

Computer-Aided Project Management System of the New York State Department of Transportation: A User's Perspective

JAMES CHICOINE

The process of developing and implementing a computerized project management system (PMS) for the New York State Department of Transportation (NYSDOT) is examined. Effective management of projects and resources is an important element in the implementation of a capital transportation program. Executive management determined that a computerized project management system was necessary to assist the central and regional offices in the management of the NYSDOT's program. With the introduction of the Computer-Aided Management System (CAMS), the NYSDOT accrues many benefits, from being able to monitor projects more closely and accurately, to having a system that provides useful human resource information. Furthermore, from a regional user's viewpoint, a number of different elements have come into play in the development and implementation of CAMS in the pilot region. Each of these elements, especially executive management's and users' perspectives and support of the new system, have greatly influenced the success of the system to date. The future success of the system depends on how well it can be altered to reflect management's changing needs and on how much support each managerial level provides the PMS.

Faced with a complex and growing capital program, the New York State Department of Transportation's (NYSDOT's) executive management decided that a computerized project management system (PMS) was needed to monitor and control its capital projects.

Even in the age of major technological developments and information collection innovations, there are a number of complex and difficult issues that must be addressed when implementing a PMS. Developing such a system at NYSDOT was no exception. The purpose of this paper is to provide an overview of how the system was developed to reflect the managers' goals and objectives, how it was implemented in one of the pilot regions, and finally, the system's benefits. As will be shown, a computerized PMS is a complex tool that affects a using agency in a number of different ways. As a result, several points of experience from the Region 1 pilot are outlined to assist other entities with the development and implementation of PMS's.

ORGANIZATION OF NYSDOT

As with any agency, implementation of a PMS is controlled by, and will affect, the organization of the agency. To clarify the Computer-Aided Management System's (CAMS's) relationships in the NYSDOT, the organization chart of Region 1 is included (see Figure 1). As shown by the chart, there are several unique features associated with NYSDOT's organization: first, within the 11 regional offices, there are several functional units (design, construction, etc.). Furthermore, along with a special central office CAMS task force, there is a CAMS coordinator in each of the regional offices.

GOALS OF CAMS

Before CAMS, the NYSDOT used the Current Work Program (CWP) as the primary system to monitor its projects. The CWP was a manually updated and coded system developed in the late 1960s. In addition, a number of project monitoring subsystems existed within the NYSDOT's central office and 11 regional offices.

In 1984, NYSDOT executive management decided that an enhanced management information system was needed; thus the following goals were developed:

- Encompass all existing systems into one comprehensive project management system.
- Provide easily accessible, current, and accurate information for the NYSDOT's managers.
- Provide human resource management capabilities within the system.

ELEMENTS OF PAC II

Following the Spring 1984 evaluation of software systems available for the NYSDOT's mainframe computer, a Burroughs 7900, the NYSDOT selected PAC II, a copyrighted product of AGS Management Systems. The PAC II system is both a project and resource management tool with the following general capabilities:

- Develop project schedules with critical path or resource availability information.

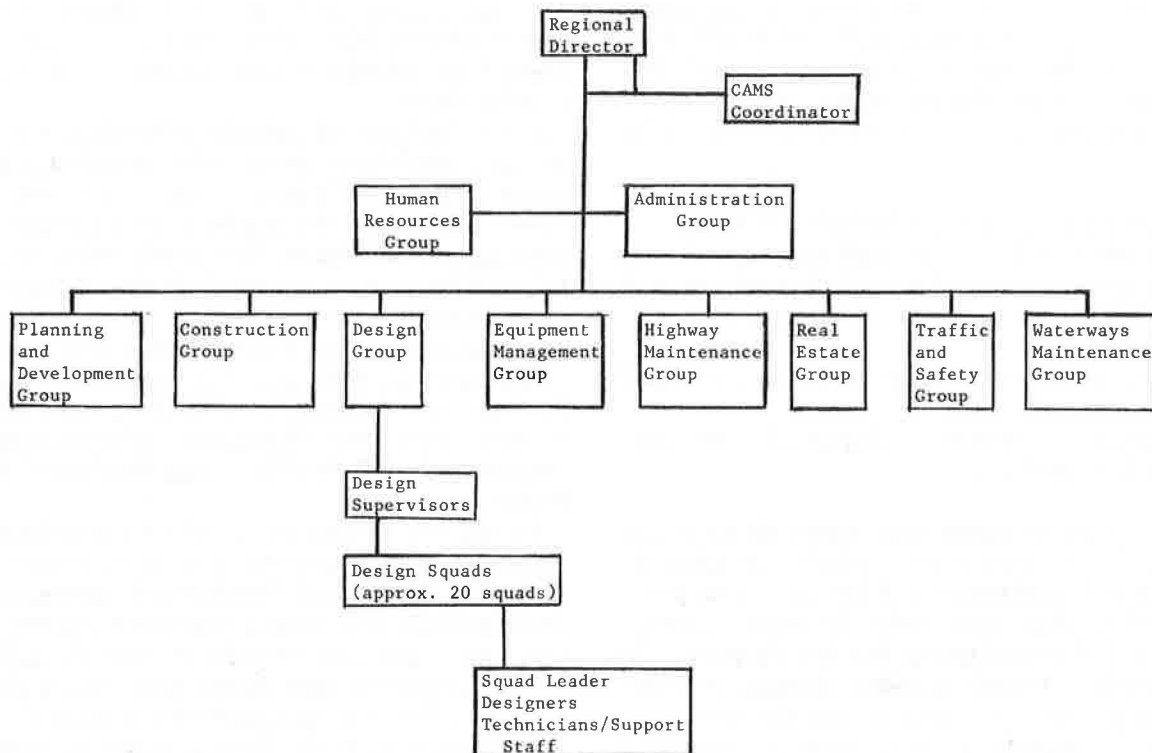


FIGURE 1 NYSDOT Region 1 organization chart.

- Provide human resource and equipment cost information.
- Provide information at three hierarchical levels: (a) event/activity, (b) phase, and (c) project.
- Provide information to what-if questions, such as what would happen to a project if half of its designers were reassigned to another project.
- Monitor five sets of dates (original, approved, previously approved, projected, and actual).
- Provide a multitude of reports (including exception reports) with the report writer subsystem.
- Be modified to reflect changes in the design and real estate processes used by the NYSDOT.

DEVELOPMENT OF CAMS

To develop CAMS, an executive steering committee was formed (regional directors of NYSDOT Regions 1 and 9 are members, as well as other top level central office management), whose responsibility is to guide the transformation of PAC II into a tool that meets the NYSDOT's project management needs. A central office CAMS task force also was formed, made up of middle managers from various central office units, to handle the detailed development and evaluation of items that the executive committee found important. Furthermore, a technical/engineering committee was established to assist the task force with the development of the models and other technical tasks.

Region 1 (Albany area) and Region 9 (Binghamton area) were selected as the pilot regions for the new system. Region 1

has a medium-size program in relation to the other 10 NYSDOT regions. It has both rural and urbanized areas. Region 9 has a relatively small dollar value program and is mostly rural in character.

As its first major task, in September 1984 the technical committee and CAMS task force started to develop models for the following project types:

1. Two-hearing process, federal funds;
2. Combined hearing, federal funds;
3. Straight highway rehabilitation and preservation (R&P) (no effect), federal funds;
4. Minor highway reconstruction and R&P (no effect), federal funds;
5. Bridge replacement, federal funds;
6. Bridge rehabilitation, federal funds;
7. One hearing, 100 percent state funds (subject to processing under the New York State Environmental Quality Review Act); and
8. Highway rehabilitation and preservation (no effect), 100 percent funds (no special environmental processing).

Because CAMS is a statewide system, there is a need for standardization, given that users are in both the central and regional offices. The models provide standard input data, including events and activities, durations, and the probable critical path. When developing or changing a project schedule, the CAMS coordinator has the flexibility within the model structures of adding or deleting events, changing the model default values (duration, etc.), and revising the critical path. This flexibility is especially important given that every project is unique and should be treated as such.

Because PAC II is a generic software program, the system was adapted to meet the needs of the NYSDOT. With assistance from the technical committee and the CAMS coordinators of the two pilot regions, the CAMS task force addressed and developed a number of items, including the following:

1. The standard unit of time should be a work day, not work week, given possible technical and rounding problems.
2. One master file per region should be used instead of one statewide file, given the size of the files and possible demands on the computer.
3. Special areas for information, such as description and funding data, were developed.
4. Programs were developed so that special, nonstandard reports could be produced.

Because executive management wished to implement CAMS in the two pilot regions quickly, not all of the capabilities of the system were used during the initial phase. In May 1985, the decision was made to have the two pilot test regions put their project information into the master files based upon the approved schedules and model structures. The following discussion explains how the system was implemented in Region 1, but does not address implementation of the system in the nonpilot regions, currently taking place.

IMPLEMENTATION OF CAMS IN REGION 1

In June 1985, Region 1 personnel were asked to decide what project events in addition to the standard events were important to them and should be included in CAMS schedules for Region 1. By allowing regional personnel some latitude to decide what events to monitor, it was believed that CAMS would become more acceptable to project managers. One concern was the need to eliminate the duplication of effort required to update multiple reporting systems. By selecting approximately 70 events and activities, which included the standard model events, CAMS accounted for what was being covered previously by the CWP and regional reports, thus providing the opportunity to discontinue the regional reports.

After several meetings between central office and regional managers, the regional group directors were informed what CAMS was and what its expected benefits were. Upon receiving some initial suggestions from the group directors, the coordinator needed to decide where each of the 150 Region 1 projects were in the design of right-of-way (ROW) processes, and how to fit the appropriate events into the remaining amount of time scheduled to complete design. Upon developing draft schedules, the coordinator conducted meetings with the design squad leaders to explain CAMS in general and to have them review the proposed schedules for their projects. The advantage of this review was that the squad leaders had a proposal in hand, and were not required to develop schedules from scratch. This process made it easier and faster for the reviewers, which in turn helped the system

to become more acceptable to its users. During this review, human resource information, event and activity default descriptions, and other standard description data were being placed in the master file.

In July 1985, two schedules that reflected the NYSDOT's approved schedule and the regional projected schedule were placed in the master file for each project. A number of new CAMS reports were then produced for updating purposes and for general information. The schedule update reports (see Figure 2 for an example) are used by the design squad leaders, the real estate liaison, the planning coordinator, and several other offices such as the mapping services unit. Each unit's update reports are different, as they are set up to include only the events and information for which the groups are responsible or interested. Managerial or summary reports are also produced. See Figure 3 for an example of Comprehensive Project Report 2.

The schedule reports are updated by the squad leaders and reviewed by their design supervisors. In a pilot region, these procedures were done on a 2-week cycle for the first 6 months and, as an experiment, later were changed to a monthly basis. (The other regions are still using the biweekly cycle.) The CAMS coordinator then reviews each unit's update and develops a list of projects to be discussed at a monthly program meeting. At this meeting, there is a discussion of possible schedule adjustments and solutions to the problems; the regional director then either disapproves or approves the proposed project changes accordingly. The master file is then updated and the project reports are distributed the following day. Approximately 2 weeks elapse between the submittal of the marked-up update reports to supervisors and generation

1130.38	RT 22,WADHAMS-WHALLONSBERG	CONST. COST:	.679	+JOHNSON W	
RESOURCE NAME	ACTIVITY DESCRIPTION	APPROVED FINISH	SYS PROJ FINISH	ACTUAL FINISH	CONST TOT \$
		00/00/00	00/00/00	00/00/00	

G	MAJOR PROJECT CHANGES (G)				
G	AS OF LET DT TOT. \$	GENERAL			
G	/ / .	*****			
G	/ / .	*****			
G	/ / .	*****			
G	/ / .	*****			
G	/ / .	*****			
G	*****				
G	GENERAL COMMENTS				
G					
G					
G					
G					
G					

+JOHNSON W	START PHASE 5-6 DESIGN	10/11/85	10/11/85	10/11/85	.730
HANSEN	PHASE 5-6 AUTH REQ'D	03/04/86	03/04/86	03/04/86	
+JOHNSON W	1ST UTIL WORKSHEET COMPL	03/17/86	03/17/86	03/17/86	
+JOHNSON W	TYPICAL SECTIONS COMPL	05/16/86	05/16/86	05/16/86	
HANSEN	PHASE 5-6 FINCOT ISSUED	08/07/86	08/07/86	08/07/86	
+JOHNSON W	FINAL SOILS REC REQ'D	10/02/86	10/02/86	10/02/86	
+JOHNSON W	ARM INFO TO MAPPING UNIT	10/07/86	10/07/86	10/07/86	
+GALEA	INITIAL UTIL INVENT COMPL	10/20/86	10/20/86	10/20/86	
+JOHNSON W	PLANS COMPLETE	10/23/86	10/23/86	10/23/86	
+JOHNSON W	PLANS OUT-REGIONAL REV	10/27/86	10/27/86	10/27/86	
+GALEA	FINAL UTIL INVENT COMPL	11/10/86	11/10/86	11/10/86	
+JOHNSON W	FINAL PSSE SUBMITTED	01/15/87	01/15/87	01/15/87	.866
+JOHNSON W	ENGR'S ESTIMATE COMPL	01/16/87	01/16/87	01/16/87	
+GALEA	UTIL PRELET PACKAGE COMPL	01/16/87	01/16/87	01/16/87	
HODGES	LOE TO MD	01/22/87	01/22/87	01/22/87	.846
+JOHNSON W	LETTING HELD	03/26/87	03/26/87	03/26/87	.866
HANSEN	LOE APPROVED	04/06/87	04/06/87	00/00/00	
+SCALZO	ABSTRACT REQ MAP COMPLETE	04/06/87	04/06/87	00/00/00	
+R R BUSHEY INC	CONSTRUCTION COMPLETION	10/30/87	10/30/87	00/00/00	

FIGURE 2 Region 1 design update report.

PROJECT 1130.38					PROJECT 1130.38								
DESCRIPTION: RT 22, WADHAMS TO WHALLONSURG AND I-87, SOUTH OF EXIT 34, S.B. LANES													
TYPE OF PROJECT: HIGHWAY RESURFACING													
L O C A T I O N	COUNTY	CITY-TOWN-VILLAGE	CONGRESS DISTRICT	SENATE DISTRICT	ASSEMBLY DISTRICT	F U N D I N G		PRELIM ENGR	RIGHT- OF-WAY	CONST- RUCT'N	RR/UTIL /OTHER	TOTAL	
	ESSEX	ESSEX (T)	26	45	113		FEDERAL SHARE	0.000	0.000	0.000	0.000	-	0.000
	ESSEX	CHESTERFIELD(T)	26	45	113		STATE SHARE	0.000	0.006	0.679	0.000	-	0.685
	ESSEX	LEWIS (T)	26	45	113		LOCAL SHARE	0.000	0.000	0.000	0.000	-	0.000
	****	*****	XX	XX	***		OTHER SHARE	0.000	0.000	0.000	0.000	-	0.000
						TOTALS	0.000	0.006	0.679	0.000	-	0.685	
						SCHEDULED DATE	ACTUAL DATE						
SCHEDULE/ ACCOMPLISHMENTS: PROJECT APPROVAL ROW ACTIVITY START DESIGN PLAN APPROVAL FINAL DESIGN COMPLETION ROW ACTIVITY FINISH LETTING CONSTRUCTION COMPLETION						1/24/86	1/24/86						
						10/07/86	10/07/86						
						0/00/00	0/00/00						
						1/15/87	1/15/87						
						3/16/87	3/23/87						
						3/26/87	3/26/87						
						10/30/87	0/00/00						
COMMENT:													

FIGURE 3 Comprehensive Project Report 2.

of the new update reports. Finally, the central office program and management planning group (PPMG) reviews the proposed schedule changes in order to decide whether or not to approve the projected schedule, as PPMG controls regional allocations and the overall statewide program.

CAMS was accepted and supported by the central office and regional managers with only minor reservations that were expected as the result of implementing a new system. Their support was vital in giving the system a chance to succeed.

Despite the higher-level support, the regional designers had reservations about CAMS, because it was initially requiring more of their time to update than did the previous system. However, after several months, the designers found they were spending much less time on the updates because they had become more accustomed to the system and there were fewer changes needed, especially with the more complex projects. Furthermore, all the regional staff began to become aware of the benefits of the system and, as a result of their input, improvements were made to the system.

BENEFITS OF CAMS

Region I personnel and management have received a number of benefits from CAMS. The first major benefit is that there is now better coordination among each of the regional units. As an example, real estate personnel now have a better idea when the ROW-taking line review meeting is scheduled and when they will receive the ROW mapping. By knowing what is happening with the schedule, each group can plan the use of their resources better and each needs to contact others less often with regard to progress of a project.

In addition to better coordination, the designers now have a clearer idea of the processes that their projects need to go through and the consequences of delays. By establishing a critical path for each project, regional personnel are assisted

in determining the current status of the project, insight is provided into how current delays may affect the letting, and where time could possibly be saved if the project is behind schedule is shown. Furthermore, detailed critical paths are used when establishing new or changing project schedules. Thus, the region now has more reliable and accurate project scheduling, which could possibly lead to less overprogramming of funds.

The detailed schedules are also useful in providing information and documentation when a project delay is unavoidable. The schedules can show where tasks and reviews are taking longer than originally expected and whether and where time can or cannot be made up. This is an important benefit to program managers and department executive management.

CAMS resource management information has also been a benefit to regional design supervisors when assigning new projects to squads or reassigning old projects. This benefit is the result of monitoring the actual designer or engineer-in-charge for projects in construction for project activities. Several regional units have also been experimenting with more detailed resource management. A discussion of their activities is presented in the following sections. Full resource management is one of the final stages of implementation of CAMS and may provide the key to determining staffing levels and distribution for many NYSDOT functions.

Another major benefit of CAMS is flexibility in report generation. With CAMS, reports can be tailored for each group and are more useful and concise. The flexibility and tailoring is also used for the different managerial levels. For example, the design squad leaders want and receive different reports than do their supervisors, which in turn differ from reports that are sent to group leaders and executive management. In addition to standard reports, the system allows for exception reporting, thus allowing the managers to see only the problem projects. This capability results from the ability of the system to monitor the central office approved and regional projected schedules.

CHANGES AND DEVELOPMENTS OF CAMS IN REGION 1

As with any new system, changes are often necessary and new ideas need to be experimented with and evaluated. The following briefly explains several changes made to CAMS in Region 1 since its inception.

Experiments with Resource Management

Since the implementation of CAMS, one design squad has been tracking in detail their time on detailed design activities. The regional design engineer wants to monitor activities in detail for future human resource and fiscal evaluation for staffing and other purposes and in order to see how well the CAMS system operates at its highest level.

The design process was broken down in detailed steps for each project in one design squad. Tasks were then assigned to the human resources. The unique aspects of the design experiment are (a) the level of detail is much greater than even that in the models; and (b) every person in the squad is monitoring his or her time, as it has been found that a technician's availability could be as critical as the squad leader's, with regard to advancing projects.

In May 1985, the regional real estate office also initiated detailed human resource management for three projects. As with the regional design engineer, the regional real estate officer wanted to collect detailed resource and cost information for various functions in his group. The major difference from design's experiment is that the activities are not as detailed or numerous.

The potential benefits associated with the design and real estate units have yet to be fully exposed. More time and use are needed before a final evaluation can be made. It is not clear whether the extra effort required for full human resource management will yield correspondingly more and better use of the system.

Addition of New Events

Various managers in Region 1 requested that new events be added to CAMS as the system developed. The major change has been the addition of utility-related events. Several of the design managers felt that the utility events were needed to remind the designers of the necessary steps and associated time frames dealing with utility activities and to ensure that proper coordination with utility corporations and municipalities was effected.

Addition of New Information

New information has also been added to the system, including the project construction cost at different stages (i.e., when the project design starts, at design approval, etc.). Monitoring of construction costs will provide a historical record and information for financial analyses, and will aid in cost control.

Changes in Reports

The final major change has been with the report formats. As the users became more familiar with CAMS, new and different information has been presented on the reports. Furthermore, they have been changed to reflect the users' special requests and needs.

FUTURE DEVELOPMENTS

As stated, changes are necessary to any system to reflect its users' needs, and as a result some tasks and developments are considered to be important for the future success of the system.

Use of Microcomputers

Each regional office recently received a microcomputer and software including communications software and hardware so that the microcomputer can be tied into the mainframe. The microcomputer will be used for (a) generating critical path charts; (b) downloading information from the mainframe to be used with other microcomputer programs, possibly resulting in greater sorting capabilities and aiding in the development of special reports that the mainframe report-writer system is unable to produce; and (c) up- or downloading information to and from PAC MICRO, a copyrighted microcomputer program from AGS Management System compatible with PAC II.

Fiscal Replacement Reports

The NYSDOT is in the process of developing a fiscal subsystem that can be used by different groups and offices. This subsystem would replace the current fiscal systems used by the central and regional offices.

Integration of Information Systems

To date, there have been initial investigations of the possibility of tying CAMS into other NYSDOT information systems such as the accounting and highway condition systems. Each of the latter systems is being modernized with the possibility of integrating with CAMS.

POINTS OF EXPERIENCE AND IMPORTANCE

Based on the Region 1 CAMS coordinator's experiences with implementing CAMS in Region 1, there are several points that should be outlined because they have had an impact on how successfully CAMS operates, and as a result, could guide other entities when developing and implementing or altering a PMS.

1. Desired characteristics for the new system must be chosen and fully evaluated before making system software comparisons. The system must meet the identified needs. Furthermore, with a full evaluation of the agency's needs at an early stage in the process, less time and effort will be spent when implementing the system.

2. Affected parties should be involved in the selection and development of a system. If so, the implementation stage will go more smoothly, and the system has a better chance of becoming an accepted and useful tool for the agency. It is essential to identify the needs of managers at all levels, especially when usually a large portion of the information will be coming from the lower managerial levels (i.e., squad leaders).

3. Standardization of formats, procedures, and information is important in the development of a system and in the generation of information. With standardization, time and effort are saved when inputting data and producing information for various managers.

4. The system should be understandable to its users. If not, the system will not be used fully and alternative databases will be developed. It is, however, not necessary for the system's software to be user friendly.

5. Presentations to top managers should be clear and concise and outline realistic expectations. Flashy presentations that may have taken days to develop may make managers believe that it takes a minimal amount of effort to operate the system, thus needing fewer personnel and much less time than is really required. Also, expectations may be raised beyond a reasonable level. There can be few or no misconceptions about the system and capabilities if future disappointments are to be avoided. Management should understand how much it takes to implement and operate the system and, just as important, that reliability does not appear without substantial groundwork.

6. The data collected for the system should pass the So What? test. With any new information system, there is a tendency to collect more data than are even necessary for the agency at all organizational levels. The need for all data should be carefully considered before it is collected. The effort that is required to collect and maintain excess data is often lost time.

7. Data going into the system must be reliable, timely, and usable. Those supplying the data must fully understand what, why, and when data are needed. This point should also be kept in mind when determining what needs to be reinforced and stressed during system implementation and when developing the system documentation and user manuals.

8. The possible impacts of the system on the organization in both the central and regional offices must be considered. One impact could be the way in which the central office perceives and handles the region's project and program changes and requests, and in which all offices produce and evaluate such information.

9. System capability with other agency databases should be addressed. Integration is important because there are major gains in efficiency to be realized by eliminating duplicate systems and data collections and the potential of discrepancies between systems.

10. A considerable amount of time and effort is required to build and maintain a usable database. Significant forethought should be put into deciding what to monitor and how. Furthermore, sufficient staffing has to be provided in order to input and maintain the data.

11. The system should not be difficult to update. The users should not have to put significant amounts of time into updating the system, thus taking time away from their main functions. The users' benefits must outweigh the update time and effort.

12. If the decision is made to use a commercial software program, the agency should find out how many entities use the program with the same type of computer, to what extent they have used the system, and if possible, their experiences with the system and the supplier. The number of users and their level of usage will assist in evaluating the possibility of encountering "bugs" and the type of support the agency might expect from the supplier.

13. The system documentation should be clear and accurate. The manuals and documentation must identify all system aspects and procedures, including troubleshooting procedures.

14. Managers are needed even with a computerized PMS. A system provides information and not answers, thus managers are still needed for coordination and decision-making functions.

15. The way in which reports present the information is very important; if the user does not understand what is shown, the information will be considered useless.

16. The agency's computer must have the capability of handling a major database. If the agency has a PMS with limited access and processing capabilities, the success of the system will be negatively affected. Hence, an accurate estimate of available computer processing and storage capabilities must be made before implementing a new system.

MEETING GOALS AND EXPECTATIONS

Because circumstances differ in each location within the agency, expectations also differ. The following discussion applies to the Region 1 experience after the system had been operating for approximately 1 year.

CAMS was able to fully or partially meet the goals, as evidenced by the CAMS reports, resource management information, and the elimination of some of the duplicate databases.

From the viewpoint of the Region 1 CAMS coordinator, the user benefits outweighed the costs in time and effort. Regional personnel saved time with the new system, given improved coordination and accessible information that could be sorted and presented to reflect the users' needs. In addition, the system proved to be flexible in handling various requests as well as changes in the processes with which the users had to deal.

Furthermore, a number of important elements were in place that allowed the successful implementation of CAMS in Region 1. These elements included a management and staff who had the desire to implement an enhanced information

system and who were willing to give CAMS a chance to succeed. The success could not be attributed to a single individual or approach, but to many individuals and many different approaches and situations. Implementation of a system is a very complex and time-consuming process and it requires a considerable amount of effort by all affected agency personnel.

The success of the system in the future will depend upon whether or not enhancements can be made to reflect the executive managements' and users' needs and continuing evolution of process changes for project development. An information system cannot stand alone; it needs continued support from all levels of the agency. That support can only be gained if the system serves its users and satisfies their needs.

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