the past several years. Air Force Regulation (AFR) 93-5, Airfield Pavement Evaluation Program, fully explains the PCI inspection method (10). PAVER requires additional data for each section, including pavement structure (by layer), maintenance and repair history, traffic history, traffic history, drainage, condition history (previous PCI values, distress types, quantities, and severities), current maintenance policy for that section, current labor and material rates, and so on (6:12; 7:2; 20:2).

Drawing upon this data base, PAVER "provides the engineer with a practical decision-making procedure for identifying cost-effective maintenance and repairs on roads, streets and airports (20:2)." Specifically, PAVER predicts the present and future condition of the section based on previous PCI inspection results. It then uses PCI

projections in conjunction with the rest of its data base (see Figure 2) to recommend a range of maintenence and repair (M&R) alternatives. The system also performs life-cycle costing on these alternatives and analyzes them for their short and long range impacts on pavement condition and expected pavement life. The analysis includes investigation of the "do nothing" alternative—in other words, if the best alternative is to do nothing, PAVER will help the engineer to make that decision (see Figure 3). Ultimately, this analysis allows the engineer to "optimize the funds allocated for maintenance and repair [7:2]" by rationally prioritizing projects according to pavement condition and use (6:7-10; 7:2).

Finally, PAVER provides for custom-designed reports that can be used by the engineer, by in-house maintenance personnel, or by higher level decision-makers. Examples include condition survey reports and ratings, PCI inspection schedules for the next six years based on section condition and projected deterioration rates, listings of M&R alternatives for various pavement sections, economic analysis reports, budget planning reports, and so on (6:7-10; 7:2).

As mentioned above, PAVER can be operated either manually or by computer. As a manual system, PAVER is complete in itself. That is, it includes all aspects, capabilities, and procedures necessary to manage pavements. As a computer-based program, PAVER operates on the same principles as the manual system, but adds numerous time-saving capabilities. These include: a) automated data entry, storage, update, and retrieval processes; b) data manipulation, formatting, and processing; and c) custom-designed report-generating programs that use

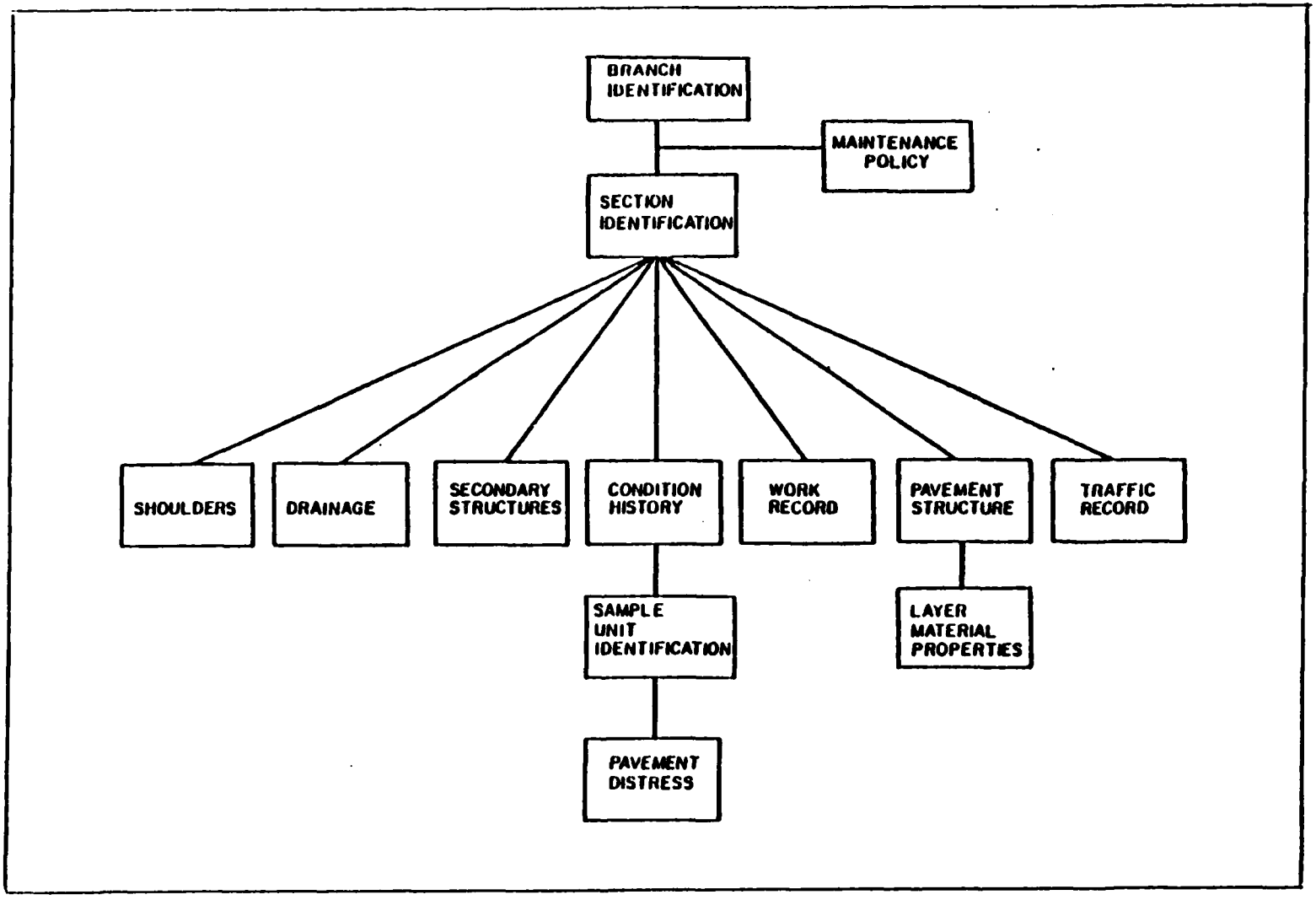


Figure 2. PAVER Data Structure (6:12)

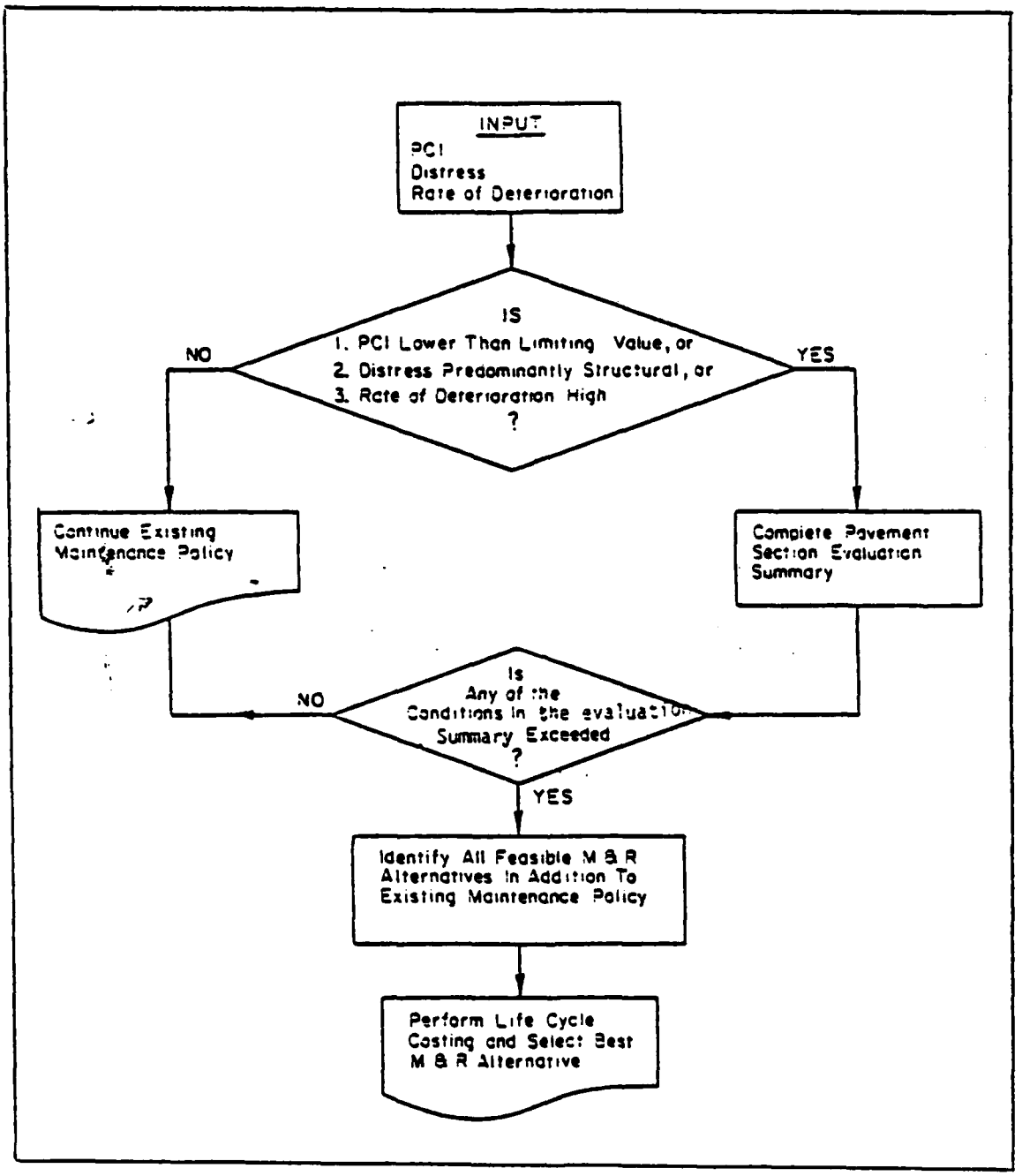


Figure 3. Flow Diagram of the Decision Process for Determining M&R Needs (6:24)

stored and/or processed data to aid the user in determining, planning, and scheduling pavement maintenance and repair (6:7-10; 7:2).

Due to PAVER's wide range of capabilities, and because it can be operated either manually or by computer,

> the PAVER system offers the flexibility of implementation at various levels. The highest level of implementation would be the inclusion of all pavements on the installation and use of the automated system. The lowest level would be the use of the PCI as the basis of project approvals and establishment of priorities. A gradual implementation includes starting with a specific group of pavements . . . and then including other pavements on a predefined schedule [7:2].

C. Specific Issue

PAVER has been implemented to varying degrees at a number of military installations including Fort Eustis, VA; the Naval Training Center, Great Lakes, IL; and McClellan Air Force Base, CA. Similarly, numerous member cities of the APWA are in various stages of PAVER implementation. These cities include Tampa, FL; Ann Arbor, MI; Tacoma, WA; and Mesa, AZ (20:2).

The Air Force has now taken PAVER implementation one step further. In a policy letter dated 18 June 1984, the AFESC Commander made PAVER implementation mandatory for a minimum of one base per MAJCOM during FY 86 and for all bases by December, 1988 (19). This is a very good indication that the Air Force understands the importance and potential impact of PAVER.

PAVER has the potential to improve pavement management such that the general condition of the network can be greatly enhanced. The Army Corps of Engineers (COE) compared two military bases with similar pavement networks and identical maintenance budgets. The base using

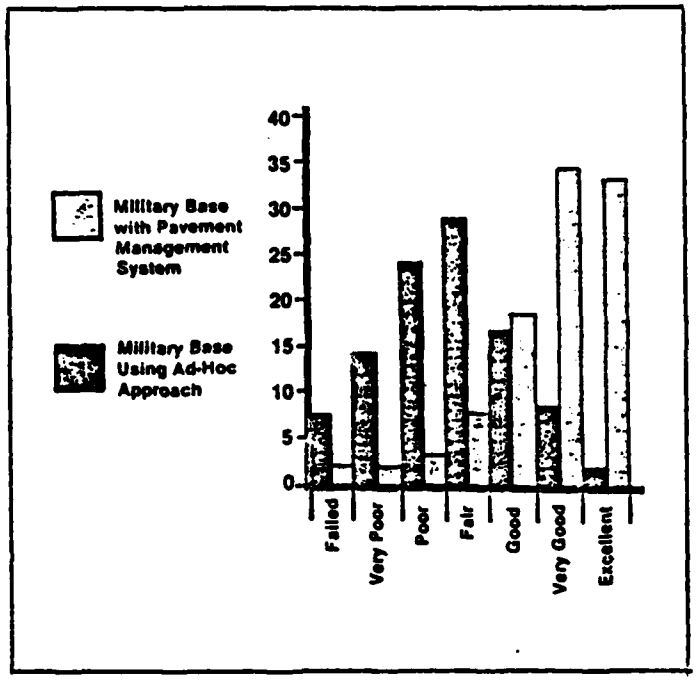


Figure 4. Comparison of the Average Pavement Condition of Two Military Bases (14:15)

systematic pavement management techniques had an average network condition PCI rating of 75 (on a scale of 0 to 100, with 100 being optimum), whereas the base using ad-hoc pavement management methods had an average PCI rating of 41 (14:15). This indicates that a systematic approach improves decision-making capabilities, such that the best maintenance alternative is usually selected. As a result, funds can be put to optimal use, both for an individual project and for the improvement of the entire pavement network. Figure 4 provides a graphical representation of the results of the study.

The PAVER pavement management system provides the systematic techniques necessary to improve and assist decision-making, thereby resulting in an overall improvement in pavement condition. In turn, better pavements mean less FOD, and thus fewer problems such as damage

to aircraft and equipment, injury to personnel, and so on. Furthermore, better pavements now mean additional years of useful service life, as well as less money spent to maintain them (see below).

In these times of doing "more with less," saving money is certainly a key concern of the BCE. PAVER can benefit him greatly by helping to minimize problems such as the following. First, project costs are soaring due to the effects of inflation, sky-rocketing energy and raw material costs, and ever increasing labor rates. PAVER can recommend more efficient and effective M&R projects to offset these increases. Second, the BCE must deal with manpower reductions, as well as an increase in the amount of M&R required all over the base, and thus must face a reduction in the number of engineering manhours available to inspect and manage the pavements. PAVER can improve productivity, thereby saving numerous manhours. Third, the huge pavement management data base described earlier continues to grow with each inspection or maintenance action. This data base is far too extensive and complex for the engineer to memorize, document, or analyze, except in general terms. If information becomes unusable due to being "lost" in a myriad of data and records, then many expensive manhours used to gather and record the data have been wasted. PAVER can counter this problem. Finally, project funds are limited and must therefore be used wisely.

It is upon this last point that PAVER can save the most money. This is because proper and timely maintenance can greatly reduce project costs. Figure 5 shows just how significant the timing can be.

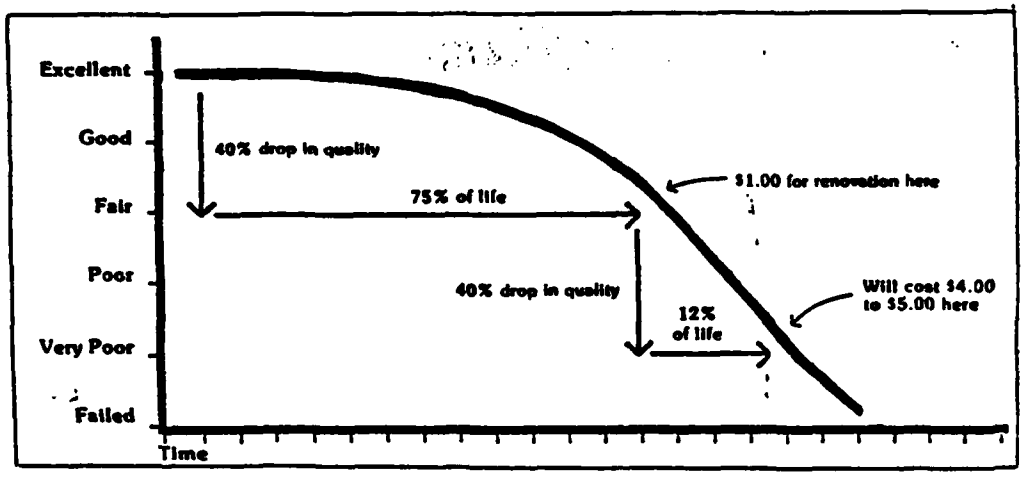


Figure 5. Pavement Life Cycle (14:2)

In a few brief words, the old truism "a stitch in time saves nine" certainly summarizes this graph (19:2).

Based on projected PCIs and deterioration rates, PAVER provides the engineer with the ability to select the most appropriate M&R technique and to predict the most opportune time to schedule the project. This allows the engineer adequate time to budget for the project, as well as to prepare the contract documents. This long range planning also provides numerous financial benefits, including: a) reducing M&R project costs, b) spending money on the projects which are the most needed and most beneficial, c) reducing costs on major projects, such as Military Construction Program (MCP) projects, and d) reducing the number of major reconstruction or replacement projects needed.

Together, the phrases "long range planning" and "financial benefits" represent yet another important aspect of PAVER. By using PAVER, the often used "band-aid" approach of continuously doing "emergency" repairs can be minimized. Strategies such as frequent pot-hole filling, or putting off a project until it becomes an "emergency", are far more expensive than a systematic M&R plan (22:12). Thus, the sooner PAVER is implemented, the sooner it can fulfill its ultimate objective. This is to save money while improving the condition of the pavement network through more aggressive management.

D. Problem Statement

Now that PAVER implementation will be mandatory for all Air Force bases, implementation procedures that are smooth and effective are of paramount importance. Unfortunately, only a limited amount of guidance exists in this area. CERL's "PAVER User's Guide" is, as the name implies, intended to assist the user in mastering PAVER (5). As such, it provides some helpful information regarding the PAVER implementation process. Chapters II and IV of this report will address implementation guidance more fully.

The "PAVER Implementation Brochure" (19), published by HQ AFESC in September, 1983, provides helpful guidance, and is an excellent starting point for bases about to implement PAVER. One of the most important aspects of the brochure is that it is also a motivational "sales brochure" intended to "sell" the pavement engineer on the importance of PAVER, and thus give him additional incentive to begin implementation. However, the implementation guidance provided is

somewhat general in nature and limited in scope for use as an in-depth reference pamphlet.

In order for the pavement engineer to implement PAVER quickly and easily, additional information will be necessary to him. Such information includes a more in-depth implementation reference guide, a summary of "lessons learned" from those users who have already implemented PAVER, and suggestions on how to resolve and avoid problems that others have encountered. Further, a knowledge that others are facing similar problems and frustrations, as well as a confirmed belief that others are interested in his problems (MAJCOM, for example) and are ready and willing to help, will also be of great importance to the engineer.

Through this research effort, these problems can be addressed. Sources of information for solutions to these problems include installations and cities that have already implemented PAVER, or that have at least begun implementation. Additionally, questions and concerns from installations and cities that have not yet begun PAVER implementation will serve as an excellent source of ideas for "preventive" management, in that these issues can be addressed and solved before such agencies begin actual implementation. For this to be successful, personnel at all management levels should be queried —from the base, to the MAJCOM, to HQ AFESC. Additionally, officials from small and large cities, as well as from APWA, should be contacted.

The results of this research can then be forwarded to HQ AFESC for action and dissemination to the field, as applicable. In order for the PAVER system to become a valuable asset to pavement engineers

throughout the Air Force and elsewhere, this information must be gathered, consolidated, published, and distributed as soon as possible.

E. Research Objectives

The first objective of this investigation is to determine what problems exist with regard to PAVER implementation, particularly with regard to airfield pavements on Air Force bases.

The second objective is to identify those problems which can be resolved or avoided based on "lessons learned" elsewhere, and to identify those problems that still need to be forwarded to HQ AFESC for further investigation.

The third objective of this research effort is to develop an organized, consolidated summary of problems (past, present, and future), "lessons learned," and recommendations for improvement and/or successful implementation from the field.

The final objective is to provide this information to HQ AFESC for their use, further investigation, and/or dissemination into the field, as applicable.

Only after these research objectives are met can the ultimate objective of PAVER be realized, which is to reduce the expenditure of Air Force funds, while at the same time improving the condition of airfield pavements.

F. Research Questions

The following questions will be answered through this research effort:

1) What problems have been encountered in the field during implementation of PAVER that

a) have been solved, such that the solution(s) can be disseminated in the form of "lessons learned?"

b) still require solving, and should be forwarded to HQ AFESC for resolution?

2) What questions or concerns are there at installations that have not yet implemented PAVER that

a) can be answered by already existing data or "lessons learned?"

b) still require solving, and should be forwarded to HQ AFESC for resolution?

3) What recommendations for improvements or refinements to PAVER can be obtained from the field and forwarded to HQ AFESC while investigating questions "a" and "b" above?

G. Justification for Study

By improving implementaiton of PAVER throughout the Air Force, pavement management techniques and capabilities can be vastly improved. In turn, this will result in the improved condition and prolonged life of a very valuable asset--pavements. Further, better protection can be afforded to aircraft, ground vehicles, support equipment, and personnel, again saving Air Force dollars. These savings can be multiplied throughout the Department of Defense (DOD) by disseminating the findings of this investigation to Army, Navy, and other military installations. Similarly, additional federal funds can be saved through the use of PAVER for all federal agencies. Encouragement of cities, counties and states to implement and improve PAVER capabilities can result in savings of tax dollars at local, state, and federal levels, since project costs are often split across all three levels.

H. Scope and Limitations of Study

For purposes of clarity and conciseness, this study focuses on improving the PAVER implementation process for airfield pavements at Air Force bases. However, successful PAVER implementation is equally important to all DOD installations and to the entire civilian community, whether it be used to manage airfields or streets. The majority of principles, concepts, and findings discussed in this report should apply equally well to any such uses of PAVER.

I. Availability of Data

PAVER has been implemented to varying degrees at a number of military installations and cities throughout the country. These sources, in addition to officials at HQ AFESC, CERL, and APWA, provide an adequate data base for information regarding PAVER implementation. An "infinite" data base exists in military installations and cities that have not yet implemented PAVER. Chapter III of this report provides more information on the data bases that were used, as well as the statistical assumptions that were made.

J. Definitions, Acronyms, and Abbreviations

For a summary of definitions, see Appendix A. For a summary of acronyms and abbreviations, see Appendix B.

II. Literature Review

A. Introduction

An understanding of the need for an effective pavement maintenance management system was developed in Chapter I. This need is and has been so intense that nearly every source listed in the bibliography of this report had an introduction that used phrases such as "limited funds availability," "deteriorated pavement condition," "need to increase pavement condition while reducing project costs," and so on.

PAVER is intended to supply the capabilities necessary to manage pavements effectively. "Simply put, . . . the objective is to . . . maintain . . . pavements in the best condition possible and to predict the performance of the pavement network given a limited amount of money [2:3]."

In order to benefit from these capabilities, PAVER must be effectively implemented. An important factor in effective PAVER implementation is an understanding of pavement management systems. This chapter explains PAVER and other systems, discusses the benefits and problems of PAVER implementation, and summarizes various views on "generic" implementation techniques. This literature review establishes the basic framework against which the results of the PAVER implementation surveys (discussed in subsequent chapters) are analyzed.

B. PAVER: Pavement Management System

A general overview of PAVER was provided in Section I-B. A concise, operational definition of PAVER is contained in Appendix D. Additionally, an important aspect of PAVER is that it can, and should, be implemented at both the project and network levels. Only when both levels are addressed by a PMS can it truly be successful (22:12). The two levels are defined as follows:

> Project level management considers cost effective maintenance/repair alternatives and schemes in the formulation of given projects. Network level management prioritizes those projects, inventories the pavement sections, establishes budgetary needs, analyzes the current and future overall pavement condition, and projects annual inspection requirements [22:12].

PAVER has been successfully tested by the Army (17:70), Navy (22:12-14), Air Force (8), and APWA (4:69), and is now ready for Air Force-wide implementation.

C. Other Pavement Management Systems

In order to uncover implementation problems that could possibly affect PAVER, three pavement management systems were reviewed. The first method was developed by the PMS Group for Waterloo, Ontario, Canada; the second was developed by four independent consultants for the city of Palo Alto, CA; and, the third was developed by Austin Research Engineers, Inc. (ARE) for the city of Arvada, CO.

All three PMSs were developed as computer programs for managing roads and streets. The PMS Group used a two-year survey cycle to examine pavements based on ride quality, roughness, and

structural capacity. The survey results are evaluated against a list of pre-defined rehabilitation alternatives and associated costs. The evaluation provides such information as the expected performance of each alternative, the estimated cost, the consequences of accelerating or delaying the project, and the anticipated condition of the network over the next ten years (4:67).

Palo Alto's PMS requires a 100% condition survey annually and is based on the severity and extent of distresses identified by technicians as they drive through the area being inspected. The survey results are combined with such information as the design, construction and maintenance history, and traffic volume to set maintenance priorities, estimate costs, determine cost benefits per vehicle mile (based on average daily traffic), and evaluate expected project performance (4:67-68).

ARE's PMS requires a condition survey of half the pavements annually, and is based on a subjective evaluation of distress types and ride quality. The system also considers cross pans (concrete drainage swales), curbs, and gutters when analyzing data in order to select maintenance alternatives and strategies. The PMS also sets maintenance priorities, but does not dictate how the budget is spent (4:68-69).

The review indicated that there were implementation problems or concerns common to all of them. The problems included training, manpower, equipment, funding, condition survey inspections, practicality, (line and) staff involvement, and top management support (4:66).

Training was a problem in almost all aspects of implementation. Key concerns included training personnel in how a PMS works, how to collect and use data, and, most importantly, how to operate the PMS on a computer. Secondary factors such as educating personnel in the benefits and costs of the PMS were also important (4).

Manpower limitations were also addressed as being a potential implementation problem. Key concerns included manpower availability to conduct condition surveys, gather necessary background data, and operate the PMS. Potential solutions included the use of consultants to set up or, in one case, operate the PMS, and the use of technicians to conduct surveys in order to reduce engineering manhours (4).

The ability to obtain adequate equipment, particularly computer hardware and software, was considered to be a major hurdle to effective PMS implementation. The computer capabilites must be such that they effectively support the PMS. They must also be understandable and operable by those who intend to use them, as mentioned in the discussion of training (4).

Closely related to each of the three aspects already discussed is funding. The degree of funding affects training, manpower, and equipment availability, and therefore is crucial from the very beginning. Initial costs for setting up the PMS may run over $30,000, and annual costs can be just as high, but the money saved on the first project could potentially pay for a year's use. At the network level, however, savings should not be

expected or budgeted for, since the typical M&R backlog will quickly use up any funds saved on other projects. Rather, a more efficient and effective use of funds can be expected, thus resulting in an overall improvement in the pavement network (4).

Establishment of a condition survey method was another key concern of the three PMSs. The PMS Group developed an annual inspection method, but because of the high cost, have changed to inspecting once every two years, thus saving $10,000 to $15,000 per year (4:67). In Palo Alto, a subjective inspection method is used to inspect 100% of the pavements annually (4:68). ARE also established a subjective rating system, developed a training guide, tested the method for consistency, and now uses it to survey half of the pavements each year (4:69).

A system which is practical, versus theoretical, also helped to establish PMS implementation. All three cities considered development and refinement of such a system to be one of the primary implementation problems that they faced. Further, development of a system that the city could operate without the aid of consultants added to the PMS design difficulties (4).

Problems with (line and) staff involvement were avoided by ensuring that consultants developing the system worked closely with city officials. Typical line and staff members involved with PMS development included the public works director, construction managers, designers, planners, and so on. In at least one case, city agency members were assigned specific duties to keep them involved and active. The general tendency was to

develop a PMS that the city could operate independently, once it was implemented (4).

The issue of receiving top management support was also identified as a critical element to successful implementation. Once top officials were convinced of the benefits of developing and implementing a PMS, support was readily available. Thus, the key problem with management support was obtaining it initially, so that implementation could begin. After that, top managers generally ensured that funds, manpower, equipment, and so on were available (4).

Finally, an underlying theme throughout the discussion of PMS implementation was that the key factors are inter-related. None can be changed without somehow affecting some of the others. For example, top management support affects funding and the degree of staff involvement. Funding, in turn, affects manpower, training, and equipment availability, which affect the success of the PMS. The PMS's success affects top management support, and the cycle is thus completed.

D. Generic Implementation Techniques

Keen and Morton provide some additional insight into implementation of generic Management Information Systems (MIS) and decision support systems (DSS), both of which PAVER fits into. PAVER's large, interactive data base is indeed a system that manages information; and, its data manipulation and report generating capabilities certainly support decision-making.

Therefore, the implementation "musts" of Keen and Morton should apply.

The first point that Keen and Morton make is that the system being implemented must receive top management support. Secondly, there must be a clear felt need by the client. Third, there should be an immediate, visible problem to work on. Fourth, early commitment by the user and conscious (line and) staff involvement are necessary. Fifth, there should be a well institutionalized MIS (or working) group to analyze and solve problems. Sixth, there should be stability (minimum number of transfers) of the personnel using the system. Finally, teamwork is essential (15:196). Interestingly, many of these ideas exactly echo those discussed previously.

E. PAVER Versus Other Systems

A great deal has been written about PAVER implementation and the resulting benefits. This section compares the suggestions and recommendations for PAVER implementation to those for other systems, as discussed in Sections II-C and II-D. This section is organized in much the same format: each of the topics discussed above is addressed, beginning with training.

Surprisingly, training is one area of PAVER implementation that is potentially far less troublesome than it is for other PMS systems. First, two intensive, comprehensive, and fully developed training courses are available for PAVER users-- one sponsored by CERL and the Facilities Support Engineering Agency (FESA), in conjunction with the University of Illinois, and one

sponsored by APWA (20; 1). Second, AFESC has published a brief PAVER implementation brochure that serves as an excellent primer for bases that are just beginning implementation. The brochure provides points of contact for additional assistance and recommends the training just described (19:13,17-19). Third, FESA is currently the point of contact for any problems with mainframe interface, thus eliminating the need to train anyone at base level to handle such problems (19:5).

The very nature of PAVER itself also helps to eliminate training problems. First, because it is user friendly, PAVER can be operated with little or no initial training in computers. The user can expand his or her abilities as he or she becomes more familiar with the system (19:17). Second, inexperienced engineers can also use and benefit from PAVER:

> Inexperienced engineers can draw upon the many years of valuable pavement engineering experience built into the system as they design projects, while experienced pavement engineers use the system as a[n] extensive analysis and detailed comparison tool. In either case, the [system] greatly enhance[s] an engineer's abilities for objectively comparing many more alternative designs [2:2].

Finally, PAVER's design allows it to be implemented on a small-scale, step-by-step basis. Thus, the required information can be input for just a few key features (such as runways and primary taxiways). The engineer can work with this data on a trial basis until he or she has learned to input, update, manipulate, and use the data effectively. Additional features (such as secondary taxiways and parking aprons) can be added as time, funds, and training permit (19:7; 22:13; 4:69).

Only three potential training problems were uncovered from the literature review. One potential problem is with the wording of the PAVER implementation brochure. The section on training, if not read carefully, may leave the reader with the impression that because the PAVER computer program is user friendly, no training is required in order to use it. The intent, however, appears to be that no computer experience is required by those who wish to use it. The brochure does recommend that formal PAVER training be obtained (19:17). The second problem is that AFR 93-5 does not provide any guidance regarding PAVER, although it is very helpful with respect to PCI procedures (10). Finally, a closely related problem is that the PAVER implementation brochure refers to a technical report that is available for roads and streets, but which has only limited application for use on airfields (for example, the pavement distress types are quite different) (19:18; 12). A similar publication for airfields, established as a manual or regulation, would be more beneficial to the pavement engineer. Further, he or she would be far more likely to receive a copy of it at base level than a copy of a technical report.

Manpower is a problem area that plagues PAVER, just as it does other PMSs. This is especially true since Air Force implementation of PAVER is scheduled to be accomplished without a change in manpower levels (19:8-11). Further, PAVER data collection and entry into the computer could require a twelve to eighteen month effort (although Tacoma, WA, completed it in

seven), thereby taking away many manhours used for current pavement design and management (19:7; 22:13; 4:69).

Fortunately, there are solutions to this manpower problem. The most effective solution is the use of consultants such as architectural and engineering (A&E) firms to augment manpower. The degree of augmentation can vary, depending on the base's needs. The A&E can be contracted to conduct all or part of the condition survey, collect some or all of the historical information, and implement the system for some or all of the features. Care must be exercised, however, to ensure that the base personnel work closely with the A&E so that, as eventual users of the system, they are fully trained and qualified to operate it (19:8,9-11; 22:13). For example, base personnel and the A&E must be trained to conduct PCI inspections properly, so that distress identifications are the same, no matter who conducts the condition survey. Another option available is to use temporary help such as summer overhires or college students, or to use technicians, such as site developers or pavements and grounds specialists (19:10).

Equipment adequacy is another area where PAVER appears to have the edge over other PMSs. Three primary reasons exist for this advantage. First, PAVER can be operated either manually or by computer, thus giving the base the option of whether or not to invest in computer equipment, although the computerized method is recommended (19; 7; 8). Second, the mainframe computer, the most expensive portion of the system, is available world-wide on a

time-sharing basis (complete with a hot-line for assistance), thus greatly reducing not only the initial investment, but the funds and manpower necessary to run and maintain it (19:5,15). Finally, the desk-top micro-computers necessary to interface with the mainframe (see Figure 6) are already being installed at base level under a separate program (WIMS: Work Information Management System). Lease options exist for bases not yet equipped with WIMS, and selection assistance is available from higher headquarters (19:12-13; 8). Due to previous testing by the Navy, many of the interface problems have already been eliminated (22:13).

Three problems were uncovered regarding equipment support for PAVER. The first problem is a minor one: some WIMS systems may not include the modem that is necessary for interfacing with the main computer. However, a modem can be installed quickly and economically to solve this problem (8). The second problem is only a temporary one, although the length of time is as yet unspecified: FESA, rather than an Air Force agency, is the point of contact for mainframe assistance. AFESC is scheduled to become the Air Force's point of contact, once there are enough Air Force users (19:5). This should make assistance easier to obtain, since it will be available via an Autovon number, and since Air Force personnel will be able to relate more comfortably to personnel and organizational structures with which they are familiar.

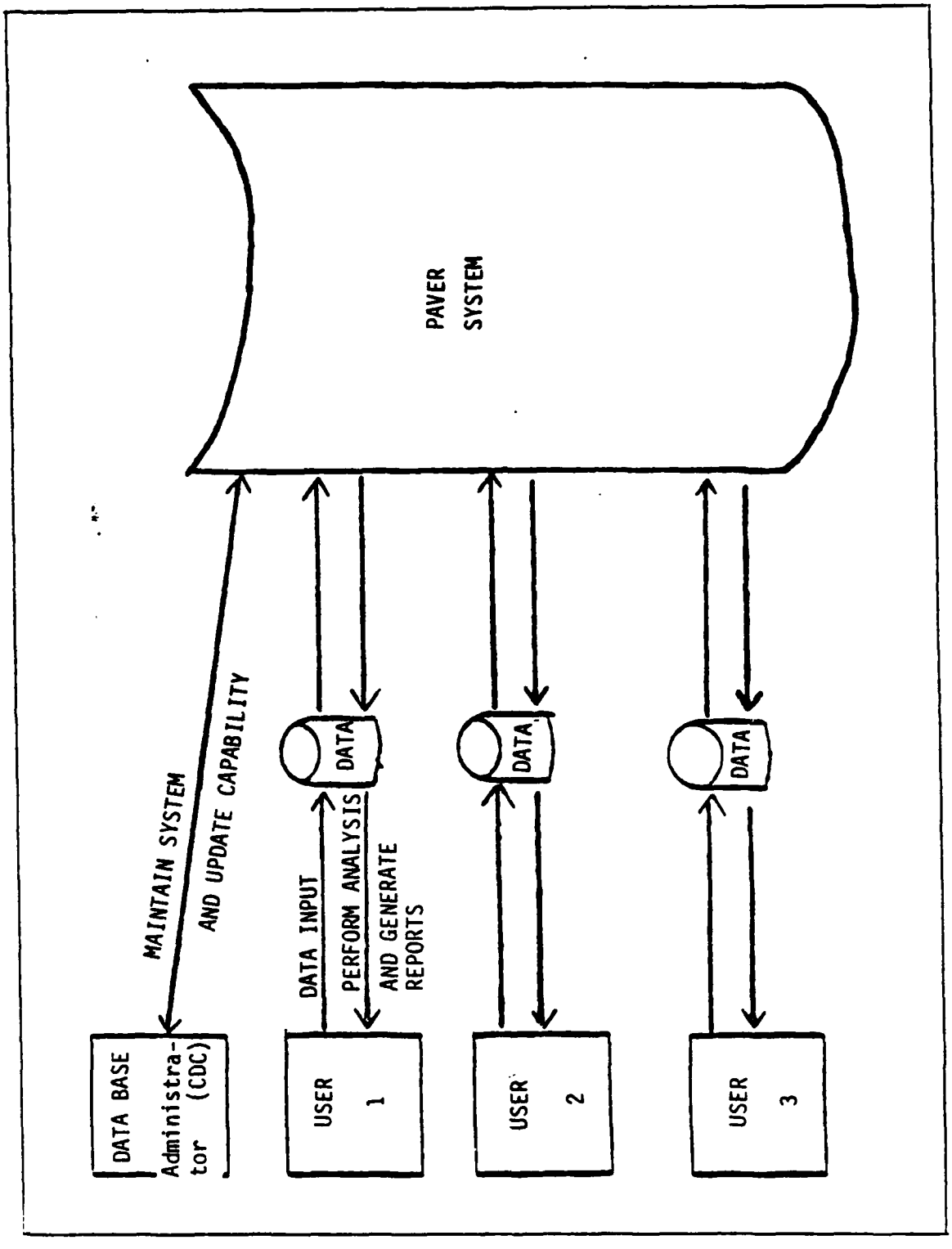


Figure 6. Operational Environment (21)

The third equipment problem is also a temporary one. Due to the change-over from Boeing Computer Services Company (BCS) to Control Data Corporation (CDC) as supplier of mainframe computer service, there is now an interface problem between the mainframe and the microcomputers. This problem is being addressed by CERL, with the assistance of the Command Pavement Engineer from Tactical Air Command (TAC).

Funding problems should not directly affect the base, since money to run PAVER is to be provided by MAJCOM (19). Therefore, funding problems should not hinder PAVER implementation: in fact, the base should ultimately benefit. Numerous reasons exist for this. Savings should result due to reduced manhours (in the long run) necessary to inspect and manage pavements (50-70% less!), and cost avoidance by performing proper and timely maintenance (6:31-48; 17:70; 22:12-14). Other financial benefits of implementing PAVER are that microcomputers are already being installed under the WIMS program (19; 8), PAVER can be implemented on a small scale, adding additional information as funds permit (19:7), and the use of microcomputers to batch-update the mainframe computer is much cheaper than direct mainframe access (19; 22).

Two potential drawbacks to PAVER funding exist. One is that implementation costs can be as much as $90,000-110,000, although expenses approximately one third this amount are expected for a "typical" base (6:31-48; 4:69). The other potential drawback is that MAJCOMs are required to fund PAVER out of previously

established budgets. This short notice funding will have to result in cuts in some other area, possibly even pavement maintenance funds. Such funding is likely to result in "hard feelings" toward PAVER, and may result in PAVER receiving less money than anticipated due to budgetary compromises.

As a result of extensive development and field-testing, the PCI inspection method is by far the largest advantage of using PAVER (see section II-B). The PCI greatly reduces inspection time by using random sampling techniques (as compared to 100% inspection), and it provides a consistent, meaningful, repeatable, and verifiable rating based on type, severity, and quantity of distresses (19:3; 10:3-1). "The PCI closely agrees with the collective judgment of many experienced pavement engineers [18:381]," and it correlates well with maintenance and repair needs (18:398). These facts support the importance of the PCI method, and allow the base to conduct pavement condition surveys, rather than wait for the command pavement engineer to conduct them on a five year recurring cycle (10:3-1; 9:1-2,3-1). Other advantages include the fact that the base does not need to develop their own condition survey method in order to use PAVER, almost all Air Force pavement engineers are already experienced with the PCI, and the new PAVER techniques allow up to six years between required inspections if the current condition and rate of deterioration are favorable (6:9). This last fact, combined with the random sampling aspect, far outweighs the fact that more subjective evaluation techniques are generally quicker to perform on a small-scale, one-time basis (4:69).

The practicality aspect of PAVER also makes implementation a fairly easy task. PAVER's design is relatively generic, it is component-like in nature, and its management techniques are already well developed and refined. Thus, almost any base or small to medium sized city can use it, as is. In fact, each of the other PMSs reviewed eventually developed into a system that resembled, but fell short of, PAVER's capabilities (4:69). Other practical aspects include standardized comparison of projects at MAJCOM, and the ability to set the level of minimum acceptable pavement standards (22:12).

Line and staff involvement, on the other hand, is an area where PAVER implementation could possibly run into difficulties. Caution must be used to ensure that all responsibilities and duties do not fall upon one person. Line and staff involvement, and identification of a PAVER manager are concepts that are supported and documented by numerous sources, including AFESC's implementation brochure (19:6; 22:13; 4:66).

Receiving top management support is another area where PAVER implementation is doing well. While no literature was found that dealt with base level management support, managers above base level appear to be fully committed to PAVER. Air Force Logistics Command (AFLC) has accelerated the PAVER implementation start date to 1 October 1984 (8). Further, the PAVER implementation brochure urges key decision-makers at base level to get involved, and notes that assistance is available (implying MAJCOM and AFESC) (19:5-6). Although their availability is well known, seeing it in print emphasizes their support of PAVER.

One potential problem area with regard to top management support was also noted. PAVER was one of 25 major topic areas discussed at the 1983 MAJCOM-AFESC Pavement Engineers' Conference (19). Although much of the other literature indicates that top managers are concerned about PAVER, the minutes of this conference indicate that there are numerous other areas in pavement research and development that are putting a demand on the managers' time. Because PAVER implementation has such far-reaching effects, top managers must continue to treat it as one of the higher priorities.

Each of the above potential problems areas is inter-related with the others, as shown in the discussion. Similarly, the key implementation factors addressed by Keen and Morton are inter-related, and some of them, such as top management support, duplicate the factors already analyzed.

Other factors addressed by Keen and Morton, such as the requirement for a clear felt need by the client and an immediate, visible problem, will not be a problem for PAVER implementation. The clear felt need is reinforced by budget and manpower constraints, coupled with deteriorated pavement networks. The immediate, visible problem is evident on almost every roadway and airfield on every Air Force base.

The potential problem of user commitment can quickly be overcome by following the advice of the implementation brochure: appoint a qualified PAVER manager and get the decision-makers involved as early as possible (19:6). This point is supported by

the Navy's experience: by using PAVER, the engineers "quickly gained confidence in and enthusiasm for the system [22:13]."

The recommendation for a well institutionalized MIS (or working) group has probably rarely been followed to the extent that PAVER enjoys. Development and testing have involved the Army, Air Force, Navy, and APWA, and scores of experienced pavement engineers, and the efforts and involvement do not show signs of diminishing (17:70; 19; 22; 4:69). Only one weakness shows up in this area, and that is a lack of guidance for establishing a working group at base level.

Stability is an implementation concern that PAVER may have trouble with. Due to the transient nature of military personnel, and due to the long implementation process, it is quite possible to see turnover of key personnel. Fortunately, many of the Air Force's pavement engineers are civilians and are, therefore, less transient than the military members. Additionally, many bases should be able to use site developers and shop personnel to assist in inspecting the pavements and implementing PAVER. This will provide additional stability over the use of A&E support, especially if civilians are used (19:8).

Finally, the area of teamwork does not appear to be a problem with PAVER implementation. The discussion above concerning staff involvement, top management support, and establishment of an MIS group shows that there is a great deal of teamwork involved in implementing PAVER.

F. Summary

A pavement management system is a necessary fact in today's engineering environment. PAVER can provide most or all of the support needed to effectively manage pavements at both the project and network levels. Based on the literature reviewed, PAVER appears to have the fewest potential implementation problems, all of which are closely inter-related. In general, current Air Force policies and trends indicate that PAVER implementation is headed in the right direction and things should generally go smoothly. A comparison of this analysis and how base level managers perceive PAVER implementation forms the basis of Chapter IV. Chapter III outlines the methodology for gathering data from the field.

III. Methodology

A. Introduction

Manual and computerized methods were used to gather and analyze data relative to the research questions and objectives discussed in Chapter 1. The nature of the research dictated that exploratory data gathering procedures be used. Thus, surveys were used wherever possible to gather information such as "what problems/anxieties exist," "how have these problems been solved in the field," "what other recommendations are there," and so forth.

In order to gather additional information that was not obtainable through surveys (for reasons discussed below), secondary sources of information were used. These included telephone interviews, personal interviews, and a literature review.

Data collection and analysis were geared toward identification of PAVER implementation problems at bases and headquarters with PAVER, as well as identification of PAVER implementation fears at bases and headquarters without PAVER. The intent of such research was to uncover solutions that would eliminate, or at least minimize, as many PAVER implementation problems or apprehensions as possible.

Throughout most of this analysis, opinions, comments, and suggestions were not attributed to any one person or base. Rather, they were attributed to a survey group, in order to protect the anonymity that was guaranteed by the surveys, or that was agreed to when conducting personal and telephone interviews. This guarantee of

anonymity helped to elicit additional and more candid responses that might have been otherwise obtained.

B. Survey Development

As mentioned previously, surveys were a key element in data gathering. In fact, they were an invaluable tool because this research effort was aimed at identifying unknown problems. The surveys were designed to serve as thought-provoking guides for the respondents, allowing them to list and explain as many problems in as many areas as they desired.

Four separate but similar surveys were developed in order to obtain four different viewpoints on PAVER implementation. The four groups of respondents were: bases with PAVER, bases without PAVER, headquarters with PAVER, and headquarters without PAVER. The survey groups were further delineated by limiting the research to the six primary MAJCOMs within the CONUS and Alaska: Air Force Logistics Command (AFLC), Air Training Command (ATC), Alaskan Air Command (AAC), Military Airlift Command (MAC), Strategic Air Command (SAC), and Tactical Air Command (TAC). All stateside bases with BCE positions (within these commands) were surveyed. Appendix C lists the survey recipients.

The Air Force survey approval process resulted in further limiting of respondents. In order to shorten the approval process, surveys were sent only to military members. For this reason, all surveys sent to base level were addressed to the BCE. All surveys sent to headquarters level were addressed to the Deputy Chief of Staff (DCS) for Engineering and Services.

The researcher developed the surveys based on personal experience with pavement management and knowledge of PAVER gained from the University of Illinois short course "Pavement Management: The PAVER System 20." The course, co-sponsored by CERL, the University of Illinois, and FESA, was a:

> comprehensive intensive three-day short course designed to provide practical instruction on the fundamentals and techniques of modern pavement management. The course was conducted on a basic applied level to include instruction and actual involvement in management of a network [20:2].

The research advisor, Major Edward L. Miller, pavements instructor, School of Civil Engineering, Air Force Institute of Technology (AFIT), played a vital role in editing and guiding the development of the surveys. Mr. Gary Harvey, then Command Pavements Engineering for HQ MAC, provided additional assistance in final revision of the surveys.

As discussed previously, the surveys were designed to serve as thought-provoking guides to assist the respondents in identifying as many PAVER implementation problems or anxieties as possible. For this reason, the surveys consisted of about forty questions each, with eighty percent multiple choice, plus space for respondent remarks, comments, or questions. The remaining questions requested that a short essay-type answer be provided. Survey participation was voluntary and all survey respondents were given the option to respond anonymously. In no case was the name of the respondent or the base a factor in the analysis.

Appendices D-G contain the survey packages that were sent to the field. The survey packages included the survey itself, two cover

letters, an operational definition of PAVER, Privacy Act statements, a computer score sheet, and a return envelope. Samples of the survey results are shown in Appendix M.

C. Survey Analysis

The multiple choice responses to the survey questions were analyzed using the Statistical Package for the Social Sciences (SPSS) (16). The "FREQUENCIES" program on SPSS was used to provide a summary of the response rate to each alternative of each question. A complete summary of the multiple choice responses is provided in Appendices H-L. Chapter IV highlights key information from these appendices, such as any trends, response extremes, or other interesting factors that were identified.

The SPSS program "CROSSTABS" was considered for use in investigating possible relationships between responses to groups of two or three questions. However, the "CROSSTABS" program was not used because the output did not provide the general comparisons desired by the researcher. Therefore, comparisons were done manually. Another reason for conducting the comparisons manually was that the survey questions were established to gather information about attitudes, perceptions, and implementation status with respect to PAVER. However, the analysis was based on the fourteen potential implementation problems discussed in Chapter II. Analysis by "CROSSTABS" would have required an inordinate amount of initial recoding.

Finally, the remarks and short answers were reviewed and are discussed in Chapter IV. The information gained from this portion of

the survey helped to supplement and expand the results obtained from the objective portion of the surveys.

D. Assumptions

The first assumption made with respect to the survey results was that the BCEs and DCSs had adequate information to respond to the surveys, that they discussed the survey with their pavement engineer before responding to it, or that they delegated the responsibility for completing the survey to the pavement engineer. In all cases, however, the responses are still attributed to the addressee. Therefore, all information received from the survey respondents is assumed reliable and is assumed to be from the viewpoint of the pavement engineer.

The second assumption was that potential PAVER implementation problems did not have to be statistically proven to be a factor. Rather, the researcher was interested in uncovering any potential problem or concern at any base. Thus, if there was a general impression that a base was (or bases were) having, or might later have, a problem or concern in a particular category, then that was a valid enough reason to address it.

E. Limitations

From the beginning, the scope of the research was a self-imposed limitation. That is, the research was directed primarily toward information pertaining to PAVER usage at stateside USAF airfields. As such, the majority of the survey and interview questions dealt with PAVER as an airfield management tool and the survey repondents were limited to the six MAJCOMs, as discussed in Section III B.

A closely related limitation was a restriction regarding survey respondents. Due to the lengthy approval process involved with surveying civilian personnel or members of other services, surveys were only sent to BCEs and DCSs with the Air Force. This prevented the surveying of personnel working for CERL, APWA, Army posts, Navy stations, cities, private or commercial airports, or engineering consulting firms, but it did not prevent obtaining information through telephone and personal interviews.

Another limitation resulted from the exploratory nature of the thesis. One of the objectives of the thesis was to identify problems and anxieties regarding PAVER implemantation. There is no guarantee, however, that all of these problems or anxieties have been uncovered. The questions asked in the surveys, telephone interviews, and personal interviews could only serve as stimuli for evoking responses--no method exists for determining if every pertinent question was asked.

Similarly, even if all of the questions were asked, there is no guarantee that all of the answers were provided. Some of the problems may have been overlooked while respondents were filling out the survey, or respondents may have been hesitant to list all of the problems or anxieties which they had encountered. A myriad of reasons may exist for this reluctance to answer, including time constraints, self-esteem, fear of reprisal, and so on. Furthermore, a number of surveys were not returned at all. As such, some of the biggest problems or fears, or some of the best solutions, may have gone unreported.

Yet another limitation was the small sample size for three of the four surveys, even though 100 percent sampling was used. The

population size for bases with PAVER was only five. However, only four of the five bases responded. Three of the four responses were received when the researcher contacted the bases and conducted the survey over the phone. This technique may have affected the responses somewhat, but the value of the information gained far outweighed the bias that may have been introduced.

Similarly, the population size for headquarters with and without PAVER was just three each. Since the data obtained from all of these surveys was used primarily for descriptive statistics, and since no inferential observations have been made without appropriate qualifying remarks, the resulting analysis can be considered sound.

A final limitation of this thesis was the fact that very few specific problems were identified by bases and headquarters with PAVER. Only information of a general nature was provided. Similarly, bases without PAVER often could not "hazard a guess" to some of the questions, as one respondent put it. Thus, in keeping with the original assumptions, only a general analysis was conducted.

F. Secondary Data Sources

Because of the survey approval process time constraints discussed in the previous section, secondary data sources were used to provide supplementary information to the survey responses. These secondary sources included the literature review, telephone interviews, and personal interviews. Chapter II summarizes the results of the literature review. The telephone and personal interviews are discussed in Chapter IV.

Many of the interviews were conducted at the University of Illinois PAVER short course. Those interviewed included representatives of CERL, the University of Illinois, APWA, several major cities, private and commercial airports, engineering and consulting firms, Army posts, Navy stations, and the Command Pavement Enginners (Civil Service employees) of the six MAJCOMs which were surveyed. Each has had some involvement with PAVER, in degrees varying from novice to expert. Similarly, each had varying levels of anxieties concerning future implementation of PAVER, or varying levels of problems concerning the usage or current implementation of PAVER. These interviews definitely gave further insight into the results obtained from the surveys (see Chapter IV).

IV. Analysis

A. Introduction

Training, manpower, equipment, top management support, and user commitment are the primary problems affecting PAVER implementation. These findings are based on the results of the surveys, to which 56 of 83 addressees responded. By group, the responses were as follows: 5 out of 5 bases with PAVER; 45 out of 72 bases without PAVER; 3 out of 3 headquarters with PAVER; and, 3 out of 3 headquarters without PAVER. Because of the 100% response rate from the three small survey groups, and because of the overall 67.5% response rate, this data collection method was considered successful.

Very few telephone or personal interviews were conducted, due in part to the success of the surveys. Additionally, a great deal of information was gained from three secondary sources: the University of Illinois PAVER short course, the literature review, and a group interview with the Command Pavement Engineers from four of the six MAJCOMs surveyed.

The analysis of the survey results is structured around the research questions listed in Chapter I and the fourteen potential implementation problems identified in Chapter II. Secondary information is used to supplement this analysis and the survey results are compared to the anticipated implementation status identified in the literature review. Finally, the responses

provided by a contractor and the base for which it provides contract maintenance are compared.

The overall analysis is geared toward identification of Air Force-wide problems. Chapter V provides recommendations for use by HQ AFESC in assisting those at MAJCOM and base level.

B. Problems at Bases with PAVER

The first research question analyzed was:

1) What problems have been encountered in the field during implementation of PAVER that:

   a) have been solved, such that the solution(s) can be disseminated in the form of "lessons learned?"

   b) still require solving, and should be forwarded to HQ AFESC for resolution?

The analysis of parts "a" and "b" was conducted simultaneously for the sake of simplicity and understanding. Also, the inputs from headquarters with PAVER are included in this section. The results for each of the fourteen potential implementation problems are discussed herein, beginning with training.

Training. Several problems were observed with respect to training. First, while training was identified by MAJCOMs and AFESC as one of the most important categories relative to PAVER implementation, they felt that the existing formal training methods were inadequate for Air Force pavement engineers. All felt that the CERL and APWA short courses provided good training, however the courses were inadequate in addressing specific Air Force problems and covering usage of PAVER to manage airfields.

Updating the current AFIT pavement engineering course to include coverage of PAVER was the overwhelming solution proposed.

Second, a problem identified both at base and MAJCOM level was the need for an improved PAVER users' manual. All of the MAJCOM pavement engineers agreed that a complete, easy to read, step-by-step "cookbook" is "desperately needed." They went on to say that the manual should be developed such that a first time user of PAVER can understand it, rather than having to first learn how to use PAVER in order to understand the manual. Comments from base level mirrored those from MAJCOM.

Third, bases do not appear to be putting appropriate emphasis on the use of formal training. Five bases are using PAVER and two of these bases have been using PAVER for over two years, yet only one of the five had attended the CERL short course (although three of the remaining four are planning on attending). At the same time, the level of knowledge indicated by the surveys clearly shows that training is a problem, since only one of the five could use PAVER to manipulate data and generate reports (the one who attended the course). Generally, training had been informally acquired from MAJCOM, or more commonly, was self-taught from Air Force regulations and PAVER technical reports. One reason for this may be that only one of the three MAJCOMs with PAVER knows how to manipulate data and generate reports.

Briefly, then, three training-related problems were identified by the surveys as affecting PAVER implementation: the

lack of a formal Air Force training course, the need for an improved and more helpful users' manual, and the need for appropriate headquarters-level emphasis requesting bases to obtain the necessary training.

Thus, the status of training is not quite as optomistic as the viewpoint discussed in the literature review. Problems identified by both the literature review and the surveys need to be resolved. Training-related problems are further addressed under "Manpower," "Top Management Support," and "User Commitment."

Manpower. Manpower problems were also key areas affecting PAVER implementation. First, although the pavement engineer is considered (by all levels from base to AFESC) to be the primary user of PAVER, he cannot run the entire program by himself. Educating the pavement engineer to accept this fact, and training him how to use other manpower sources were the primary solutions provided by AFESC and the MAJCOMs. Unless the pavement engineer receives manpower assistance, accurate inspection and historical data cannot be gathered. In turn, the outputs from PAVER become meaningless, due to the inaccurate data that was input. To overcome this, the pavement engineer should use any competent manpower sources available who are able to conduct pavement inspections and assist in implementing PAVER. These sources include, but are not limited to, technicians, site developers, pavements and grounds specialists, competent overhires, college students, and A&E firms.

The second problem related to manpower is the restrictions placed upon the pavement engineer by his supervisor. Specifically, most supervisors require that a certain number of manhours be spent on design. While this is not bad when considered separately, it becomes a major problem when the number of manhours left for PAVER implementation and usage are restricted. Education of top managers on the importance of PAVER and eventual reduction in the number of engineering manhours required (by using effective and efficient management techniques) will help to alleviate this problem.

While current manning standards should not be affected by PAVER implementation, the manpower problem can be eliminated by the proper use of temporary additional manpower sources and by educating supervisors on the need for sufficient manhours for the use of PAVER. This information corresponds to what was identified in the literature review.

Equipment. Equipment problems were the third major problem area facing PAVER implementation, although these problems are expected to be only temporary. First, the problem of not having a microcomputer to access the PAVER mainframe computer will be solved by installaiton of WIMS. Second, the problem of interfacing between the microcomputer and the mainframe is now being analyzed by CERL and at least one MAJCOM. This problem is a result of converting to a new contractor who supplies the mainframe, and requires a slightly different access language. The problem should be alleviated soon.

Three other problems also need resolving in order to improve the status of equipment usage. Access to mainframe computer assistance should be provided via an Autovon phone number. This would improve the ease and speed with which help could be obtained. The need for user-friendliness and an improved users' guide has already been discussed. However, these problems are reiterated, since they affect the successful use of computer equipment to operate PAVER.

The results of the surveys show that the problems with current mainframe access are considered to be greater in the field than were identified by the literature review. However, these problems are considered to be temporary.

Funds. Both the survey results and the literature review revealed that funds were one area where PAVER did not face too many problems. This was due primarily to the fact that bases did not have to worry about obtaining funds for computer support equipment (such as terminals, modems, and so on), or for obtaining funds to pay for the computer access time used. These funds were provided by MAJCOM.

The area of funding could, in fact, be a possible solution to the three key implementation problems just discussed. Funds can help to solve the training problem by using them to enroll pavement engineers and technicians in the CERL short course. Funds can be used to hire college students, A&E firms, or summer overhires to assist in pavement inspection and PAVER implementation. Finally, funds can be used to accelerate the

computer acquisition process, so that the computerized version of PAVER can be used even sooner.

Inspection. As discussed in the literature review, and as supported by the survey results, the PCI inspection method is not a problem affecting PAVER, other than due to the manpower problems discussed previously. The PCI provides a consistent, useful indication of the pavement condition. Further, most bases should be familiar with the procedures by now, although two of the bases with PAVER indicated that their PCIs were "outdated."

Practicality. The literature review fully explained why PAVER does not face any practicality issues. The survey results supported this idea, since no one using PAVER indicated that he planned to make any changes, additions, deletions, or modifications to the existing PAVER program. However, there was a general "wait and see" approach taken by two of the three MAJCOMs and their bases as to whether or not to use PAVER on roads and streets. Most are waiting to see just how helpful PAVER is for airfields before using it for roads and streets.

Staff and "Line" Involvement. Problems associated with base-level staff involvement were discussed under manpower. Contrary to the concerns expressed in the literature review, base-level "line" involvement (below the management level) does not appear to be a problem for those using PAVER. Technicians, pavements and grounds personnel, and secretarial staff are involved, at least to some degree, at all of the bases. MAJCOM and AFESC support this whole-heartedly.

Top Management Support. Top management support is the fourth of five key implementation problems facing PAVER, according to the survey results. While bases rated MAJCOM support as good to very good, they also felt that HQ AFESC support was of little direct help to them and that base-level management generally hindered them. The issue of not receiving direct support from HQ AFESC was not really a problem in the past, for two reasons. First, the bases were not generally expected to deal directly with AFESC, but rather with MAJCOM. Second, because MAJCOM was providing very good support, there had not been a need to receive direct help from AFESC, unless required. The situation now appears to be different.

Bases and MAJCOMs indicated that they would now like to see more direct involvement of AFESC with PAVER. The time has arrived for AFESC, rather than CERL, to become the PAVER focal point for Air Force engineers. In particular, bases are looking for additional Air Force policy and guidance with respect to implementation assistance, such as a supplement to, or updated version of, the PAVER implementation brochure. MAJCOMs are looking to AFESC for direct involvement in correcting the software interface problem and in working with AFIT to establish a PAVER training course.

MAJCOMs are concerned that PAVER should not be made mandatory until computer hardware is available at base level, the software interface problems have been resolved, and an improved, user-friendly manual has been developed.

Bases are looking to MAJCOM level for more assistance in supporting formal training programs. This is a direct result of the problems bases are facing in obtaining management support. Base level managers continue to push for project designs, at the expense of manhours needed to implement PAVER and to attend PAVER training courses.

Clear Felt Need and Immediate, Visible Problem. As discussed in Chapter II, the need for a good PMS is clearly felt, since budget and manpower limitations have a significant impact on pavement management. Similarly, the problem of deteriorated pavements is immediately visible to everyone. The survey results confirmed the findings of the literature review: these areas do not hinder PAVER implementation.

User Commitment. The results of the surveys support the findings of the literature review: the more knowledge and experience the user has with PAVER, the more favorable the comments about it. This was evident in both the base and headquarters surveys. An additional factor that improves user commitment is agreement by the bases, MAJCOMs, and AFESC that the pavement engineer should be the primary user of PAVER. This, in turn, stems off possible problems with "areas of responsibility," as are too often found in similar jobs such as base traffic engineering.

Problems related to user commitment are really by-products of the other key problems addressed previously. For example, the frustrations brought on by inadequate training and manhours,

troublesome interface problems, and the lack of adequate top management support can have a severe negative impact on user commitment. Left unchecked, these problems can cause user commitment to become the number one item affecting PAVER implementation. For this reason, user commitment is considered one of the five key implementation problems.

Management Information System (MIS) Group. Again, the results of the surveys support the findings of the literature review. The well-established MIS group is not a problem affecting PAVER implementation. All comments relative to the MIS group were positive, except for the expressed need for an improved users' manual. Comments regarding correction of the interface problem also apply to this group, but the fact that none of the users plans any changes to the PAVER system speaks extremely well of the MIS group's research and development efforts.

Stability. The results of the surveys are the same as those of the literature review: stability is a minor factor affecting PAVER implementation. The establishment of an accurate PAVER data base should reduce many of the problems caused by turn-over of engineering personnel. For example, complaints such as "no maintenance records exist," "no PCI values were found anywhere in the files," and so on, can be virtually eliminated by turning to the PAVER data base.

Teamwork. As discussed previously, this is not an area of major concern for PAVER implementation. Overall, base level

personnel are working together adequately. Training the pavement engineer how to more effectively use his teammates is a definite must, and can be accomplished adequately at the formal training courses. However, teamwork among bases (sharing solutions and "lessons learned") should be highly encouraged by MAJCOM. This is not currently being done— in fact, most of the bases had no idea which other bases were implementing PAVER. Additionally, staff support at all levels must function as a single unit to insure PAVER is implemented at the "working-level."

C. Concerns at Bases without PAVER

The second question analyzed in this research effort was:

2) What questions or concerns are there at installations that have not yet implemented PAVER that

   a) can be answered by already existing data or "lessons learned?"

   b) still require solving, and should be forwarded to HQ AFESC for resolution?

The analysis of parts "a" and "b" was conducted simultaneously for the sake of simplicity and understanding. Also, the inputs from headquarters without PAVER are included in this section.

Because of the similarity between many of the anticipated problems and the problems experienced by those currently using PAVER, many of the comments provided in Section II-B of this report apply equally well here. The analysis and/or comparison to the literature review are not repeated in this section, unless it is done to add emphasis to a particular point. The results

for each of the fourteen potential implementation problems are discussed, beginning with training.

Training. Training is as severe a problem for bases without PAVER as it is for those with it. Also, at bases without PAVER, the training problem is increased by the lack of basic education on what PAVER is. Sixty percent of the bases know very little about PAVER. Half of those (29% of the respondents) know nothing about it.

The problem becomes a "front-line concern" when considering the fact that only 18% of bases without PAVER accurately track and manage their pavements. The MAJCOMs support sending the pavement engineers to the CERL short course in order to help them begin implementation. Yet, 50% of the bases anticipate receiving only a small amount of beneficial training from the course. Twenty-nine percent do not plan to attend at all. At these bases, MAJCOM education and motivation of base personnel to attend the short course is paramount.

One Command Pavement Engineer offered the following sound reason for sending his pavement engineers to the course: he estimates that less than 40% of the data used to prepare current pavement management reports is accurate. He blames this on having an excessive number of inexperienced lieutenants as pavement engineers, and thus has a large number of personnel who need as much pavement management training as possible.

Manpower. Manpower matched training as the biggest concern facing bases without PAVER. The problem is amplified due to the

lack of any information as to how long PAVER implementation will take. Base estimates ranged from 60 to 2280 manhours, with 63% estimating less than 400 manhours. At 20 hours per week spent on PAVER, that is only five months implementation time-- half to one third the amount of time described in the literature review. Since about half the bases said that their data was not accurate due to manhour constraints, the under-estimation of the required implementation manhours could negatively impact effective implementation. Some of the engineers have already expressed a concern for the number of manhours required for pavement-related tasks, and feel overwhelmed by the manhours required for PAVER implementation. Education, as has been stated before, is a key to overcoming these apprehensions and is a first step in the solution process.

MAJCOM pavement engineers realize the problems affecting base level manhours, particularly the emphasis on design. The next step is for them to train their engineers how to supplement their efforts with the help of other personnel, as discussed previously.

Equipment. Equipment problems are considered to be another of the key factors affecting implementation. However, for bases without PAVER, the concerns in this area were about one-third as much as for training or manpower. While half of the respondents expect to operate PAVER by computer, 16% do not expect to have computer access. Base personnel need to be advised of the WIMS equipment that they will be receiving, to be trained how to use

it, and to be advised of the modems and any other connections that they will require in order to access PAVER. This must be done prior to the base receiving its equipment, so that it may be purchased as a package unit. Otherwise, the base may incur increased purchase costs, or the base might not receive the necessary accessories until a future fiscal year.

Funds. Because of the MAJCOM funding of PAVER implementation, this area is not a key concern for bases without PAVER. However, some bases did request that AFIT or MAJCOM provide training funds for attendance at the CERL short course. They also identified the need for funds to hire an A&E firm to do pavement inspection. As one base put it, the money spent for equipment and training is "money well spent!"

Inspection. The only two problem areas regarding the PCI inspection method that were addressed were the manhours necessary to conduct the inspections and the validity of previous data. Due to the age of some PCI data, and due to turnover in personnel, the old data is somewhat suspect at some bases. Half of the bases that responded to the question regarding the percentage of currently existing data that will be usable with PAVER felt that less than 60% would be usable.

Practicality. Again, survey responses supported what has already been said in the literature review. That is, PAVER provides an output that is "easy for management to understand." Further, only one base proposed to make any changes to PAVER (but did not list them). As the MAJCOMs indicated, if the current

Pavement Maintenance Plan, the condition survey, and the pavement evaluation results are good, then bases should be able to use almost all of this data immediately. Finally, because 58% of the bases are currently using subjective management techniques, PAVER's practical approach to pavement management should be a big help to them.

Staff and "Line" Involvement. Bases without PAVER had a positive view of the extent to which staff and line personnel would be involved. Both bases and headquarters without PAVER felt that such involvement was important. As evidenced by bases with PAVER, line involvement does not appear to be a problem, however, staff involvement may be one.

Top Management Support. Top management support, on the other hand, is one of the five key problem areas. Sixty-seven percent of the bases indicated that they expect at least a great deal of help from their MAJCOM, while only 40% of the bases initially heard about PAVER from their MAJCOM. This point relates back to the discussion on training: bases expect and should be receiving most of their direct support from MAJCOM. An important aspect of this is for the Command Pavement Engineer to keep all of his pavement engineers as informed as possible about PAVER, whether that base is using it or not. Only when the engineer knows about and begins to appreciate the value of PAVER, will he be interested in learning more and ultimately implementing it.

In fact, 24% of the bases said that they did not plan to implement PAVER for one reason or another (time, money, interest) and 9% did not indicate whether they would implement PAVER or not. Those who did plan to implement it noted a "resistance to change" in their base-level managers. For this reason, many indicated that the MAJCOM should make formal training mandatory, so that the base would be required to send them. MAJCOMs also identified the heavier "emphasis on design" as a lack of top managment support for PAVER, and suggested that AFESC get more involved in encouraging training.

Clear Felt Need and Immediate, Visible Problem. Remarks regarding the clear felt need for PAVER and the existence of an immediate, visible problem are unchanged from previous discussions. See comments regarding bases with PAVER.

User Commitment. Similarly to bases with PAVER, the user commitment is identified as a key problem because of the possiblity of it quickly becoming the number one problem. The elimination of problems in the other four key areas (training, manpower, equipment, and top management support) should prevent this area from becoming a major item. Currently, 67% of bases not using PAVER plan to use PAVER to some extent. Twenty percent have already begun some phase of implementation. This fact alone is reason enough to support training of the engineers as soon as possible.

Management Information System (MIS) Group. The comments regarding the MIS group paralleled those of the bases with PAVER.

Generally, the bases know of at least some of the sources available for assistance, and feel that these sources are ready and willing to help them. MAJCOMs feel that the group is effective, but that it needs to assist in convincing base level managers to support PAVER.

Stability. Problems with stability are affecting some of the bases (and even the MAJCOMs). Evidence of this is that 51% of the bases without PAVER had heard of it for the first time within the past year. Thirteen percent heard of it for the first time when they opened their survey package.

At base level, the complaints regarding turnover were that the amount of information that is (or isn't) transferred from predecessor to successor greatly affects the anticipated number of manhours required to implement PAVER. At MAJCOM, a concern is that there may be too many inexperienced lieutenants filling the position of pavement engineer, thus causing a severe continuity problem due to the transient nature of military personnel.

Teamwork. Half of the bases without PAVER plan to get at least a little help from other bases, citing them as "the ones solving the problems," and as "often having good ideas." At least one MAJCOM displayed a strong sense of teamwork, and plans to draw on the experience of others as much as possible.

D. Refinements to PAVER

The final research question analyzed was:

3) What recommendations for improvements or refinements to PAVER can be obtained from the field and forwarded to HQ AFESC while investigating questions "a" and "b" above?

Only one MAJCOM provided specific plans for improving PAVER. His plans call for adding the Pavement Maintenance Plan (PMP), the Pavement Improvement Plan (PIP), and, eventually, the results of the Pavement Evaluation Team to his PAVER data file. Since the PMP and the PIP use much of the same data already included in the PAVER data base, development of such a program should be relatively simple. Similarly, construciton of the data base for the Pavement Evaluation Team results should be fairly simple, since many of the data elements are the same. This will provide the pavement engineer with yet another powerful tool for quickly and accurately assessing the overall condition and structural capabilities of his pavements.

E. Base vs. Contractor

The survey results provided by a contractor and the base for which he provides contract maintenance were surprisingly similar. In fact, there was only one question where there was more than one degree of difference. That question asked for an estimated total number of hours required to implement PAVER. The base estimated 1200 hours, while the contractor estimated 2800. The difference in the estimates could possibly be due to different interpretations of the extent of work involved with implementation. Therefore, the results of the surveys can be considered virtually identical. This is a good indication that PAVER implementation contracts can be developed and that a mutual agreement should be relatively easy to obtain.

F. Summary

The successful survey return rate of 67.5% provided sufficient data to analyze problems and concerns facing bases with and without PAVER. Information from secondary sources added support to the analysis, as did the literature review. Further, the fourteen potential implementation problems identified in Chapter II served as the analysis structure for this report. From the data gathered, the primary problems facing bases implementing PAVER are training, manpower, equipment, top management support, and user commitment. The analysis also showed that implementation of PAVER via contract is probably a feasible alternative. Chapter V provides the conclusions and recommendations of this report.

V. Conclusions and Recommendations

A. Introduction

PAVER is an effective pavement management system. The proper use of its capabilities can save numerous dollars in maintenance, repair, and reconstruction costs. PAVER's use also can improve the overall condition of the pavement network, which in turn means less chance of foreign object damage. Thus, aircraft, equipment, vehicles, and aircrew and ground personnel are better protected. Therefore, swift and proper implementation of PAVER is crucial.

While fourteen potential problem categories were identified by the literature review, the surveys and secondary data sources indicated that five were key problem areas affecting PAVER implementation. They were: training, manpower, equipment, top management support, and user commitment. Conclusions and recommendations for each of these five areas follow.

B. Conclusions

Based on the results of the literature review, PAVER appears to be the best PMS for the Air Force. However, the survey responses indicate that PAVER faces some tough implementation problems now and in the future. The problems are as follows:

1. Training.
    a. The current CERL and APWA PAVER training courses are not entirely adequate for Air Force pavement

engineers. Specifically, the courses do not provide sufficient coverage of implementation problems peculiar to the Air Force, nor do they concentrate on management of airfield pavements. An Air Force sponsored course is necessary.

b. Bases with PAVER have not been adequately trained. Two factors have caused this problem: MAJCOMs have not put enough emphasis on receiving formal training and base level managers have failed to support formal training.

c. Bases without PAVER have not been properly educated by MAJCOM as to what PAVER is, consists of, or can do for the pavement engineer.

d. Many of the training-related problems or concerns are due to the user being forced to "train-as-he-goes." As the user gains knowledge of and experience with PAVER, these problems tend to diminish.

2. Manpower.

a. Sufficient manhours do not exist for the pavement engineer to implement and operate PAVER by himself. Pavement engineers and base level managers must understand that assistance is needed from technicians, specialists, clerical staff, overhires, A&E contractors, or any other competent source that is available. The problem is a large one, but it is not insurmountable.

b. Currently, base level supervisors severely restrict the number of manhours available for PAVER implementation, primarily due to the emphasis on project design.

3. Equipment.

a. Most equipment problems appear to be temporary ones. The basic equipment support problem will be solved by the installation of WIMS microcomputers. The interface problem between the microcomputers and the mainframe is currently being staffed. However, an understandable PAVER users' guide is still desperately needed.

b. Eighty-two percent of the bases resonding to the survey who use or intend to use PAVER plan to use computers to operate some or all of the system. In order to keep this high percentage, equipment problems must be solved as soon as possible.

4. Top Management Support.

a. Top management support of PAVER from base level supervisors is severely lacking.

b. Top management direct support from MAJCOM is perceived very favorably at base level. That is, bases feel that they get good support and assistance when they deal directly with MAJCOM. However, indirect support from MAJCOM, such as "encouraging" base level managers to support PAVER, is inadequate.

c. Top management support from HQ AFESC is generally sufficient. More direct involvement is expected by bases and MAJCOMs in areas such as establishing an Air Force PAVER training course, solving the computer interface problem, and disseminating "general interest" items applicable to all pavement engineers.

5. User Commitment.

a. User commitment is somewhat favorable at this time at bases with and without PAVER, however many still are hesitant to use the system.

b. User commitment is a direct function of PAVER training and experience. The amount of training and experience is directly affected by manhour availability, equipment status, and top management support.

c. User commitment is affected by problems in any of the fourteen potential problem categories. Key problems are not restricted to the five areas emphasized in this report— for any given base, any problem category can become a key one. Thus, no PAVER implementation problem should be taken lightly. Every problem should be reduced or eliminated as soon as possible, to ensure that PAVER implementation progresses as quickly and as smoothly as possible.

C. Recommendations

The following recommendations are provided with respect to each of the five key problem areas:

1. Training.

   a. HQ AFESC should assist AFIT in developing an Air Force sponsored PAVER short course. The course should be specifically designed to address problems peculiar to the Air Force and to management of airfield pavements. The existing CERL and APWA short courses should serve as a basis for developing and structuring the course. The course length should be a minimum of one week (versus the three-day courses now offered), to allow sufficient training in the use of the PCI inspection method. Also, more "hands-on" training should be incorporated into the course than is offered in existing courses, using the AFIT WIMS terminals as the training medium.

   b. An alternate approach to establishing a new PAVER course should also be considered: the use of two training courses, each directed toward a different audience. This approach would involve development of two comprehensive courses that cover PAVER and the material currently taught at AFIT, but which are designed for either new, inexperienced pavement engineers, or for trained, experienced engineers.

The course for the inexperienced engineers should cover such aspects as how and why PAVER was developed, PCI inspection methods, reference materials (what regulations, manuals, and so on exist, and how to use them), and basic pavement engineering techniques and concepts. The course for experienced engineers should serve as a refresher, as well as provide state-of-the-art maintenance, repair, and reconstruction methods, and advanced applications of PAVER capabilities.

c. MAJCOMs and AFESC must stress the importance of attending formal training as early in the implementation process as possible. They should not only stress this to the pavement engineer, but to base level supervisors as well, so that the pavement engineer gets the local support he needs in order to attend the training. Formal PAVER training should be made mandatory if bases do not voluntarily obtain it.

d. MAJCOMs and AFESC should disseminate any and all information regarding PAVER implementation as soon as it is available. Most bases are on the "leading edge" of the PAVER implementation process and are therefore currently in dire need of this information. The sooner information is sent into the field, and the more information the engineer has

to draw upon, the easier the implementation process will be. Further, those who are more experienced with PAVER should be careful never to assume that a base pavement engineer already knows something about PAVER. Whenever there is a doubt as to whether or not even one engineer knows the solution to a given problem, that solution should be publicized.

2. Manpower.

   a. The pavement engineer must train competent personnel to conduct pavement condition surveys, collect historical data, and input this information into the computer. Possible manpower sources include site developers, pavements and grounds specialists, A&E firms, college students, and summer overhires. He must act as a team leader for this effort, supervising and spot-checking all aspects of PAVER implementation. Such assistance will help the pavement engineer get the system "on-line," thus preventing discouragement or feeling over-whelmed by the magnitude of historical and condition survey data that must be collected.

   b. The pavement engineer should implement PAVER gradually, beginning with key features and adding others on a pre-defined schedule. First, this will allow him to conduct a condition survey and collect and enter all applicable data for key features such

as runways and primary taxiways. Second, it will provide him with a usable system which will serve as a prototype for training purposes, and will provide meaningful outputs for managing key features at the same time.

c. In order for the pavement engineer to obtain maximum benefit from his additional help or from the phased implementation, he must first devise an organized plan for conducting surveys, inputing data, and incorporating all key features. This schedule should include a color-coded map or similar briefing aid, and should be presented to base-level supervisors. This will ensure that he has properly identified what the managers consider key pavements, will provide him with an opportunity to emphasize the importance of PAVER, and a chance to enlist enthusiastic support from base-level managers.

d. The pavement engineer can also be instrumental in getting position descriptions changed (for personnel such as clerical staff and technicians) to include various aspects of PAVER implementation and operation. This provides the non-engineer with greater challenge, a larger variety of work, and possibly some tangible rewards (increased pay).

3. Equipment.

a. Continue to purchase necessary computer equipment and support items for all bases. This includes

modems, connections, paper, ribbons, and all other supplies necessary to access, use, and receive outputs from PAVER.

b. AFESC should assign someone to develop a users' manual as soon as possible, with full dissemination to the field. The manual should be a complete training manual. Therefore, it should include everything from the "whats" and "whys" of pavement management and the history and development of the PCI, to detailed, step-by-step procedures and helpful hints for using PAVER.

4. Top Management Support.

a. AFESC should ensure that the recommended PAVER course is on the agenda at the next AFIT Program Review Committee (PRC) meeting. AFESC must also ensure that the course receives full support of the MAJCOMs, as well as themselves, at that meeting.

b. AFESC should assign a person within their office to be directly responsible for PAVER implementation to include resolving the "language problems" associated with the switchover from BCS to the CDC system. This should include assistance and guidance from the Engineering and Services Laboratory's Product Transition Division.

c. AFESC should revitalize the old "Pavement Newsletter" in the form of a "PAVER Newsletter." This, coupled with sufficient coverage of PAVER at

the 1984 Worldwide Pavements Conference, could solve the information dissemination problem.

d. In order to increase direct base-level support, someone should talk to base level managers while they are at AFIT attending the Chief Engineers' managment course or the BCE Staff Course. This is an ideal opportunity to stress the importance of PAVER and to elicit the much needed direct support from base-level managers. A handout which they could take home and show to other base-level managers would help also. The article written by Christine Johnson (14), the AFESC PAVER implementation brochure (19), and Chapter I of this report provide a good starting point for developing such a handout.

5. User Commitment.

a. Because user commitment is greatly influenced by the amount of education the user has about PAVER, MAJCOMs and AFESC must talk to their bases about PAVER even more than they have in the past. They must ensure that new ideas and solutions to problems receive the fastest and widest dissemination possible.

b. AFESC should bring a "successful" PAVER user to the Worldwide Pavements Conference to help "sell" the other attendees on how good a system PAVER is.

c. Finally, AFESC and the MAJCOMs should encourage the bases to use and experiment with PAVER as much as possible, as well as encourage them to ask lots of questions. Through hands-on experience and direct education, pavement engineers will soon appreciate the capabilities provided by PAVER, and will become voluntary, enthusiastic users.

Appendix A: Definitions

"CROSSTABS":

an SPSS computer program which cross-tabulates the responses to one question against those of another question.

descriptive statistics:

data which defines or describes a sample or population.

"FREQUENCIES":

an SPSS computer program which, among other features, lists the number of responses to each response alternative for each question of a survey.

inferential statistics:

data which can be used for predicting expected future outcomes.

PAVER:

a state-of-the-art pavement management system developed and extensively test by CERL over the past ten years (for more information about PAVER, see Section B of Chapters I and II, as well as Appendix D).

Appendix B: Acronyms and Abbreviations

A&E	Architectural and Engineering
AAC	Alaskan Air Command
AFB	Air Force Base
AFESC	Air Force Engineering and Services Center
AFIT	Air Force Institute of Technology
AFLC	Air Force Logistics Command
AFR	Air Force Regulation
APWA	American Public Works Association
ARE	Austin Research Engineers
ATC	Air Training Command
BCE	Base Civil Engineer
BCS	Boeing Computer Services Company
CDC	Control Data Corporation
CERL	Construction Engineering Research Laboratory
COE	Corps of Engineers
CONUS	Continental United States
DCS	Deputy Chief of Staff
DOD	Department of Defense
DSS	Decision Support Systems
FESA	Facilities Engineering Support Agency
FOD	Foreign Object Damage
HQ	Headquarters
M&R	Maintenance and Repair
MAC	Military Airlift Command
MAJCOM	Major Command

MCP	Military Construction Program
PAVER	(a pavement management system; not an acronym)
PCI	Pavement Condition Index
PIP	Pavement Improvement Plan
PMP	Pavement Maintenance Plan
PMS	Pavement Management System
PRC	Program Review Committee
SAC	Strategic Air Command
SPSS	Statistical Package for the Social Sciences
TAC	Tactical Air Command
TM	Technical Manual
TR	Technical Report
USAF	United States Air Force
WIMS	Work Information Management System

Appendix C: Survey Recipients

The following list identifies those bases which received PAVER implementation surveys. The list is divided into four primary groups representing the four survey groups: bases with PAVER, bases without PAVER, headquarters with PAVER, and headquarters without PAVER. Each survey group is then sub-divided according to MAJCOM.

Chapter III, Section B, provides additional information on how the recipients were selected. Appendices D-M contain the survey packages and a summary of the survey results.

Bases With PAVER

AFLC. 1. 2849 ABG/DE
Hill AFB UT 84056

2. 2852 ABG/DE
McClellan AFB CA 95652

ATC. 1. 64 CES/CC
Reese AFB TX 79489

2. 82 CES/CC
Williams AFB AZ 85224

TAC. 1. 1 CES/CC
Langley AFB VA 23665

Bases Without PAVER

AAC. 1. 5010 CES/CE
EIELSON AFB AK 99702

2. 21 CES/DE
ELMENDORF AFB AK 99506

AFLC. 1. 2803 ABG/DE
NEWARK OH 43057

2. 2853 ABG/DE
ROBINS AFB GA 31098

3. 2854 ABG/DE
TINKER AFB OK 73145

4. 2750 ABG/DE
WRIGHT-PATTERSON AFB OH 45433

ATC. 1. 3345 CES/CC
CHANUTE AFB IL 61868

2. 14 CES/CC
COLUMBUS AFB MS 39701

3. 2851 ABG/DE
Kelly AFB TX 78241

4. 3380 CES/CC
KEESLER AFB MS 39534

5. 3700 ABG/CC
LACKLAND AFB TX 78840

6. 47 CES/CC
LAUGHLIN AFB TX 78840

7. 3415 CES/CC
LOWRY AFB CO 80230

8. 323 CES/CC
MATHER AFB CA 95655

9. 12 ABG/DE
RANDOLPH AFB TX 78148

10. SARPMA/CC
SAN ANTONIO TX 78208

11. 3750 CES/CC
SHEPPARD AFB TX 76311

12. 71 ABG/DE
VANCE AFB OK 73701

MAC. 1. 443 CES/CC
ALTUS AFB OK 78352

2. 1776 CES/CC
ANDREWS AFB MD 20331

3. 1100 CES/CC
BOLLING AFB DC 20332

4. 437 CES/CC
CHARLESTON AFB SC 29404

5. 436 CES/CC
DOVER AFB DE 19901

6. 834 CES/CC
HURLBURT FIELD
EGLIN AFB FL 32544

7. 314 CES/CC
LITTLE ROCK AFB AR 72076

8. 62 CES/CC
MCCHORD AFB WA 98438

9. 438 CES/CC
MCGUIRE AFB NJ 08641

10. 63 CES/CC
NORTON AFB CA 92409

11. 317 CES/CC
POPE AFB NC 28308

12. 375 CES/CC
SCOTT AFB IL 62225

13. 60 CES/CC
TRAVIS AFB CA 94535

SAC. 1. 2 CES/CC
BARKSDALE AFB LA 61110

2. 100 CES/CC
BEALE AFB CA 96903

3. 97 CES/CC
BLYTHEVILLE AFB AR 72315

4. 7 CES/CC
CARSWELL AFB TX 76127

5. 93 CES/CC
CASTLE AFB CA 95342

6. 96 CES/CC
DYESS AFB TX 79607

7. 44 CES/CC
ELLSWORTH SD 57706

8. 92 CES/CC
FAIRCHILD AFB WA 99011

9. 90 CES/CC
F. E. WARREN AFB WY 82001

10. 321 CES/CC
GRAND FORKS AFB ND 58205

11. 416 CES/CC
GRIFFISS AFB NY 13441

12. 305 CES/CC
GRISSOM AFB IN 46971

13. 410 CES/CC
K. I. SAWYER AFB MI 49843

14. 42 CES/CC
LORING AFB ME 04750

15. 341 CES/CC
MALMSTROM AFB MT 59402

16. 22 CES/CC
MARCH AFB CA 92508

17. 381 CES/CC
MCCONNELL AFB KS 67221

18. 92 CES/CC
MINOT AFB ND 58705

19. 3902 CES/CC
OFFUTT AFB NE 68113

20. 509 CES/CC
PEASE AFB NH 03801

21. 380 CES/CC
PLATTSBURGH AFB NY 12903

22. 4392 AEROSG/DE
VANDENBERG AFB CA 93437

23. 351 CES/CC
WHITEMAN AFB MO 65305

24. 379 CES/CC
WURTSMITH AFB MI 48753

TAC. 1. 76 CES/CC
BERGSTROM AFB TX 78743

2. 27 CES/CC
CANNON AFB NM 88101

3. 836 CES/CC
DAVIS MONTHAN AFB AZ 85707

4. 23 CES/CC
ENGLAND AFB LA 71301

5. 35 CES/CC
GEORGE AFB CA 92392

6. 49 CES/CC
HOLLOMAN AFB NM 88330

7. 31 CES/CC
HOMESTEAD AFB FL 33039

8. 820 CES/CC
LAKE MEAD BASE NV 89110

9. 53 CES/CC
LUKE AFB AZ 85309

10. 56 CES/CC
MACDILL AFB FL 33608

11. 347 CES/CC
MOODY AFB GA 31601

12. 366 CES/CC
MT HOME AFB ID 83648

13. 354 CES/CC
MYRTLE BEACH AFB SC 29577

14. 47 CES/CC
NELLIS AFB NV 89191

15. 4 CES/CC
SEYMOUR JOHNSON AFB NC 27531

16. 363 CES/CC
SHAW AFB SC 29152

17. 325 CSG/DE
TYNDALL AFB FL 32403

Headquarters With PAVER

AFLC. HQ AFLC/DE
WRIGHT-PATTERSON AFB OH 45433

MAC. HQ MAC/DE
SCOTT AFB IL 62225

TAC. HQ TAC/DE
LANGLEY AFB VA 23665

Headquarters Without PAVER

AAC. HQ AAC/DE
ELMENDORF AFB AK 99506

ATC. HQ ATC/DE
RANDOLPH AFB TX 78148

SAC. HQ SAC/DE
OFFUTT AFB NE 68113

Appendix D: Survey Package for Bases with PAVER

The following pages display the survey package for bases with PAVER. Each package contained the following:

1. Cover letter from Colonel Smith, Dean, School of Systems and Logistics.
2. Privacy Act Statement.
3. Cover letter from Captain McLean, Graduate Student--Engineering Management (researcher).
4. Definition of PAVER.
5. Survey.
6. Computer score sheet (not shown).
7. Return envelope (not shown).

Appendix C lists the recipients of this survey. Table I of Appendix H summarizes the survey results.

The Military Personnel Center (MPC) assigned survey control number "USAF-SCN-84-64A" to this survey.

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (AU)
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

25 JUN 1984

REPLY TO ATTN OF: LSH(AFIT/GEM/LSM/84S-12)/Capt T. R. McLean/AUTOVON 785-4437

SUBJECT: PAVER Implementation Survey (USAF-SCN-84-64)

TO:

1. Would you please take the time to complete the enclosed survey package regarding implementation of the pavement management system, PAVER. We have included an envelope to return the completed survey and computer score sheet.

2. A graduate student in the Engineering Management program developed this survey as part of his thesis research. The purpose is to acquire data necessary to recommend improved methods of implementing PAVER in the future. The final report will be available to HQ AFESC, Major Commands, and the US Army Construction Engineering Research Laboratory, which is working in conjunction with the American Public Works Association to improve the PAVER system. We will amalgamate responses to the questions and will not attribute responses to any individual. Of course, your participation in this research is voluntary but we sure need your input.

3. I thank you in advance for your help.

Larry L. Smith

LARRY L. SMITH, Colonel, USAF
Dean
School of Systems and Logistics

1 Atch
Survey Package

PRIVACY STATEMENT

In accordance with paragraph 8, AFR 12-35, the following information is provided as required by the Privacy Act of 1974:

a. Authority:

(1) 5 U.S.C. 301, Departmental Regulations; and/or

(2) 10 U.S.C. 8012, Secretary of the Air Force, Powers, Duties, Delegation by Compensation; and/or

(3) EO 9397, 22 Nov 43, Numbering System for Federal Accounts Relating to Individual Persons; and/or

(4) DOD Instructin 1100.13, 17 Apr 68, Surveys of Department of Defense Personnel; and/or

(5) AFR 30-23, 22 Sep 76, Air Force Personnel Survey Program.

b. Principal Purposes. The survey is being conducted to collect information to be used in research aimed at illuminating and providing inputs to the solution of problems of interest to the Air Force and/or DOD.

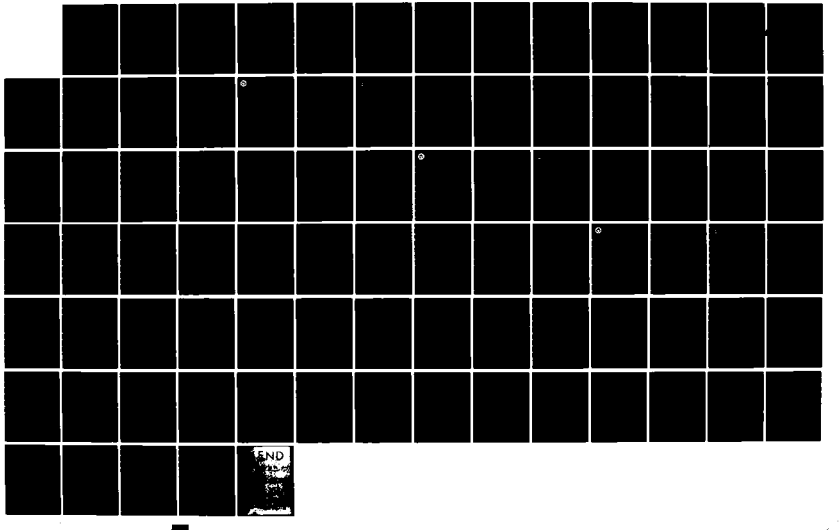
c. Routine Uses. The survey data will be converted to information for use in research of management related problems. Results of the research, based on data provided, will be included in written master's theses and may also be included in published articles, reports, or texts. Distribution of the results of the research, based on the survey data, whether in written form or presented orally, will be unlimited.

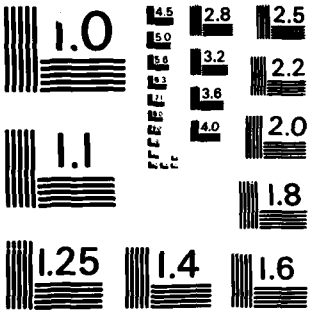
d. Participation in this survey is entirely voluntary.

e. No adverse action of any kind may be taken against any individual who elects not to participate in any or all of this survey.

AD-A147 727 IMPROVING PAVER IMPLEMENTATION(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF SYSTEMS AND LOGISTICS T R MCLEAN SEP 84 AFIT/GEM/LSM/84S-12 2/2

UNCLASSIFIED F/G 5/2 NL





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NATIONAL BUREAU OF STANDARDS - 1963 - A

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (AU)
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

25 JUN 1984

REPLY TO ATTN OF: LSH (AFIT/GEM/LSM/84S-12/Capt T. R. McLean/AUTOVON 785-4437

SUBJECT: PAVER Implementation Survey for Headquarters With PAVER

TO:

1. Please take time to complete the enclosed survey regarding implementation of the pavement management system, PAVER. Use the enclosed envelope to return the completed survey and computer score sheet within one week after receipt.

2. As a Civil Engineering Officer (5525C), I understand the value of your time, and I truly appreciate your assistance. This information is an essential portion of my thesis research in the Graduate Engineering Management program at the Air Force Institute of Technology.

3. Since my background includes over three years of pavement management experience, I have established improvement of future PAVER implementation as the goal of my thesis effort. I intend to use your inputs as part of my overall evaluation. An equally important aspect of the information gained through the survey is that HQ AFESC and the various MAJCOMs will have my final report available to assist in PAVER implementation and usage at their bases.

4. If you have any questions or suggestions while completing this survey, please contact me at Autovon 785-4437.

5. Any contact with me, including all responses to this survey, will be kept in strict confidence. The question on the survey regarding the name of your MAJCOM is only for trend analysis of responses. Questions regarding the point of contact are strictly for use in clarifying responses and for follow-up, as required.

6. Again, thank you very much for your time and cooperation. Your assistance will play a vital role in improving management of Air Force pavements in the future.

Timothy R. McLean, CAPT, USAF
Graduate Student--
Engineering Management

4 enclosures

1. Definition of PAVER
2. Survey
3. Computer Score Sheet
4. Return Envelope

DEFINITION OF PAVER

For the purposes of this survey, the PAVER pavement management system is defined as EITHER the manual procedures OR the computer-based program which have been developed and tested over the past ten years by the U. S. Army Construction Engineering Research Laboratory (CERL) for HQ AFESC.

As described in CERL Technical Report M-294 (October, 1981), the PAVER pavement management system

> "is designed to optimize the funds allocated for pavement maintenance and rehabilitation (M&R). The system includes procedures for dividing the pavement into manageable sections, pavement condition survey and rating, pavement evaluation, rational determination of M&R needs and priorities, performance of life-cycle costing on feasible M&R alternatives, and manual and automated systems for data storage and retrieval. The automated system provides custom-designed reports based on stored and/or processed data.
>
> An important part of PAVER is the pavement condition survey and rating [PCI] procedure . . .
>
> The PAVER system offers the flexibility of implementation at various levels. The highest level of implementation would be the inclusion of all pavements on the installation and use of the automated system. The lowest level would be the use of the PCI as the basis for project approvals and establishment of priorities. A gradual implementation includes starting with a specific group of pavements . . . and then including other pavements on a predefined schedule."

As described here by CERL, PAVER, as a manual system, is complete in itself. That is, it includes all of the aspects and capabilities necessary to manage pavements.

PAVER, as a computer program, operates on the same basic principles as the manual system, but adds numerous time-saving capabilities. These include: a) automated data entry, storage, update, and retrieval processes; b) data manipulation, formatting, and processing; and c) custom-designed report-generating programs that aid the user in determining, planning, and scheduling pavement maintenance and repair.

PAVER IMPLEMENTATION SURVEY
FOR BASES WITH PAVER

Please read the enclosed definition of PAVER before answering this survey. Then, answer the multiple choice questions by circling the ONE response which BEST reflects your answer. Your comments, suggestions, and questions are welcomed and appreciated for ALL survey questions (please use the space provided or the backs of these pages).

After you have completed this survey, please encode your answers for questions 1-5, 7, 9-15, 17-40, and 42-43 on the enclosed computer score sheet. Return this survey AND the computer score sheet in the envelope provided. Once again, thank you very much for your assistance.

---

1. What is your MAJCOM?

   A. AAC
   B. AFLC
   C. ATC
   D. MAC
   E. SAC
   F. TAC
   G. Other (please specify: _____)

2. What is your geographic area?

   A. Northeast (ME, NH, VT, MA, RI, CT, NY, PA, NJ, DE, MD, VA, WV, KY, OH)
   B. North central (MI, IN, IL, WI, MN, IA, ND, SD, NE)
   C. Northwest (MT, WY, ID, WA, OR)
   D. Southwest (CA, NV, UT, AZ, CO, NM)
   E. South central (KS, OK, TX, MO, AR, LA)
   F. Southeast (MS, TN, AL, GA, FL, SC, NC)
   G. Alaska
   H. Other

3. How familiar are you with the PAVER pavement management system? (EITHER manually OR computer assisted)

   A. I know what the basic components of PAVER are.
   B. I know what the basic components of PAVER are and I understand how they interrelate.
   C. I am able to use my knowledge and understanding of PAVER to ensure that proper data is input into the system.
   D. I am able to manipulate data, generate outputs, and use these outputs to assist in decision-making.
   E. I am able to do all of the above, plus do more advanced analysis than is currently available through PAVER.
   F. None of the above.

   Comments:

4. When did you find out about PAVER?

A. 0-6 months ago
B. 6-12 months ago
C. 12-18 months ago
D. 18-24 months ago
E. 24-30 months ago
F. 30-36 months ago
G. over 36 months ago

5. From whom did you initially find out about PAVER?

A. HQ AFESC
B. MAJCOM
C. Another base within my MAJCOM
D. Another base outside of my MAJCOM
E. AFIT ("Pavement Engineering" short course)
F. Univ. of Illinois (three day short course: "Pavement Management: The PAVER System")
G. Construction Engineering Research Lab
H. Worldwide Air Force Pavements Conference
I. Other (please specify: _____)

Comments:

6. What percentage of your information on how to implement PAVER did you gain from each of the following sources?

HQ AFESC:	_____	%
MAJCOM:	_____	%
Other bases within my MAJCOM:	_____	%
Other bases outside of my MAJCOM:	_____	%
AFIT ("Pavement Engineering" short course)	_____	%
Univ. of Illinois (three day short course: "Pavement Management: The PAVER System")	_____	%
Construction Engineering Research Lab	_____	%
Worldwide Air Force Pavements Conference	_____	%
Other (please specify: _____)	_____	%
TOTAL:	100	%

Comments:

7. Who do you intend to turn to in the future as the primary source of assistance with PAVER implementation problems?

A. HQ AFESC
B. MAJCOM
C. Another base within my MAJCOM
D. Another base outside of my MAJCOM
E. AFIT ("Pavement Engineering" short course)
F. Univ. of Illinois (three day short course: "Pavement Management: The PAVER System")
G. Construction Engineering Research Lab
H. Worldwide Air Force Pavements Conference
I. Other (please specify: _____)

Please explain why:

Who else do you plan to rely on? Why?

8. Please rank the following list of sources of information in the order that you feel will be most useful to bases which have not yet implemented PAVER-- (1 = most useful):

HQ AFESC	_____
MAJCOM	_____
Other bases within MAJCOM	_____
Other bases outside of MAJCOM	_____
AFIT ("Pavement Engineering" short course)	_____
Univ. of Illinois (three day short course: "Pavement Management: The PAVER System")	_____
Construction Engineering Research Lab	_____
Worldwide Air Force Pavements Conference	_____
Other (please specify: _____)	_____

Comments:

Please use the following list to answer questions 9 through 14:

A. Base Civil Engineer
B. Chief, Engineering and Environmental Planning
C. Chief, Engineering Design
D. Pavement Engineer
E. Technician or Site Developer
F. Chief, Operations
G. Superintendent, Pavements and Grounds
H. Foreman, Pavements and Grounds
I. Clerical, Secretarial, or Administrative Specialist
J. Other (please specify: _____)

9. Who is the primary user of the information provided by PAVER?

10. Who is the secondary user of the information provided by PAVER?

11. Who has primary responsibility for conducting inspections and gathering information necessary to keep the data base accurate and up-to-date?

12. Who has secondary responsibility for conducting inspections and gathering information necessary to keep the data base accurate and up-to-date?

13. Who has primary responsibility for entering this information into the data base?

14. Who has secondary responsibility for entering this information into the data base?

Comments on questions 9 through 14, above:

---

15. Approximately what percentage of the data previously used to complete pavement management reports (pavement condition index report, pavement maintenance plan, and pavement improvement plan) were you able to adapt for use with PAVER?

A. 0-20%
B. 20-40%
C. 40-60%
D. 60-80%
E. 80-100%

Comments:

16. Approximately how many manhours were required to create the data base used by PAVER after the decision was made to implement PAVER? (include construction history research, pavement condition inspections, data entry, etc.)

By pavement engineer: _____
By technicians or site developers: _____
By pavements and grounds superintendent: _____
By pavements and grounds foreman: _____
By clerical, secretarial, or administrative specialists: _____
By other (please specify _____): _____
By other (please specify _____): _____
By other (please specify _____): _____

Comments:

17. Were there any costs incurred as a result of implementing PAVER, other than the manhours listed above?

A. Yes
B. No

If yes, please provide the following information:

Nature of expense:

Estimated cost:

Comments:

Please use the following list to answer questions 18 through 24:

A. Very Good	D. Poor
B. Good	E. Very Poor
C. Fair	F. Not Used/ Not Applicable

During INITIAL implementation of PAVER at your base (first six months), how would you rate the training, assistance, or guidance received from:

18. HQ AFESC: _____

Strengths:

Weaknesses:

19. Your MAJCOM: _____

Strengths:

Weaknesses:

20. Other bases: _____

Strengths:

Weaknesses:

21. AFIT ("Pavement Engineering" short course): _____

Strengths:

Weaknesses:

22. University of Illinois (three day short course "Pavement Management: The PAVER System"): _____

Strengths:

Weaknesses:

23. Construction Engineering Research Laboratory (CERL): _____

Strengths:

Weaknesses:

24. "Other": _____

please specify "other":

Strengths:

Weaknesses:

Please use the following list to answer questions 25 through 31:

A. Very Good	D. Poor
B. Good	E. Very Poor
C. Fair	F. Not Used/ Not Applicable

During SUBSEQUENT implementation of PAVER at your base (after the first six months), how would you rate the training, assistance, or guidance received from:

25. HQ AFESC: _____

Strengths:

Weaknesses:

26. Your MAJCOM: _____

Strengths:

Weaknesses:

27. Other bases: _____

Strengths:

Weaknesses:

28. AFIT ("Pavement Engineering" short course): _____

Strengths:

Weaknesses:

29. University of Illinois (three day short course "Pavement Management: The PAVER System"): _____

Strengths:

Weaknesses:

30. Construction Engineering Research Laboratory (CERL): _____

Strengths:

Weaknesses:

31. "Other": _____

please specify "other":

Strengths:

Weaknesses:

32. Which of the following statements best describes the status of computer use for PAVER at your base:

A. We do not have any computer access for PAVER and therefore must rely totally on manual analysis procedures.

B. We have computer access, but still prefer to operate PAVER manually.

Reasons:

C. We operate portions of PAVER manually, and operate other portions by computer.

Manual portions:

Computer portions:

Reasons:

D. We operate all applicable portions of PAVER on the computer.

Comments on question 32:

33. Have you made any additions, deletions, or modifications to PAVER?

A. Yes
B. No

If yes, please describe:

Additions:

Deletions:

Modifications:

Other comments:

34. How accurate is the data that is entered into your PAVER system? (including construction history, pavement condition index ratings, and so on).

A. All of the data is accurate.
B. Most of the data is accurate (approx. 95%).
C. The majority of the data is accurate (approx 75% or more)
D. Some of the data is accurate (approx. 40% or more).
E. Less than 40% of the data is accurate.

Comments:

35. In your opinion, what is the primary reason that the data is not accurate?

A. Not applicable; all of our data is accurate.
B. We do not feel that it is necessary to use PAVER for anything except mission essential pavements.
C. We do not feel that it is necessary to use PAVER for anything except management of pavements scheduled for maintenance, repair, or reconstruction within the next three years, or so.
D. We would like to do a more thorough job of implementing PAVER, but even if we had additional manhours available, we would have more important uses for those manhours.
E. We would like to do a more thorough job of implementing PAVER, but we require additional manhours to do so.
F. We do not feel that any additional time spent on PAVER would be beneficial.
G. We already spend too much time on PAVER, but have to spend as much time as we do in order to satisfy requirements levied upon us by higher levels of management.
H. Other; please specify:

Comments:

36. How accurate do you feel the data needs to be that is entered into the PAVER system?

A. All of the data should be accurate.
B. Most of the data should be accurate (approx. 95%).
C. The majority of the data should be accurate (approx. 75% or more).
D. Some of the data should be accurate (approx. 40% or more).
E. Less than 40% of the data needs to be accurate.

Please explain why.

37. Did you encounter any problems implementing PAVER due to a lack of information, training, assistance, or guidance regarding the program?

A. Yes
B. No

If yes, please provide the following information for each problem encountered:

Nature of problem:

How it was solved:

Who solved it at base level (position title only):

Who assisted in solving (HQ AFESC, MAJCOM, etc.):

Who would you have preferred assistance from:

Comments:

38. Did you encounter any problems implementing PAVER due to errors, contradictions, or oversights in the program itself?

A. Yes
B. No

If yes, please provide the following information for each problem encountered:

Nature of problem:

How it was solved:

Who solved it at base level (position title only):

Who assisted in solving (HQ AFESC, MAJCOM, etc.):

Did you receive assistance from where you expected it:

Comments:

39. Are you currently encountering any problems regarding the use of PAVER?

A. Yes
B. No

If yes, please provide the following information for each problem:

Nature of problem:

Possible solutions:

Who is working the problem at base level (position title only):

Who is assisting in solving (HQ AFESC, MAJCOM, etc.):

What other assistance would you like to be receiving:

Comments:

40. Do you forsee any future problems regarding the use of PAVER?

A. Yes
B. No

If yes, please provide the following information for each problem:

Nature of problem:

Possible solutions:

Who at base level should work to solve the problem (position title only):

Who should assist in solving the problem (HQ AFESC, MAJCOM, etc.):

Comments:

41. Please provide a brief narrative description of any benefits that have resulted directly from the implementation of PAVER. (The following list is intended to serve as a starting point only.) Please provide as many examples as possible. Specific manhour and dollar figure examples would especially be appreciated.

Pavement management manhours reductions, by position:

Project cost reductions:

Improved project justification:

Elevation of project priority:

Increased funding for pavement projects:

Elimination of a project due to improved preventive maintenance:

Improved decision making:

Other:

42. Do you intend to implement PAVER for roads/streets?

A. Yes; we plan to implement PAVER for all roads/streets.
B. Yes; but only for mission essential roads/streets.
C. Yes; but only for roads/streets for which we are planning maintenance, repair, or reconstruction work.
D. Yes; but only because we are being directed to do so.
E. No; even if we had the necessary additional manhours, we would use them for other purposes.
F. No; but if we had the necessary additional manhours, we would implement PAVER for roads/streets.
G. No; not unless directed to do so, because we do not feel that the time spent would be beneficial.
H. No; our MAJCOM has recommended that we not implement PAVER for roads/streets.
I. Other; please specify:

Comments:

43. When do you plan to begin PAVER implementation for roads/streets?

A. We have already begun implementation.
B. We plan to begin within one year.
C. We plan to begin one to two years from now.
D. We plan to begin two or more years from now.
E. We do not plan to implement PAVER for roads/streets.

Comments:

44. Please provide a point of contact at your base regarding this survey. A point of contact is necessary in case of questions regarding responses to the survey, or in case any other questions should arise. (Contents of this survey WILL be held in confidence).

Name:
Rank/title:
Position title:
Duty mailing address:

Duty phone number (Autovon):

Thank you very much for your time and assistance. Your inputs will help to improve the PAVER program not only at your base, but throughout the Air Force, Department of Defense, and the civilian community.

Appendix E: Survey Package for Bases Without PAVER

The following pages display the survey package for bases without PAVER. Each package contained the following:

1. Cover letter from Colonel Smith, Dean, School of Systems and Logistics.
2. Privacy Act Statement.
3. Cover letter from Captain McLean, Graduate Student--Engineering Management (researcher).
4. Definition of PAVER.
5. Survey.
6. Computer score sheet (not shown).
7. Return envelope (not shown).

Appendix C lists the recipients of this survey. Table II of Appendix I summarizes the survey results. Table V of Appendix L provides additional information and summarizes the results for a base which returned two surveys--one from the contractor who performs the base maintenance, and one from the base which acts as the quality assurance evaluator for that contract.

The Military Personnel Center (MPC) assigned survey control number "USAF-SCN-84-64B" to this survey.

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (AU)
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

25 JUN 1984

REPLY TO ATTN OF: LSH(AFIT/GEM/LSM/84S-12)/Capt T. R. McLean/AUTOVON 785-4437

SUBJECT: PAVER Implementation Survey (USAF-SCN-84-64)

TO:

1. Would you please take the time to complete the enclosed survey package regarding implementation of the pavement management system, PAVER. We have included an envelope to return the completed survey and computer score sheet.

2. A graduate student in the Engineering Management program developed this survey as part of his thesis research. The purpose is to acquire data necessary to recommend improved methods of implementing PAVER in the future. The final report will be available to HQ AFESC, Major Commands, and the US Army Construction Engineering Research Laboratory, which is working in conjunction with the American Public Works Association to improve the PAVER system. We will amalgamate responses to the questions and will not attribute responses to any individual. Of course, your participation in this research is voluntary but we sure need your input.

3. I thank you in advance for your help.

Larry L. Smith

LARRY L. SMITH, Colonel, USAF
Dean
School of Systems and Logistics

1 Atch
Survey Package

PRIVACY STATEMENT

In accordance with paragraph 8, AFR 12-35, the following information is provided as required by the Privacy Act of 1974:

a. Authority:

(1) 5 U.S.C. 301, Departmental Regulations; and/or

(2) 10 U.S.C. 8012, Secretary of the Air Force, Powers, Duties, Delegation by Compensation; and/or

(3) EO 9397, 22 Nov 43, Numbering System for Federal Accounts Relating to Individual Persons; and/or

(4) DOD Instructin 1100.13, 17 Apr 68, Surveys of Department of Defense Personnel; and/or

(5) AFR 30-23, 22 Sep 76, Air Force Personnel Survey Program.

b. Principal Purposes. The survey is being conducted to collect information to be used in research aimed at illuminating and providing inputs to the solution of problems of interest to the Air Force and/or DOD.

c. Routine Uses. The survey data will be converted to information for use in research of management related problems. Results of the research, based on data provided, will be included in written master's theses and may also be included in published articles, reports, or texts. Distribution of the results of the research, based on the survey data, whether in written form or presented orally, will be unlimited.

d. Participation in this survey is entirely voluntary.

e. No adverse action of any kind may be taken against any individual who elects not to participate in any or all of this survey.

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (AU)
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

25 JUN 1984

REPLY TO ATTN OF: LSH (AFIT/GEM/LSM/84S-12/Capt T. R. McLean/AUTOVON 785-4437

SUBJECT: PAVER Implementation Survey for Headquarters Without PAVER

TO:

1. Please take time to complete the enclosed survey regarding implementation of the pavement management system, PAVER. Use the enclosed envelope to return the completed survey and computer score sheet within one week after receipt.

2. As a Civil Engineering Officer (5525C), I understand the value of your time, and I truly appreciate your assistance. This information is an essential portion of my thesis research in the Graduate Engineering Management program at the Air Force Institute of Technology.

3. Since my background includes over three years of pavement management experience, I have established improvement of future PAVER implementation as the goal of my thesis effort. I intend to use your inputs as part of my overall evaluation. An equally important aspect of the information gained through the survey is that HQ AFESC and the various MAJCOMs will have my final report available to assist in PAVER implementation and usage at their bases.

4. If you have any questions or suggestions while completing this survey, please contact me at Autovon 785-4437.

5. Any contact with me, including all responses to this survey, will be kept in strict confidence. The question on the survey regarding the name of your MAJCOM is only for trend analysis of responses. Questions regarding the point of contact are strictly for use in clarifying responses and for follow-up, as required.

6. Again, thank you very much for your time and cooperation. Your assistance will play a vital role in improving management of Air Force pavements in the future.

Timothy R. McLean, CAPT, USAF
Graduate Student--
Engineering Management

4 enclosures

1. Definition of PAVER
2. Survey
3. Computer Score Sheet
4. Return Envelope

DEFINITION OF PAVER

For the purposes of this survey, the PAVER pavement management system is defined as EITHER the manual procedures OR the computer-based program which have been developed and tested over the past ten years by the U. S. Army Construction Engineering Research Laboratory (CERL) for HQ AFESC.

As described in CERL Technical Report M-294 (October, 1981), the PAVER pavement management system

> "is designed to optimize the funds allocated for pavement maintenance and rehabilitation (M&R). The system includes procedures for dividing the pavement into manageable sections, pavement condition survey and rating, pavement evaluation, rational determination of M&R needs and priorities, performance of life-cycle costing on feasible M&R alternatives, and manual and automated systems for data storage and retrieval. The automated system provides custom-designed reports based on stored and/or processed data.
>
> An important part of PAVER is the pavement condition survey and rating [PCI] procedure . . .
>
> The PAVER system offers the flexibility of implementation at various levels. The highest level of implementation would be the inclusion of all pavements on the installation and use of the automated system. The lowest level would be the use of the PCI as the basis for project approvals and establishment of priorities. A gradual implementation includes starting with a specific group of pavements . . . and then including other pavements on a predefined schedule."

As described here by CERL, PAVER, as a manual system, is complete in itself. That is, it includes all of the aspects and capabilities necessary to manage pavements.

PAVER, as a computer program, operates on the same basic principles as the manual system, but adds numerous time-saving capabilities. These include: a) automated data entry, storage, update, and retrieval processes; b) data manipulation, formatting, and processing; and c) custom-designed report-generating programs that aid the user in determining, planning, and scheduling pavement maintenance and repair.

PAVER IMPLEMENTATION SURVEY
FOR BASES WITHOUT PAVER

Please read the enclosed definition of PAVER before answering this survey. Then, answer the multiple choice questions by circling the ONE response which BEST reflects your answer. Your comments, suggestions, and questions are welcomed and appreciated for ALL survey questions (please use the space provided or the backs of these pages).

After you have completed this survey, please encode your answers for questions 1-5, 7-18, 20-34, and 36-37 on the enclosed computer score sheet. Return this survey AND the computer score sheet in the envelope provided. Once again, thank you very much for your assistance.

---

1. What is your MAJCOM?

   A. AAC D. MAC G. Other (please specify: _____)
   B. AFLC E. SAC
   C. ATC F. TAC

2. What is your geographic area?

   A. Northeast (ME, NH, VT, MA, RI, CT, NY, PA, NJ, DE, MD, VA, WV, KY, OH)
   B. North central (MI, IN, IL, WI, MN, IA, ND, SD, NE)
   C. Northwest (MT, WY, ID, WA, OR)
   D. Southwest (CA, NV, UT, AZ, CO, NM)
   E. South central (KS, OK, TX, MO, AR, LA)
   F. Southeast (MS, TN, AL, GA, FL, SC, NC)
   G. Alaska
   H. Other

3. How familiar are you with the PAVER pavement management system? (EITHER manually OR computer assisted)

   A. This is the first time that I have heard of PAVER.
   B. I have heard of PAVER, but know nothing about it.
   C. I know a little bit about PAVER.
   D. I know what the basic components of PAVER are.
   E. I know what the basic components of PAVER are and I understand how they interrelate.
   F. I am able to use my knowledge and understanding of PAVER to ensure that proper data is input into the system.
   G. I am able to manipulate data, generate outputs, and use these outputs to assist in decision-making.
   H. I am able to do all of the above, plus do more advanced analysis than is currently available through PAVER.
   I. None of the above.

   Comments:

4. When did you find out about PAVER?

A. 0-6 months ago
B. 6-12 months ago
C. 12-18 months ago
D. 18-24 months ago
E. 24-30 months ago
F. 30-36 months ago
G. over 36 months ago

5. From whom did you initially find out about PAVER?

A. HQ AFESC
B. MAJCOM
C. Another base within my MAJCOM
D. Another base outside of my MAJCOM
E. AFIT ("Pavement Engineering" short course)
F. Univ. of Illinois (three day short course: "Pavement Management: The PAVER System")
G. Construction Engineering Research Lab
H. Worldwide Air Force Pavements Conference
I. Other (please specify: _____)

Comments:

6. What percentage of your information of what PAVER is did you gain from each of the following sources?

HQ AFESC:	_____	%
MAJCOM:	_____	%
Other bases within my MAJCOM:	_____	%
Other bases outside of my MAJCOM:	_____	%
AFIT ("Pavement Engineering" short course)	_____	%
Univ. of Illinois (three day short course: "Pavement Management: The PAVER System")	_____	%
Construction Engineering Research Lab	_____	%
Worldwide Air Force Pavements Conference	_____	%
Other (please specify: _____)	_____	%
TOTAL:	100	%

Comments:

7. What system of pavement management are you currently using for airfields? (Unless you indicate otherwise, it will be assumed that in addition to the response you select, you use the pavement condition index, the pavement maintenance plan, and the pavement improvement plan as part of your overall management process.)

A. We use subjective judgment to manage our airfield pavements.
B. We use "management-by-exception"-- i.e., we monitor only those airfield pavements which are in the worst condition.
C. We maintain and repair airfield pavements as directed by higher levels of management.
D. We maintain an accurate system for tracking the condition, rate of deterioration, construction history, maintenance and repair history, and traffic history of each of our airfield pavement features (eg: index card or similar filing system).
E. Other; please specify:

Comments:

8. Who do you intend to turn to (primary source) for more information about what PAVER is?

A. HQ AFESC
B. MAJCOM
C. Another base within my MAJCOM
D. Another base outside of my MAJCOM
E. AFIT ("Pavement Engineering" short course)
F. Univ. of Illinois (three day short course: "Pavement Management: The PAVER System")
G. Construction Engineering Research Lab
H. Worldwide Air Force Pavements Conference
I. Other (please specify: _____)
J. I do not intend to seek any further information.

Please explain why:

Who else do you plan to rely on? Why?

9. Do you intend to implement PAVER for airfields?

A. Yes; we plan to implement PAVER for all airfield pavements.
B. Yes; but only for mission essential airfield pavements.
C. Yes; but only for airfield pavements for which we are planning maintenance, repair, or reconstruction work.
D. Yes; but only because we are being directed to do so.
E. No; even if we had the necessary additional manhours, we would use them for other purposes.
F. No; but if we had the necessary additional manhours, we would implement PAVER for airfield pavements.
G. No; not unless directed to do so, because we do not feel that the time spent would be beneficial.
H. No; our MAJCOM has recommended that we not implement PAVER for airfield pavements.
I. Other; please specify:

Comments:

10. When do you plan to begin PAVER implementation for airfield pavements?

A. We have already begun implementation.
B. We plan to begin within one year.
C. We plan to begin one to two years from now.
D. We plan to begin two or more years from now.
E. We do not plan to implement PAVER for airfield pavements.

Comments:

11. Who do you intend to turn to as the primary source of assistance with PAVER implementation problems?

A. HQ AFESC
B. MAJCOM
C. Another base within my MAJCOM
D. Another base outside of my MAJCOM
E. AFIT ("Pavement Engineering" short course)
F. Univ. of Illinois (three day short course: "Pavement Management: The PAVER System")
G. Construction Engineering Research Lab
H. Worldwide Air Force Pavements Conference
I. Other (please specify: _____)
J. We do not plan to implement PAVER.

Please explain why:

Who else do you plan to rely on? Why?

Please use the following list to answer questions 12 through 17:

A. Base Civil Engineer
B. Chief, Engineering and Environmental Planning
C. Chief, Engineering Design
D. Pavement Engineer
E. Technician or Site Developer
F. Chief, Operations
G. Superintendent, Pavements and Grounds
H. Foreman, Pavements and Grounds
I. Clerical, Secretarial, or Administrative Specialist
J. Other (please specify: _____)

12. Who do you feel should be the primary user of the information provided by PAVER?

13. Who do you feel should be the secondary user of the information provided by PAVER?

14. Who do you feel should have primary responsibility for conducting inspections and gathering information necessary to keep the data base accurate and up-to-date?

15. Who do you feel should have secondary responsibility for conducting inspections and gathering information necessary to keep the data base accurate and up-to-date?

16. Who do you feel should have primary responsibility for entering this information into the data base?

17. Who do you feel should have secondary responsibility for entering this information into the data base?

Comments on questions 12 through 17, above:

---

18. Approximately what percentage of the data previously used to complete pavement management reports (pavement condition index report, pavement maintenance plan, and pavement improvement plan) do you expect you will be able to adapt for use with PAVER?

A. 0-20%
B. 20-40%
C. 40-60%
D. 60-80%
E. 80-100%

Comments:

19. Approximately how many manhours do you feel will be required to create the data base used by PAVER after the decision is made to implement PAVER? (include construction history research, pavement condition inspections, data entry, etc.)

By pavement engineer: _____
By technicians or site developers: _____
By pavements and grounds superintendent: _____
By pavements and grounds foreman: _____
By clerical, secretarial, or administrative specialists: _____
By other (please specify _____): _____
By other (please specify _____): _____
By other (please specify _____): _____

Comments:

20. Will you incur any costs as a result of implementing PAVER, other than the manhours listed above?

A. Yes
B. No

If yes, please provide the following information:

Nature of expense:

Estimated cost:

Comments:

Please use the following list to answer questions 21 through 27:

A. Almost all	D. A small amount
B. A large amount	E. Almost none
C. Some	F. Not used/ not applicable

During INITIAL implementation of PAVER at your base (first six months), how much of the training, assistance, or guidance do you expect to receive from:

21. HQ AFESC: _____

Comments:

22. Your MAJCOM: _____

Comments:

23. Other bases: _____

Comments:

24. AFIT ("Pavement Engineering" short course): _____

Comments:

25. University of Illinois (three day short course "Pavement Management: The PAVER System"): _____

Comments:

26. Construction Engineering Research Laboratory (CERL): _____

Comments:

27. "Other": _____

please specify "other": _____

Comments:

28. Which of the following statements best describes the probable status of computer use for PAVER at your base:

A. We do not expect to have any computer access for PAVER and therefore will rely totally on manual analysis procedures.

B. We will have computer access, but will still operate PAVER manually.

Reasons:

C. We will operate portions of PAVER manually, and will operate other portions by computer.

Manual portions:

Computer portions:

Reasons:

D. We will operate all applicable portions of PAVER on the computer.

E. We do not plan to implement PAVER.

Comments on question 28:

29. Do you plan to make any additions, deletions, or modifications to PAVER?

A. Yes
B. No

If yes, please describe:

Additions:

Deletions:

Modifications:

Other comments:

30. How accurate is the data that is entered into your pavement condition index report, pavement maintenance plan, and pavement improvement plan? (including construction history, pavement condition index ratings, and so on).

A. All of the data is accurate.
B. Most of the data is accurate (approx. 95%).
C. The majority of the data is accurate (approx 75% or more)
D. Some of the data is accurate (approx. 40% or more).
E. Less than 40% of the data is accurate.

Comments:

31. In your opinion, what is the primary reason that the data is not accurate?

A. Not applicable; all of our data is accurate.
B. We do not feel that it is necessary to have accurate data for anything except mission essential pavements.
C. We do not feel that it is necessary to have accurate data for anything except management of pavements scheduled for maintenance, repair, or reconstruction within the next three years, or so.
D. We would like to do a more thorough job of obtaining accurate data, but even if we had additional manhours available, we would have more important uses for those manhours.
E. We would like to do a more thorough job of obtaining accurate data, but we would require additional manhours to do so.
F. We do not feel that any additional time spent on obtaining accurate data would be beneficial.
G. We already spend too much time obtaining accurate data, but have to spend as much time as we do in order to satisfy requirements levied upon us by higher levels of management.
H. Other; please specify:

Comments:

32. How accurate do you feel the data needs to be that is entered into the PAVER system?

A. All of the data should be accurate.
B. Most of the data should be accurate (approx. 95%).
C. The majority of the data should be accurate (approx. 75% or more).
D. Some of the data should be accurate (approx. 40% or more).
E. Less than 40% of the data needs to be accurate.

Please explain why.

33. Do you anticipate any problems implementing PAVER due to a lack of information, training, assistance, or guidance regarding the program?

A. Yes
B. No

If yes, please provide the following information for each problem anticipated:

Nature of problem:

How should it be solved:

Who should solve it at base level (position title only):

Who should assist in solving (HQ AFESC, MAJCOM, etc.):

Comments:

34. Do you forsee any future problems regarding the implementation of PAVER?

A. Yes
B. No

If yes, please provide the following information for each problem:

Nature of problem:

Possible solutions:

Who at base level should work to solve the problem (position title only):

Who should assist in solving the problem (HQ AFESC, MAJCOM, etc.):

Comments:

35. Please provide a brief narrative description of any benefits that you feel would result directly from the implementation of PAVER. (The following list is intended to serve as a starting point only.) Please provide as many examples as possible. Specific manhour and dollar figure examples would especially be appreciated.

Pavement management manhours reductions, by position:

Project cost reductions:

Improved project justification:

Elevation of project priority:

Increased funding for pavement projects:

Elimination of a project due to improved preventive maintenance:

Improved decision making:

Other:

36. Do you intend to implement PAVER for roads/streets?

A. Yes; we plan to implement PAVER for all roads/streets.
B. Yes; but only for mission essential roads/streets.
C. Yes; but only for roads/streets for which we are planning maintenance, repair, or reconstruction work.
D. Yes; but only because we are being directed to do so.
E. No; even if we had the necessary additional manhours, we would use them for other purposes.
F. No; but if we had the necessary additional manhours, we would implement PAVER for roads/streets.
G. No; not unless directed to do so, because we do not feel that the time spent would be beneficial.
H. No; our MAJCOM has recommended that we not implement PAVER for roads/streets.
I. Other; please specify:

Comments:

37. When do you plan to begin PAVER implementation for roads/streets?

A. We have already begun implementation.
B. We plan to begin within one year.
C. We plan to begin one to two years from now.
D. We plan to begin two or more years from now.
E. We do not plan to implement PAVER for roads/streets.

Comments:

38. Please provide a point of contact at your base regarding this survey. A point of contact is necessary in case of questions regarding responses to the survey, or in case any other questions should arise. (Contents of this survey WILL be held in confidence).

Name:
Rank/title:
Position title:
Duty mailing address:

Duty phone number (Autovon):

Thank you very much for your time and assistance. Your inputs will help to improve the pavement management program not only at your base, but throughout the Air Force, Department of Defense, and the civilian community.

Appendix F: Survey Package for Headquarters with PAVER

The following pages display the survey package for headquarters with PAVER. Each package contained the following:

1. Cover letter from Colonel Smith, Dean, School of Systems and Logistics.
2. Privacy Act Statement.
3. Cover letter from Captain McLean, Graduate Student--Engineering Management (researcher).
4. Definition of PAVER.
5. Survey.
6. Computer score sheet (not shown).
7. Return envelope (not shown).

Appendix C lists the recipients of this survey. Table III of Appendix J summarizes the survey results.

The Military Personnel Center (MPC) assigned survey control number "USAF-SCN-84-64C" to this survey.

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (AU)
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

25 JUN 1984

REPLY TO ATTN OF: LSH(AFIT/GEM/LSM/84S-12)/Capt T. R. McLean/AUTOVON 785-4437

SUBJECT: PAVER Implementation Survey (USAF-SCN-84-64)

TO:

1. Would you please take the time to complete the enclosed survey package regarding implementation of the pavement management system, PAVER. We have included an envelope to return the completed survey and computer score sheet.

2. A graduate student in the Engineering Management program developed this survey as part of his thesis research. The purpose is to acquire data necessary to recommend improved methods of implementing PAVER in the future. The final report will be available to HQ AFESC, Major Commands, and the US Army Construction Engineering Research Laboratory, which is working in conjunction with the American Public Works Association to improve the PAVER system. We will amalgamate responses to the questions and will not attribute responses to any individual. Of course, your participation in this research is voluntary but we sure need your input.

3. I thank you in advance for your help.

LARRY L. SMITH, Colonel, USAF
Dean
School of Systems and Logistics

1 Atch
Survey Package

PRIVACY STATEMENT

In accordance with paragraph 8, AFR 12-35, the following information is provided as required by the Privacy Act of 1974:

a. Authority:

(1) 5 U.S.C. 301, Departmental Regulations; and/or

(2) 10 U.S.C. 8012, Secretary of the Air Force, Powers, Duties, Delegation by Compensation; and/or

(3) EO 9397, 22 Nov 43, Numbering System for Federal Accounts Relating to Individual Persons; and/or

(4) DOD Instructin 1100.13, 17 Apr 68, Surveys of Department of Defense Personnel; and/or

(5) AFR 30-23, 22 Sep 76, Air Force Personnel Survey Program.

b. Principal Purposes. The survey is being conducted to collect information to be used in research aimed at illuminating and providing inputs to the solution of problems of interest to the Air Force and/or DOD.

c. Routine Uses. The survey data will be converted to information for use in research of management related problems. Results of the research, based on data provided, will be included in written master's theses and may also be included in published articles, reports, or texts. Distribution of the results of the research, based on the survey data, whether in written form or presented orally, will be unlimited.

d. Participation in this survey is entirely voluntary.

e. No adverse action of any kind may be taken against any individual who elects not to participate in any or all of this survey.

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (AU)
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

25 JUN 1984

REPLY TO ATTN OF: LSH (AFIT/GEM/LSM/84S-12)/Capt T. R. McLean/AUTOVON 785-4437

SUBJECT: PAVER Implementation Survey for Bases With PAVER

TO:

1. Please take time to complete the enclosed survey regarding implementation of the pavement management system, PAVER. Use the enclosed envelope to return the completed survey and computer score sheet within one week after receipt.

2. As a Civil Engineering Officer (5525C), I understand the value of your time, and I truly appreciate your assistance. This information is an essential portion of my thesis research in the Graduate Engineering Management program at the Air Force Institute of Technology.

3. Since my background includes over three years of pavement management experience, I have established improvement of future PAVER implementation as the goal of my thesis effort. I intend to use your inputs as part of my overall evaluation. An equally important aspect of the information gained through the survey is that HQ AFESC and the various MAJCOMs will have my final report available to assist in PAVER implementation and usage at their bases.

4. If you have any questions or suggestions while completing this survey, please contact me at Autovon 785-4437. Your MAJCOM pavement engineer has agreed to serve as a secondary point of contact: _____.

5. Any contact with me, including all responses to this survey, will be kept in strict confidence. Questions on the survey regarding geographic area and MAJCOM are only for trend analysis of responses. Questions regarding the point of contact are strictly for use in clarifying responses and for follow-up, as required.

6. Again, thank you very much for your time and cooperation. Your assistance will play a vital role in improving management of Air Force pavements in the future.

Timothy R. McLean, CAPT, USAF
Graduate Student--
Engineering Management

4 Enclosures:

1. Definition of PAVER
2. Survey
3. Computer Score Sheet
4. Return Envelope

DEFINITION OF PAVER

For the purposes of this survey, the PAVER pavement management system is defined as EITHER the manual procedures OR the computer-based program which have been developed and tested over the past ten years by the U. S. Army Construction Engineering Research Laboratory (CERL) for HQ AFESC.

As described in CERL Technical Report M-294 (October, 1981), the PAVER pavement management system

> "is designed to optimize the funds allocated for pavement maintenance and rehabilitation (M&R). The system includes procedures for dividing the pavement into manageable sections, pavement condition survey and rating, pavement evaluation, rational determination of M&R needs and priorities, performance of life-cycle costing on feasible M&R alternatives, and manual and automated systems for data storage and retrieval. The automated system provides custom-designed reports based on stored and/or processed data.
>
> An important part of PAVER is the pavement condition survey and rating [PCI] procedure . . .
>
> The PAVER system offers the flexibility of implementation at various levels. The highest level of implementation would be the inclusion of all pavements on the installation and use of the automated system. The lowest level would be the use of the PCI as the basis for project approvals and establishment of priorities. A gradual implementation includes starting with a specific group of pavements . . . and then including other pavements on a predefined schedule."

As described here by CERL, PAVER, as a manual system, is complete in itself. That is, it includes all of the aspects and capabilities necessary to manage pavements.

PAVER, as a computer program, operates on the same basic principles as the manual system, but adds numerous time-saving capabilities. These include: a) automated data entry, storage, update, and retrieval processes; b) data manipulation, formatting, and processing; and c) custom-designed report-generating programs that aid the user in determining, planning, and scheduling pavement maintenance and repair.

PAVER IMPLEMENTATION SURVEY
FOR HEADQUARTERS WITH PAVER

Please read the enclosed definition of PAVER before answering this survey. Then, answer the multiple choice questions by circling the ONE response which BEST reflects your answer. Your comments, suggestions, and questions are welcomed and appreciated for ALL survey questions (please use the space provided or the backs of these pages).

After you have completed this survey, please encode your answers for questions 1-4, 6, 8-14, 16-37, and 39-42 on the enclosed computer score sheet. Return this survey AND the computer score sheet in the envelope provided. Once again, thank you very much for your assistance.

---

1. What is your MAJCOM?

   A. AAC D. MAC G. Other (please specify: _____)
   B. AFLC E. SAC
   C. ATC F. TAC

2. How familiar are you with the PAVER pavement management system? (EITHER manually OR computer assisted)

   A. I know what the basic components of PAVER are.
   B. I know what the basic components of PAVER are and I understand how they interrelate.
   C. I am able to use my knowledge and understanding of PAVER to ensure that proper data is input into the system.
   D. I am able to manipulate data, generate outputs, and use these outputs to assist in decision-making.
   E. I am able to do all of the above, plus do more advanced analysis than is currently available through PAVER.
   F. None of the above.

   Comments:

3. From whom did you initially find out about PAVER?

   A. HQ AFESC
   B. Another MAJCOM
   C. AFIT ("Pavement Engineering" short course)
   D. Univ. of Illinois (three day short course: "Pavement Management: The PAVER System")
   E. Construction Engineering Research Lab
   F. Worldwide Air Force Pavements Conference
   G. Other (please specify: _____)

   Comments:

4. When did you find out about PAVER?

A. 0-6 months ago
B. 6-12 months ago
C. 12-18 months ago
D. 18-24 months ago
E. 24-30 months ago
F. 30-36 months ago
G. over 36 months ago

5. What percentage of your information on how to implement PAVER did you gain from each of the following sources?

HQ AFESC: _____ %
Another MAJCOM: _____ %
AFIT ("Pavement Engineering" short course) _____ %
Univ. of Illinois (three day short course:
"Pavement Management: The PAVER System") _____ %
Construction Engineering Research Lab _____ %
Worldwide Air Force Pavements Conference _____ %
Other (please specify: _____) _____ %

TOTAL: 100 %

Comments:

6. Who do you intend to turn to in the future as the primary source of assistance with PAVER implementation problems?

A. HQ AFESC
B. Another MAJCOM
C. AFIT ("Pavement Engineering" short course)
D. Univ. of Illinois (three day short course:
"Pavement Management: The PAVER System")
E. Construction Engineering Research Lab
F. Worldwide Air Force Pavements Conference
G. Other (please specify: _____)

Please explain why:

Who else do you plan to rely on? Why?

7. Please rank the following list of sources of information in the order that you feel will be most useful to bases which have not yet implemented PAVER— (1 = most useful):

HQ AFESC _____
MAJCOM _____
AFIT ("Pavement Engineering" short course) _____
Univ. of Illinois (three day short course:
"Pavement Management: The PAVER System") _____
Construction Engineering Research Lab _____
Worldwide Air Force Pavements Conference _____
Other (please specify: _____) _____

Comments:

Please use the following list to answer questions 8 through 13:

A. Base Civil Engineer
B. Chief, Engineering and Environmental Planning
C. Chief, Engineering Design
D. Pavement Engineer
E. Technician or Site Developer
F. Chief, Operations
G. Superintendent, Pavements and Grounds
H. Foreman, Pavements and Grounds
I. Clerical, Secretarial, or Administrative Specialist
J. Other (please specify: _____)

8. At base level, who do you feel should be the primary user of the information provided by PAVER?

9. At base level, who do you feel should be the secondary user of the information provided by PAVER?

10. At base level, who do you feel should have the primary responsibility for conducting inspections and gathering information necessary to keep the data base accurate and up-to-date?

11. At base level, who do you feel should have the secondary responsibility for conducting inspections and gathering information necessary to keep the data base accurate and up-to-date?

12. At base level, who do you feel should have the primary responsibility for entering this information into the data base?

13. At base level, who do you feel should have the secondary responsibility for entering this information into the data base?

Comments on questions 8 through 13, above:

---

14. In your opinion, approximately what percentage of the data previously used to complete pavement management reports (pavement condition index report, pavement maintenance plan, and pavement improvement plan) were you able to adapt for use with PAVER?

A. 0-20%
B. 20-40%
C. 40-60%
D. 60-80%
E. 80-100%

Comments:

15. Approximately how many manhours did you require to create the data base used by PAVER, after the decision was made to implement PAVER? (include construction history research, pavement condition inspections, data entry, etc.)

By pavement engineer: _____
By assistant pavement engineer: _____
By technicians: _____
By clerical, secretarial, or administrative specialists: _____
By other (please specify _____): _____
By other (please specify _____): _____
By other (please specify _____): _____

Comments:

16. Do you know of any costs that you incurred as a result of implementing PAVER, other than the manhours listed above?

A. Yes
B. No

If yes, please provide the following information:

Nature of expense:

Estimated cost:

Comments:

Please use the following list to answer questions 17 through 22:

A. Very Good	D. Poor
B. Good	E. Very Poor
C. Average	F. Not Used/ Not Applicable

During INITIAL implementation of PAVER within your MAJCOM (first six months), how would you rate the training, assistance, or guidance that you received from:

17. HQ AFESC: _____

    Strengths:

    Weaknesses:

18. Other MAJCOMs: _____

    Strengths:

    Weaknesses:

19. AFIT ("Pavement Engineering" short course): _____

    Strengths:

    Weaknesses:

20. University of Illinois (three day short course "Pavement Management: The PAVER System"): _____

    Strengths:

    Weaknesses:

21. Construction Engineering Research Laboratory (CERL): _____

    Strengths:

    Weaknesses:

22. "Other": _____

    please specify "other": _____

    Strengths:

    Weaknesses:

Please use the following list to answer questions 23 through 28:

A. Very Good	D. Poor
B. Good	E. Very Poor
C. Average	F. Not Used/ Not Applicable

During SUBSEQUENT implementation of PAVER within your MAJCOM (after the first six months), how would you rate the training, assistance, or guidance that you received from:

23. HQ AFESC: _____

Strengths:

Weaknesses:

24. Other MAJCOMs: _____

Strengths:

Weaknesses:

25. AFIT ("Pavement Engineering" short course): _____

Strengths:

Weaknesses:

26. University of Illinois (three day short course "Pavement Management: The PAVER System"): _____

Strengths:

Weaknesses:

27. Construction Engineering Research Laboratory (CERL): _____

Strengths:

Weaknesses:

28. "Other": _____

please specify "other": _____

Strengths:

Weaknesses:

29. Which of the following statements best describes the status of computer use for PAVER within your MAJCOM:

A. We do not have any computer access for PAVER and therefore must rely totally on manual analysis procedures.

B. We have computer access, but still prefer to operate PAVER manually.

Reasons:

C. We operate portions of PAVER manually, and operate other portions by computer.

Manual portions:

Computer portions:

Reasons:

D. We operate all applicable portions of PAVER on the computer.

Comments on question 29:

30. Have you made any additions, deletions, or modifications to PAVER? (If yes, please describe them below.)

A. Yes B. No

Additions:

Deletions:

Modifications:

Other comments:

31. In your opinion, how accurate is the data that is entered into the PAVER system by a "typical" base within your MAJCOM? (including construction history, pavement condition index ratings, and so on).

A. All of the data is accurate.
B. Most of the data is accurate (approx. 95%).
C. The majority of the data is accurate (approx 75% or more)
D. Some of the data is accurate (approx. 40% or more).
E. Less than 40% of the data is accurate.

Comments:

32. In your opinion, what is the primary reason that the data is not accurate?

A. Not applicable; all of the data is accurate.
B. Most bases do not feel that it is necessary to use PAVER for anything except mission essential pavements.
C. Most bases do not feel that it is necessary to use PAVER for anything except management of pavements scheduled for maintenance, repair, or reconstruction within the next three years, or so.
D. Most bases would like to do a more thorough job of implementing PAVER, but even if they had additional manhours available, they would have more important uses for those manhours.
E. Most bases would like to do a more thorough job of implementing PAVER, but they would require additional manhours to do so.
F. Most bases do not feel that any additional time spent on PAVER would be beneficial.
G. Most bases already spend too much time on PAVER, but have to spend as much time as they do in order to satisfy requirements levied upon them by higher levels of management.
H. Other; please specify:

Comments:

33. How accurate do you feel the data needs to be that is entered into the PAVER system?

A. All of the data should be accurate.
B. Most of the data should be accurate (approx. 95%).
C. The majority of the data should be accurate (approx. 75% or more).
D. Some of the data should be accurate (approx. 40% or more).
E. Less than 40% of the data needs to be accurate.

Please explain why.

34. Did you encounter any "command-wide" problems implementing PAVER due to a lack of information, training, assistance, or guidance regarding the program?

A. Yes
B. No

If yes, please provide the following information for each problem encountered:

Nature of problem:

How it was solved:

Was it solved at MAJCOM level:

Who assisted in solving (HQ AFESC, another MAJCOM, etc.):

Comments:

35. Did you encounter any "command-wide" problems implementing PAVER due to errors, contradictions, or oversights in the program itself?

A. Yes
B. No

If yes, please provide the following information for each problem encountered:

Nature of problem:

How it was solved:

Was it solved at MAJCOM level:

Who assisted in solving (HQ AFESC, another MAJCOM, etc.):

Comments:

36. Are you currently encountering any "command-wide" problems regarding the use of PAVER?

A. Yes B. No

If yes, please provide the following information for each problem:

Nature of problem:

Possible solutions:

Who is working the problem:

Who is assisting in solving (HQ AFESC, another MAJCOM, etc.):

What other assistance would you like to be receiving:

Comments:

37. Do you forsee any future problems regarding the use of PAVER?

A. Yes B. No

If yes, please provide the following information for each problem:

Nature of problem:

Possible solutions:

Who should work to solve the problem (MAJCOM, base, etc.):

Who should assist in solving the problem (HQ AFESC, another MAJCOM, etc.):

Comments:

38. Please provide a brief narrative description of any benefits that have resulted directly from the implementation of PAVER. (The following list is intended to serve as a starting point only.) Please provide as many examples as possible. Specific manhour and dollar figure examples would especially be appreciated.

Pavement management manhours reductions, by position:

Project cost reductions:

Improved project justification:

Elevation of project priority:

Increased funding for pavement projects:

Elimination of a project due to improved preventive maintenance:

Improved decision making:

Other:

39. Do you require all airfield pavement projects from your bases to have a PCI listed on the DD Form 1391 and/or the Pavement Project Questionaire?

A. Yes B. No

Comments:

40. Has any actual PAVER analysis been tied into project submission requirements or justifications yet?

A. Yes B. No

Comments:

41. Do you intend to implement PAVER for roads/streets?

A. Yes; we plan to implement PAVER for all roads/streets.
B. Yes; but only for mission essential roads/streets.
C. Yes; but only for roads/streets for which we are planning maintenance, repair, or reconstruction work.
D. Yes; but only because we are being directed to do so.
E. No; even if we had the necessary additional manhours, we would use them for other purposes.
F. No; but if we had the necessary additional manhours, we would implement PAVER for roads/streets.
G. No; not unless directed to do so, because we do not feel that the time spent would be beneficial.
H. No; our MAJCOM policy is that we will not implement PAVER for roads/streets.
I. Other; please specify:

Comments:

42. When do you plan to begin PAVER implementation for roads/streets?

A. We have already begun implementation.
B. We plan to begin within one year.
C. We plan to begin one to two years from now.
D. We plan to begin two or more years from now.
E. We do not plan to implement PAVER for roads/streets.

Comments:

43. Please provide a point of contact regarding this survey. A point of contact is necessary in case of questions regarding responses to the survey, or in case any other questions should arise. (Contents of this survey WILL be held in confidence).

Name:
Rank/title:
Position title:
Duty mailing address:

Duty phone number (Autovon):

Thank you very much for your time and assistance. Your inputs will help to improve the PAVER program not only within your MAJCOM, but throughout the Air Force, Department of Defense, and the civilian community.

Appendix G: Survey Package for Headquarters without PAVER

The following pages display the survey package for headquarters without PAVER. Each package contained the following:

1. Cover letter from Colonel Smith, Dean, School of Systems and Logistics.
2. Privacy Act Statement.
3. Cover letter from Captain McLean, Graduate Student--Engineering Management (researcher).
4. Definition of PAVER.
5. Survey.
6. Computer score sheet (not shown).
7. Return envelope (not shown).

Appendix C lists the recipients of this survey. Table IV of Appendix K summarizes the survey results.

The Military Personnel Center (MPC) assigned survey control number "USAF-SCN-84-64D" to this survey.

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (AU)
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

25 JUN 1984

REPLY TO ATTN OF: LSH(AFIT/GEM/LSM/84S-12)/Capt T. R. McLean/AUTOVON 785-4437

SUBJECT: PAVER Implementation Survey (USAF-SCN-84-64)

TO:

1. Would you please take the time to complete the enclosed survey package regarding implementation of the pavement management system, PAVER. We have included an envelope to return the completed survey and computer score sheet.

2. A graduate student in the Engineering Management program developed this survey as part of his thesis research. The purpose is to acquire data necessary to recommend improved methods of implementing PAVER in the future. The final report will be available to HQ AFESC, Major Commands, and the US Army Construction Engineering Research Laboratory, which is working in conjunction with the American Public Works Association to improve the PAVER system. We will amalgamate responses to the questions and will not attribute responses to any individual. Of course, your participation in this research is voluntary but we sure need your input.

3. I thank you in advance for your help.

LARRY L. SMITH, Colonel, USAF
Dean
School of Systems and Logistics

1 Atch
Survey Package

PRIVACY STATEMENT

In accordance with paragraph 8, AFR 12-35, the following information is provided as required by the Privacy Act of 1974:

a. Authority:

(1) 5 U.S.C. 301, Departmental Regulations; and/or

(2) 10 U.S.C. 8012, Secretary of the Air Force, Powers, Duties, Delegation by Compensation; and/or

(3) EO 9397, 22 Nov 43, Numbering System for Federal Accounts Relating to Individual Persons; and/or

(4) DOD Instructin 1100.13, 17 Apr 68, Surveys of Department of Defense Personnel; and/or

(5) AFR 30-23, 22 Sep 76, Air Force Personnel Survey Program.

b. Principal Purposes. The survey is being conducted to collect information to be used in research aimed at illuminating and providing inputs to the solution of problems of interest to the Air Force and/or DOD.

c. Routine Uses. The survey data will be converted to information for use in research of management related problems. Results of the research, based on data provided, will be included in written master's theses and may also be included in published articles, reports, or texts. Distribution of the results of the research, based on the survey data, whether in written form or presented orally, will be unlimited.

d. Participation in this survey is entirely voluntary.

e. No adverse action of any kind may be taken against any individual who elects not to participate in any or all of this survey.

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (AU)
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

25 JUN 1984

REPLY TO ATTN OF: LSH (AFIT/GEM/LSM/84S-12)/Capt T. R. McLean/AUTOVON 785-4437

SUBJECT: PAVER Implementation Survey for Bases Without PAVER

TO:

1. Please take time to complete the enclosed survey regarding implementation of the pavement management system, PAVER. Use the enclosed envelope to return the completed survey and computer score sheet within one week after receipt.

2. As a Civil Engineering Officer (5525C), I understand the value of your time, and I truly appreciate your assistance. This information is an essential portion of my thesis research in the Graduate Engineering Management program at the Air Force Institute of Technology.

3. Since my background includes over three years of pavement management experience, I have established improvement of future PAVER implementation as the goal of my thesis effort. I intend to use your inputs as part of my overall evaluation. An equally important aspect of the information gained through the survey is that HQ AFESC and the various MAJCOMs will have my final report available to assist in PAVER implementation and usage at their bases.

4. If you have any questions or suggestions while completing this survey, please contact me at Autovon 785-4437. Your MAJCOM pavement engineer has agreed to serve as a secondary point of contact: _____.

5. Any contact with me, including all responses to this survey, will be kept in strict confidence. Questions on the survey regarding geographic area and MAJCOM are only for trend analysis of responses. Questions regarding the point of contact are strictly for use in clarifying responses and for follow-up, as required.

6. Again, thank you very much for your time and cooperation. Your assistance will play a vital role in improving management of Air Force pavements in the future.

Timothy R. McLean, CAPT, USAF
Graduate Student--
Engineering Management

4 Enclosures:

1. Definition of PAVER
2. Survey
3. Computer Score Sheet
4. Return Envelope

DEFINITION OF PAVER

For the purposes of this survey, the PAVER pavement management system is defined as EITHER the manual procedures OR the computer-based program which have been developed and tested over the past ten years by the U. S. Army Construction Engineering Research Laboratory (CERL) for HQ AFESC.

As described in CERL Technical Report M-294 (October, 1981), the PAVER pavement management system

> "is designed to optimize the funds allocated for pavement maintenance and rehabilitation (M&R). The system includes procedures for dividing the pavement into manageable sections, pavement condition survey and rating, pavement evaluation, rational determination of M&R needs and priorities, performance of life-cycle costing on feasible M&R alternatives, and manual and automated systems for data storage and retrieval. The automated system provides custom-designed reports based on stored and/or processed data.
>
> An important part of PAVER is the pavement condition survey and rating [PCI] procedure . . .
>
> The PAVER system offers the flexibility of implementation at various levels. The highest level of implementation would be the inclusion of all pavements on the installation and use of the automated system. The lowest level would be the use of the PCI as the basis for project approvals and establishment of priorities. A gradual implementation includes starting with a specific group of pavements . . . and then including other pavements on a predefined schedule."

As described here by CERL, PAVER, as a manual system, is complete in itself. That is, it includes all of the aspects and capabilities necessary to manage pavements.

PAVER, as a computer program, operates on the same basic principles as the manual system, but adds numerous time-saving capabilities. These include: a) automated data entry, storage, update, and retrieval processes; b) data manipulation, formatting, and processing; and c) custom-designed report-generating programs that aid the user in determining, planning, and scheduling pavement maintenance and repair.

PAVER IMPLEMENTATION SURVEY
FOR HEADQUARTERS WITHOUT PAVER

Please read the enclosed definition of PAVER before answering this survey. Then, answer the multiple choice questions by circling the ONE response which BEST reflects your answer. Your comments, suggestions, and questions are welcomed and appreciated for ALL survey questions (please use the space provided or the backs of these pages).

After you have completed this survey, please encode your answers for questions 1-4, 6-17, 19-32, and 34-35 on the enclosed computer score sheet. Return this survey AND the computer score sheet in the envelope provided. Once again, thank you very much for your assistance.

---

1. What is your MAJCOM?

   A. AAC
   B. AFLC
   C. ATC
   D. MAC
   E. SAC
   F. TAC
   G. Other (please specify: _____)

2. How familiar are you with the PAVER pavement management system? (EITHER manually OR computer assisted)

   A. This is the first time that I have heard of PAVER.
   B. I have heard of PAVER, but know nothing about it.
   C. I know a little bit about PAVER.
   D. I know what the basic components of PAVER are.
   E. I know what the basic components of PAVER are and I understand how they interrelate.
   F. I am able to use my knowledge and understanding of PAVER to ensure that proper data is input into the system.
   G. I am able to manipulate data, generate outputs, and use these outputs to assist in decision-making.
   H. I am able to do all of the above, plus do more advanced analysis than is currently available through PAVER.
   I. None of the above.

   Comments:

3. When did you find out about PAVER?

   A. 0-6 months ago
   B. 6-12 months ago
   C. 12-18 months ago
   D. 18-24 months ago
   E. 24-30 months ago
   F. 30-36 months ago
   G. over 36 months ago

4. From whom did you initially find out about PAVER?

A. HQ AFESC
B. Another MAJCOM
C. AFIT ("Pavement Engineering" short course)
D. Univ. of Illinois (three day short course: "Pavement Management: The PAVER System")
E. Construction Engineering Research Lab
F. Worldwide Air Force Pavements Conference
G. Other (please specify: _____)

Comments:

5. What percentage of your information of what PAVER is did you gain from each of the following sources?

HQ AFESC:	_____	%
Another MAJCOM:	_____	%
AFIT ("Pavement Engineering" short course)	_____	%
Univ. of Illinois (three day short course: "Pavement Management: The PAVER System")	_____	%
Construction Engineering Research Lab	_____	%
Worldwide Air Force Pavements Conference	_____	%
Other (please specify: _____)	_____	%
TOTAL:	100	%

Comments:

6. What system of pavement management are you currently using for airfields? (Unless you indicate otherwise, it will be assumed that in addition to the response you select, you use the pavement condition index, the pavement maintenance plan, and the pavement improvement plan as part of your overall management process.)

A. We use subjective judgment to manage our airfield pavements.
B. We use "management-by-exception"— i.e., we monitor only those airfield pavements which are in the worst condition.
C. We maintain and repair airfield pavements as directed by higher levels of management.
D. We maintain an accurate system for tracking the condition, rate of deterioration, construction history, maintenance and repair history, and traffic history of each of our airfield pavement features (eg: index card or similar filing system).
E. Other; please specify:

Comments:

7. Who do you intend to turn to (primary source) for more information about what PAVER is?

A. HQ AFESC
B. Another MAJCOM
C. AFIT ("Pavement Engineering" short course)
D. Univ. of Illinois (three day short course: "Pavement Management: The PAVER System")
E. Construction Engineering Research Lab
F. Worldwide Air Force Pavements Conference
G. Other (please specify: _____)
H. I do not intend to seek any further information.

Please explain why:

Who else do you plan to rely on? Why?

8. Do you intend to implement PAVER for airfields?

A. Yes; we plan to implement PAVER for all airfield pavements.
B. Yes; but only for mission essential airfield pavements.
C. Yes; but only for airfield pavements for which we are planning maintenance, repair, or reconstruction work.
D. Yes; but only because we are being directed to do so.
E. No; even if we had the necessary additional manhours, we would use them for other purposes.
F. No; but if we had the necessary additional manhours, we would implement PAVER for airfield pavements.
G. No; not unless directed to do so, because we do not feel that the time spent would be beneficial.
H. No; our MAJCOM policy is that we will not implement PAVER for airfield pavements.
I. Other; please specify:

Comments:

9. When do you plan to begin PAVER implementation for airfield pavements?

A. We have already begun implementation.
B. We plan to begin within one year.
C. We plan to begin one to two years from now.
D. We plan to begin two or more years from now.
E. We do not plan to implement PAVER for airfield pavements.

Comments:

10. Who do you intend to turn to as the primary source of assistance with PAVER implementation problems?

A. HQ AFESC
B. MAJCOM
C. AFIT ("Pavement Engineering" short course)
D. Univ. of Illinois (three day short course: "Pavement Management: The PAVER System")
E. Construction Engineering Research Lab
F. Worldwide Air Force Pavements Conference
G. Other (please specify: _____)
H. We do not plan to implement PAVER.

Please explain why:

Who else do you plan to rely on? Why?

Please use the following list to answer questions 11 through 16:

A. Base Civil Engineer
B. Chief, Engineering and Environmental Planning
C. Chief, Engineering Design
D. Pavement Engineer
E. Technician or Site Developer
F. Chief, Operations
G. Superintendent, Pavements and Grounds
H. Foreman, Pavements and Grounds
I. Clerical, Secretarial, or Administrative Specialist
J. Other (please specify: _____)

11. Who do you feel should be the primary user of the information provided by PAVER?

12. Who do you feel should be the secondary user of the information provided by PAVER?

13. Who do you feel should have primary responsibility for conducting inspections and gathering information necessary to keep the data base accurate and up-to-date?

14. Who do you feel should have secondary responsibility for conducting inspections and gathering information necessary to keep the data base accurate and up-to-date?

15. Who do you feel should have primary responsibility for entering this information into the data base?

16. Who do you feel should have secondary responsibility for entering this information into the data base?

Comments on questions 11 through 16, above:

17. Approximately what percentage of the data previously used to complete pavement management reports (pavement condition index report, pavement maintenance plan, and pavement improvement plan) do you expect you will be able to adapt for use with PAVER?

A. 0-20%
B. 20-40%
C. 40-60%
D. 60-80%
E. 80-100%

Comments:

18. Approximately how many manhours do you feel will be required at base level to create the data base used by PAVER after the decision is made to implement PAVER? (include construction history research, pavement condition inspections, data entry, etc.)

By pavement engineer: _____
By technicians or site developers: _____
By pavements and grounds superintendent: _____
By pavements and grounds foreman: _____
By clerical, secretarial, or administrative specialists: _____
By other (please specify _____): _____
By other (please specify _____): _____
By other (please specify _____): _____

(Also, how many hours do you feel will be required of you:)

Comments:

19. Will you and/or your bases incur any costs as a result of implementing PAVER, other than the manhours listed above?

A. Yes
B. No

If yes, please provide the following information:

Nature of expense:

Estimated cost:

Comments:

Please use the following list to answer questions 20 through 25:

A. Almost all	D. A small amount
B. A large amount	E. Almost none
C. Some	F. Not used/ not applicable

During INITIAL implementation of PAVER at your bases (first six months), how much of the training, assistance, or guidance do you expect them to receive from:

20. HQ AFESC: _____

Comments:

21. Your MAJCOM: _____

Comments:

22. AFIT ("Pavement Engineering" short course): _____

Comments:

23. University of Illinois (three day short course "Pavement Management: The PAVER System"): _____

Comments:

24. Construction Engineering Research Laboratory (CERL): _____

Comments:

25. "Other": _____

please specify "other": _____

26. Which of the following statements best describes the probable status of computer use for PAVER within your command:

A. We do not expect to have any computer access for PAVER and therefore will rely totally on manual analysis procedures.

B. We will have computer access, but will still operate PAVER manually.

Reasons:

C. We will operate portions of PAVER manually, and will operate other portions by computer.

Manual portions:

Computer portions:

Reasons:

D. We will operate all applicable portions of PAVER on the computer.

E. We do not plan to implement PAVER.

Comments on question 26:

27. Do you plan to make any additions, deletions, or modifications to PAVER?

A. Yes
B. No

If yes, please describe:

Additions:

Deletions:

Modifications:

Other comments:

28. In your opinion, how accurate is the data that a "typical" base enters into the pavement condition index report, pavement maintenance plan, and pavement improvement plan? (including construction history, pavement condition index ratings, and so on).

A. All of the data is accurate.
B. Most of the data is accurate (approx. 95%).
C. The majority of the data is accurate (approx 75% or more)
D. Some of the data is accurate (approx. 40% or more).
E. Less than 40% of the data is accurate.

Comments:

29. In your opinion, what is the primary reason that the data is not accurate?

A. Not applicable; all of the data is accurate.
B. Most bases do not feel that it is necessary to have accurate data for anything except mission essential pavements.
C. Most bases do not feel that it is necessary to have accurate data for anything except management of pavements scheduled for maintenance, repair, or reconstruction within the next three years, or so.
D. Most bases would like to do a more thorough job of obtaining accurate data, but even if they had additional manhours available, they would have more important uses for those manhours.
E. Most bases would like to do a more thorough job of obtaining accurate data, but they would require additional manhours to do so.
F. Most bases do not feel that any additional time spent on obtaining accurate data would be beneficial.
G. Most bases already spend too much time obtaining accurate data, but have to spend as much time as they do in order to satisfy requirements levied upon them by higher levels of management.
H. Other; please specify:

Comments:

30. How accurate do you feel the data needs to be that is entered into the PAVER system?

A. All of the data should be accurate.
B. Most of the data should be accurate (approx. 95%).
C. The majority of the data should be accurate (approx. 75% or more).
D. Some of the data should be accurate (approx. 40% or more).
E. Less than 40% of the data needs to be accurate.

Please explain why.

31. Do you anticipate any problems implementing PAVER due to a lack of information, training, assistance, or guidance regarding the program?

A. Yes
B. No

If yes, please provide the following information for each problem anticipated:

Nature of problem:

How should it be solved:

Who should solve it at MAJCOM level (position title only):

Who should assist in solving (HQ AFESC, another MAJCOM, etc.):

Comments:

32. Do you forsee any future problems regarding the implementation of PAVER?

A. Yes
B. No

If yes, please provide the following information for each problem:

Nature of problem:

Possible solutions:

Who should work to solve the problem at base level (position title only):

Who should assist in solving the problem (HQ AFESC, another MAJCOM, etc.):

Comments:

33. Please provide a brief narrative description of any benefits that you feel would result directly from the implementation of PAVER. (The following list is intended to serve as a starting point only.) Please provide as many examples as possible. Specific manhour and dollar figure examples would especially be appreciated.

Pavement management manhours reductions, by position:

Project cost reductions:

Improved project justification:

Elevation of project priority:

Increased funding for pavement projects:

Elimination of a project due to improved preventive maintenance:

Improved decision making:

Other:

34. Do you intend to implement PAVER for roads/streets?

A. Yes; we plan to implement PAVER for all roads/streets.
B. Yes; but only for mission essential roads/streets.
C. Yes; but only for roads/streets for which we are planning maintenance, repair, or reconstruction work.
D. Yes; but only because we are being directed to do so.
E. No; even if we had the necessary additional manhours, we would use them for other purposes.
F. No; but if we had the necessary additional manhours, we would implement PAVER for roads/streets.
G. No; not unless directed to do so, because we do not feel that the time spent would be beneficial.
H. No; our MAJCOM policy is that we will not implement PAVER for roads/streets.
I. Other; please specify:

Comments:

35. When do you plan to begin PAVER implementation for roads/streets?

A. We have already begun implementation.
B. We plan to begin within one year.
C. We plan to begin one to two years from now.
D. We plan to begin two or more years from now.
E. We do not plan to implement PAVER for roads/streets.

Comments:

36. Please provide a point of contact regarding this survey. A point of contact is necessary in case of questions regarding responses to the survey, or in case any other questions should arise. (Contents of this survey WILL be held in confidence).

Name:
Rank/title:
Position title:
Duty mailing address:

Duty phone number (Autovon):

Thank you very much for your time and assistance. Your inputs will help to improve the pavement management program not only within your MAJCOM, but throughout the Air Force, Department of Defense, and the civilian community.

Appendix H: Survey Results for Bases with PAVER

Table I (next page) shows a summary of the responses to each question of the survey shown in Appendix D. The total number of respondents to this survey was 5 out of 5 bases surveyed.

Because some of the questions were essay questions, all multiple choice responses for that question are identified as "not applicable" in the table. Note that the total number of responses to a question may be less than the total number of surveys returned, since not all respondents answered every question.

TABLE I

Survey Results for Bases with PAVER

Question Number	Number of Responses										
	A	B	C	D	E	F	G	H	I	J	Total
1.	-	2	2	-	-	1	-	+	+	+	5
2.	1	-	-	3	1	-	-	-	+	+	5
3.	-	1	3	1	-	-	+	+	+	+	5
4.	1	2	-	-	2	-	-	+	+	+	5
5.	-	5	-	-	-	-	-	-	-	+	5
6.	+	+	+	+	+	+	+	+	+	+	+
7.	-	4	-	-	-	1	-	-	-	+	5
8.	+	+	+	+	+	+	+	+	+	+	+
9.	-	-	-	4	1	-	-	-	-	-	5
10.	-	1	1	1	-	1	-	1	-	-	5
11.	-	-	-	5	-	-	-	-	-	-	5
12.	-	-	1	-	1	-	-	2	-	-	4
13.	-	-	-	3	2	-	-	-	-	-	5
14.	-	-	-	1	-	-	-	-	2	-	3
15.	2	-	-	2	1	+	+	+	+	+	5
16.	+	+	+	+	+	+	+	+	+	+	+
17.	1	4	+	+	+	+	+	+	+	+	5
18.	-	-	1	-	-	3	+	+	+	+	4
19.	3	1	-	-	-	-	+	+	+	+	4
20.	-	-	-	-	-	4	+	+	+	+	4
21.	1	-	-	-	-	3	+	+	+	+	4
22.	1	-	-	-	-	3	+	+	+	+	4
23.	-	-	-	-	-	4	+	+	+	+	4
24.	-	1	1	-	-	2	+	+	+	+	4
25.	-	-	1	-	-	2	+	+	+	+	3
26.	3	-	-	-	-	-	+	+	+	+	3
27.	-	-	-	-	-	3	+	+	+	+	3
28.	-	1	-	-	-	2	+	+	+	+	3
29.	-	-	-	-	-	3	+	+	+	+	3
30.	-	1	-	-	-	2	+	+	+	+	3
31.	1	1	-	-	-	1	+	+	+	+	3
32.	-	-	-	5	+	+	+	+	+	+	5
33.	-	5	+	+	+	+	+	+	+	+	5
34.	-	2	2	-	-	+	+	+	+	+	4
35.	1	-	-	-	3	1	-	-	+	+	5
36.	1	3	1	-	-	+	+	+	+	+	5
37.	5	-	+	+	+	+	+	+	+	+	5
38.	2	2	+	+	+	+	+	+	+	+	4
39.	2	2	+	+	+	+	+	+	+	+	4
40.	3	2	+	+	+	+	+	+	+	+	5
41.	+	+	+	+	+	+	+	+	+	+	+
42.	2	-	-	1	-	2	-	-	-	+	5
43.	2	1	1	1	-	+	+	+	+	+	5
44.	+	+	+	+	+	+	+	+	+	+	+

\- This response choice not selected for this question.
\+ This response choice not applicable for this question.

Appendix I: Survey Package for Bases without PAVER

Table II (next page) shows a summary of the responses to each question of the survey shown in Appendix E. The total number of respondents to this survey was 45 out of 72 bases surveyed.

Because some of the questions were essay questions, all multiple choice responses for that question are identified as "not applicable" in the table. Note that the total number of responses to a question may be less than the total number of surveys returned, since not all respondents answered every question.

Table V of Appendix L provides additional information and summarizes the results for a base which returned two surveys--one from the contractor who performs the base maintenance, and one from the base which acts as the quality assurance evaluator for that contract. However, in preparing Table II of this appendix, only the results received from the BCE were included. The contractor's responses were not included since the contractor was not part of the survey population.

TABLE II

Survey Results for Bases without PAVER

Question Number	Number of Responses										
	A	B	C	D	E	F	G	H	I	J	Total
1.	1	4	8	5	18	9	-	+	+	+	45
2.	6	9	4	8	10	7	1	-	+	+	45
3.	5	8	14	6	6	3	3	-	-	+	45
4.	13	10	7	4	5	3	3	+	+	+	45
5.	3	18	1	1	6	-	1	5	10	+	45
6.	+	+	+	+	+	+	+	+	+	+	+
7.	26	-	4	8	7	+	+	+	+	+	45
8.	2	25	-	-	2	6	2	1	2	5	45
9.	22	1	1	1	1	6	3	-	10	+	45
10.	9	7	11	3	11	+	+	+	+	+	41
11.	1	31	1	-	-	1	2	-	3	5	44
12.	6	4	-	31	-	1	1	-	-	1	44
13.	5	4	4	5	1	3	13	6	-	3	44
14.	-	-	2	30	2	-	5	4	-	1	44
15.	-	1	3	9	6	2	11	12	-	-	44
16.	-	1	3	25	2	1	-	-	11	1	44
17.	-	1	2	13	12	1	3	3	8	1	44
18.	6	4	9	5	13	+	+	+	+	+	37
19.	+	+	+	+	+	+	+	+	+	+	+
20.	14	24	+	+	+	+	+	+	+	+	38
21.	2	5	9	8	13	4	+	+	+	+	41
22.	13	17	4	5	2	-	+	+	+	+	41
23.	-	2	7	10	15	7	+	+	+	+	41
24.	1	6	11	5	14	4	+	+	+	+	41
25.	5	5	9	1	8	13	+	+	+	+	41
26.	-	3	7	3	18	10	+	+	+	+	41
27.	1	-	-	-	5	18	+	+	+	+	24
28.	7	-	8	18	8	+	+	+	+	+	41
29.	1	35	+	+	+	+	+	+	+	+	36
30.	5	17	11	5	4	+	+	+	+	+	42
31.	3	-	-	8	21	6	1	2	+	+	41
32.	17	23	3	-	-	+	+	+	+	+	43
33.	23	20	+	+	+	+	+	+	+	+	43
34.	22	18	+	+	+	+	+	+	+	+	40
35.	+	+	+	+	+	+	+	+	+	+	+
36.	17	3	1	1	1	8	7	-	3	+	41
37.	1	5	9	8	16	+	+	+	+	+	39
38.	+	+	+	+	+	+	+	+	+	+	+

\- This response choice not selected for this question.
\+ This response choice not applicable for this question.

Appendix J: Survey Results for Headquarters with PAVER

Table III (next page) shows a summary of the responses to each question of the survey shown in Appendix F. The total number of respondents to this survey was 3 out of 3 headquarters surveyed.

Because some of the questions were essay questions, all multiple choice responses for that question are identified as "not applicable" in the table. The total number of responses to a question may be less than the total number of surveys returned, since not all respondents answered every question.

TABLE III

Survey Results for Headquarters with PAVER

Question Number	Number of Responses										
	A	B	C	D	E	F	G	H	I	J	Total
1.	-	1	-	1	-	1	-	+	+	+	3
2.	1	-	1	-	1	-	+	+	+	+	3
3.	1	-	-	-	2	-	-	+	+	+	3
4.	-	-	-	-	1	-	2	+	+	+	3
5.	+	+	+	+	+	+	+	+	+	+	+
6.	2	-	1	-	-	-	-	+	+	+	3
7.	+	+	+	+	+	+	+	+	+	+	+
8.	-	-	-	3	-	-	-	-	-	-	3
9.	-	2	-	-	-	-	1	-	-	-	3
10.	-	-	-	3	-	-	-	-	-	-	3
11.	-	-	-	-	3	-	-	-	-	-	3
12.	-	-	-	3	-	-	-	-	-	-	3
13.	-	-	-	-	2	-	-	-	1	-	3
14.	2	-	-	-	1	+	+	+	+	+	3
15.	+	+	+	+	+	+	+	+	+	+	+
16.	1	2	+	+	+	+	+	+	+	+	3
17.	-	-	-	-	-	3	+	+	+	+	3
18.	1	-	-	-	-	2	+	+	+	+	3
19.	-	1	-	-	-	2	+	+	+	+	3
20.	-	-	-	-	-	3	+	+	+	+	3
21.	1	1	-	-	-	1	+	+	+	+	3
22.	-	1	1	-	-	1	+	+	+	+	3
23.	-	-	-	-	-	3	+	+	+	+	3
24.	1	-	-	-	-	2	+	+	+	+	3
25.	-	1	-	-	-	2	+	+	+	+	3
26.	-	-	-	-	-	3	+	+	+	+	3
27.	1	1	-	-	-	1	+	+	+	+	3
28.	-	-	1	-	-	2	+	+	+	+	3
29.	1	1	-	1	+	+	+	+	+	+	3
30.	-	3	+	+	+	+	+	+	+	+	3
31.	-	1	1	-	-	+	+	+	+	+	2
32.	-	-	-	-	-	-	-	3	+	+	3
33.	2	1	-	-	-	+	+	+	+	+	3
34.	2	1	+	+	+	+	+	+	+	+	3
35.	1	2	+	+	+	+	+	+	+	+	3
36.	1	2	+	+	+	+	+	+	+	+	3
37.	2	1	+	+	+	+	+	+	+	+	3
38.	+	+	+	+	+	+	+	+	+	+	+
39.	2	1	+	+	+	+	+	+	+	+	3
40.	2	1	+	+	+	+	+	+	+	+	3
41.	-	-	-	-	-	-	-	1	2	+	3
42.	1	-	-	-	2	+	+	+	+	+	3
43.	+	+	+	+	+	+	+	+	+	+	+

\- This response choice not selected for this question.
\+ This response choice not applicable for this question.

Appendix K: Survey Results for Headquarters without PAVER

Table IV (next page) shows a summary of the responses to each question of the survey shown in Appendix G. The total number of respondents to this survey was 3 out of 3 headquarters surveyed.

Because some of the questions were essay questions, all multiple choice responses for that question are identified as "not applicable" in the table. The total number of responses to a question may be less than the total number of surveys returned, since not all respondents answered every question.

TABLE IV

Survey Results for Headquarters without PAVER

Question Number	Number of Responses										
	A	B	C	D	E	F	G	H	I	J	Total
1.	1	-	1	-	1	-	-	+	+	+	3
2.	-	-	1	-	-	1	1	-	-	+	3
3.	-	-	-	1	-	2	-	+	+	+	3
4.	2	-	-	1	-	-	-	+	+	+	3
5.	+	+	+	+	+	+	+	+	+	+	+
6.	1	-	-	-	2	+	+	+	+	+	3
7.	3	-	-	-	-	-	-	-	+	+	3
8.	3	-	-	-	-	-	-	-	-	+	3
9.	2	1	-	-	-	+	+	+	+	+	3
10.	3	-	-	-	-	-	-	-	+	+	3
11.	1	-	-	2	-	-	-	-	-	-	3
12.	-	1	1	-	-	-	1	-	-	-	3
13.	-	-	-	3	-	-	-	-	-	-	3
14.	-	-	-	-	1	-	2	-	-	-	3
15.	-	-	-	3	-	-	-	-	-	-	3
16.	-	-	1	-	2	-	-	-	-	-	3
17.	1	-	-	-	2	+	+	+	+	+	3
18.	+	+	+	+	+	+	+	+	+	+	+
19.	3	-	+	+	+	+	+	+	+	+	3
20.	-	-	1	2	-	-	+	+	+	+	3
21.	1	1	1	-	-	-	+	+	+	+	3
22.	-	-	1	1	1	-	+	+	+	+	3
23.	1	1	-	1	-	-	+	+	+	+	3
24.	-	-	2	-	1	-	+	+	+	+	3
25.	-	-	1	-	1	-	+	+	+	+	2
26.	-	-	1	2	-	+	+	+	+	+	3
27.	1	2	+	+	+	+	+	+	+	+	3
28.	-	1	1	-	1	+	+	+	+	+	3
29.	-	-	-	1	-	-	1	1	+	+	3
30.	2	1	-	-	-	+	+	+	+	+	3
31.	1	2	+	+	+	+	+	+	+	+	3
32.	2	1	+	+	+	+	+	+	+	+	3
33.	+	+	+	+	+	+	+	+	+	+	+
34.	1	-	1	-	-	1	-	-	-	+	3
35.	-	-	-	3	-	+	+	+	+	+	3
36.	+	+	+	+	+	+	+	+	+	+	+

\- This response choice not selected for this question.
\+ This response choice not applicable for this question.

Appendix L: Survey Results for Base with Contract Maintenance

Table V (next page) shows a summary of the responses to each question of the survey shown in Appendix E, as supplied by a base with contract maintenance. The base provided two responses to the survey. The first was an unsolicited (but welcomed) response from the contractor who performs the base maintenance and who is therefore a potential user of PAVER. The second response was from the BCE whose organization acts as the quality assurance evaluator for that contract.

Responses provided by the contractor and the BCE are shown in Table V for comparison. However, in preparing Table II, Survey Results for Bases without PAVER, Appendix I, only the survey results received from the BCE were included. The contractor's responses were not included since the contractor was not part of the survey population.

Because some of the questions were essay questions, responses for those questions are identified as "not applicable" in the table.

Table V

Survey Results for Base with Contract Maintenance

Question Number	Base Response	Contractor Response
1.	C	C
2.	E	E
3.	G	D
4.	E	E
5.	I	I
6.	N/A	N/A
7.	A	E
8.	I	F
9.	D	A
10.	D	D
11.	I	A
12.	D	D
13.	H	G
14.	J	E
15.	H	G
16.	D	D
17.	H	I
18.	E	E
19.	N/A	N/A
20.	A	A
21.	F	E
22.	D	E
23.	F	F
24.	F	F
25.	B	B
26.	D	F
27.	F	F
28.	D	D
29.	B	B
30.	C	B
31.	E	E
32.	B	B
33.	B	A
34.	A	B
35.	N/A	N/A
36.	A	A
37.	D	D
38.	N/A	N/A

N/A not applicable

Appendix M: Sample Survey Results

The following pages are samples of actual survey responses received from the field. The first one is from a base with PAVER; the next two are from bases without PAVER; and, the last two are from headquarters with and without PAVER, respectively.

Please use the following list to answer questions 18 through 24:

A. Very Good	D. Poor
B. Good	E. Very Poor
C. Fair	F. Not Used/ Not Applicable

During INITIAL implementation of PAVER at your base (first six months), how would you rate the training, assistance, or guidance received from:

18. HQ AFESC: F

Strengths:

Weaknesses:

19. Your MAJCOM: A

Strengths: Operates computers very [well]

Weaknesses:

20. Other bases: F

Strengths:

Weaknesses:

21. AFIT ("Pavement Engineering" short course): F

Strengths:

Weaknesses:

22. University of Illinois (three day short course "Pavement Management: The PAVER System"): A

Strengths: Explained PAVER use very well.

Weaknesses: Could improve op. manual.

23. Construction Engineering Research Laboratory (CERL): F

Strengths:

Weaknesses:

24. "Other": F

please specify "other":

Strengths:

Weaknesses:

33. Do you anticipate any problems implementing PAVER due to a lack of information, training, assistance, or guidance regarding the program?

(A) Yes
B. No

If yes, please provide the following information for each problem anticipated:

Nature of problem:
LACK OF INFORMATION. WHAT IS REQUIRED?

How should it be solved:
FUNNEL INFORMATION TO US. SEND US TO THE U of I SHORT COURSE (AFIT OR MAJCOM FUNDING).

Who should solve it at base level (position title only):
BASE PAVEMENT ENGINEER

Who should assist in solving (HQ AFESC, MAJCOM, etc.):
MAJCOM

Comments:

34. Do you forsee any future problems regarding the implementation of PAVER?

A. Yes
B. No

If yes, please provide the following information for each problem:

Nature of problem:

Possible solutions:

Who at base level should work to solve the problem (position title only):

Who should assist in solving the problem (HQ AFESC, MAJCOM, etc.):

Comments:
I CAN'T FORSEE PROBLEMS IF I DON'T REALLY KNOW WHAT IT CAN OR CAN'T DO.

33. Do you anticipate any problems implementing PAVER due to a lack of information, training, assistance, or guidance regarding the program?

(A.) Yes
B. No

If yes, please provide the following information for each problem anticipated:

Nature of problem:
Lack of information on system

How should it be solved:
Research through MAJCOM Pavements Engineer

Who should solve it at base level (position title only):
Pavements Engineer

Who should assist in solving (HQ AFESC, MAJCOM, etc.):
Majcom Pavements Engineer

Comments:

34. Do you forsee any future problems regarding the implementation of PAVER?

(A.) Yes
B. No

If yes, please provide the following information for each problem:

Nature of problem: Resistance to use by Engineers and Technicians not familiar with the system

Possible solutions: Training

Who at base level should work to solve the problem (position title only):
Pavement Engineer

Who should assist in solving the problem (HQ AFESC, MAJCOM, etc.):
Majcom

Comments:

Please use the following list to answer questions 17 through 22:

A. Very Good	D. Poor
B. Good	E. Very Poor
C. Average	F. Not Used/ Not Applicable

During INITIAL implementation of PAVER within your MAJCOM (first six months), how would you rate the training, assistance, or guidance that you received from:

17. HQ AFESC: F

Strengths:

Weaknesses: A complete, easy to understand users manual is desparately needed.

18. Other MAJCOMs: A

Strengths: AFLC very helpful

Weaknesses:

19. AFIT ("Pavement Engineering" short course): B

Strengths: Introduces PCI and provides sufficient training for pavement engineers to begin PCI computati
Weaknesses: Course needs to be expanded to teach PAVER,

20. University of Illinois (three day short course "Pavement Management: The PAVER System"): F

Strengths:

Weaknesses:

21. Construction Engineering Research Laboratory (CERL): B

Strengths: Most knowledgeable of computer operations.

Weaknesses: User manual is not complete; should be revised for CDC application.

22. "Other": C

please specify "other": FESA

Strengths: Very responsive

Weaknesses: Not sufficiently knowledgeable on PAVER system yet.

28. In your opinion, how accurate is the data that a "typical" base enters into the pavement condition index report, pavement maintenance plan, and pavement improvement plan? (including construction history, pavement condition index ratings, and so on).

A. All of the data is accurate.
B. Most of the data is accurate (approx. 95%).
(C.) The majority of the data is accurate (approx 75% or more)
D. Some of the data is accurate (approx. 40% or more).
E. Less than 40% of the data is accurate.

Comments: THIS SHOULD BE IMPROVED.

29. In your opinion, what is the primary reason that the data is not accurate?

A. Not applicable; all of the data is accurate.
B. Most bases do not feel that it is necessary to have accurate data for anything except mission essential pavements.
C. Most bases do not feel that it is necessary to have accurate data for anything except management of pavements scheduled for maintenance, repair, or reconstruction within the next three years, or so.
(D.) Most bases would like to do a more thorough job of obtaining accurate data, but even if they had additional manhours available, they would have more important uses for those manhours. As determined by their supervisors.
E. Most bases would like to do a more thorough job of obtaining accurate data, but they would require additional manhours to do so.
F. Most bases do not feel that any additional time spent on obtaining accurate data would be beneficial.
G. Most bases already spend too much time obtaining accurate data, but have to spend as much time as they do in order to satisfy requirements levied upon them by higher levels of management.
H. Other; please specify:

Comments: MANY BASES (BCE) ARE TOTALLY DEDICATED TO "DESIGN EFFORT" AND DON'T REALIZE THE GREAT IMPORTANCE OF HAVING AN EFFECTIVE PAVEMENT MANAGEMENT SYSTEM.

30. How accurate do you feel the data needs to be that is entered into the PAVER system?

A. All of the data should be accurate.
(B.) Most of the data should be accurate (approx. 95%).
C. The majority of the data should be accurate (approx. 75% or more).
D. Some of the data should be accurate (approx. 40% or more).
E. Less than 40% of the data needs to be accurate.

Please explain why. THERE IS NO REASON FOR DATA TO BE INACCURATE. THE MORE ACCURATE THE DATA THE MORE EFFECTIVE THE MANAGEMENT SYSTEM.

Bibliography

1. American Public Works Association and Public Technology, Inc. "APWA PAVER: Pavement Management System Implementation Training." A comprehensive 3-day short course, descriptive registration materials. Baltimore MD, 30-31 October and 1 November 1984.

2. Artman, Capt David H., Jr. and others. "Optimization of Long Range Major Rehabilitation of Airfield Pavements." Paper presented at 62nd Annual Meeting of Transportation Research Board. USAF and University of Illinois, January 1983.

3. Ayars, Charles O., Realty Officer, Real Property Division. Telephone interview. HQ USAF/LEER, Washington DC, 16 February 1982. Cited by Dronen, Capt Michael W. An Evaluation of the Pavement Condition Index Prediction Model for Rigid Airfield Pavements. MS Thesis, LSSR 64-82. School of Systems and Logistics, Air Force Institute of Technology, Wright-Patterson AFB OH, September 1982 (AD-A123 002).

4. Bernstein, Corinne S. "Can Management Techniques Solve Pavement Woes?" Civil Engineering, 54 (3): 66-69 (March 1984).

5. Construction Engineering Research Laboratory. Automated Data Processing (ADP) User's Manual for PAVER." ADP-356. Champaign IL, prior to 15 April 1983.

6. Construction Engineering Research Laboratory. Overview of the PAVER Pavement Management System and Economic Analysis of Field Implementing the PAVER Pavement Management System. Manuscript No. CERL-TM-M-310. Champaign IL, March 1982.

7. Construction Engineering Research Laboratory. Pavement Maintenance Management for Roads and Parking Lots. Report No. CERL-TR-M-294. Air Force Engineering and Services Center, Tyndall AFB, October 1981.

8. Cornell, Brig Gen David M., DCS Engineering and Services. Implementation of a Pavement Maintenance Management System. Letter to AFLC BCEs. HQ AFLC. Wright-Patterson OH, 5 July 1984.

9. Department of the Air Force. Airfield Pavement Evaluation Program. AFR 93-5. Washington: Government Printing Office, 17 July 1984.

10. Department of the Air Force. Airfield Pavement Evaluation Program. AFR 93-5. Washington: Government Printing Office, 18 May 1981.

11. Dexter, Gerald H., GS-11, Pavement Engineer/Project Officer. Telephone interview. 509 CSG/DEED, Pease AFB NH, 3 August 1983.

12. Engineering and Services Laboratory. Pavement Maintenance Management for Roads and Parking Lots. Report No. ESL-TR-80-53. Air Force Engineering and Services Center, Tyndall AFB FL, September 1980.

13. Gilbert , Maj Gen William, D., USAF. "Air Force Real Property Maintenance." The Military Engineer, 71: (80-81) (March/April 1979).

14. Johnson, Christine. "Pavement Maintenance Management Systems." Article presented in University of Illinois and Construction Engineering Research Laboratory short course, "Pavement Management: The PAVER System." Champaign IL, 3-5 April 1984.

15. Keen, Peter G. and Michael S. Scott Morton. Decision Support Systems: An Organizational Perspective. Reading MA: Addison-Wesley Publishing Company, 1978.

16. Nie, Norman H. and others. Statistical Package for the Social Sciences, Second Edition. New York: McGraw-Hill Book Company, 1975.

17. Shahin, Mohamed Y. "PAVER-Pavement Management System Synopsis," Worldwide Air Force Pavements Conference Handbook: 70. Air Force Engineering and Services Center, Tyndall AFB FL, 1-3 December 1981.

18. Shahin Mohamed Y. and others. "Condition Evaluation of Jointed Concrete Airfield Pavement," Proceedings of the American Society of Civil Engineers, 106 (TE4), Report 15527: 381-399 (July 1980).

19. Smith, Col Jerry A., Commander, USAF. Implementation of a Pavement Maintenance Management System (PAVER). Letter, including PAVER Implementation Brochure, to MAJCOM DCSs for Engineering and Services, and others, HQ AFESC, Tyndall AFB FL, 18 June 1984.

20. University of Illinois at Urbana-Champaign and Construction Engineering Research Laboratory. "Pavement Management: The PAVER System." An intensive 3-day short course, course brochure. Champaign IL, 3-5 April 1984.

21. University of Illinois at Urbana-Champaign and Construction Engineering Research Laboratory. "Pavement Management: The PAVER System." An intensive 3-day short course, course notes. Champaign IL, 3-5 April 1984.

22. Uzarski, LCDR Donald R., CEC, USN. "PAVER Paves the Way at Great Lakes," The Navy Civil Engineer, 23 (1): 12-14 (Spring 1983).

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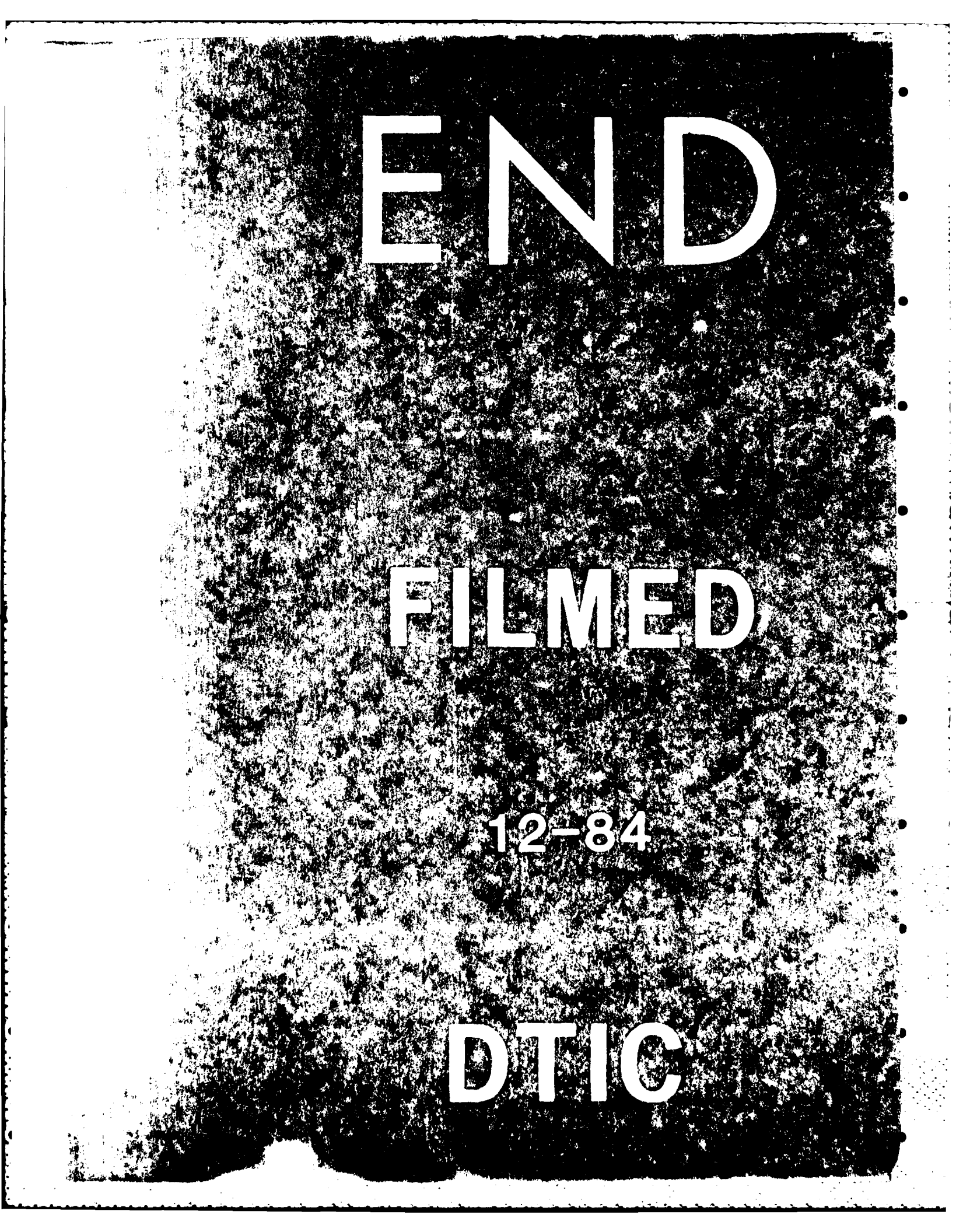
PAVER is a state-of-the-art pavement management system that can be operated either manually or by computer and is designed to optimize the funds allocated for pavement maintenance, repair, or reconstruction. Much has already been written about the benefits of PAVER. The intent of this report is not to detract from any of those writings, but rather to supplement them. Problem areas affecting PAVER implementation are addressed so that current or future users might benefit from the lessons others have learned. Problems which were uncovered for which there are currently no solutions can now be researched and resolved. The information necessary to identify and analyze potential PAVER implementation problems was gathered through surveys sent to current and future users, through a literature review, and through telephone and personal interviews. Fourteen potential problem areas were identified, with five of them being most likely to affect PAVER implementation. These five areas are training, manpower, equipment, top management support, and user commitment. Recommended solutions are included.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