Guidance on Successful Computer Maintenance Management System (CMMS) Selection and Practices

DETAILS

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Abstract

This Guidebook documents and presents the results of a study of the CMMS practices in airports in the US at the current time through surveys and case studies. It further delivers evaluation, selection and implementation guidelines for use by airports of varied sizes and budgets. Features and capabilities of a CMMS are outlined for reference during the selection process. Good implementation practices and lessons learned from the research are presented to assist airports in their own implementation. The findings of the study suggest that the preparation of the airport for an implementation should include an extensive requirements definition process to assure that the software selection fits the airport's needs, and that the configuration of the software be tailored to suit the airport's business processes.

EXECUTIVE SUMMARY

Airports are complex entities, with many diverse sets of assets including taxiways and runways, check-in kiosks, fleets of vehicles, power grids and energy systems, security systems, mechanical systems, computer systems, baggage handling systems, and signage, just to name a few. Keeping these vital assets operational and spare parts storage at optimal service levels is a constant challenge. Airport Computer Maintenance Management Systems (CMMS) are tools used to help manage the large number and varied types of airport assets. A CMMS can simplify and streamline maintenance operations by helping to schedule work, maintain inventory levels, manage records, track history, and perform many other useful functions to manage airport assets. There are many vendors of CMMS software and many available options from which to make a selection. How does an airport know which one and what options to choose?

With the assortment of features, functions, and capabilities of the CMMS and add-on components available on the market, it can be an overwhelming task for airport staff to understand and evaluate the best solution for their airport when selecting a CMMS that will work now and in the future. The choice of the best CMMS for the airport is a question that drives this Guidebook. There is no best software and no best option for every airport, since the most appropriate solution depends on an airport's specific needs. Until the airport defines those needs, it is impossible to know which software fits best. This Guidebook is written to help airports understand their own requirements and then match them against CMMS software to select the most suitable solution.

After an airport selects the CMMS to implement, the question of determining how the airport wants to implement the CMMS needs to be addressed. Questions could include, for example, what assets does the airport want to manage? How does the airport want to communicate data between the CMMS and the procurement system? What about the scheduling system, financial systems? The implementation section of the Guidebook addresses these and other issues, and sheds light on the decisions the airport needs to make to carry out a successful implementation.

It is important to focus on the right factors for success in an implementation of this kind. To help understand what those factors are, a survey and various case studies of airports that implemented CMMS were conducted. Successful implementations of CMMS revealed factors that were commonly cited as important to the implementation's success. Lessons learned from those airports are cited in this report so that other airports can learn from their experiences. Some of the observations from that research may be surprising, including the fact that internal support, adequate budget and resource allocation, development of requirements, and executive support all were considered more relevant than the specific functionalities of a particular software package.

This Guidebook is accompanied by an evaluation tool and a User Guide to the tool. The evaluation tool can be used to help airports define their requirements for a CMMS program. Those requirements can be used in a Request for Proposal, other procurement efforts, or in an internal development/ implementation process.

PART I: GUIDEBOOK

Chapter 1: Overview

The objective of this Guidebook is to provide guidance to airport staff in selecting a Computerized Maintenance Management System (CMMS) that best meets an airport's individual needs, and in successfully integrating it into airport processes, procedures, and other information technology systems. An additional purpose of the Guidebook is to provide guidance for development and implementation of a CMMS program and serve as a reference for the airport professional.

This Guidebook is intended to serve large, medium, and small airport audiences. It discusses opportunities to achieve efficiencies and cost benefits of individual CMMS program components, as well efficiencies and benefits of the implementation of a complete CMMS program. A complete full-featured, integrated, CMMS program can be the right solution for a large airport; yet it might not be feasible for smaller airports or budget-constrained airports. For those airports with limited budgets and/or resources, the Guidebook provides assistance towards a suitable program start-up as well as with implementing specific program components that can be beneficial given the airport's unique situation. For those airports that might choose to implement CMMS program components, the Guidebook provides guidance for a phased approach towards a complete CMMS program as an ultimate goal. For example, it might be advantageous for such an airport to begin accumulating asset data into an asset catalog as part of regular maintenance activities.

The Guidebook defines the components of a CMMS program. It can assist the airport in making informed decision about the feasibility of CMMS. Furthermore, the Guidebook intends to supply the information that an airport professional would need to understand the concepts of CMMS, and to have a high-level understanding of their issues and benefits.

Some key strategies are identified in the Guidebook with a special marker.

Key strategies will be identified with this marker. They may be stand-alone initiatives with independent benefit, antecedents to a successful implementation, or building blocks to implementing a larger-scale CMMS.

In addition, the Guidebook provides a review of current approaches to CMMS programs in practice at airports. This includes considerations and decisions made during CMMS program selection and implementation. Lessons learned from airports' experience are included to help guide the CMMS evaluation and implementation processes. Good CMMS implementation practices and benefits are also included.

Finally, the Guidebook is accompanied by an Evaluation Tool and User Guide to help airports define their requirements for a CMMS program to use in a Request for Proposal, other procurement efforts, or in an internal development/implementation process.

Airport Computerized Maintenance Management Systems

Maintenance planning and execution is a critical aspect of a facilities management organization within an airport. Airports, in general whether large or small, have a substantial number of assets, many with high dollar values. Managing the maintenance of these assets proactively protects them, allows planning of resources to maintain them, and facilitates budgeting for replacement. A CMMS can track maintenance activities, provide automation for activities and data exchange, and provide reporting for executives. CMMS can include financial review and analysis for cost of asset maintenance and replacement, physical tracking of the asset, and tools for maintaining data about the assets managed by the CMMS.

Despite all that a CMMS can do for the airport, it is difficult for decision makers and maintenance professionals at airports to plan a CMMS project. They need tools to help explain the benefits and costs, provide an overview of CMMS, and provide guidance for the airport staff in selecting and integrating the CMMS into airport processes, procedures, and other airport systems. This applies to airports of all sizes. A small airport might not have the budget to do a CMMS implementation with the same scope and scale as a large airport, but there are aspects of a CMMS that most airports can adopt.

Airports need guidance, not just on the selection, but also on how to implement a CMMS. Vendors will imply that success depends on the software, yet there is evidence of successful (and not so successful) implementations of each particular software commonly on the market. Therefore, the reasons for success are probably not linked to a particular software. More likely, success is linked to the airport's understanding of how a CMMS fits within its maintenance practices and how the use of a CMMS can improve those practices. It is also likely that implementation of a CMMS will cause changes within those practices.

The potential for improvement in maintenance functions and processes, and in the ability to predict and manage assets drive most airports towards an adoption of a CMMS. Many did so early in the history of CMMS, replacing manual practices with some automation and better record keeping. Some of those airports have moved to full asset management systems, taking benefit of life-cycle analysis and planning for their resources. Many airports without budget and/or identified return on investment have not yet done so. While a full-blown CMMS might not be economically feasible for some of those airports, many could still benefit from a roadmap for a phased implementation of CMMS, or from specific modules from a CMMS that meet budget and specific needs.

In general, the main driver for the successful adoption of technologies in airports is the need for improvement of some element of the airport's business. In the case of CMMS, these drivers would include creating greater operational effectiveness, enhancing of preventive maintenance scheduling, enhancing service delivery, optimizing asset life while minimizing asset cost, improving budgeting and planning capabilities, enhancing resource management, minimizing downtime, increasing reliability, enhancing environmentally sound operations, improving management decision-making, and enhancing productivity.

In many cases, management of airport infrastructure is distributed across airport departments, with the responsibility for assets also distributed, which in turn leads to the evolution of department-centric systems and methodologies for maintenance programs. This is also likely to lead to duplication of efforts across these departments. Generally, these department-centric stand-alone systems create the following inefficiencies and problems within the airport:

- Separate silos of information are not shared with other airport departments

- Difficult information exchange among departments and systems
- Lack of timely coordination
- Applications which are difficult to support
- Redundant data entry for different systems
- Insufficient distribution of relevant data across departments and systems
- Impede establishment of standards within the airport
- Duplicate and non-standard physical infrastructures (e.g., servers, databases, networks, cable plants, etc.)
- Lack of cost effectiveness in supporting multiple systems
- Difficulty in inter-departmental communications
- Difficulty in achieving common organizational goals

Department-centric systems also leave the airport without the "big picture" perspective of airport assets and maintenance that is critical to operations and planning. The integration of these disparate systems would allow the airport both an overview of the asset maintenance requirements and the detail to manage each asset optimally. Airports need to create an integrated business process to support the integration of CMMS programs.

From this, systems that might be considered for integration include: Geographic Information System (GIS), Resource Management Systems (RMS), Common Use systems, Pavement Management Systems (PMS), Gate Management Systems (GMS), Asset Information Management Systems (AIMS), Airport Operational Databases (AODB), Automated Vehicle Identification (AVI) systems, runway incursion systems, airfield systems, airport procurement and financial systems, airport capital planning systems, airport safety systems, pavement maintenance systems, building management systems, Building Information Management (BIM) systems, Supervisory Control And Data Acquisition (SCADA) systems, airport help desk, airport Enterprise Resource Planning (ERP) systems, human resources systems, other airport back-office systems, and potentially all airport operational systems.

The Guidebook assists airports to determine which of these systems should be integrated to provide optimal data use and the resulting efficiencies for their airport. The benefit of integrating each system should be evaluated on a case-by-case basis, in order to produce a roadmap that allows the airport to systematically approach integrations and make decisions about which ones have the required/desired cost-benefit to support a decision for such an integration.

The airport will need to decide the level of application integration that is desired based on practicality and budget? For example, GIS integration can pull information from underlying databases to spatially display and visually analyze asset infrastructure. The level to which this is taken will drive the cost of implementing GIS integration. The airport might want to click on a specific camera in a terminal map, and see the maintenance history for that camera as well as its specification and upcoming preventive maintenance.

An airport-wide CMMS program can allow airport executives a better insight into how the airport maintains assets in real-time, and can enable the creation of real-time monitoring of key performance indicators (KPIs). Convergence of the silos of information contained within departments is an essential way for executives to reach into the departments' information resources in order to better manage airport assets from an overall airport perspective. Historical data can be analyzed to identify opportunities for improvement and to develop a better ability to set and meet or exceed performance benchmarks, including preventative maintenance and management of assets.

A challenge in implementation of an airport CMMS, as with any system, is cost. There are options, which range from a custom system developed natively within the airport over time, implementation of some modules of a full CMMS implementation, a "vanilla" implementation of a CMMS without customization, to a full-scale off-the shelf and highly-customized CMMS. Each of these has advantages and disadvantages. Budget and resources are factors in determining what kind of implementation will work at any given airport. A full-scale off-the shelf and highly customized CMMS can be a multi-million dollar expenditure. And the successful execution of a CMMS program requires many airport resources.

The dependency of a CMMS on a reliable asset catalog (also referred to as asset inventory or asset dictionary) is vast. Some large airports have implemented airport-wide Asset Information Management (AIM) systems. Some others have implemented custom solutions. But in all cases, an asset catalog is critical to a successful implementation of a CMMS. Although a comprehensive asset catalog is needed to manage all assets, most airports start with particular types of assets and include additional ones as their program matures.

There is little in the current available literature about airport CMMS. However, efforts to identify and locate relevant materials are currently underway in the airport and other industries, within organizations such as the American Association of Airport Executives (AAAE), the Airports Council North America (ACI-NA), the Environmental Protection Agency (EPA), American Water Works Association (AWWA), Institute of Asset Management (IAM), The Airport Association for Benchmarking (TAAB), and others. Airports, obviously, also have investigated solutions to CMMS and are good sources of information for this study.

The Transportation Research Board (TRB) has an American Association of State Highway and Transportation Officials (AASHTO) subcommittee on asset management. The subcommittee supports a Transportation Asset Management Today website, and the TRB sponsors a transportation asset management conference. The National Cooperative Highway Research Program (NCHRP) funded a recently published report on Analytical Tools for Asset Management and another on An Asset-Management Framework for the Interstate Highway System. These and other industry sources can provide a wealth of information on asset management and CMMS that is considered for, or can be extrapolated to, airports.

CMMS versus Enterprise Asset Management Systems

What is the difference between a CMMS and an Enterprise Asset Management (EAM) system? CMMS have been in use for more than thirty years. Generally, a CMMS tracks the maintenance activities and costs for assets. It can also track workflow and cost for maintenance activities. Typically, a CMMS provides management of work orders, preventive maintenance, inventory, and asset history.

An EAM system includes those components as well as functionalities addressing inspection and monitoring of assets. Monitoring is done with regular periodic condition assessments of the assets, and the system attempts to maintain a desired level of service at the lowest life-cycle cost.

EAM systems can be defined as managing infrastructure capital assets to minimize the total cost of owning, operating, and maintaining assets at acceptable levels of service. These systems touch the entire organization and manage the interdependencies of maintenance, operations, asset performance, personnel productivity, life-cycle costs, and capital planning.

A first step in any EAM plan is for an organization to conduct a needs assessment to understand what is required to accomplish its asset management goals. In the past, many organizations managed their

activities by capital and operating expenditures found in their accounting systems. However, airports are a capital "asset" intensive business, so they are "asset-centric" by definition because assets are central to their business purpose. Just as with a CMMS, one of the first tasks for any EAM plan is compiling existing assets into an inventory, an "asset catalog". Both EAM and CMMS require a commitment to maintain such an asset catalog.

CMMS can be the starting point for an airport EAM. CMMS planning should include EAM as an eventual goal. Therefore, the CMMS program should be structured with that in mind. One approach might be that an airport procures an EAM software and only implements those modules relevant to CMMS. The scope of the data required for an EAM includes the total life-cycle cost of an asset, and not just its maintenance costs. The initial cost data can be captured in the CMMS.

It is important for the airport to understand the long-term goal for the CMMS. If that goal includes a full EAM system with life-cycle costs for assets across the entire airport, the procurement of the CMMS should be approached with that goal in mind. Airport case studies, as provided in Appendix B, describe the progress of five airports, two of which began a CMMS program and have evolved it into a full EAM system.

Chapter 2: CMMS at Airports

There is only limited published information available at the time of this writing (both on the Internet and in print) that addresses airport-specific implementations of CMMS. Most of the available literature on CMMS evaluation and implementation, however, is general across industries, with much of the focus on plant maintenance management. Some of the more recent studies are focused on best practices and standards development for asset management. This leaves the airport operator without good guidance for the specific issues and implications of maintenance management for airports, such as regulatory issues concerning FAA regulations for Part 139 discrepancy maintenance and safety management requirements. There are some resources on maintenance and asset management from the (ACI-NA), Operations and Technical Affairs Committee. This committee meets twice a year at the ACI-NA Annual conference. There are additional efforts by ACI-NA within the Business Information Technology Committee, who also conducts conferences, including presentations focusing on asset and maintenance management.

A new international family of standards was published by the International Organization for Standardization (ISO), superseding the British Standards Institute (BFI) Publicly Available Specification (PAS) 55 in January 2014 for asset management standards. The ISO 55000 family of standards is the first set of International Standards for Asset Management. It is comprised of:

- ISO 55000, which specifies an overview, concepts, and terminologies;
- ISO 55001, which defines the requirements for an asset management system; and
- ISO 55002, which provides an interpretation and implementation guide for the management system.

Current State of the Industry

The content presented in this section is based on survey data received from selected airports in the first phase of this project, as well as on the results from the case study research phase (see Appendix B for the case study reports). Pertinent findings from the case studies and the survey are summarized here to provide relevant information about current considerations in regard to evaluating and implementing a CMMS.

Survey Results

The goal of the survey was to build a foundation for the development of this CMMS Guidebook and the accompanying tool. The research was focused on the methods that airports currently use to successfully select and implement a CMMS, as well as their lessons learned from their experiences. The survey and the case studies collected data from airports of different types, sizes, and geographic diversity.

The survey indicated a great maturity in CMMS implementations in use at airports. Many of those airports have incorporated not just asset maintenance functionality, but also FAA Part 139 inspections and reports, in addition to safety management system capabilities within their CMMS. Although asset management functionality has not yet been achieved very successfully in many CMMS implementations,

airports are, however, actively working towards asset management capabilities to effectively manage assets through their life cycle, from selection to end-of-life.

Airport Profile

The survey was sent to hub, origin & destination (OD), and general aviation (GA) airports; small, medium, and large airports; and airports located east and west of the Mississippi River. The sample was not representative and it comprised about 2% of the more than 5,000 airports open to the general public in the U.S. Thirty-four (34%) percent of the airports contacted responded to the survey. Figure 2-1, shows the airport breakdown by type, whereas Figure 2-2 provides the breakdown by size.

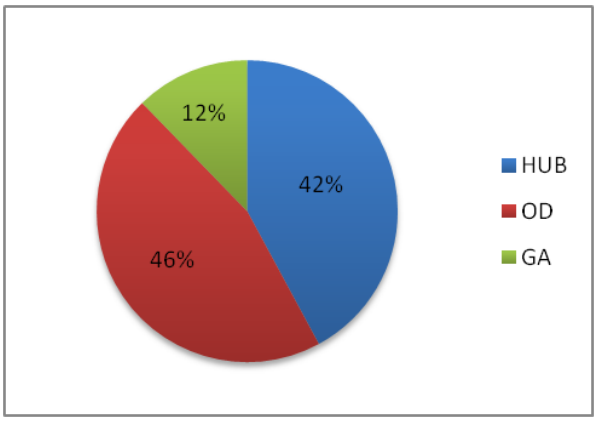


Figure 2-1 Survey Respondent Airport Types

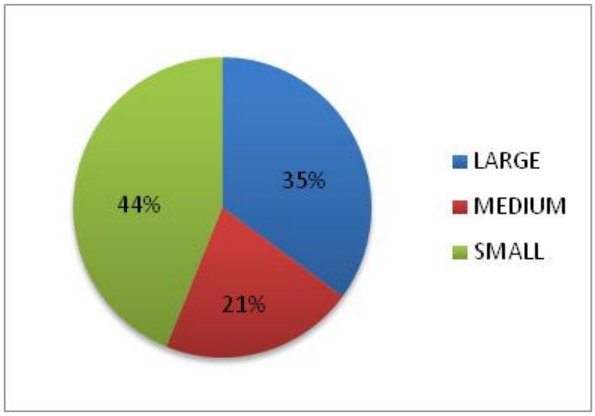


Figure 2-2 Survey Respondent Airport Sizes

Data from the survey provided the following results:

- Of the responding airports, about half had a CMMS or Asset Management System. Of the responding airports with a CMMS, 60% were large hub airports, indicating that *budget and size are likely predictors of the feasibility of implementing a CMMS*. Only about 7% of the responding large airports did not have a CMMS.
- Eighty-one percent (81%) of the responding airports that implemented a CMMS or Asset Management Systems were Hub airports. Nineteen percent (19%) of these airports that implemented a CMMS or Asset Management System were Destination airports.
- Fifty-nine percent (59%) of the Hub airports that reported implementing a CMMS or Asset Management System were of Large size. Thirty-two percent (32%) of the Hub airports that reported implementing a CMMS or Asset Management System were of Medium size. Nineteen percent (19%) of the Hub airports that reported implementing a CMMS or Asset Management System were of Small size.
- Ninety-three percent (93%) of the Large Hub airports reported implementing a CMMS. Seventy-eight percent (78%) of the Medium Hub airports and 31% of the Small Hub airports reported implementing a CMMS. Similar to the Small Hub airports, 29% of the Destination airports reported implementing a CMMS.
- Of the airports that reported implementing a CMMS or Asset Management System: 35% began their implementation in the last five (5) years; 26% of them started in the last five to ten (5-10) years; and 39% began their implementations more than ten (10) years ago.
- The types of software implemented varied. Costs, therefore, ranged from less than $100,000 to $2,000,000. The largest cost factor for many of the airports was identified as professional services. It has been noted by responding airports that in addition to the initial software licensing

costs, budget should include training, annual maintenance, support, and license renewal fees. It should also be noted that the reported costs did not include internal staff costs.

- Most airports reported more than 100 users of the CMMS. One of the smaller airports responding to the survey reported more than 350 users of their CMMS. This is because of the varied airport functions incorporated into their CMMS.

Evaluation

The survey asked the airports to list and evaluate the CMMS in use. A total of 15 different CMMS software types were reported as implemented. Many different reasons, as listed below, were given for choosing particular software. The reasons are presented in order of ranked importance:

- General functionality and features
- Price
- Ease of use
- Compatibility with hardware/operating system
- Integration with other software
- Availability of local support
- Ease of implementation
- General reputation of software and software vendor
- Availability of training
- Employs latest technology
- Compatibility with previous CMMS and/or Asset Management software
- Other

Under "Other", these additional reasons were cited:

- GIS centric solution that worked well with the airport's existing GIS
- Selection was influenced by or mandated by the airport's prevailing authority (City or State government)
- Ease of incorporation with NOTAMS and CFR 139 regulations
- Flexibility to use for multiple departments (Facility, Security, Safety, and Transportation)
- Requirements for maintenance of pavement funded by the Airport Improvement Program (AIP)

Cost of the Implementation

Almost half of the airports reporting that they implemented a CMMS or Asset Management System used only internal staff for the implementation. These airports also reported lower costs for the implementation, but did not report internal staff time as part of the cost.

The remaining airports used a consultant, a vendor, or both. Interestingly, only 70% of the respondents reported that airport internal staff was involved in the implementation. Reported costs were typically higher when airports used consultants and vendors.

About half of the reporting airports implemented the CMMS in a single phase; the others implemented CMMS over multiple phases. In great part, airports that reported a multi-phase implementation tended to have higher budgets, and they reported greater benefits from their CMMS. They also generally reported managing more types of assets.

Note: No conclusion can be drawn about the relation of cost to multiple phases for airports that developed a custom CMMS because of the previously stated lack of data for internal staff cost.

The use of internal staff in implementation of a CMMS can delay other projects that the airport might deem critical. That should be considered in the decision to do the implementation with in-house staff or in getting some additional assistance in the implementation.

Managed Assets

All of the airports that have implemented a CMMS or Asset Management System reported managing the following facilities or pavement areas:

- Ramp Tower
- Administration Buildings
- Cargo
- Hangers
- Maintenance Facilities
- Aircraft Parking
- Ramp Are
- Roadways
- Runways
- Taxiways
- Bridges

The following assets were maintained in the CMMS by some of the airports in the survey:

- Passenger Terminals
- HVAC
- Lighting
- Plumbing
- Electrical
- Baggage
- Parking Garages/Lots
- Signage
- Drainage
- Fuel Infrastructure
- Navaids
- Utilities
- Security
- People Mover Stations
- Tanks
- Communication
- Elevated Bridges
- Instruments
- Information Technology
- Electrical Car Charges
- Seawall
- Janitorial
- Assets
- Vertical Transportation
- Ground Service Equipment
- Boilers and Chillers
- Automated and Roll-up Doors
- Fire Suppression Systems
- Alarm Notifiers
- Landscape
- Buses for Rental Car Facilities and Employees

Benefits from the Implementation

After CMMS implementation, airports stated benefits to the airport as a result. More than half of the airports reported:

- Improved business intelligence / key performance indicators
- Improvements in equipment reliability
- Improved cost controls
- Improved spare parts control
- Reduction in labor costs
- Improvements in equipment availability
- Reduction in materials costs
- Reduction in other costs

Ease of Use & Features and Functions

Airports rated the ease of use of their CMMS and the fit of the features and functions to the airport similarly. This suggests that there might be a correlation between the two. The majority of the results were midrange: satisfactory, good, or very good. Figures 2-3 and 2-4 show the results in percentages (%).

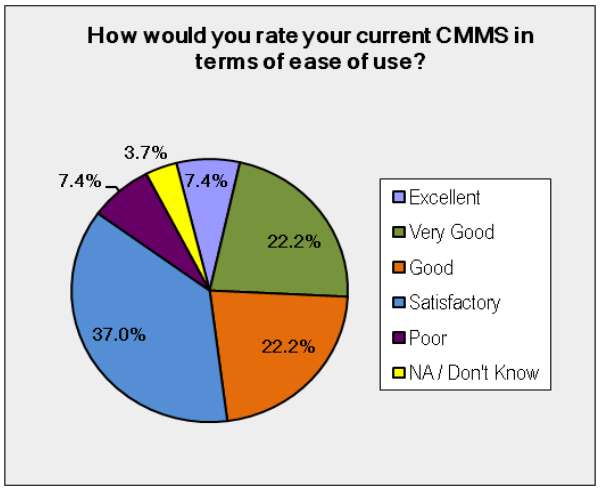


Figure 2-3 Ease of Use

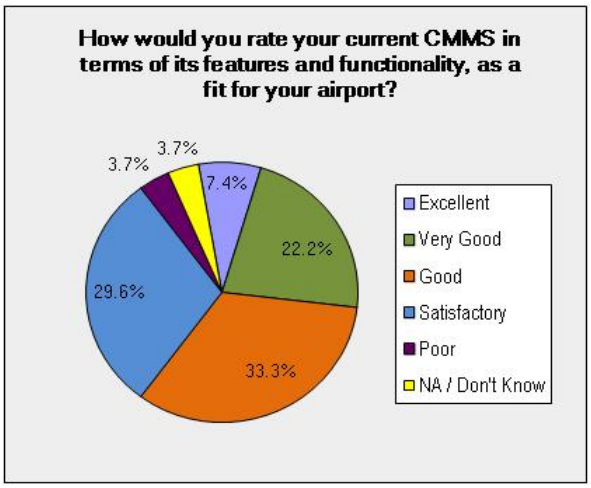


Figure 2-4 CMMS Fit for the Airport

Lessons Learned

Airports reported lessons learned from their implementations of CMMS in their survey responses. They can be grouped into three categories:

- Initial support and resources needed, for those comments that impact the budgeting, critical support, and initial strategies needed to get the CMMS program started,
- Planning, for those comments that impact the evaluation and procurement of the CMMS, and
- Configuration and ongoing maintenance support, for those that impact the implementation, configuration and longer-term maintenance and support for the CMMS.

Tables 2-1, 2-2, and 2-3 provide the lessons learned in regard to support resources, planning and procurements, and configuration and maintenance support, respectively.

Initial Support and Resources Needed
Budget support is critical.
Strong executive management sponsorship is critical to the program's success.
Senior management, sponsors, and subject matter experts buy-in is essential.
Buy-in and support from upper management is critical.
Be prepared to invest the time and money initially to upload airport assets into the system.
IT has to be dedicated to support software and hardware both during and after the implementation.
Establish a partnership between stakeholders: sponsors, subject matter experts, and the airport's technology services organization (IT).
A collaboration between senior management, technology services, and the end users will help insure the

best results.
Prepare user community for increased technology use.
Hire a consultant to assist in justifying the cost of the software.
Have open, clear, continuous communication with all stakeholders. Leave no one behind.
Invest in immersion training for implementation team prior to requirements gathering workshops.
Have business processes and resources in place before immersion training.

Table 2-1 Lessons Learned – Support Resources

The lessons learned cited from airports responding to the survey talk about support from management and collaboration among stakeholders as key to starting the CMMS program. Identifying program sponsors and selling executive management on the benefits can be key to finding the budget required for a CMMS implementation.

Planning and Procurement
Create a well-defined requirements document.
Determine how you plan to use the system—develop a use case.
Focus on asset data structure with reporting in mind.
Thoughtfully, map out an implementation plan that coincides with business process change management.
Develop a communication plan for stakeholder community.
Develop a strong implementation plan that meets the requirements of the airport.
Create policies and procedures within the application to support your organization's processes.
Verify data maintenance routines to meet records retention needs.
Evaluate any new system thoroughly before procurement.
Ensure the Business drives the procurement and implementation, and that it is not done by solely by IT.
Knowing that you will be using the system for many years, ensure you have selected the right system for the long haul. It is difficult to switch software mid-stream if the right selection is not made initially.
Make the implementation user friendly and ensure it will suit your users' individual needs.
Carefully select data fields for the assets.
Spend the time on a good implementation plan with buy-in and feedback from end users.
Select a competent vendor/consultant partner committed to a successful implementation.

Table 2-2 Lessons Learned – Planning & Procurement

Requirements for a CMMS are developed during the planning phase of the project. While it is possible to embark on a CMMS implementation without adequate planning, many organizations find that the outcome is not what was expected. Establishing the airport's specific requirements is key to achieving the hoped-for goals of CMMS implementation.

Configuration and Maintenance Support
It is important to consider the needs of management, work control and technicians in the implementation. The software must be capable of being tailored for each, and the configuration should be adapted for ease of use by each group.
Ensure that the implementation team has CMM/EAM implementation expertise - we hired a consultant to assist us.
Include ongoing technical support in the procurement.
Be prepared to dedicate personnel to maintain inventory control.
Seize opportunities where CMMS can be leveraged into other areas of the enterprise.
Dedicated personnel will be required to manage the system on a daily basis.
Select a knowledgeable and competent vendor to assist with upgrades.
User training is critical.
Use your airport's data for end-user training instead of using a generically configured system. It will help if the users are familiar with the assets and processes they are being trained on.
Airports must be willing to invest the time required to administer the system in order to maximize its potential.

Table 2-3 Configuration & Maintenance Support

It should not be forgotten to plan the resources needed to maintain the system after it is implemented. That includes maintenance cost and staff to manage the application. Not just IT staff, but an airport should plan for system administrators to manage new users, new requirements definitions, including new assets, and system improvements.

Case Studies

Case study airports were chosen for their diversity, as well as for a successful CMMS implementation. Two of the airports have implemented IBM Maximo, a small and a large airport to illustrate the differences were chosen. Another large airport implemented Infor EAM. Two additional medium-sized airports were chosen: one developed a custom solution; the other implemented Cityworks, a GIS centric system usually regarded as a solution for cities instead of for airports. The airports chosen were geographically diverse: located on the east coast, west coast, and in the country's midsection. The airports included two southern airports, a far north airport, a northwest airport, and a central airport. All except one were hub airports. The geographic diversity was considered to add both cultural and climate diversity to the case study effort.

The airports selected for case studies were:

- Dallas/Fort Worth International Airport
- General Mitchell International Airport
- Seattle-Tacoma International Airport
- Southwest Florida International Airport
- Ted Stevens Anchorage International Airport

The case study reports are presented in Appendix B. No assessment on the suitability of a particular software is included in these reports. The success of the implementation of the CMMS at any airport does

not seem related to the particular software chosen, but on other factors including the successful definition of requirements, the airport's support for the system, and the right resources on the implementation and maintenance team. The case study airports reported more significant benefits overall than the larger pool of airports. The only CMSS implementation that was expected, but not achieved, was a reduction in materials costs. Figure 2-5 shows the benefits achieved from CMMS implementation as reported by these airports.

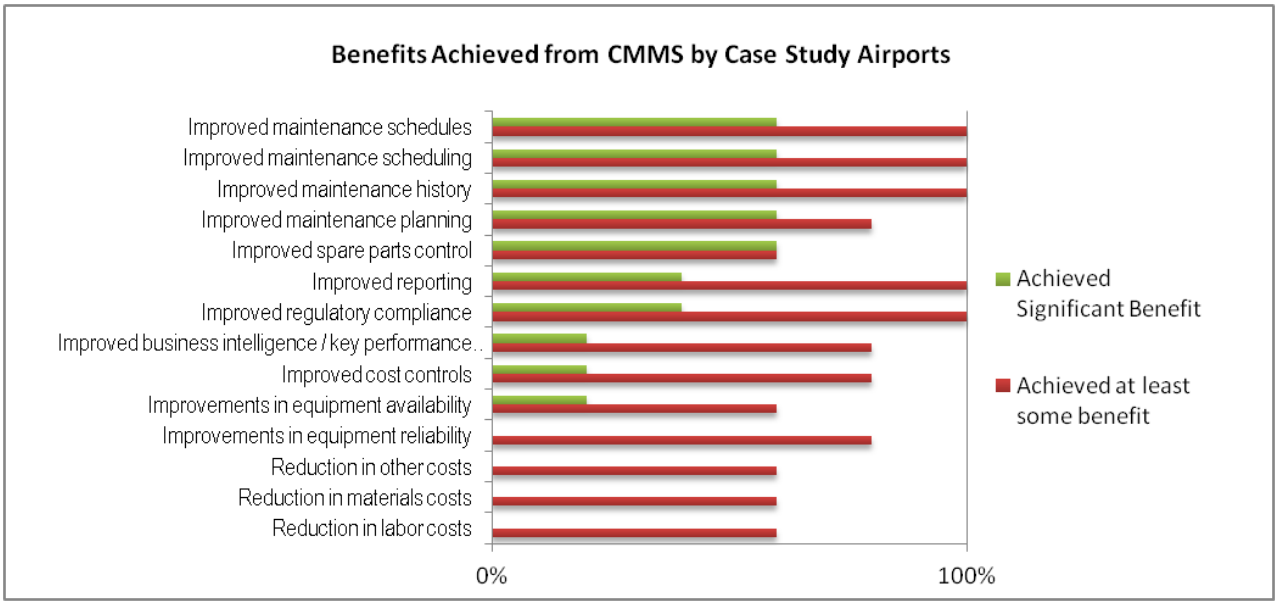


Figure 2-5 Case Study Airports CMMS Benefits

Of particular interest to this Guidebook is the fact that three of the five case study airports used the CMMS across multiple departments utilizing workflow to automate processes. Part 139 reporting is automated in two of the airports, eliminating manual reporting and duplicate data entry and providing electronic records for FAA inspection through the CMMS. In two of the airports, some safety management system functions are also incorporated in the CMMS. One of the airports has integrated the airport GIS with CMMS. Four airports are using mobile tools.

Compliance Requirements

There are many regulatory requirements on U.S. airports from federal, state, and local governments. While state requirements vary across the U.S., federal requirements are imposed primarily by the FAA certification of airports, and secondarily by the requirement for grants received under the Airport Improvement Program funds. Additionally, there are compliance regulations from the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA). The costs of complying with these regulatory requirements impact both airport capital and operating costs. Maintenance records play a large part in compliance and reporting requirements to these agencies. These agencies (primarily the FAA) provide some funding for new regulatory initiatives, but ongoing compliance costs typically are the responsibility of the airport. Although not all regulations have impacts on maintenance of assets, the record keeping inherent in a CMMS can be leveraged to address many of these regulatory requirements.

The CMMS system can be a tool in the Part 139 compliance by providing maintenance records for the inspection reports. Two of the case study airports have achieved FAA approval of automated inspections reporting by integrating their CMMS systems that have other data needed for the reports. The automated inspections reports save time and provide accurate records to document the airports' compliance.

An FAA's anticipated circular will mandate airports to implement safety management systems (SMS). An SMS can also be integrated with a CMMS to provide maintenance data for assets involved in incidents. Again, some of the case study airports have already initiated workflow within their CMMS to assist in compliance with the airport's risk management plan and the anticipated regulation. Airports considering an SMS implementation may want to include integration language in any SMS procurement.

Budget and Business Case

Implementing a CMMS can enable an airport to manage assets more efficiently, saving time and money. A well-researched business case can help persuade the budget-makers at the airport of the benefits of CMMS software and its utility for the airport. Many of the reasons that an airport might want a CMMS are not directly related to cost. A good strategy for a business analysis is to begin with a discussion of the role of the maintenance department and its responsibilities at the airport. Then it should be discussed where improvements can be made by implementation of a CMMS, such as:

- Increased efficiency of the maintenance work order response times
- Improved planned maintenance scheduling
- Optimized asset life by better preventive maintenance
- Administrative savings by elimination of manual processes
- Improvements in contractor and SLA management
- Longer asset life because of better maintenance
- Better reporting
- Better risk management
- Improved stock control
- Improved facility scheduling
- Fewer breakdowns because of better maintenance
- Reduction in overtime costs because of fewer breakdowns

For each item in the list an airport should be specific about how the CMMS will help improve it. Included should be an assessment of the Impact that continuing "business as usual" will have, as a contrast to the outline of improvements that the CMMS implementation will give. In addition, a cost benefit analysis should include costs for the CMMS implementation and the savings expected from the implementation of CMMS software. The cost components should include:

- Infrastructure
- End-devices (including mobile devices)
- Software purchase
- License costs (whether per seat, concurrent users, or enterprise licensing)
- Ongoing support costs
- Annual or monthly subscription costs
- Data migration costs
- Configuration and customization of the software
- Internal staff costs for system administration and management
- Training costs

- Consulting costs

While the costs of the CMMS implementation are possible to estimate, it is sometimes difficult to get good estimates for configuration, data migration and customization costs. Assigning dollar values to benefits is even more difficult. The benefits are often intangible and provide efficiencies that are difficult to quantify. In addition, the benefits are often improvements in capabilities that have no direct cost benefit, but provide the ability to better manage the airport and its assets. For example, a calculation on the time that can be saved through elimination of redundant data entry and automation of manual steps can be quantified, but the improvement in an airport executive's ability to gauge performance through the use of Key Performance Indicators (KPIs) is not.

To calculate a return on investment, these values will need to be determined. That is commonly done by taking the your reduction in maintenance costs, subtracting the cost of your CMMS and dividing the result by the cost of your CMMS. The reduction in maintenance costs might include:

- Any quantifiable savings based on extending asset life
- Resource efficiencies due to decreased downtime
- Energy usage improvements due to proper maintenance
- More efficient scheduling of work force
- Less waste in inventory

A business case should state the business objectives for a CMMS implementation, summarize the costs and benefits, give recommendations and explain the criteria for them, and provide the next steps towards the goal. The analysis might conclude with steps and benefits beyond the initial implementation of a CMMS, including automation of work processes with an integrated CMMS. Citing examples of other airports' improvements might also be effective.

System Integrations

A general definition of systems integration is to combine elements (data or processes) of one system with elements of another system. The result is an enhanced system with subsystems (the original systems) that provide improved functionality over the original independent systems.

Integration of a CMMS with other systems should be undertaken as part of a phased approach to implementation. It is important to get the CMMS up and running, configured properly and stable before integrating it to other systems. This approach simplifies troubleshooting of problems that might arise during each phase.

An airport can realize benefits by sharing information between a CMMS and other airport systems. Systems integrations can provide additional functionality and eliminate redundant processes. Some benefits of systems integrations might include:

- Time savings by elimination of redundant data entry into multiple systems
- More accurate data by eliminating errors caused by redundant data entry
- Better information by the accumulation of additional data
- Streamlining of workflow by allowing processes to continue between systems

- Improve capabilities of the independent systems
- Eliminate unnecessary paper flow
- Decrease the average time it takes to execute standard processes
- Streamline and improve reporting processes
- Improve the ability to audit data through verification from multiple sources
- Reduction in resources to process data
- Reduction in time to process data
- Increased confidence in data received
- Potential reduction in time to report data
- Improvement in ease of reporting data
- Improved accuracy in financial analyses and reporting

There are two standard approaches to systems integration. The first is to execute a system that interfaces directly with other airport systems. Often large software packages, including CMMS software, will have interfaces already built for other kinds of software that are usually interfaced with the CMMS, like financial, procurement, or scheduling packages. This can be convenient, even though it adds to the cost of the CMMS. A vendor-supplied interface has the additional benefit that the vendor is responsible for updating the interface when the software package versions change.

A second approach to systems integration is to implement a central storage for data that interfaces independently to each system. Often, airports implement a centralized data store to consolidate data collected by administrative and operational systems at the airport for sharing and analysis. To take advantage of the available large amount of data, it can be stored in a central storage location. Sometimes that central storage location is an Airport Operational Database (AODB). The AODB is a source for the collection, storage, and distribution of key airside and terminal information across an airport. Data in the AODB can then be used to feed other systems that require the same data, as well as provide business intelligence for airport executives and managers. An AODB can be used to store data from unrelated systems, as shown in the system block diagram in Figure 2-6.

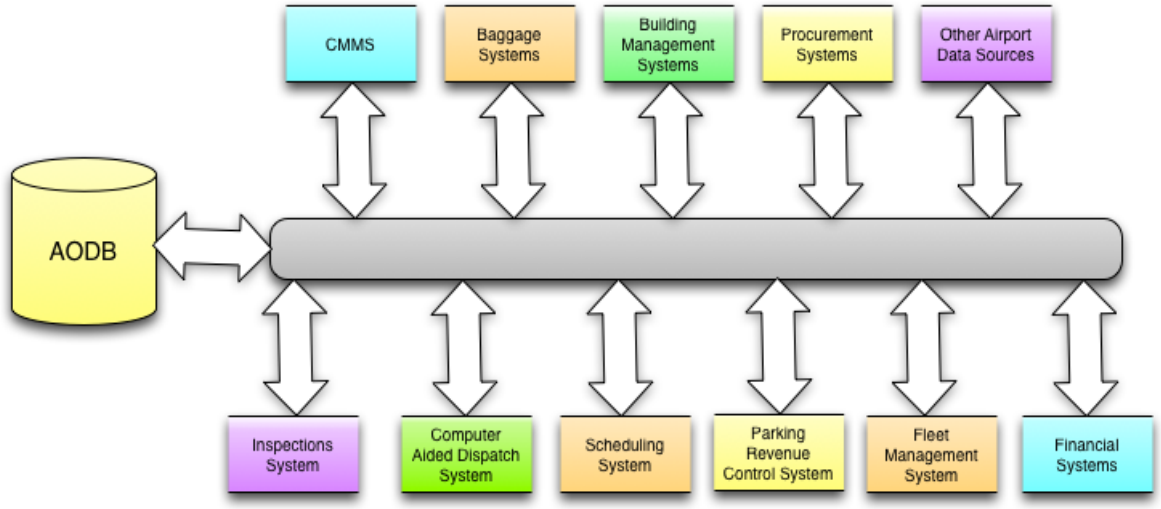


Figure 2-6 Airport Operational Database

Figure 2-6 illustrates only a few of the systems that could be integrated with a CMMS. Additional beneficial integrations that might include:

- Geographic information system (GIS)
- Operations inspections application
- Fueling system
- Financial software
- Purchase requisition system
- Lease management system
- Inventory system
- Security access system
- Facility management system
- Baggage handling system
- Payroll system
- Resource management system
- Gate management system
- Common use systems
- General ledger updates
- Human resources system
- Time and labor system
- Airfield lighting system
- Building management system
- Inspection application (to manage general and Part 139 inspections)
- Safety management system
- Scheduling system
- Property management system
- Pavement management system
- Other CMMS system
- Inventory control system
- Automatic vehicle identification system
- Computer-aided dispatch systems
- Electronic log books
- Incident management systems
- Any other system at airports that hold or use data about assets

Data integrations with CMMS should use standards and best practices identified in the larger context of aviation data systems to facilitate data sharing between other systems and the CMMS. The data that is used by each system will need some translation from one system to another. An interface between the two systems will provide that translation. For example, seconds may be represented to one decimal place in a system requiring precise timekeeping; however in systems that do not require such precision, seconds may be represented as whole numbers. An interface control document should be developed that records the communications protocols, the data exchanged, and other relevant information about the communications between two systems. This interface control document will be needed as reference for any updates to the interfaces between the systems that are integrated.

CMMS integrations can provide a more thorough, accurate, and automated maintenance management solution as has been demonstrated in some airports. Those airports have expanded the system capabilities of their CMMS to automate Part 139 inspections reports, procurements, safety reporting, and scheduling based on data from the CMMS. Additionally, as airport's integration of its GIS with its CMMS can provide an ease of use for airport users of the CMMS that leads to greater use of the system by airport staff. It could be advantageous to integrate the CMMS with a property management system that is used to track airport rental space. Interface to the property management system can allow the airport to track maintenance of items for lessees. The integration might be particularly useful if done in conjunction with GIS integration, which would view the property management system data. Another potential integration for CMMS is an integrated document management solution to store operator's manuals and maintenance manuals for assets.

In the case study reports in Appendix B, all the airports had integrated, or planned to integrate, other systems with their CMMS. Some of the airports have already extensive integrations. Part 139 report automation, GIS integration, requisition system integrations, scheduling system integrations, and safety incident reporting are among the airport-specific integrations cited in the case study reports.

Centralized maintenance planners may be employed to optimize resourcing. If scheduling will be done in a third-party software, that can also be integrated with a CMMS. More efficiency between shops in the maintenance department, as well as within particular crews, can be achieved by using centralized

scheduling. Centralizing the reporting structure for the maintenance planners will make integration, standardizing of processes, and sharing resources between the shops essential.

Hosted Solutions

A hosted solution is a software delivery model in which software and associated data are centrally hosted in the cloud by independent software vendors or application service providers (ASPs). Hosted solutions are also referred to as Software-as-a-Service (SaaS). SaaS is typically accessed by users using a web browser or a client application that is installed on a local computer. SaaS has been a significant software deployment and delivery model for most of the leading enterprise software companies.

CMMS software is available as hosted solution from a number of vendors. There are both advantages and disadvantage of using a hosted solution for CMMS. A hosted solution can provide a quick implementation of a full-featured CMMS with a low up-front cost. This is particularly advantageous to an airport needing most or all of the features of a CMMS, but with a smaller budget and small staff to support the software. And with a hosted solution, the airport does not have to procure and manage the hardware or the software. Many hosted CMMS solutions also offer mobile applications that run on smart phones and tablets.

In marketing hosted solutions, vendors claim better reliability, better security, and better performance than airports can provide internally. That can be the case if airports are not rigorous in their own technology performance. However, hosted solutions are generally located in data centers with the ability to provide the a level of service that will meet the most stringent performance and security requirements.

When discussing a hosted CMMS solution with vendors, airports should not forget to involve the IT department, or a consultant to talk about the technical details. It's not just the features that matter. The details can make or break the implementation. For example:

- Are there redundant computing platforms co-located at data center?
- How will the vendor implement integrations of other systems with the CMMS?
- Are there different environments for production, development, training?
- Is there frontline user support 24/7?
- How often does the vendor do database back-ups?
- Do your users have unlimited connect time?
- What are the service level agreements for availability and performance? And what are the specific penalties for not meeting those SLAs?
- Who does the user and license administration?

The biggest disadvantage of a hosted CMMS is the dependence on an Internet connection for access to the CMMS software and database. The retrieval time for data will be slower than if the CMMS were on servers at the airport, no matter how fast the airport's Internet connection might be. In addition, there is always some possibility that the Internet connection will fail, or will become degraded, impacting the performance of the CMMS. Slow performance can greatly affect the acceptance of the CMMS application by users.

It is important, when selecting a hosted CMMS, to discuss the vendor's capability of integrating other applications with it. Some vendors provide good interfaces to allow integration with other airport systems. Airports

should identify the systems to be interfaced up front and ask if the vendor has interfaces to those systems.

Custom Solutions versus Off-the-Shelf Software

Some airports have developed custom solutions to CMMS. In great part, custom solutions arise organically, over time, without an understanding of the overall airport requirements for an enterprise-wide CMMS solution. These custom solutions have advantages and disadvantages. In the best cases, the custom-developed solution fits the airport's needs because it was developed for very specific circumstances. The ability for an airport to develop custom software also implies a competence within the organization in software development, so the custom software may be very well integrated into both airport processes and other airport applications. A custom application as discussed in Case Study Report 5 in Appendix B, was driven by specific needs and is very well adapted to the airport's processes.

Building a complete full-featured CMMS from scratch is a large task. If that is the desired, needed solution, a custom CMMS is not likely to be the right choice. It is much more likely that customization of an off-the-shelf CMMS will be more economical.

In other cases cited by surveyed airports without a CMMS, development of partial solutions using spreadsheets, checklists, and email contribute to their ability to manage assets. The transition to an off-the-shelf software can be aided by these efforts in that records of work and assets can often be imported directly into an off-the shelf system thereby retaining much of the history that is useful in determining life-cycle and predictive maintenance.

The disadvantages of a custom solution are usually in the maintainability of the software because documentation, both at the system level and for the users, can be overlooked due to workload for the development team. Maintaining integrations with other applications can also be problematic when other applications are upgraded, requiring adaptation of the custom software. Another disadvantage of custom software, stemming from the usual lack of documentation, is the reliance on specific individuals for maintenance and support of the software. However, for airports without budget for a commercial CMMS, custom software can provide benefits that can also be accrued from an off-the-shelf software package.

Future of CMMS

The direct evolution of a CMMS for an airport is to apply the data that exists within that CMMS to promote life-cycle management of the airport's assets. However, there are other trends to watch when evaluating and implementing a CMMS. If these fit the needs of the airport, it would be beneficial to plan for them when evaluating and implementing a CMMS. Some future trends include:

- Coupling of CMMS with asset on-board diagnostics as assets become more intelligent
- Integrations with systems to improve work flow and provide better situational awareness
- The need for reliable maintenance and facility data to achieve and maintain LEED and other sustainability certifications
- The use of CMMS tools to analyze which tasks, processes, or functions to outsource
- Mobile applications for CMMS. Work orders is the leading mobility application in use
- Better adoption of CMMS by newer workers who are more digitally savvy

- Business intelligence to evaluate performance, efficiencies and areas for improvement
- Better tracking and reporting
- Hosted solutions for smaller or budget-constrained airports
- Support for regulatory compliance with maintenance records

Chapter 3: Roles and Stakeholders

Today's airports are large-scale facilities comprised of complex systems and many types of infrastructure, including buildings, bridges, seawalls, underground utilities, mechanical systems, electrical systems, baggage handling systems, plumbing systems, drainage, roadways, vehicle fleets, and many other diverse assets. It is inefficient to manage these many types of assets in traditional manual methods with the vast amounts of asset data required to do so. Maintenance management systems built on databases are well suited to manage the volume of data associated with maintenance activities. High cost labor and decreasing availability of resources exacerbate the issues for airport maintenance managers. The incentive for a CMMS for maintenance managers is clear, but there are other stakeholders within the airport for CMMS.

This section identifies the CMMS stakeholders and describes their functions and their involvement in the CMMS evaluation, selection, and implementation processes. Airports are similar to other large-scale facilities, however, they have the added responsibility of needing to provide a safe environment for the millions of passengers who pass through these facilities each year.

Thus, while the roles and stakeholders for an airport CMMS are similar to the roles and stakeholders for a CMMS for any large-scale facility, the airport facility, as an open environment, can be subject to a higher level of scrutiny and oversight. One difference is the immediacy of safety issues at an airport; hence a more focused approach to situations that can pose potential dangers to the traveling public and work staff exists. Airports have the additional requirement of compliance with FAA Part 139 rules to retain certification.

In the airport environment, typical stakeholders of the CMMS can be divided into two groups: internal and external. Tables 3-1 and 3-2 provide typical roles for both internal and external stakeholders, respectively, although specific roles may vary from airport to airport.

Internal Stakeholders	Organizational Role
Airport Facilities Maintenance	Deploy, manage, and account for the results and effectiveness of the CMMS. This group has access to the skill sets needed to perform the work orders needed at the airport.
Airport Construction	Acquisition of new assets and the commissioning of new facilities. Data from these activities are needed to populate the CMMS so that these new assets can be managed properly. This group will enforce the airport policies, procedures, and standards needed to keep the CMMS data up to date and accurate.
Airport Operations	Assurance of safety at the airport. This includes proscribed inspections, regulated reporting requirements, activity logs, and due diligence. Initiate work orders to the CMMS and utilize historical information for reporting purposes.
Airport Information Technology	Integrate information sources and assure quality of data, timeliness of information, accuracy and availability of the system. The CMMS in an airport environment will be active 24 hours a day 7 days a week. High availability and support is crucial for the successful operation of an airport CMMS.

Internal Stakeholders	Organizational Role
Airport Finance & Accounting	Group responsible for accurate recording and portrayal of cost information related to the operation of the airport maintenance function. Cost information gathered in the CMMS must be processed carefully for the airport rates and charges process in order to assess airlines as part of operating and maintenance expenses.
Airport Business & Property Management	Group responsible for management of airport property spaces for lease to tenants and other revenue sources. Accurate understanding of the levels of maintenance and costs associated to facilities factor into the calculation of the lease rates.
Airport Planning	Group responsible for the future layout of the airport, the planning function would be supplemented with accurate maintenance and cost information associated to the current facility layout in order to determine future requirements.
Airport Environmental	Group responsible for the tracking and the remediation of environmental concerns particularly as they relate to the facilities. The CMMS provides a record of maintenance to areas that may be affected by environmental mandates, particularly for asbestos locations and areas that have underground environmental plumes to manage.
Airport Legal and Risk Management	Group responsible to deal with potential liability issues arising from accidents and accusations of insufficiently maintained assets. The CMMS should provide accurate accounting of ongoing maintenance schedules; preventive and well as reactive that is compliant to a prescribed industry accepted schedule.

Table 3-1 Internal Stakeholders Roles

External Stakeholders	Organizational Role
Traveling Public	Airport travelers are stakeholders in the sense that they are affected by how well the airport is able to maintain its facilities in a safe manner. The traveling public is the reason that an airport exists in the first place.
Government Regulators	Group responsible for the direct oversight of safety and proper procedure execution particularly in the airside operating areas of the airport. FAA mandates are minimum requirements necessary to operate the airport for certification purposes and best practices.
Airport Vendors	Group that provides materials and equipment to the airport. Historical experiences, reliability records, warranty applications, and expected life cycles that are all managed within a CMMS in part determine specifications needed by the airport.
Airport Tenants	Group that can initiate and demand service requests that are contractually obligated from the airport by virtue of the relationship. Tenants will track requests and are affected by any assessed charges that may arise from a work order request.
Contracted Companies	Group that is contracted by the airport as an extension of the services being provided and subject to oversight by the airport for compliance to the contracts and any service level agreements that may be in place. A contracted company will have a connection to the CMMS if their contract demands services that are dispatched through work orders that are either reactive or preventative in nature.

Table 3-2 External Stakeholders' Roles

With respect to CMMS evaluation, selection, and implementation, each stakeholder has specific roles at various stages in the CMMS project. These stages are defined as:

- Define requirements (evaluate)
- Select a solution
- Implement a solution
- Maintain and support the solution (post implementation)

Tables 3-3 and 3-4 use a RACI matrix (Responsible, Accountable, Consulted, Informed) matrix to define roles for the stakeholders in a CMMS project. This is a common methodology used to assign roles within a team to clarify responsibilities. In the RACI matrix, for each stage of the project, every stakeholder is assigned to be *accountable*, *consulted*, *responsible*, or *informed* for the work in that stage. The terms accountable, consulted, responsible, and informed are defined as:

- Responsible – Those who do the work to achieve the task.
- Accountable – The person or role ultimately answerable for the correct and thorough completion of the specific deliverable or task, and the one who delegates the work to those who are responsible.
- Consulted – Those whose opinions are sought, typically subject matter experts. There is a two-way communication between the consultants and the project's responsible staff.
- Informed – Those who are kept up-to-date on progress, often only on completion of the task or deliverable. There is generally just a one-way communication to those informed.

In addition to the RACI assignments, certain stakeholders are considered primary in a role while others are considered secondary. The assigned responsibilities for the CMMS by stakeholder for each stage are shown in Tables 3-3 and 3-4.

Internal Stakeholder	Define Requirements	Select Solution	Implement Solution	Support Solution
Airport Facilities Maintenance	Primary Accountable	Primary Accountable	Primary Accountable	Primary Accountable
Airport Construction	Consulted	Consulted	Informed	Consulted
Airport Operations	Secondary Accountable	Consulted	Informed	Informed
Airport Information Technology	Responsible	Responsible	Responsible	Responsible
Airport Finance & Accounting	Consulted	Consulted	Informed	Informed
Airport Business & Property Management	Consulted	Consulted	Informed	Informed
Airport Planning	Consulted	Consulted	Informed	Informed
Airport Environmental	Consulted	Consulted	Informed	Informed
Airport Legal and Risk Management	Consulted	Consulted	Informed	Informed

Table 3-3 Internal Stakeholders' Roles during the CMMS Life cycle

External Stakeholder	Define Requirements	Select Solution	Implement Solution	Support Solution
Traveling Public	Consulted	n/a	n/a	n/a
Government Regulators	Consulted	n/a	n/a	n/a
Airport Vendors	Consulted	n/a	n/a	Informed
Airport Tenants	Consulted	n/a	n/a	Consulted
Contracted Companies	Consulted	Informed	Informed	Consulted

Table 3-4 External Stakeholders' Roles during the CMMS Life cycle

While it is important to have active participation from stakeholder groups across the airport, it is also relevant to consider the impact of the optimal size of the stakeholder group. Smaller groups tend to take less time to organize and act more quickly. Larger groups allow more representation and allow the work of the group to be spread among more staff. Although there will most likely be a minimum number of staff required to represent all stakeholder groups, it is important to keep the group size in mind when forming the stakeholder committee. A good rule of thumb is that ten to fifteen members is a manageable committee size.

Chapter 4: An Approach to Evaluating CMMS Software

This section introduces a suggested evaluation approach to choosing a CMMS. This approach does not begin with looking at the software packages available on the market, but starts with identifying the requirements for a CMMS. It focuses on identification of the airport's needs so that software can be matched to fit those needs. The airport should first identify the assets to manage, determine what asset data will be managed, identify features needed in the CMMS, and then determine anticipated support for future enhancements. This evaluation approach is implemented in the CMMS Evaluation Tool accompanying this Guidebook. A User Guide for this tool is provided in Appendix C. Following the steps discussed in this section will give the airport a roadmap to evaluate CMMS software solutions. But first, it is important to assemble the team of stakeholders discussed in Chapter 3 and devise a plan to evaluate CMMS requirements.

The airport manages assets across many categories including facilities, airfield, fleets, pavement, systems, airside structures, and landside structures. A CMMS that can be used for the variety of asset types will be required if the airport decides to manage all its assets with the CMMS. If an airport decides to manage only one type or a limited number of types of assets, a system that is specifically designed for that kind of asset type might be a better choice. Therefore, the first step in evaluating a solution is to identify the assets that will be managed by the airport.

By limiting the requirements for a CMMS to specific types of assets, the initial cost of the CMMS implementation can be substantially reduced. That is true even if the software costs are not lower, because the configuration and implementation costs scale to both the type and number of assets to be managed. So it is important to have a list of required assets for management, as well as a list of assets that might be managed in a later phase. The software chosen must meet the long-term need for capabilities, but the initial cost will only include cataloging the required assets and configuring the software to manage those assets.

This is an important aspect for airports with limited budgets. It is possible that a small airport might only choose to implement a CMMS for its fleet of vehicles, for example. While the airport will not enjoy the benefit of a full-featured CMMS program, there are benefits to be gained from any limited implementation of a CMMS.

It is also likely that most airports already have a pavement management system and will not choose to include pavement management in the requirements for their CMMS. Since January 1, 1995, airports have been required to have an effective pavement management system, if they accept AIP funds for pavement replacement or reconstruction. The required pavement management systems has only four basic elements:

- A pavement inventory with dimensions, locations, and maintenance history of the airport's paved surfaces.
- An inspection schedule with detailed annual assessments and monthly drive-by observations.
- Inspection records with dates, findings, locations of pavement distress, and remedial actions.
- A method to retrieve data at FAA request.

Two pavement management systems that were developed under contract with the Army Corps of Engineers are Micro-PAVER and PAVEAIR. They have been implemented broadly at airports and fulfill these basic requirements.

The following sections address the four asset selection steps for purposes of determining the best CMMS solution for the airport. These steps are:

- ✓ Step One: Choose the Assets to Manage in the CMMS
- ✓ Step Two: Decide What Management Functions to Incorporate into the CMMS
- ✓ Step Three: Identify Initial Integrations
- ✓ Step Four: Analyze Workflow to Incorporate into the CMMS

Step One. Choose CMMS Assets

To determine the best CMMS solution, the airport should begin by choosing which assets they want to accumulate into an asset catalog for management in the CMMS, and the functions that a CMMS is to support in management of those assets. The list of categories of assets that are managed by CMMS at airports can be found in the Managed Assets Section of Chapter 2. For each of those categories of assets, the airport will decide what functions to include in the evaluation criteria for the CMMS. That first step to defining requirements for a CMMS not only catalogs those assets and their functions, but also prioritizes them. The process flow for this first step is shown in Figure 4-1.

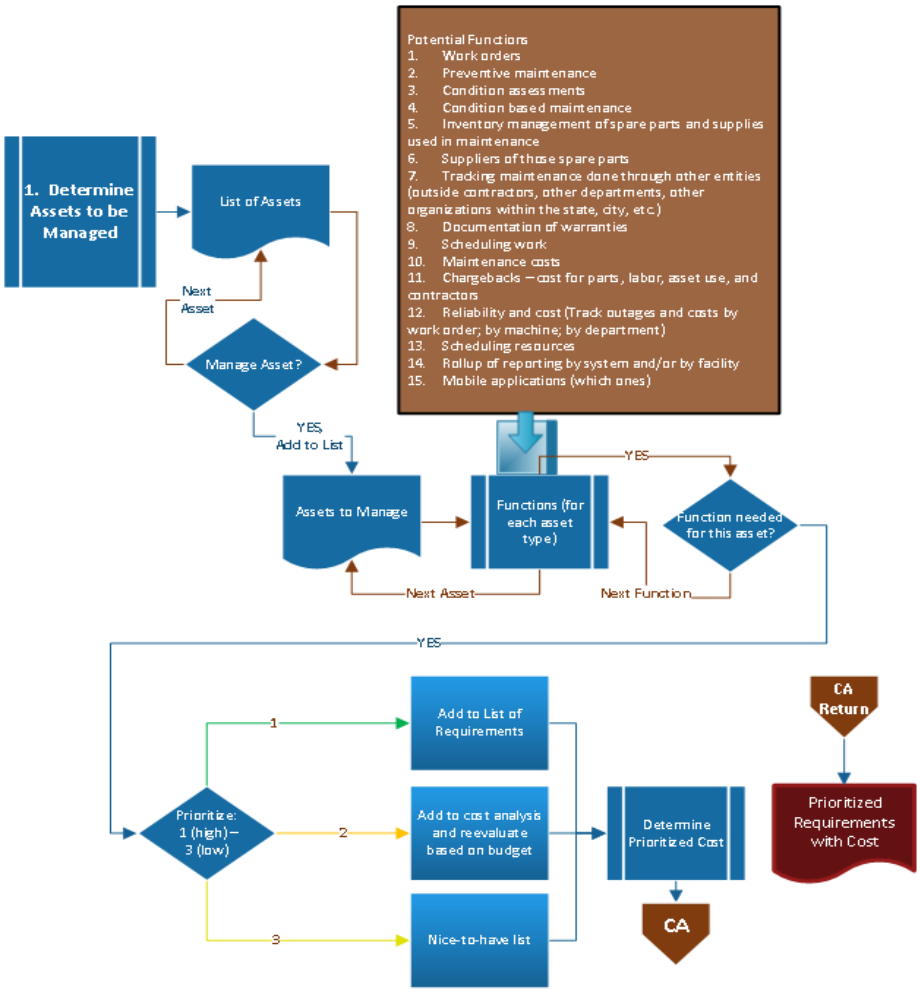


Figure 4-1 Step 1 – Determining and Prioritizing Assets

Step Two. Decide How To Manage the Selected Assets in the CMMS

After identifying the asset categories in Step One, now in Step Two an airport should identify how the airport wants to use the CMMS to manage the assets. CMMS functions that can be used to manage assets include:

- Work orders
- Preventive maintenance
- Condition assessments
- Condition-based maintenance
- Inventory management of spare parts and supplies used in maintenance
- Information database for suppliers of spare parts
- Tracking maintenance for work through other entities (outside contractors, other departments, other organizations within the state, city, etc.)
- Documentation of warranties
- Work Scheduling
- Maintenance cost history
- Chargebacks – cost for parts, labor, asset use, and contractors

- Reliability and cost history (Track outages and costs by work order; by machine; by department)
- Resource scheduling
- Reporting, with rollups by system and/or by facility
- Mobile applications

For example, if an airport decides to manage passenger-loading bridges with its CMMS, it should then determine which of the functions in the list are required to manage the passenger-loading bridges at the airport. Perhaps chargebacks are not needed. Work orders, however, are probably needed for all asset categories.

The airport should then have a list of assets to manage and the related management functions. Budgets, time, and resources may limit the scope of the implementation, so prioritization of the list of assets and functions is important.

A prioritization scale should be chosen for selecting the functions that an airport wants to manage in a CMMS implementation. A possible four-tiered scale is shown in Table 4-1.

High	Mission critical requirement
Medium	Required eventually but could wait
Low	A enhancement that would be nice to have when resources permit
NR	Not required

Table 4-1 Prioritization Scale

It should be noted, that alternately, it might be advantageous to the airport to prioritize based on planned phases of implementation. Assets to be included in the first phase would have high priority, assets to be added in phase two would have medium priority, assets in later phases would have low priority. Assets that are not planned for inclusion within the expected implementation phases (and budget) would not be required.

Primary functions of a CMMS include the various functions listed earlier. Appendix E provides a detailed checklist showing all primary functions grouped by asset types. In this checklist the airport should prioritize functions to implement for each type of asset. Functions prioritized as “High” will be included in the CMMS requirements. The “Medium” priority functions will be included as a consideration based on budget. The “Low” will be listed in the nice-to-have considerations. The “NR” categorized functions will not be included in the requirements.

To summarize the process for this first two steps:

1) Identify the assets to manage
2) Identify how to manage each asset (the functions) and prioritize.

Step Three. Identify Integrations

As discussed in Chapter Two, CMMS can be integrated with other systems that use asset data, such as building management and SCADA systems, financial systems, procurement systems, scheduling systems, inspection systems, safety management systems, GIS, and CAD systems. Some of those integrations might be particularly beneficial. For example, integration with a purchasing system, may be very beneficial if the maintenance management system has an inventory management feature, allowing automatic receipt of

inventory into the system. Integration with a purchasing system can trigger generation of a purchase request when spare parts inventory reaches a minimum level, based on the requirement requisition of a part on a work order. Also, scheduling systems can flag the need for additional resources when loads are high.

There are other beneficial integrations with other systems, including:

- GIS
- Logbook
- Computer aided dispatch (CAD)
- Incident Management System
- Procurements
- HR/Payroll
- Scheduling software
- Safety management system
- Document management system
- Building management systems (please specify)
- Warehouse / Inventory
- Building Information Management (BIM) Systems

There should be consideration for any future integrations that might be desirable including data integration with Building Information Management (BIM) Systems to populate your CMMS with information collected during design and construction. The use of BIM for construction projects is emerging. There is movement towards development of open formats for data, and that should be specified in all design and construction projects on the airport to facilitate data exchange with existing and new applications.

Benefits of integrating these systems with a CMMS may include:

- Elimination of double entry of data
- Faster to update information
- Improved data quality
- Automatically generated reporting
- Up-to-date data improves processes
- Easy retrieval data
- Greater efficiency of work processes
- Automatic generation of work orders
- More efficient work practices
- Near-immediate access to data gives a better situational awareness
- Less hard copy documentation required due to electronic storage and up-to-date data

It is difficult to generally gauge the cost of integrations with CMMS software because the costs depend somewhat on the choice of the CMMS. Specifying important integrations will require that RFP responses include the integration cost. However, specifying integrations that are not necessary might cause the implementation costs to be higher than expected. Careful consideration to what integrations are required should be done.

If the airport chooses all systems for potential integrations for inclusion in the RFP or the requirements for development, separate pricing should be requested for each integration so that a cost benefit analysis of each can be undertaken. Often, integrations are reserved for later phases in a CMMS implementation, but

identified in the original procurement to preclude difficulties with a chosen CMMS in the later phase. It is important to list integrations as future enhancements in the original procurement documents for that reason.

There are many potential difficulties when integrating systems from different sources, including proprietary software, outdated applications, and siloed applications (running on networks that are not physically available). Discussions with the airport's IT department, support staff, and/or vendors supporting the applications can help understand what the particular difficulties of integrations might be. Those problems can be addressed in planning, since they address larger problems that must be solved by organizational strategic thinking.

Step Four. Analyze Workflow Management

Airports have business processes or workflows that map out how people work in your to accomplish airport operations. These workflows identify what is expected of staff for particular procedures. Workflows are used for work management, operations checklists and standard operating procedures, materials management, and other functions on the airport campus. Understanding these workflows is critical when implementing a CMMS because automating them is one of the main advantages of a CMMS. Documentation of workflow will outline procedure steps and descriptions, desired outcomes, specific responsibilities and accountabilities, and criteria for completion.

Workflow is certainly followed within the maintenance organization for routine procedures. Those procedures may be documented and kept up-to-date, or they may be not formalized but just rely on organizational knowledge passed to team members when they are trained in their roles. Whatever the circumstance, those procedures are the basis for the day-to-day operations of the maintenance department.

For automation within a CMMS, those workflows must be examined, starting with all documented standard and emergency operating procedures (SOPs and EOPs). It is not uncommon for those procedures to deviate from the way business is really done, and for some portion of operating procedures to be undocumented. Interviews with maintenance staff can help fill in those gaps. After the operating procedures of the maintenance organization is understood, there may also be events that happen outside the maintenance organization that are included in the workflow for a particular procedure. It is important to understand the entire process including the work done outside of the maintenance department. It is the complete workflow, from beginning through to the desired outcome at completion that needs to be evaluated for inclusion in the CMMS. While it is possible to automate part of a workflow, it might be possible to achieve greater benefit at little cost by considering the process start to finish. This evaluation process is depicted in Figure 4-2.

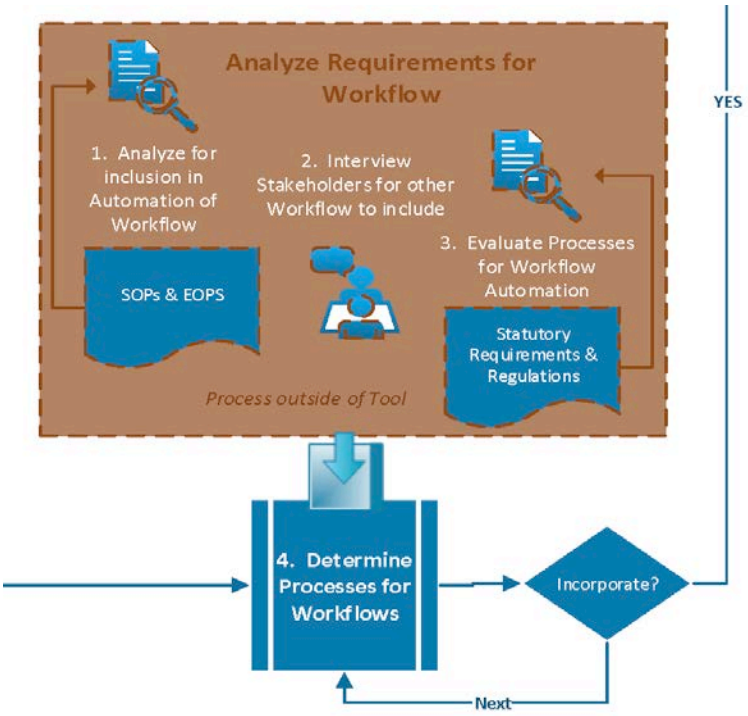


Figure 4-2 Analyze Existing Workflows

Each of the identified workflows should be analyzed for potential for automation in a CMMS. Some workflow automations that might benefit the airport include:

- FAR Part 139 inspections, reporting and record-keeping
- NOTAM and field condition reporting
- Internal and external safety reporting procedures
- Requisitions based on inventory levels
- Scheduling preventive maintenance
- Sign replacement procedures (see Figure 4-3 below for an example)

For those signs that require replacement, the following procedure shall be observed.

Sign Replacement Procedure	
1	Airport Manager identifies/establishes specifications for sign to be replaced. *Note:* Due to the potentially wide variety of signs in use at the state-managed airports, it will be incumbent upon the Airport Manager to utilize appropriate sign design specifications. These may be found within WSDOT Aviation, WSDOT, or FAA (see references below).
2	Airport Manager or WSDOT Region Maintenance contacts WSDOT Yakima Sign Shop, places order and supplies shipping information.
3	WSDOT Yakima Sign Shop completes order and ships to WSDOT Region Maintenance or local airport caretaker/sub-contractor.
4	WSDOT Region Maintenance or local airport caretaker/sub-contractor replaces sign.

Figure 4-3 Sign Replacement Procedure

Source: Washington State DOT State-Managed Airport Handbook. February 2011. Chapter 4.

There is no question that automating workflow in a CMMS can bring efficiencies and benefits to any airport. There is really no question of whether to automate in a CMMS. The question is rather what processes to automate and to what extent. The assessment of workflows at an airport assumes: (1) that the airport understands the point at which the organization will be mature in its implementation of a CMMS, and (2) that the organization understands what a full-featured CMMS can provide. Often, for this reason, an airport (at the start of a CMMS effort) will engage an industry subject matter expert in order to help address any knowledge gaps.

There are two kinds of automation. The first is using an internal workflow that is built in to the CMMS; workflow for work orders is a common built-in function.

A second kind requires integrations with other systems. For example, some airports have successfully implemented a workflow arrangement between the FAA Part 139 inspection process and the generation and remediation of work orders for areas found deficient in the inspection. That workflow process could require integrations with a computer-aided dispatch system and an inspection (or inspection reporting) system. At Phoenix Sky Harbor International Airport, the Operations Airside inspection crews use a PC in their vehicles to track their real-time location on the airfield in performing their shift inspections. The system allows them to indicate whether there are Part 139 discrepancies on the airfield. As shown in Figure 4-4, in the case of a discrepancy, a sub work order is automatically generated that is linked to the inspection, which is then dispatched to the appropriate work crew to perform the remediation. Once the work is completed, a record of the inspection, the work order, is generated and the completion of the work is available as a system record. These records can then be presented to the FAA, if required.

Figure 4-4 Typical Workflow

This workflow requires data from one system to be distributed to additional systems, and control of the process to flow with the data. A representation of the data flow between the systems is shown in Figure 4-5.

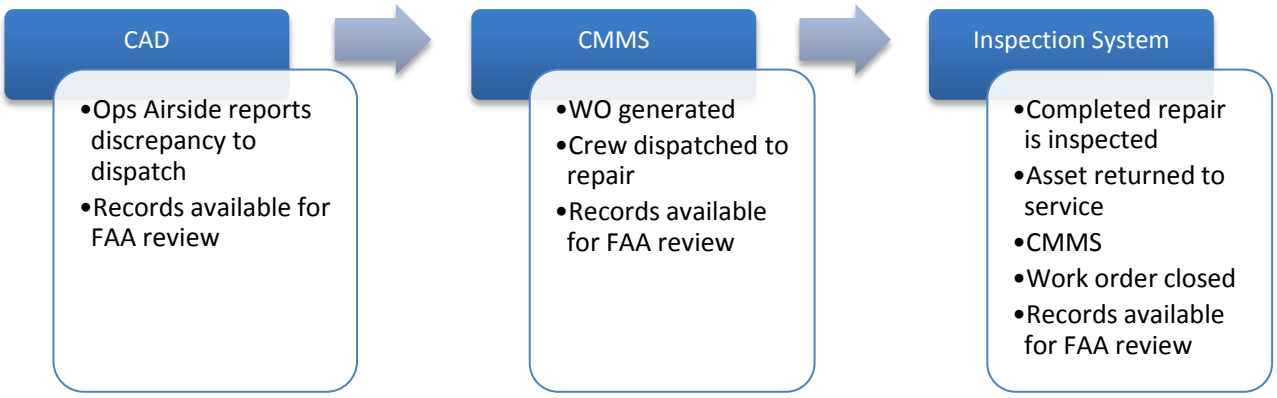


Figure 4-5 Potential integrations for the workflow

Two of the case study reports presented in Appendix B have a similar process for Part 139 discrepancy reporting. Each airport has implemented the automation in the way that is most useful to them. The data flow required depends on the other supporting systems. In some cases, the integrations can require minimal cost and effort. In other cases, the cost and effort might prevent the feasibility of the integration.

Even though some workflows requiring integrations can be expensive, some online commercial tools could help achieve workflow automation at a relatively low cost. For example, the Google Map Coordinates feature, as shown in Figures 4-6 and 4-7, allows a company to assign work orders to remotely located staff who can easily be located using Google Map services. Field staff could accept/reject the work orders, update work order status, and notify the dispatcher when work orders are complete using online services.

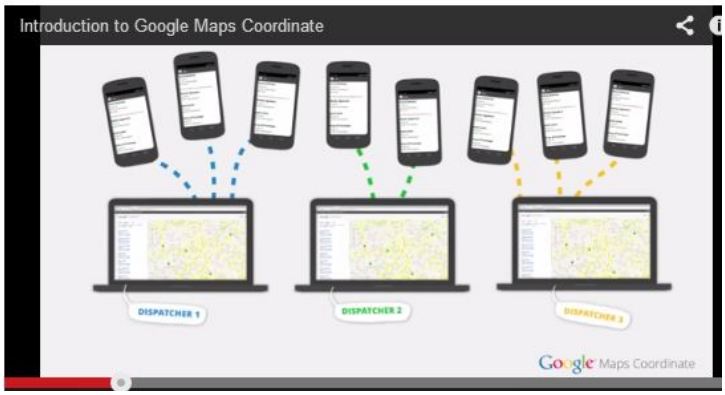


Figure 4-6 Simplified Work Dispatch

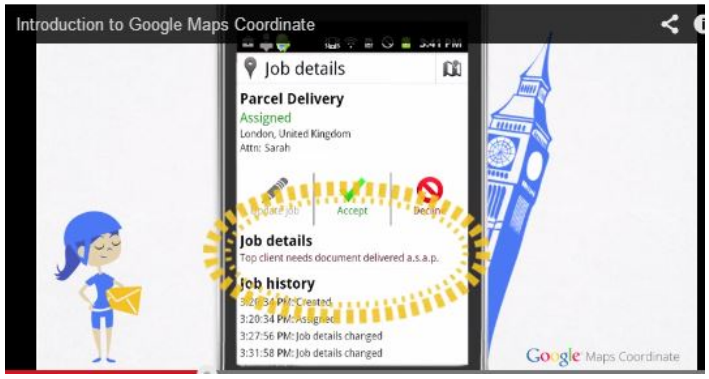


Figure 4-7 Simplified Work Details

This simple solution could allow an airport to electronically dispatch work assignments to field staff located throughout the airport, with assignments made to optimize locations and with the ability to track progress and maintain records of the assignment. This very elementary application for a 10-person operation is available in a subscription-based model at a relatively low annual cost, although there is some additional cost for smart phones and their ongoing airtime costs. While many of the details inherent in a CMMS would not be available, this could enable a small organization to go paperless from a paper-based system. Hence, an initial foray into an automated system can be made at very low cost with some level of benefit. Alternatively, more comprehensive, hosted solutions are available at somewhat higher costs. At the other extreme, overall costs can easily reach in the millions of U.S. dollars for a large-scale enterprise level system with many data sources.

The examples are given to help the airport understand the options available for automation. Although automation of workflow will be accomplished in implementation and configuration of the CMMS, during this evaluation process the airport will decide the requirements for the CMMS. Those critical workflows should be identified at that time, so that the CMMS purchased will support the airport requirements.

Each candidate workflow should be prioritized for inclusion in the CMMS requirements. Processes that support regulatory compliance might be prioritized "High" because they have significant impact on operations and because automated documentation provides the airport with a record for compliance.

After examining documented procedures for candidate workflows, it would be beneficial to develop use cases for the CMMS by interviewing targeted maintenance staff. A use case is associated with a particular function of the system. It describes the way that the CMMS is to be used by the staff, and for what purposes it is used. The use cases could be presented as addenda to an RFP or development requirements.

Support for Future Enhancements and Features

In specifying the CMMS the airport plans to implement, there should be consideration for the following features, functions, and capabilities, each having an impact on implementation costs:

- Inventory Database
- Inspections
- Preventive Maintenance (PM)
- Predictive Testing & Inspection
- Proactive Maintenance
- Work Request (WR) & Work Order (WO)
- Trouble Calls
- Work Orders for PM, Repair, ROI
- Work Order Estimating
- Maintenance History
- Material Management
- Tool and Equipment Management
- Scheduling
- Backlog for Maintenance and Repair
- Contract Administration
- Utilities
- Environmental Tracking
- CAD Support
- Priority System
- Warranty Tracking
- Management Reports
- User Customization
- Ad Hoc Query
- Data Sharing and Integrations With Other Systems
- Presentation Graphics
- Warranty
- Transaction Recording
- Data Import and Export
- Bar Coding Data Interface
- Archive
- Back-up
- Licensing
- Capacity
- User Documentation
- Menus/User Interface
- Error Handling
- Password Protection

The complexity of the implementation greatly influences its success and cost. However, a tiered approach to implementation and a specification by the airport that certain features, functions, and capabilities are desired in the future will avoid a dead-end implementation in which the eventual goal cannot be achieved. An airport should include any high priority eventual goal as a future enhancement in the initial RFP or development requirements.

A detailed checklist, providing individual features and functionalities for each of the items in the list above is provided in Appendix D. The checklist should be used by the airport not only to define its requirements but also be utilized in the development of an RFP or specifications document for the development of a CMMS. A sample section of the checklist is shown in Table 4-2.

Feature/Functionality/Capability	Required
1. Inventory Database	
a. Recording of data for each facility, system, vehicle, and all collateral equipment and inventory	
b. A unique identifier for each maintained item	
c. Grouping items by systems and subsystems	
d. Provide for storing of make, model, location, custody, facilities maintenance standards reference, facilities maintenance requirements reference, financial information, maintenance manuals, and standard reports	
e. Develop policies, procedures, manual or mechanized to facilitate new data coming from various sources to be added to the database as new facilities are built or modified	
2. Inspections	
a. Permit each item to have an explicit and unique inspection schedule and frequency	
b. Inspection checklists and guides, with linkages to work orders to account for any remediation needed as a result	
c. Storage for, or link within the system, to maintenance standards and drawings, prior inspection results, safety, current or pending work orders, and work requests for the system being inspected	
d. Storage for, or link within the system, to information on plans and coordination requirements	
e. Provide the means to report on inspections, their results, and the associated work orders generated to remediate issues found to assess the efficacy of the inspection program	
3. Preventive Maintenance (PM)	
a. PM scheduling	
b. PM work order preparation based on maintenance requirements	
c. Multiple levels of scheduling based on criticality, use, condition, or calendar term	
d. Coupling of inventory data, maintenance checklist, parts, safety requirements and special environmental concerns, coordination/outage requirements results of the last PM, diagnostic and maintenance references, drawings, special tool or equipment requirements, and special skill or trade requirements	
e. Schedule reporting for each week to provide planning for resources and summary schedules	
f. Capability to schedule future PM dates for increments based on actual completion of a previous PM	

Table 4-2 CMMS Features and Capabilities Checklist Sample

Evaluation Tool Overview

The CMMS Evaluation Tool ("Tool") provides a step-by-step guide through the selection process, including selection of modules and/or features of CMMS for implementation using prioritization and budget. It therefore, requests input from the user about characteristics of the user's airport, and needs for the CMMS. Industry research was incorporated into the Tool's specifications and development.

The Tool is based on the concept of a decision tree, using high-level questions and the respective users' answers to document the specific needs of the airport. Based on these answers, the Tool generates a list of requirements that can be used for evaluating software options or for using in a procurement document.

The Tool has implemented the evaluation approach in this chapter. In order to ensure the output is meaningful and useful, it is highly recommended that the user not only be familiar with this approach, but also to do the required research, data collection, and decision-making prior to using the Tool. The output of the Tool suggests requirements to be considered for use, but should be modified to fit the airport's actual requirements.

The User's Guide is provided in Appendix C.

Chapter 5: Selection and Implementation of an Airport CMMS

This chapter describes a process for selecting and implementing a CMMS at an airport. Since the CMMS impacts multiple departments or business units of the airport, this process should involve stakeholders across the entire airport and the CMMS should provide support for functions across all business units. Success should be measured by the degree to which the CMMS meets all business needs.

The Selection Process

The selection process uses the requirements gathered during the evaluation process. Ideally, the process of gathering asset data and understanding workflows should already be underway. The selection process should now formalize the procedures for matching the gathered airport requirements to capabilities of available software.

The stakeholders involved in the selection process were defined in Chapter 3. Many of the stakeholders who are now focusing their efforts on the selection process were previously involved in the requirements-gathering process.

There are many full-featured CMMS software solutions, incorporating many features and capabilities. Selection of a full-featured CMMS will ensure that an airport will be able to add options that are not implemented initially. But an optimal selection of a CMMS is specific to the requirements of the airport and the environment in which the CMMS will be deployed. Selection of a CMMS involves more than merely evaluating the capabilities of the software. It also requires determining whether the software is within the airport's budget and then analyzing the requirements of the airport against the features and capabilities of the software. In addition, it requires vetting the software vendor and the performance of the contractor providing installation services.

Researching (other airports, vendors, consultants) CMMS costs is important. If the CMMS budget is small, the airport should consider a hosted solution or starting small, with the most critical department or area where the greatest cost savings can be achieved in the shortest time.

The first step in the selection process is to research available software in the market. CMMS software is widely available, so the larger issue will not be to find a software, but to narrow down candidate CMMS software based on the prioritized list of airport requirements. Research can be done in-house through the Internet or with the assistance of an industry expert knowledgeable in the maintenance/asset management field.

It is sometimes difficult to compare software from demonstrations by vendors. A script can make that comparison easier. It should focus on some of the particular business processes at the airport. Then, after the mandatory elements have been covered in the script, a vendor can demonstrate additional features of the software.

If procurement rules allow it, the airport might request a demonstration of the software from vendors. In addition to demonstrations, airport staff might also visit vendor labs for hands-on experiences with live CMMS systems. Selected airport staff might attend training sessions or review course materials to determine the suitability of specific CMMS training for their airport.

A tour of other airport CMMS implementations can offer very good information about its functionalities when deployed in an airport setting.. The organizations and associations mentioned in Chapter 1 can provide contacts and relevant information..

Other software/vendor information is available through publically accessible user groups. For example, SAP has an annual SAPHIRE event, where SAP Plant Maintenance and Material Management users can request new features, get information about best practices, and exchange ideas with peers. Other large vendors conduct similar events.

Depending on the rules of the procurement process, the airport might then choose one of several procurement options. In some cases, based on the research, a short list of candidate solutions might be created and assessed for suitability. In others, the procurement process will be publicly bid. But the assessment process is essentially the same, focused on the software's suitability of meeting the requirements gathered during the evaluation phase. Additional requirements stemming from the research during the procurement phase should be expected to be added to the requirements list.

Regardless of the procurement mechanism, a software solution should be chosen that best meets the business needs of the airport. Additional considerations might need to be made in the following areas:

- Ease of integrating existing system data during the conversion period (initial implementation) or on an ongoing basis if the existing system will remain.
- Capabilities of the airport to manage the CMMS, including but not limited to server maintenance, networks, backend software such as databases and their administration, workstation deployments, and client software.
- The extent of configuration required versus customizations (which are much more difficult to implement and maintain) and the work required either by in-house or outsourced staff.

Sample CMMS Software Assessment Matrix

A suggested method for assessing the requirements gathered by the airport is to provide each vendor with a list of the requirement so that the vendor can illustrate the capabilities of the software to provide

the required functions. The airport can rate each software option based on how well it meets the functional requirements, and tally the results for a comparative score.

An extract from a sample of the Vendor Assessment Matrix is shown in Table 5-1. The full sample is included in Appendix F. This matrix is a ranking scorecard with sample requirements used to rank software from multiple vendors in a software selection process. It uses a rank scale of 1-10 and tallies scores for a total comparative ranking at the end.

Requirement	1	2	3	4
Work Request & Work Order Tracking. The CMMS shall provide the capability to track requests for facilities maintenance work or other work requirements received from any source from receipt through final work completion. This includes tracking its progress through planning and estimating, scheduling, execution by in-house shops or contractor forces, and while any administrative or planning actions are undertaken such as waiting for funding or incorporating the work into a capital project.				
Trouble Calls. The CMMS shall permit receipt and issue of Trouble Calls (TC). It also shall provide the status of TC tickets pending action, underway, and completed.				
Work Orders for PM, Repair, ROI, etc. The CMMS shall provide for the preparation of specific or one-time work orders for Repair, PGM, ROI and other work that is of fixed duration and scope. This shall be integrated with work order estimating and scheduling. The CMMS shall be able to identify the work order by customer, funding source, and work breakdown structure.				
Work Order Estimating. The CMMS shall provide for an integrated work order estimating system. The system shall provide planners and estimators with assistance in preparing work order craft, time, and material estimates. It shall permit including local labor and material rates, local unique cost factors, or standard work tasks.				
Preventive Maintenance (PM). A CMMS shall provide complete PM scheduling and PM order preparation based on inventory and facilities maintenance requirements including multiple levels of scheduling based on criticality, use, condition, or calendar time. The system shall track inventory data, facilities maintenance checklist, parts required, safety requirements and special environmental concerns, coordination/outage requirements, results of the last PM, diagnostic and maintenance references, drawings, special tool or equipment requirements, and special skill or trade requirements. It shall permit scheduling to the week, be able to give resource requirement reports and summary schedules. It shall include the capability to adjust future PM dates based on the actual completion date of the latest PM is a valuable feature.				
……				
TOTAL				

Table 5-1 Vendor Assessment Matrix

Based on the airport's procurement rules, the outcome of the comparison of software to the airport's requirements, any other criteria adopted by the airport during the procurement process, and the cost of the CMMS, the airport will decide the best fit CMMS for its requirements. Whether the selected CMMS is in-house, hosted, large or small, the next step is critical to making certain that the benefits of the CMMS are realized.

The Implementation Process

At this stage, the airport will need a plan for a implementing the selected CMMS software. This section discusses how to plan that implementation process.

Implementation planning should include stakeholders previously identified in Chapter 3. These stakeholders are even more critical to the success of the project at this stage, as they will provide an interface between the project and the other staff at the airport. And as the implementation progresses, they will provide valuable feedback to the project so that the process can be adjusted if the plan does not achieve the desired results. At a minimum, that plan will advise all of stakeholders of how the project will proceed, what the tasks are in the project, who is responsible, what things outside the project that success is dependent on, when tasks will complete, and how the project will be judged successful.

During the selection process, it was decided whether the implementation is to be done by the airport staff in-house, or by a team including the software vendor or consultants (or both). Whether the implementation is done entirely in-house or not, should be determined in the project plan. This, and other elements of the plan, including specific tasks that are unique to CMMS, are discussed in the following sections,

The Project Plan

Using the general project management best practices, a project manager should draft a project plan for approval that would include:

- A *communications plan*, to discuss meeting, expectations for reporting, time allotted for review of documents and other communications protocols for the project
- A *quality plan*, to set the standards for quality assurance and control throughout the project to ensure that the submitted work is of the highest caliber
- A *project schedule*, to establish the time frame for the project tasks and a completion date for the project, including tasks, work breakdown schedule, milestones, resources, dependencies, costs loading, testing, transition to operations, and closeout
- A *testing plan*, which should be started early in the project
- A *training plan*, to ensure that training is executed just before transition to operations so that the training is fresh for staff when they are expected to use the new system and procedures.

Identify Asset Data

At some point, the airport may want to develop an Asset Management Plan to provide full life-cycle management of their assets. The ACRP Report 69 *Asset and Infrastructure Management for Airports – Primer and Guidebook (*published in March 2012) is a valuable tool to use in devising such a plan. For the purposes of evaluating a CMMS, the airport will need some elements of asset management in place. At a minimum, the airport will need to assemble its assets into a central data warehouse, commonly called a data dictionary or catalog.

To facilitate the capture of the data, some consideration should be given to the following questions:

- What (and where) is the existing data? Identify the asset data that currently exists in multiple formats – electronic, paper, in people's heads, on as-built drawings, etc. That data may include condition data, either recently collected, outdated, or original with scheduled (or unscheduled) updates. Asset information might include:
    - Asset construction dates

  - Original project/asset costs
  - Features
  - Location
  - Maintenance history
  - Inspections
  - Preventive maintenance
- Who are the decision makers for the assets? Identification of an executive sponsor, a project champion, a project manager, and support personnel will facilitate capture of data about the assets.
- What is the current process for managing that data and who is responsible for it? Who owns the process? Is the process schedule maintained?
- Who owns the available data?
- What is the reliability and quality of the data?

Some asset data from other systems might be available at the airport. The IT department or a consultant can assist in identification of data sources. That data might then be imported into the CMMS database. This migration might establish most of the records (the assets) in the database, although the records might be incomplete (without location and other information).

Before beginning the evaluation process, stakeholders should discuss how this data can be collected. This can be a daunting task, and is often done in phases. It could be done as airport staff execute work orders, or it could be done by contracting third parties to collect all airport asset and condition data - or a hybrid approach of the two. Often airports have previous systems already populated with asset data. Usually, this data can be migrated to a new system. Other times, data exists in spreadsheets and it can be imported into the CMMS. Many times data is available only in hard copy format and must be manually input into the new system. However, the data collection phase is usually time consuming because data exists in many places and in many formats.

The availability of asset data often drives the phasing of CMMS implementation. However, planning for data collection by requiring construction projects to provide electronic asset data in an open format as part of the project close out, and working with vendors and IT staff to migrate asset data from procurement and financial systems, can help close the gap.

If there is no asset data catalog in existence at the airport, there are decisions about the data that will need to be decided moving forward in the process. For example, the type of data that is stored for each asset is one of these major issues. A second issue is regarding data hierarchy, i.e. the way to store the data so that it is easily located and accessible to the user. Those two issues are addressed in more detail the next sections.

Asset Data Types

After determining the assets that the airport wants to manage, and locating any other data sources, additional data on the assets will need to be collected and be captured in the data dictionary or data catalog. An example of the asset data that might be collected, is shown in Table 5-2. It should be noted that not all fields that are identified for asset data are relevant for all assets. In this case, units are ”N/A” because they are not relevant for taxiways, while they would be very relevant for other kinds of assets, such as transformers, elevators, etc. Attributes for each asset will also vary. A second example is provided in Table 5.3, for an Electrical Distribution System comprising a high level asset with many lower level components (generators, distribution panels, transformers, etc.) for comparison. These examples illustrate the complexities that have to be handled by the underlying data structure in the data catalog.

Attribute	Data Type	Unit	Domain / Range of Values
Taxiway ID	Var	N/A	System generated unique id for the attribute / barcode
FAC ID	Var	N/A	ID used to reference Asset
Taxiway Description	Note	N/A	A description of the attribute
Taxiway Type	Combo	N/A	Way, Lane
Criticality	Number	N/A	1-5 low-high
Legacy Names	Var	N/A	Previous name of the attribute
Date Entered	Date	N/A	Date record was entered into the database
Condition Rating	Number	N/A	Condition rating of the attribute
Inspection Date	Date	N/A	Date of the last inspection for the condition rating
Year Built	Date	N/A	Year that the asset was constructed
Design Life	Number	N/A	Design life
Remaining Useful Life	Number	N/A	Estimate of remaining useful life

Table 5-2 Asset Data Example 1: Asset Data for Taxiway

Attribute	Data Type	Unit	Domain / Range of Values
System ID	Var	N/A	System generated unique id for the entity / barcode
Asset ID	Var	N/A	ID used to reference Asset
FAC ID	Var	N/A	Unique id for the entity
System Description	Text	N/A	Description of the asset
Legacy Names	Var	N/A	Previous name of the attribute
Date Entered	Date	N/A	Date record was entered into the database
Condition Rating	Number	N/A	Condition rating of the system
Inspection Date	Date	N/A	Date of the last inspection for the condition rating
Year Built	Date	N/A	Year that the system was constructed
Design Life	Number	N/A	Design life
Remaining Useful Life	Number	N/A	Remaining useful life estimate
Original Construction Cost	Number	$US	Cost of initial construction or purchase cost
Replacement Cost	Currency	$US	Current replacement value of the system
Replacement Year	Date	N/A	Anticipated year the asset will need to be replaced
Warranty Period	Date	N/A	End of the warranty period
Location ID	Var	N/A	GIS Coordinate, Building ID, or other location reference

Table 5-3 Asset Data Example 2: Asset Data for Electrical Distribution System

The number of data attributes that an airport wants to store and maintain for assets depends on the needs of the airport. More data can help in making appropriate business decisions about life cycles of assets; unless the data is maintained it will not be useful. More data takes longer to collect and maintain. Deciding how much data is useful is, therefore, important. If that decision is reevaluated after the initial data collection, additional budget may be required to add more data records to the database.

Asset Data Hierarchies

The type of data to be collected about assets is relevant, but equally important is the way that that data is structured within the asset registry. A framework, or hierarchy, for finding a single one of the thousands of assets must be assigned within the asset registry. In fact, multiple hierarchies for finding that asset are probably desirable. How the data is organized within the asset registry determines the ease with which the maintenance staff finds specific assets. When walking through the terminal, it might be important to browse the assets by location. When repairing a specific piece of equipment, it might be important to browse the assets (and spare parts) by system.

An example of an asset hierarchy is shown in Figure 5-4.

Table 5-4 Sample Asset Hierarchy.

In this example, the facility group might be a terminal building; the facility, a specific terminal; the system, an HVAC system; the component, an air-handling unit (AHU). The purpose of the asset hierarchy is to logically structure the asset data for ease of use.

Asset Data Conversion and Migration to the New CMMS

It was pointed out earlier in the Guidebook that nowadays maintenance departments are rarely doing completely manual management of asset maintenance. Whether they are using spreadsheets to track warranties, or a homegrown database to manage maintenance data, many maintenance departments have some data in electronic format. It would be beneficial to take that electronic data and import it into the new CMMS. If there is existing electronic data at the airport, data migration will likely be one of the first tasks in the project schedule after an initial installation of the new CMMS.

The data migration process might entail capturing data from an older database or from a spreadsheet or series of spreadsheets. However, no matter where the data resides, there is almost certainly a required change in format between the old data and the way format is needed in the new CMMS. Therefore, there is not only the need for the data to be moved into the new database, but the data will also have to be converted into a format required by the new CMMS.

In the event a data conversion is necessary, a data conversion plan should be developed. This plan should identify the source data locations, formats, and definitions, and map the data schema of the existing system into the new system. The conversion plan is typically done with subject matter experts who are knowledgeable about the legacy system and with the vendor of the new system. This assures that the legacy data will be migrated and properly represented in the new system. In addition to the details of the migration mapping, the data conversion plan identifies:

- Who will be involved in the conversion
- What the conversion strategy will include (e.g., timing of the conversion)
- The effects of the conversion on the existing system (e.g., will there be a need for a system outage on the legacy system during the conversion process?)
- What happens in the interim period between the conversion and commissioning of the new system (how is data updated?)
- How the airport will continue CMMS functions during the interim period
- What necessary communications are required between the legacy and new system, and the timing of those communications
- Contingency plans, including back-out procedures, that are needed should the conversion be unsuccessful
- The retention requirements for the data in the legacy system?
- Scripts and their execution schedule are needed to perform the conversion

The scripts/programs and/or manual procedures needed for the conversion need to be developed and tested. Therefore, a test plan that identifies the business processes that are supported by data to be migrated from the legacy system, should also be developed. That data is likely to include material assets, security data (e.g., names of staff able to receive work orders), contacts, work schedules, hourly rates, facility names, and locations. Work in progress items, such as open work orders and parts on order are also typically migrated. A decision must be made about which historical information needs to be migrated to the new system. Airports have reporting requirements that impact this decision. As an alternative, the legacy system might need to remain accessible post implementation of the new CMMS for reporting purposes, if history is not migrated.

After testing of the data conversion procedures, operations can be cut over to the new system according to the schedule and methods identified in the conversion plan. The data conversion should be validated and any problems should be identified and logged. If the identified data conversion issues significantly impact the ongoing operations of the CMMS, a go/no go decision must be made. Data that is converted may need to be backed-out according to the back-out procedures listed in the contingency plan. One good way to validate the converted data is to run reports from both the legacy system and the new CMMS and compare the results. For example, one can prepare control totals for the number of material items; compare the number of open work orders for a period; or determine the average time needed to complete a work order.

Configuration of the CMMS

As discussed in earlier sections, the selection of a CMMS should be based on the value of the features and functions of that CMMS that best support the business needs of the airport. Sometimes this just requires a detailed configuration using features and functions of the CMMS to support the business processes of the airport. In other cases however, a CMMS might need customization, either because of a statutory requirement, a legacy processes, or other general (to airports) or specific (to a particular airport) requirements. Changes to an “out-of-the-box” solution, particularly when the solution addresses a complex and important business area, are not uncommon. However, any customization should be evaluated on a long-term cost basis.

Configuration and customization are terms that refer to changes in the CMMS software. There is a major difference between the two. Configuration refers to the process of setting up the software, using its built-in parameters to fit the airport business processes and environment. Customization is a change to the CMMS that requires writing additional code to add features or modify features of the CMMS. Customization is costly, both initially and to maintain, and will likely have to be repeated each time

upgrades are released by the CMMS vendor. A CMMS that is a good fit for the airport will not require customization. It will, however, require configuration.

Configurations to the CMMS allow the airport to fit the software to the organizational needs. Some configurations are simple, for example the form of the asset keys or its starting point; or could be more sophisticated, such as how to prioritize a work order based on its attributes. Such adjustments are supported in the future vendor software upgrades.

During the implementation process, staff responsible for configuration typically reviews a configuration plan with the airport in order to document the configurations that support the airport's business processes. The revised, finalized configuration plan then becomes part of the project implementation plan and is retained for inclusion in the testing plan and for system documentation. Configurations may be modified after the implementation, however post implementation configuration changes should be examined carefully for impact to the system.

CMMS Customization

A customization is necessary when a particular base functionality of the software does not have a good enough fit with the requirements of the airport, and when those requirements are of high value. This occurs when the software is chosen because of its overall good fit for other requirements. Some CMMS systems handle customization better than others. If the CMMS has an open architecture, programmers can develop special code that is linked to the features or functions. In more sophisticated systems, vendors supply an application program interface (API) that enables the use of code to access specific features of the system and develop customizations. CMMS vendors typically publish their APIs and allow programmers to extend them. Moreover, CMMS vendors publish and make available data dictionaries allowing programmers to understand the data structures behind the CMMS. To the extent that this is available, an organization can perform modifications to standard "out-of-the-box" software to provide added functionality. By publishing an API and/or data dictionary, the CMMS vendor has agreed to support the published functions with new revisions and upgrades, but takes no responsibility in their implementation. However, API classes may become depreciated over time requiring reviews of these items by the airport IT support organization.

When deciding if and what functions to customize, there are several factors to keep in mind. First, the decision to customize will require specialized IT and business skills to specify, develop, and test each customization. This adds time and budget to the project and makes it more complex. Second, the customized code must be tested for each CMMS upgrade, and modified if required. Many organizations have to delay version upgrades to assess the impact on customized code; or if impacts have been assessed, they might be unable to remediate those customizations because of budget constraints. Testing a system with no customizations is far less expensive and time consuming than one with customizations. Moreover, there is often a conversion needed for a version upgrade, which is provided by the vendor. Customizations can preclude applying the standard conversion supplied by the vendor. In that case, a customized conversion for the airport would need to be developed by the vendor at cost to the airport. A customized conversion also makes the upgrade process more risky to perform.

When the CMMS vendor does not have a published API and/or data dictionary, it may still be possible to enhance features and functions with sophisticated IT programming skills. Under these circumstances, the CMMS vendor has no role in the customization of the system and the airport is on its own. As a result, an airport should undertake such a customization only under circumstances where there is a critical need to determine if procedures may be further optimized.

Integrations

Integrations are not likely to be in the first phase of the airport's CMMS implementation. Integrations are likely to be in later phases, as the CMMS matures, and as users understand its features and capabilities and how they can be used to better manage assets and work at the airport. One of the ways that users see that the CMMS improved is usually by eliminating manual data entry. Data that is being generated by the CMMS can be shared with other departments. This eliminates manual data entry into the CMMS, or into other systems by sharing common data between those systems. Another logical step to improve operations is to share business intelligence that is available through information from the CMMS. In both cases integrations are required. In the CMMS evaluation process, initial integrations were specified for inclusion in the procurement documents. The selection process took those requirements into account, so it is possible that the CMMS may have provision for desired integrations.

Additional enhancements, including incorporation of mobile tools including laptops, tablets, bar code scanners, GPS receivers, digital cameras, distance measuring devices, and RFID can extend the utility of the CMMS into the workplace. Integration with financial and procurement systems can eliminate redundant data entry, improve the quality of the data, and save time. Each airport will need to assess the areas of greatest benefit, and evaluate the difficulty of any particular integration as discussed in Chapter 4.

Considering integrations during a second or third phase of an implementation can improve the utility of the CMMS for the airport. The integrations that were most reported as beneficial in our surveys included Part 139 report automation, GIS integration, requisition system integrations, scheduling system integrations, and safety incident reporting. The integrations led to better reporting capabilities, but Part 139 reporting was reported as one of the most beneficial of all the integrations accomplished.

CMMS Support for Part 139 Inspections and Reporting

Airport safety, and more specifically airfield safety, is a critical consideration to the operations of an airport. Part of the self-inspection program at an airport is the effective reporting system to ensure prompt correction of unsafe conditions and the maintenance of inspection records showing the conditions found and the corrective actions taken as a result. The self-inspection program is codified in 14 CFR 139.327 and includes mandated daily inspection procedures, processes for resolution of discrepancies, notification requirements, and a reporting and archival system.

The CMMS system must have a robust reporting structure, be capable of rapid and efficient communications, and have the capability to retain necessary data to comply with the Part 139 requirements, and to show due diligence in the airport's assurance of a safe environment for travelers. The choice of a CMMS can, in addition to managing maintenance for the airport, also support the airport's legal duties as they pertain to satisfying the Part 139 safety requirements.

In a modern CMMS, characteristics desired for the specific support of the Part 139 requirements include:

- A rich reporting environment, with features such as work orders details that can be recalled at various points in the work order life cycle, and the capability to provide work order analysis to determine problem areas for larger scale remediation.
- A rapid dispatch capability with the option to dynamically change work order priorities sent to field staff. A CMMS should be able to use mobile devices for work orders with all necessary data needed. For example, a smart phone could be used to receive and acknowledge work orders, act as a telephone and text message center, as well as receive photos, schematics, and manuals

associated to the work order. The mobile device should receive all information needed so that a return to the maintenance shop is not required.
- The capability to generate reports or extract information needed for Part 139 inspections.

Ideally, a CMMS specific to an airport would have integrations to an airport GIS containing the geospatial inventory of runway configurations, pavement management systems, airfield lighting, signage and markings, emergency evacuation paths, buried underground assets, and airport-specific service equipment such as jet ways.

CMMS work orders in an airport environment would need to include the ability to link inspections with preventative maintenance work orders. Ideally, inspection checklists should be embedded into scheduled preventative maintenance work orders issued on a periodic basis with the ability to create work orders when there is a deficiency found in the inspection process. The CMMS would then show a record of the entire inspection process from scheduling the work to inspect, the actual execution of the inspection with the results, and any resulting work orders needed to address the inspection problems. In this manner, metrics can be taken for the time needed to perform the process and analysis can be made.

The case studies in Appendix A cite methods that two airports used in incorporating Part 139 requirements into their CMMS workflow to provide automated reporting to satisfy FAA requirements.

Post Implementation

The CMMS is implemented. Perhaps planning is underway for the next phase. Staff is learning the system. Training is ongoing. The airport has to provide resources for maintenance of the CMMS itself, and the CMMS data.

In Chapter 3, the stakeholders involved in maintaining CMMS were identified. These stakeholders all have a role in the operations of a CMMS both during and after the initial implementation. This group is responsible for the operations of the maintenance functions that the CMMS is used to manage on a daily basis.

Often, though not always, multiple departments are responsible for maintenance functions at an airport. For example, noise and flight tracking equipment, repairs and upgrades may be the responsibility of a noise reduction team outside of the facilities group. Environmental wells and measuring equipment may be the responsibility of a planning group. All assets could still be part of the CMMS, even though the maintenance procedures are managed by different business units. Each of the business units have different requirements and judge success of the implementation based on different requirements. An ongoing working group comprised of members from each business unit should meet regularly to assess that the needs of each business unit are being met. Planning for upgrades and additional functionality could continue through the working group.

The group could assemble and determine standard rates, metrics for evaluation of actual performance, distribute reports and establish that the policies and procedures for the CMMS. This group would decide on business metrics from data collected in the CMMS, distribute information about the system, provide the means to distribute training, and receive feedback on the operation of the CMMS. All stakeholders should be given the opportunity to feedback to the working group.

The airport will need to dedicate resources to the ongoing maintenance and operation of the CMMS. The level of resources needed will depend on how the CMMS is implemented, whether it is a hosted solution or whether it is deployed and managed internally. If mobile devices are part of the solution, there needs to be a mechanism to manage the distribution of those devices. If the number of end users is high, the management of the end devices can be a major task. Many organizations are now beginning to struggle with corporate policies on mobile devices, whether and to what extent must these mobile devices be locked down in terms of capabilities, the extent of geolocation, even including access to the internet, type of phone calls being made and other policies unique to mobile device security. Depending on the device being deployed and the intention of the airport, there are many factors involved in the management of the core CMMS and those devices that are distributed in the field to staff. Limitations on the distribution of data often affect the ultimate effectiveness of the CMMS..

IT support will be required as new functionality is implemented regardless of whether the CMMS is on a hosted platform or is managed by the airport. Version changes typically are preceded by database conversions and these conversions must be examined to determine whether there is any adverse impact. As previously discussed, any specialized customizations are particularly vulnerable and it is important that a proper testing environment be maintained and used.

When implementing a full scale CMMS, adequate budget and staffing must be allocated to the system once it is live. The ongoing responsibilities go beyond merely supporting the CMMS and must include how the CMMS becomes part of the cultural fabric of the airport.

As with any system implementation, benefits are realized with maturity and realization of the system's capabilities by the staff. An evaluation of the airport's requirements and a selection of a good-fit solution for those requirements is a very good start. But the implementation will take time, and will progress in phases that bring more benefit over time. The realization of the benefits of a CMMS will grow as the airport matures in its implementation.

PART II: APPENDICES

APPENDIX A: Glossary and Related Asset Management Terms

A

Alias

An alternative name used instead of a primary name.

Acquisition

The process by which the airport comes into possession and ownership of a fixed asset (examples: purchase, donation, construction, eminent domain or foreclosure).

Airport Property

All property owned by the airport, whether purchased, leased, confiscated, donated received by eminent domain, constructed or annexed. Airport property may include supplies, real property, police property, capital assets and controlled items.

Area

The way the airport subdivides the airport campus into areas. The combination of campus designation and area designation may define the general location of a facility.

As-Built Documents

Final documents and records of the assets as installed.

Asset

Capital investments maintained by the airport's accounting system. The maintenance department typically refers to an asset as any item of physical plant or equipment. It is used to describe items such as buildings, facilities, systems and components that are controlled by the airport and from which a benefit is derived. For industry purposes these items are considered fixed assets deployed or intended to be deployed in an operational environment. It is also the manageable object in a computerized maintenance management system (CMMS).

Asset Life cycle

The asset life cycle is the time span from when the asset is placed in service through its eventual replacement or disuse. How the asset's life cycle is managed is dependent on the strategies and goals of its management. These strategies normally include training, maximizing utility, preventive maintenance, evaluation and when use will stop.

Asset Management

The systematic planning and control of a physical resource through its life cycle. This may include the specification, design, and construction of the asset, its operation, maintenance and modification while in use, and its disposal when no longer required.

Asset Register

A list of all the assets in a particular workplace, together with information about those assets, such as manufacturer, vendor, make, model, specifications etc.

Assignment

A labor requirement on a work order record that has been matched to an appropriate laborer.

Attribute

A characteristic or feature of a facility, system or component.

Auto Generation of PM Work Orders

Work Orders are automatically created based on some frequency (# of weeks, meter, etc. - whichever comes first).

Auto Generation of Purchase Orders

Purchase Orders are automatically created from a list of parts that have dropped below the minimum stock on hand quantity.

B

Backlog

Backlog is the work that has not been completed by the nominated 'required by date'. The period for which each Work Order is overdue is defined as the difference between the current date and the 'required by date'. All work for which no 'required by' date has been specified is generally included on the backlog. Backlog is generally measured in "crew-weeks", that is, the total number of labor hours represented by the work on the backlog, divided by the number of labor hours available to be worked in an average week by the work crew responsible for completing this work.

Bill of Materials (BOM)

A list of all the parts and components that make up a particular asset.

Blanket Agreement

A blanket agreement is a purchase contract that specifies a vendor, a total dollar amount to be spent, and the dates between which the agreement is valid.

Blanket Contract

A blanket contract is a contractual agreement to spend a pre-determined amount of money with a specified vendor over a predefined period of time.

Breakdown

A breakdown is a specific type of failure, where an item of plant or equipment is completely unable to function.

Break Down Maintenance (BDM)

"Unplanned" corrective maintenance performed on equipment after the equipment has suffered a failure and has to be corrected during a break down of the equipment. Break down maintenance indicates a lack of planning.

Building

A building is a facility that has a roof, walls and a defined location.

Building Automation System (BAS)

This is a general term to describe a system used to monitor and control individual room temperatures, lighting and/or security. The system optimizes the start-up and performance of HVAC equipment and alarm systems. A BAS greatly increases the interaction between the mechanical systems of a building, improves occupant comfort, lowers energy use and allows off-site building control.

Building System Scorecard (BSS)

Assessment tool used to grade building systems based on established criteria.

Business Process

The defined set of business activities that represent the required steps to achieve a business objective. A business process includes the flow and use of information and resources.

C

Calendar-Based Maintenance

A maintenance strategy where specified activities (typically preventative in nature) are undertaken on a pre-determined schedule at fixed intervals of time.

Capital Spares

Usually large, expensive, long lead time parts that are capitalized (not expensed) on the books and depreciated. They are often deemed as a "protection" against downtime.

Computer Aided Facility Management (CAFM)

Computer aided facilities management system uses computers to provide facility managers with the ability to track, plan, manage, maintain and report on facilities, systems and components.

Change Order

An update to a purchase order that is already approved or printed and that changes information such as quantity or vendor.

Charge Rate

This is the rate that is charged for a mechanic or engineer's time. In addition to the direct wages, it includes provision for benefits and overhead (such as supervision, clerical support, shop tools, truck expenses, and supplies).

Claim

A request for reimbursement, replacement, or repair for an item or an asset that is under warranty.

Clearance

The control and positioning of plant equipment for providing protection for personnel and equipment during work on plant devices.

Component

Element of a system that is managed, monitored or maintained separate from the system.

Component Renewal

Component renewal is the financial requirement associated with the replacement or renewal of a system or component that has reached the end of serviceable life and with an intended design life less than the design life of the entire facility. The capital/component renewal cost includes the deconstruction of the existing system or system components and replacement with a new system of equal capability and performance.

Component Renewal Index (CRI)

Indicates the relative funding required for identified component renewal and renovation/modernization needs. CRI is derived by dividing projected component renewal by current replacement value.

Computerized Maintenance Management System (CMMS)

A computerized system designed to assist with the effective and efficient management of maintenance activities. It generally includes features such as work order management for the planning, scheduling and monitoring of work orders and maintenance needs.

Condition Assessment

Architectural and engineering due diligence assessment of an existing building and site that informs the property acquisition process. Evaluates physical condition, general code compliance, capacities/ adequacies, repair and maintenance issues, recommended replacements, capital expenditures, and provides corrective action probable costs opinions. It is also used to compare the conditions of facilities, systems or components to determine the effectiveness of maintenance practices, and compare the long-term functionality of specific facilities, systems and components.

Condition Index (CI)

An indicator of the actual physical condition of a facility, system or component. Each building system is scored based on a predefined condition scale (i.e. Excellent, Good, Average, Poor, and Fail) with a coordinating numerical scale and is totaled to determine the building’s overall CI.

Consignment

A classification type for inventory materials that are stored on-site but that are owned by an external vendor. The vendor retains ownership of the consignment items until they are used and paid for by the organization that is storing them.

Contracts

A written legally binding service maintenance agreement that defines what is to be worked on, how often, the costs, hours of service, what is covered (parts and/or labor), emergency service and limitations. Contracts are necessary as a method of managing airport vendors and costs.

Corrective Maintenance

Any maintenance activity that is required to correct a failure that has occurred or is in the process of occurring. This activity may consist of repair, or replacement of components.

Craft

A work activity performed by a labor category such as "plumbing."

Craftsperson

Alternative to Tradesperson. A skilled maintenance worker who has typically been formally trained through an apprenticeship program.

Current Replacement Value

The total expenditure in current dollars required to replace any facility, including construction costs, design costs, project management costs and project administrative costs.

D

Data Dictionary

A centralized repository of information about data such as meaning, relationships to other data, origin, usage and format.

Data Type

A category of data. Typical data types are logical (true/false), numeric, alphanumeric (character) and dates. When data are assigned a type, they cannot be treated like another type. For example, alphanumeric data cannot be calculated and digits within numeric data cannot be isolated. Date types can only contain valid dates.

Dead Date

The date past the due date plus the grace period, at which point the component becomes inoperable.

Deferred Maintenance

Deferred maintenance represents curable physical deficiencies that are present on an existing facility, system or component and that have been deferred from the time frame that they were intended to be accomplished.

Demolition

Removal of a facility, system or component that has been determined to be unsafe or no longer meets, or is not required to meet, mission goals.

Design Life

Period for which a facility, system or component is expected to function at its designated capacity without major repairs.

Direct Issue Item

An ordered item that is issued immediately upon receipt to a work order, equipment, or location rather than stocked in the storeroom.

Disposition

The process by which the airport relinquishes possession and ownership of an asset or a facility, system or component.

Documents

Documents refer to the paper trail to support CMMS functions. These may include blueprints, receipts and contracts as well as PDF, pictures and other computer based images.

Downtime

The time that an item of equipment is out of service, as a result of a fault within the equipment or within the environment. The time that an item of equipment is available, but not utilized is generally not included in the calculation of downtime.

Downtime Control

Tracking causes of asset failures to determine whether the PM program is effective and making adjustments to it if found lacking.

E

Economic Order Quantity

The optimum reorder quantity of an item, in the specified units of order, to be used as the default or standard reorder amount. The economic order quantity is a calculation of the optimum reorder amount that balances the costs of keeping inventory in stock and the costs of reordering inventory items.

Emergency Maintenance

A maintenance task carried out in order to avert an immediate hazard or to correct an unexpected failure.

Emergency Work

Maintenance work that requires immediate response from the maintenance staff. Its urgency is usually associated with safety, operational, health, or environmental effects. Emergency work is often performed without a requisite work order issued in advance.

Enterprise Asset Management (EAM)

EAM refers to the management of assets to the benefit of the organization as a whole and not limited to a specific area such as a department, location or division. It includes the entire process of managing the airport's assets throughout its life cycle from initial planning, designed use, installation, training, operations, maintenance and eventual replacement.

Escalation

A course of action that is taken when a task is not completed satisfactorily within a specific period of time.

Escalation Point

A condition or threshold that must be met in order to trigger an escalation.

Exception

A condition or event that cannot be handled by a normal process.

F

Facility

A structure or installation serving a specific function. A facility is a permanent, semi-permanent, or temporary commercial or industrial property such as a building, plant, or structure; built, established or installed for the performance of one or more specific activities or functions.

Facility Condition

Represents the current physical state of the facility, system or component. It is used to evaluate the conditions facilities, systems or components to determine the effectiveness of maintenance practices, and compare the long-term functionality of specific facilities, systems and components.

Facility Condition Assessment (FCA)

An inspection and assessment of facilities producing a complete account of system and component deficiencies and a list of remediation scenarios. FCA results inform maintenance and capital renewal planning.

Facility Condition Index (FCI)

A comparative indicator of the relative condition of facilities expressed as a ratio of the cost of remediating maintenance and repair backlog to the CRV.

Facility Fixed Asset

Any asset with a significant original value and will be capitalized. A "Facility Fixed Asset" can be a single facility or groups of facilities, a system or group of systems, a component or group of components.

Facility Group

The common features or characteristics by which a facility and its subordinate systems and components are categorized.

Facility Hierarchical Levels

A facility management best practice is to organize and maintain a hierarchical relationship between facility, system and component, sometimes called a parent–child relationship. Facilities have systems and systems have components. A facility can exist without related system records but a system cannot exist without a related facility. Likewise, a system can exist without components, but a component cannot exist without a parent system.

Facility Management (FM)

Primary function is to make sure buildings operate at maximum efficiency through the optimal integration of people, processes and technology. Includes HVAC, electrical, plumbing, lighting, cleaning and security.

Facilities Management Information System (FMIS)

The integration of several computer systems that are each designed to perform a specific function. An example would be the integration of an electronic document management system and a Computerized Maintenance Management System (CMMS) to manage facilities and the associated information.

Facility Registry

The database of information about airport facilities, systems and components and their location, attributes, characteristics and condition.

Facility Criticality:

The ranked importance of a facility to an airport’s mission.

Failure

A breakdown or decline in the performance of a facility, system or component. Note that "failure" is an event, as distinguished from "fault" which is a "state."

Failure Class

The highest level of a failure hierarchy.

Failure Code

An alphanumeric code typically entered against a work order in a computerized maintenance management system (CMMS), which indicates the failure cause (e.g. lack of lubrication, metal fatigue, etc.). These codes are employed to facilitate analysis of plant history.

Failure Hierarchy

A tree structure that shows relationships between identified problems, causes, and remedies for asset and operating location failures. Failure hierarchies are built from the top level, the failure class, down.

Feature

A physical object, such as a guardrail or mile marker, that is associated with one or more linear assets, but which does not have a unique ID.

First Cost

The cost to acquire (construct or purchase) a facility, system or component.

First-in First-out Costing

A method of cost accounting that can be used to make an inventory valuation, based on actual receipt costs. First-in first-out costing uses the "first in" (oldest) item cost for inventory transactions.

G

GIS

Geographic Information System (GIS)

The combination of cartography and technology to create and analyze spatial information about geographic features. Mapping data can be accessed, transferred, manipulated, overlaid, processed and displayed.

Geospatial

Geospatial is a term most often associated with advanced mapping techniques by merging imagery, maps, charts, and environmental data into sophisticated 3d images.

Global Positioning System (GPS)

The Global Positioning System is a U.S. space-based worldwide radio navigation system made up of three parts: satellites, control stations and receivers). Receivers are then able to provide a three-dimensional location (latitude, longitude, and altitude).

H

Hard Reservation

A firm request for items from a storeroom that is defined by the need for the items within a specific time frame. A hard reservation reduces the available balance of items. Hard reservations are prioritized and cannot be superseded by other reservation types.

I

Incident

An event that is not part of the standard operation of a service and causes or can cause a disruption to or a reduction in the quality of services and customer productivity and results in an emergency service request that must be addressed immediately. An incident report is entered into as a high priority service request.

Inspections

An inspection is the act of examining assets in order to determine their condition by checking on known issues, answering checklist questions, observing and documenting changes and making recommendations or scheduling maintenance. Inspections are a form of preventive maintenance.

Inventory

In accounting terms, inventory is a record of current assets, which includes property and equipment owned (counting parts in stock, value of work in progress, and work completed but not sold). In maintenance terms it is frequently used to describe the list of equipment and spare parts currently held in stock.

Inventory Management

The process by which inventory is controlled. Typically, this includes tracking usage of stock items, Optimization of stock levels and Control of costs.

Invoice

The bill for services or products provided to a customer. The invoice includes all charges associated with the services or products provided.

Issue Unit

The quantity of an item that is considered a single item; for example, gloves are issued in pairs. The issue unit might be different from the order unit.

Item

Inventory that might be part of an asset, but which is not strictly monitored, and whose cost is less than an asset.

J

Job Plan

A detailed description of how to implement or undertake a maintenance activity. The description includes a list of work steps (tasks) and the typical resources (labor, material, equipment) needed to perform the work steps.

K

Key Performance Indicator (KPI)

A measurement of specific actual performance that will be compared to a specific targeted performance criteria.

L

Labor

A person who carries out a specific job (a labor performs a craft).

Laborer

A human resource within a crew.

Labor Record

A document that contains information about a worker, such as craft, skill level, hours worked, and certifications. A labor record cannot exist without a corresponding person record.

Last-in First-out Costing

A method of cost accounting that can be used to make an inventory valuation, based on actual receipt costs. Last-in first-out costing uses the "last in" (newest) item cost for inventory transactions.

Lead Time

The amount of time between placing an order and receiving the items.

Legislatively Mandated

Deficiencies that must be corrected in response to regulatory or code requirements. These activities include retrofitting for code compliance, accessibility and removing hazardous materials such as asbestos and underground storage tanks.

Linear Asset

An asset that is maintained in segments, such as a road, pipeline, or railroad track. Measurements are made along the linear asset to specify work, monitoring, metering, or placement of signs.

Linear Segment

The span of a linear asset that is defined by a start and an end measure. The span can be the entire length of the linear asset or any continuous part of it.

Location

A place where assets are operated, stored, or repaired. The coordinate, name or address that uniquely locates a facility, system or component.

Lockout-Tagout (LOTO)

A safety procedure used with dangerous machines to ensure machines are properly shut down and started to prevent injury or death.

M

Maintenance

Any activity carried out on an asset in order to ensure that the asset continues to perform its intended functions, or to repair the equipment. Note that modifications are not maintenance, even though they may be carried out by maintenance personnel.

Maintenance Categories

Maintenance categories describe the primary function of the maintenance activity. Examples of maintenance categories may include the following: inspection, condition monitoring, non-destructive testing, overhauls, and faultfinding.

Maintenance Contractor Expenses

Cost of labor and material for contracted maintenance services. This does not include contract labor for capital projects.

(Total) Maintenance Cost

All direct and indirect costs regarding maintenance activities. Direct costs are costs charged to a maintenance budget as fixed costs (e.g. personnel, materials, subcontractors, and overhead). Indirect costs are related to loss of revenue due to unavailability.

Maintenance Engineering

A staff function whose prime responsibility is to ensure that maintenance techniques are effective, that equipment is designed and modified to improve maintainability, that ongoing maintenance technical problems are investigated, and appropriate corrective and improvement actions are taken.

Maintenance Labor Expenses

Direct pay for maintenance labor including overtime premium.

Maintenance Management

All activities of the management that determine the maintenance objectives, strategies, and responsibilities, and implement them by means, such as maintenance planning, maintenance control and supervision, improvement of methods in the airport, including economic, environmental, and safety aspects.

Maintenance Material Expenses

All materials, spare parts, supplies, etc., consumed for maintaining equipment and facility including materials purchased for maintenance by contractors and excluding materials for capital projects.

Maintenance Repair and Operations (MRO)

Maintenance Repair and Operations is the fixing of broken or damaged physical items. This includes any mechanical or electrical device.

Mean Time Between Failures (MTBF)

The predicted elapsed time between inherent failures of a system or component during operation. MTBF can be calculated as the arithmetic mean (average) time between failures of a system.

Mean Time To Repair (MTTR)

A basic measure of the maintainability of repairable items. It represents the average (mean) time required to repair a failed component or system.

Metadata

Information about data; for example, a text document's metadata may contain information such as: document length, author, creation date and summary.

Meters

A PM Task Work Order can be triggered by some meter frequency (Miles, millions of units, hours, KM)

Mission Critical

Activity, component, service or system whose failure or disruption will result in the failure of business operations.

Mobile Computer

The use of a computing device while in transit. Mobile computers with CMMS systems generally refer to the use of handheld devices (handheld computers).

N

New Construction

Construction that adds to an existing footprint or creates a new facility, system or component.

Non-Operational Downtime

Downtime that occurs when an asset is not normally in use.

Non-Routine Maintenance

Any maintenance task not performed at a regular, pre-determined frequency.

Non-Scheduled Maintenance

An Equipment Maintenance Strategy, where no routine maintenance tasks are performed on the equipment. The only maintenance performed on the equipment is Corrective Maintenance, and then only after the equipment has suffered a failure.

O

Operating Location

A location type that indicates the presence of operating assets (as opposed to a storage or repair facility).

Operational Downtime

Downtime that occurs during a period in which asset is normally in use. The outage causes a facility, system or component to be out of service that results in operational time to be lost.

Operator Based Maintenance

Basic maintenance tasks performed by operations/production personnel. Typically such activities include cleaning and subjective inspection. Sometimes referred to as Operator Maintenance.

Order Unit

The standard unit by which an item is ordered that can differ from the issue unit.

Outage

Term used in some industries that is equivalent to a planned shutdown. A period of time during which there is a complete planned production stoppage.

Overrun

A situation where a planned event takes longer to complete than was planned. For example, an overrun occurs when an asset was planned to be in maintenance for 5 days but it actually takes 6 days.

P

Physical Deficiencies

The presence of conspicuous defects or deferred maintenance of facilities, systems or components as observed during the field observer's walk-through survey. Physical deficiencies specifically exclude deficiencies that may be remedied with routine maintenance, miscellaneous minor repairs or normal operating maintenance.

Planned Downtime

Time when equipment is scheduled to be down and available for maintenance work. The calendar of an asset is used to calculate downtime.

Planned Maintenance

Any maintenance activity for which a pre-determined job procedure has been documented, for which all labor, materials, tools, and equipment required to carry out the task have been estimated, and their availability assured before commencement of the task.

Planning

The process of determining the resources, methods, and processes needed to perform maintenance work efficiently and effectively.

Predictive Maintenance

An equipment maintenance strategy based on measuring the condition of equipment in order to assess whether it will fail during some future period, and then taking appropriate action to avoid the consequences of that failure. The condition of equipment could be monitored using Condition Monitoring, Statistical Process Control techniques, by monitoring equipment performance, or through the use of the Human Senses. The terms Condition Based Maintenance, On-Condition Maintenance and Predictive Maintenance can be used interchangeably.

Preventive Maintenance (PM)

Maintenance that occurs on a pre-determined schedule. Typically includes inspection, testing, lubrication and minor adjustments. Equipment maintenance strategy based on replacing, overhauling or remanufacturing an item at a fixed interval, regardless of its condition at the time. The purpose of

preventive maintenance (PM) is to increase efficiencies by reducing the amount of reactive work in relation to planned maintenance thus increasing the ability of management to manage work more efficiently and with greater flexibility. PM allows for the early identification of problems and significantly increases the life cycle of equipment, lowers capital expenditure requirements and allows for better planning of capital budgets.

Preventative Maintenance Alert

A message that indicates that a preventive maintenance work order is about to become due for an asset or location.

Preventative Maintenance Record

A template for scheduled preventive maintenance work. PMs can contain job plan and corresponding safety plan information that the system copies to work orders.

Primary Failure

A failure not caused either directly or indirectly by another failure or fault.

Priority

The relative importance of a task in relation to other tasks. Used in scheduling work orders.

Proactive Maintenance

Any tasks used to predict or prevent equipment failures.

Project Record Documents

Also known as As-Built Documents, these are the final installed and/or acquired asset construction records, including, but not limited to: record drawings and specifications, product data, samples, spare parts and tools, technical manuals, permits, certificate of occupancy, miscellaneous and record submittals.

Property Condition Report (PCR)

The work product resulting from completing a Condition Assessment in accordance with the Condition Assessment Policy. The PCR incorporates the information obtained during the walk-through survey, the document review and interview portions of the Condition Assessment, and includes opinions of probable costs for remediating the physical deficiencies identified.

Purchase Order

An authorized order to an external vendor or internal supplier.

Purchase Requisition

A written request that is issued internally to the purchasing department to purchase items, materials, or services.

R

Reactive Maintenance

Maintenance Strategy to equipment malfunctions or breaks downs after they occur. Maintenance is mainly performed during irregular non-planned stops. It may be undertaken where equipment is knowingly assigned a Run-To-Failure (RTF) strategy, or No Scheduled Maintenance strategy.

Recurring Maintenance

Work activities that recur, based on normal wear patterns, on a periodic cycle of greater than 1 year and less than 10 years. Typical work includes painting, caulking, sealing, carpet replacements, tree trimming, sprinkler head replacements, curb painting, etc.

Release Purchase Order

A purchase order for a portion of the total amount or lines specified on an associated volume contract.

Remaining Useful Life

An estimate made by a qualified inspector, based upon observations and experience, on the number of remaining years that a facility, system or component will be functional before needing replacement.

Reorder Point

The point at which an inventory item should be reordered so that its in-stock balance does not fall below the level designated as safety stock during the lead-time for the order.

Repair

Any activity which returns the capability of a facility, system or component that has failed to a level of performance equal to, or greater than, that specified by its functions, but not greater than its original maximum capability. An activity that increases the maximum capability of a facility, system or component is a modification.

Requisition

A request for an asset, item, tool, or service. The requested entity can be procured from a vendor, or it can be acquired by an inter-departmental transfer.

Reserve Item

An item is placed on hold in a storeroom for a given work order, GL account, asset, or location.

Room

A space that can be accessed by a door and is enclosed by a floor, walls and a ceiling.

Root Cause Failure Analysis (RCFA)

Generally stands for a systematic procedure to investigate the root causes of asset failures (failure diagnosis). The diagnosis results are used in maintenance tasks as a proactive way to prevent repetitive failures.

Rotating Asset

A non-perishable asset that is tracked in inventory through its association with a specific rotating item.

Rotating Item

An inventory item for which each instance of the item is also tracked by its own asset number. Rotating items are typically repaired or refurbished, not discarded.

Rotating Tool

A tool for which each instance of the tool is also tracked by its own asset number.

Routine Maintenance Task

Any maintenance task that is performed at a regular, predefined interval.

Run-to-Failure (No Scheduled Maintenance)

An Equipment Maintenance Strategy, where no routine maintenance tasks are performed on the equipment. The only maintenance performed on the equipment is Corrective Maintenance, and then only after the equipment has suffered a failure. Also described as a No Scheduled Maintenance strategy.

S

Safety Stock

The minimum inventory level of an item that should always be available at the associated storeroom location.

Scheduled Downtime

A period of time when the equipment is not available to perform its intended function due to planned downtime events. These include maintenance delay (delay after an interrupt is reported, but before anyone arrives to repair it); production test; preventive maintenance; change of consumables; set-up; and facilities-related downtime.

Scheduled Work Order

A Work Order that has been planned and included on an approved Maintenance Schedule.

Segment

A defined section of a linear asset.

Service Level Agreement (SLA)

A contract between a customer and a service provider that specifies the expectations for the level of service with respect to availability, performance, and other measurable objectives.

Service Request

A request for work to be performed. A high priority service request is also known as an Incident Report. Service requests are used to track requests for work that comes into the Airport Response

Coordination Center. If the request for service requires cannot be resolved on the first response and requires additional resources, then a work order is created.

Shipment Receipt Record

A record that contains information about the receipt of materials at a location, for example, at a site or storeroom within an organization. A shipment receipt record contains details such as the quantity of items that are received, the date of receipt, and the locations of the source and destination storerooms.

Shipment Record

A record that contains information about the transfer of materials between source and destination storerooms, such as between two sites within an organization. A shipment record contains details such as the delivery method, the quantity of items, the date of the shipment, and the storeroom locations.

Shop Work Order

A work order that is created ad hoc by a shop for a discovered problem, as opposed to being created as a result of a service request or planned maintenance.

Shutdown

Outage scheduled in advance for maintenance or other services. Sometimes called planned outage.

Site

A work location, such as a plant or facility.

Soft Reservation

A request for items or tools that is not yet defined by the need for the items within a specific time frame. A soft reservation does not reduce the available balance. When a reservation is classified as soft, the item is available for eventual issue from the list of reservations.

Spare Part

Any component or equipment intended to restore a corresponding one in order to restore the original required function of the component or equipment.

Standby Node

A device that assumes the identity of a primary node if the primary node fails or is taken out of service. The standby node runs the primary node's workload until the primary node is back in service.

Subassembly

An assembled unit that is incorporated with other units into a complete assembly. A subassembly is a child asset.

Sub-Room

Rooms that can only be accessed from another room and have no doors directly off of a corridor (i.e. a room within a room).

Supervisory Control and Data Acquisition (SCADA)

A computerized system often used to collect real-time maintenance information for monitoring and control of assets.

Sustainment Cost

The total of costs required to operate, maintain, preserve and renew the facility, system or component on an annualized basis.

System

A collection of components performing a specific function for a facility. Systems are logical elements of a facility that are unique in their life cycle and/or function.

T

Tag

A physical label that is applied to an asset to indicate the device, its position, and the controlling authority.

Tag Out Procedure

The procedure for taking work assets out of service or placing them back in service to ensure a safe work environment.

Task List

In a maintenance inspection context, a task list provides directions about what to look for during an inspection. Tasks include inspecting, cleaning, tightening, adjusting, lubricating, replacing, etc. Tasks are specific, complete, and have a performance standard.

Technical Record

A record that maintains information that is related to an externally published directive or bulletin, such as an airworthiness directive or a customer service notification. Technical records are used in highly regulated industries to ensure that all regulations are properly implemented.

Telemetry

Telemetry is defined as the science and technology of automatic measurement and transmission of data by wire, radio, or other means from remote sources to a monitoring device recording and analysis. For CMMS this means the remote transmission of maintenance information.

Ticket

A record, such as a service request, incident, or problem report that can be routed and assigned a status.

Total Cost of Ownership (TCO)

The sum of the expenditures required to construct, operate, maintain, preserve and renew the facility, system or component over its intended design life with acceptable functionality.

Total Cost per Acre (or Square Foot)

A benchmark per grounds (for acre) or facility (for Square Foot) to track total expenditures relative to the size of the facility. It is the ratio of total maintenance, repair and replacement costs divided by total gross acre or square footage, respectively, of the facility.

TCO Ratio

The ratio of first cost to sustainment cost.

Total-Productive Maintenance (TPM)

TPM is an airport-wide management program that emphasizes production operator involvement in equipment maintenance, and continuous improvement approaches.

U

UNIFORMAT II Code

UNIFORMAT II is a format for classifying building elements and related site work. Elements are major building components that perform a given function, regardless of the design specification, construction method or materials used.

Unit

A unit (of measurement) is a definite magnitude of a physical quantity that is used as a standard for measurement of the same physical quantity.

Unplanned Maintenance

Any maintenance activity for which a pre-determined job procedure has not been documented, or for which all labor, materials, tools, and equipment required to carry out the task have been not been estimated, and their availability assured before commencement of the task.

Unscheduled Downtime

A period of time when the equipment is not available to perform its intended function due to unplanned downtime events. These include maintenance delay, repair, and change of consumables, out-of-spec input, and facilities-related downtime.

Unscheduled Maintenance

Any maintenance work not included on an approved maintenance schedule prior to its commencement. Note: this is not necessarily a breakdown, rather a break in the schedule of maintenance.

Uptime

The opposite of downtime. It is defined as being the time that an item of equipment is in service and operating.

V

Vendor

A person or company that supplies materials or services to another person or company.

W

Workflow

The structured sequence of activities and tasks that are used to implement a specific change, release, or other process, including automatic routing and tracking of records for approval and other tasks.

Work Inspections

Either a situational review of the work site during preparation for an existing work order, or performance of a scheduled inspection as a work order.

Workload

The amount of labor hours required to carry out specified maintenance tasks.

Work Order (WO)

An instruction with the accompanying details and information needed to perform a defined scope of work. Work Orders are created when a service request cannot be resolved on the first response, or are created automatically for planned maintenance. A Work Order contains a description of the task, details of the asset, tracking number, date requested, due date, who it is assigned to, a priority, time spent on, inspection notes, and general notes/remarks section.

Work Order Criticality

Work order importance rating based on the sum of asset criticality and work type criticality.

Work Order Priority

Ranking of a work order based on allowable work initiation time.

Work Plan

A list of the operations, labor, materials, and tools that is required to complete a work order.

Work Request (WR)

A document/online form used for making the initial request for maintenance. Once approved, the document is normally converted into a work order.

Work Type

Classification of work based on business need, such as legislatively mandated or unplanned corrective work.

Work Type Criticality

The importance of the work in maintaining functioning facilities, systems and components.

Sources of Definitions:

- http://www.mintek.com/eam-cmms/glossary/#top
- http://www.promaintainer.com/Glossary.html
- http://www.cmmssoftwareguide.com/cmms-glossary.htm
- LAWA FM Handbook
- IBM Maximo Asset Management Manual

APPENDIX B: Case Study Reports

Case Study Report 1: Dallas/Fort Worth International Airport

Case Study Report 2: General Mitchell International Airport

Case Study Report 3: Seattle-Tacoma International Airport

Case Study Report 4: Southwest Florida International Airport

Case Study Report 5: Ted Stevens Anchorage International Airport

Case Study Report 1:

Dallas/Fort Worth International Airport
CMMS Implementation & Use

Synopsis

Dallas/Fort Worth International Airport (DFW) is a large hub operating a mature CMMS platform that is widely accepted and used by diverse stakeholder groups. The functional use of the system has expanded and continues to expand since the initial implementation in 2004. It is used to manage assets pertaining to: aircraft parking, ramp area, roadways, runways, taxiways, bridges, people mover vehicles, shuttles, drainage, fuel infrastructure, lighting, tanks, baggage, HVAC, plumbing, elevated bridges, parking garage/lots, passenger terminals, passenger-loading bridges, administration buildings, maintenance facilities, pump stations, wastewater treatment facilities, and signage. The airport actively manages all airside assets, but contracts out most of the maintenance functions inside terminals B and D.

Interviewees

- Jennifer Harris – ITS Project Lead
- Keith Pachuilo – SEAM Manager
- Ed Kitchen –SEAMS Coordinator
- John Sutten – Sr. Programmer / Systems Analyst
- Meryl Fisher – Senior Database Analyst
- Scott Sizemore – Airport Operations
- Jim Hewitt – Airport Call Center
- Dawn Delaney – Airport Call Center Trainer

The airport provided a tour of the fleet maintenance shop and the airport EOC and call centers to demonstrate the use of Infor EAM in the operations.

Operational Assessment

DFW uses Infor EAM to generate and track work orders, schedule preventive maintenance, track maintenance history, monitor asset health, track FAA Part 139 discrepancies and maintenance history, and provide safety management entries and workflow for maintenance. The Part 139 tracking and safety management entries are tied to work orders and are viewed within the context of work orders. The captured information is used for regulated reporting. Additionally, Infor EAM is integrated, either directly or indirectly, with the following airport systems:

- C3 Portal for Airport Operations and Status Board
- Oracle Financials
- GIS
- PropWorks Property Management System
- Skire Program Management System

Airport Description

DFW, the world's third busiest airport by aircraft movements, serves the Dallas/Fort Worth, TX metropolitan area. In terms of passenger traffic, it is the eighth busiest airport in the world serving approximately 60M passengers annually. DFW is the largest hub for American Airlines. At 18,000 acres, DFW is the second largest airport campus in the United States. The airport is the only one in the world with seven active runways. DFW achieved 200 nonstop destinations in 2013, including 52 international and 148 U.S. domestic destinations.

DFW has its own police, fire protection, and emergency medical services. DFW manages Terminals D and E, whereas Terminals A and C are managed by American Airlines.

CMMS History at DFW

DFW began using an in-house developed CMMS in the late 1970s. The system was used until 2002, when the airport purchased and implemented DataStream's 7i asset management software. The airport upgraded to Infor EAM after the purchase of DataStream by Infor Software Solutions in 2006.

The original need for replacement of the in-house software came after the airport took over management of Terminal D. The planning for implementation was started in 2002 and completed about two years later.

Business Case

The system upgrade in 2008 was undertaken to better manage the airport's assets in support of the Asset Management Departments mission:

> *"The Asset Management Department manages the airport board's multi-billion dollar physical infrastructure by providing services necessary to ensure the safe and efficient operation of a world- class airport through core business activities of maintenance, repair, renewal, operation and special support."*

The objectives targeted for accomplishment by the Asset Management Department were:

- Development of the organization consisting of infrastructure planning and systems performance functions teaming with engineering and sustainability
- Development of work standards and criteria
- Improvement in work practices and work order management
- Development of KPIs that track the maintenance of critical systems and infrastructure renewal funding levels for benchmarking to industry standards
- Development of a five (5) year project-planning instrument

CMMS Implementation

Driver(s)

The Director of Airport Development identified and championed the need for DFW to have a cradle-to-grave asset management system. An in-house developed system had served adequately for several years, however, it was limited in accommodating the airport growth that was occurring. Both passenger volume

and physical space (Terminal D under construction) was increasing and future expectations were that DFW needed to prepare for that trend to continue. Also, assets previously supported by the airlines were transitioning to DFW control for ownership and maintenance. The increasing cost in labor resources to manage the larger number and greater scope of assets was significant. Better management of those assets required better tools for asset maintenance, repair, and replacement.

Selection Process

In early 2002, a Selection Committee of stakeholders was assembled to investigate the opportunity to recommend a new CMMS solution to replace the existing system. The highest-level requirement was to select a system superior to the current platform with enhanced functionality.

Requirements were captured to support DFW operational processes for asset management. Resources in developing the requirements included the VP of Information Technology, VP of Airport Maintenance, ADE (Airport Engineers), and resources from Asset Management and Information Technology.

Research and surveys of other airports were conducted to discover what CMMS software and applications were in use and successful. The research results were presented to the Vice Presidents.

An RFP was developed and released in mid-2002.

Evaluation of CMMS Solutions

Using the business requirements, an evaluation matrix was prepared to determine the merits of one CMMS solution versus another. The evaluation was grouped by requirement categories and then detailed requirements within each category. Table B1-1 provides the highlights of the factors used by DFW to conduct the evaluation.

Evaluation Category	Factors
Maintenance Management Functions	• asset maintenance capability • preventive, predictive, proactive maintenance features • work order management • inception to close with scheduling, tracking, and material/tool inventory management
CMMS Program Features	• user customization • ad hoc query • data import/export • data and transaction archive • user friendly system interface • security and password flexibility
CMMS Operating Environment	• data points from proposing vendors on: • hardware platform • operating system • network requirements • storage requirements • supporting software • end-device requirements and options

Evaluation Category	Factors
CMMS Vendor Data	• background of the vendor's CMMS experience years in business • customer base • support & upgrade policies • training • ability of the vendor to produce an evaluation copy of the software

Table B1-1: DFW Evaluation Summary

DataStream 7i (now Infor EAM) was selected as the system of choice and the contract award was completed by September, 2002.

Implementation

The implementation process began in September, 2002 and the estimated plan initially targeted implementation by November, 2003. Production "go-live" was achieved in December, 2004.

Table B1-2 presents the services and functions provided by the vendor and the initial software implementation.

Service or Function	Description
Base Administration	System administration functions
Asset Management	Asset identification and management
Work Management	• Repair order • Routine maintenance • Response maintenance • Preventive maintenance
Materials Management	Material allocation to repair orders
Vehicle Maintenance and Repair	Fleet management functionality
Data Collection	Data import capability
Barcode	Ability to record asset identification through barcode scanning
Mobile Capacity	Access to information in CMMS through handheld devices
Workflow	Track progress and status of work and task process sequences
Reporting	Ad hoc reporting capability
Commercial	Maintenance work cost input
Data Conversion	Data migration service
Data Integration	External data access through application program interfaces

Table B1-2: DFW Functional Components of Initial Implementation

The implementation activities were developed by the vendor, reviewed with DFW project team, and then executed through planned tasks. The tasks were used to establish the project implementation plan. Some of the key tasks listed below were planned to be replicated as a secondary tasks or as multiple iterations as necessary to achieve successful start-up.

- Future State Business Process Review
- Configuration Analysis
- Component Configuration/Testing
- Integration Planning/Install/Test

- Data Mapping/Migration Planning/Validation/Testing
- Reporting Tool Training
- Standard Operating Procedures Planning/Training
- End-user Training
- Train-the-Trainer Class

Data migration was a challenge during the implementation. Even though new naming conventions were put in place for new asset data entry, the legacy system asset data maintained the naming and descriptive information when transferred to the new system. In the Infor EAM system, naming conventions are in two formats, one for mobile assets and another for fixed location assets. The implementation contractor conducted the validation of the data.

In addition to the system vendor/contractor resources, DFW applied approximately 6 resources at a 70-80% allocation during the 2-year implementation effort.

Key Points

The configuration of the organization/security table proved later to be an obstacle to allowing contracted maintenance providers use of the system. External users of the system were not considered in the initial security model. That critical decision was one that the airport would like to change, but the change requires a significant amount of work. DFW built the security table based on the existing organization structure that had all stakeholders and users under a single organization. When maintenance was subcontracted, the single organization model did not adequately support the airport's processes. The configuration originally implemented has limited the flexibility needed to address the roles of subcontracting maintenance organizations. DFW is currently considering a reimplementation to address the single organization configuration installed.

Also, the development of the asset hierarchy will be investigated for the need to adjust. For example, DFW chose to identify and roll up costs by facility with lighting, electrical, and plumbing assets comprising the facility assets.

Airport Use of CMMS

Organizations and the Use and Benefits of CMMS

Asset Management

Asset Management controls approximately 25,000 assets with more assets continually added. Most airfield assets (lighting, pavement, signs, etc.) are in-house maintained while a majority of other asset maintenance is contracted out. Terminals that are exclusive to American Airlines are maintained by the carrier.

When the CMMS selection process was conducted, most maintenance tasks were in-house resourced. Since that time, DFW has adopted the use of contracted resources to manage and conduct maintenance tasks beginning with the custodial areas and progressing into other maintenance shop duties. In some cases, a contractor may be responsible for multiple maintenance contracts. Where contract resources are applied, the vendor is required to use the DFW CMMS system to enter and maintain work order information appropriate to the access and security level provided. The DFW Contract Coordinating

Group manages contractor service levels. Figure B1-1 provides a sample of a DFW Contractor Performance Report.

Asset and parts inventory tracking and procurement is not managed through CMMS. While some asset analysis is conducted through the CMMS system, true life-cycle analysis is not currently accomplished through the system.

Asset Management Contractor Response / Repair Time Report

Corrective Maintenance Work Orders
Work Orders between Date From 2013-09-01 and Date To 2013-09-30

All "Terminal" response times are 15 minutes.

Work Order Department	Work Order	Work Order Date Created	Work Order Date Completed	Work Order Asset	Work Order Asset Desc.	Work Order Description	Contractor Recorded Call Time	Contractor Recorded (Tech) Arrival Time	Response Time	Contractor Recorded Work Start Time	Contractor Recorded Work Completed Time	Repair Time	Work Order Comments
		12:49:55 PM	2:00:00 PM			continually flushing	11:59:00 AM	12:00:00 PM		12:00:00 PM	12:30:00 PM		repair kit A-1042-A sloan. Work order complete Inspection passed.
	1774479	Sep 1, 2013 1:23:54 PM	Sep 7, 2013 9:18:00 AM	33025.PLBG	PLUMBING.Terminal E Satellite Building 2610 N INTL	E Term SRR #12 Satellite E59 MRR Sink #6 push handle broken off	Sep 1, 2013 10:29:00 AM	Sep 1, 2013 10:30:00 AM	1 minute	Sep 1, 2013 10:30:00 AM	Sep 6, 2013 1:15:00 PM	5 days 2 hours 45 minutes	tech noted ordering part from vendor 1 progress Part receive 09/06/2013 Tech replaced push handle. Inspection passed.
	1774480	Sep 1, 2013 1:31:42 PM	Sep 6, 2013 4:56:00 PM	33025.PLBG	PLUMBING.Terminal E Satellite Building 2610 N INTL	E Term SRR #12 Satellite E59 MRR Sink #4 missing cap/plug on sink top	Sep 1, 2013 10:44:00 AM	Sep 1, 2013 10:45:00 AM	1 minute	Sep 1, 2013 10:45:00 AM	Sep 6, 2013 1:30:00 PM	5 days 2 hours 45 minutes	Tech note park request(2 Faucet hotw covers) Work in progress Part receive 09/06/2013 Tech replaced faucet cover. Inspection passed.
	1774481	Sep 1, 2013 1:39:55 PM	Sep 1, 2013 5:32:00 PM	33025.PLBG	PLUMBING.Terminal E Satellite Building 2610 N INTL	E Term SRR #12 Satellite E59 MRR Sink #1 and #2 loose faucets	Sep 1, 2013 11:14:00 AM	Sep 1, 2013 11:15:00 AM	1 minute	Sep 1, 2013 11:15:00 AM	Sep 1, 2013 11:30:00 AM	15 minutes	Tech noted tighten faucets 1 and 2 faucets on sinks. Work order complete Inspection passed.
	1774483	Sep 1, 2013 2:08:20 PM	Sep 1, 2013 4:02:00 PM	33025.STRUCT	STRUCTURAL.Terminal E Satellite Building 2610 N INTL	E Term SRR #12 Satellite E59 MRR Ceiling tile above toilet #9 wet from leak	Sep 1, 2013 11:59:00 AM	Sep 1, 2013 12:30:00 PM	31 minutes	Sep 1, 2013 12:30:00 PM	Sep 1, 2013 1:00:00 PM	30 minutes	Tech stain ceiling tile. Work order complete Inspection passed.
	1774491	Sep 1, 2013 3:08:23	Sep 1, 2013 4:30:00 PM	33024.RRMMEN. 0200158	RRMMEN.MEN'S REST ROOM.TERM E.C-57.0200158.Z-B.G-D	E Term Col 57 MRR Stall #2 no door lock	Sep 1, 2013 2:59:00	Sep 1, 2013 3:00:00	1 minute	Sep 1, 2013 3:00:00	Sep 1, 2013 3:15:00 PM	15 minutes	Tech noted door is back on and a new latch is installed. Work order complete Inspection passed.

Figure B1-1: Example of DFW Contractor Performance Report

Fleet Management

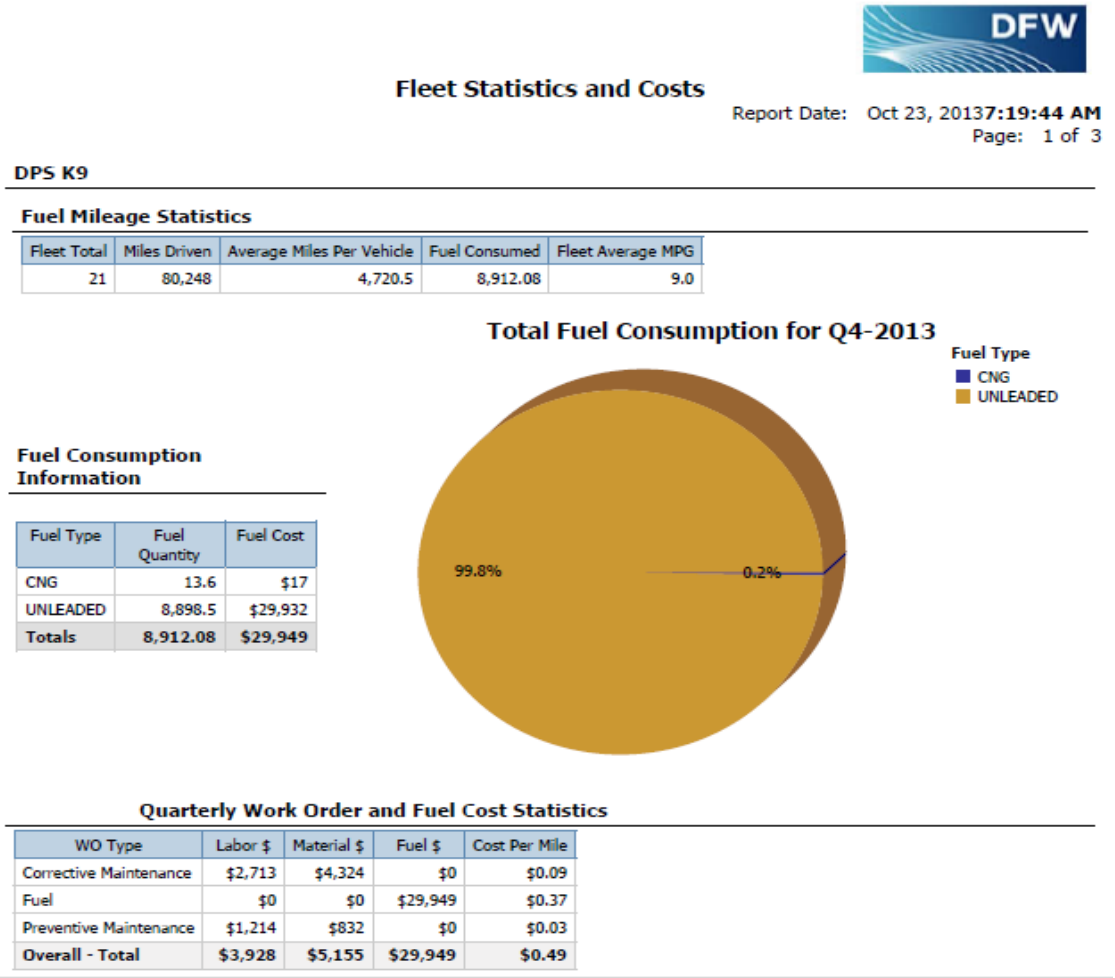
Fleet assets are primarily controlled by internal resources. Contractors may be used to conduct some repair and service tasks, but the asset management process is controlled by the Fleet business operation.

The ability to enforce processes through management support and a business user champion has enabled Fleet to maximize the use of the system and to continue to introduce new functionality that benefits Fleet asset management.

All vehicles are commissioned through Fleet. No vehicle is commissioned for use by DFW if it has not met Fleet commissioning requirements. Commissioning includes the registration of the asset in CMMS. Fleet inventory includes not only vehicles such as buses, cars, trucks, and motorcycles (police), but also trailers, construction equipment, lawn mowers, landscape equipment, etc. DFW currently has over 1,000 assets in the Fleet inventory.

Vehicles are measured for usage through metrics appropriate for the asset (mileage, fuel usage, usage hours, etc.) The assets are monitored for Preventive Maintenance through supervisor reports and Work Orders are initiated automatically for the required PM tasks. The Work Orders are monitored for status and completion.

The ownership and authority of Fleet's control on the PM processes has enabled Fleet to be the front-runner at DFW in using and maximizing CMMS functions and capabilities. The task management of CMMS has also enabled Fleet to streamline processes, reduce paper work, reduce hard-copy archived data, and produce analytical reports. Figure B1-2 provides a sample of a DFW Fleet Statistics Report



Fleet Statistics and Costs

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DPS K9

Fuel Mileage Statistics

Fleet Total	Miles Driven	Average Miles Per Vehicle	Fuel Consumed	Fleet Average MPG
21	80,248	4,720.5	8,912.08	9.0

Total Fuel Consumption for Q4-2013

Fuel Type
CNG
UNLEADED

99.8%
0.2%

Fuel Consumption Information

Fuel Type	Fuel Quantity	Fuel Cost
CNG	13.6	$17
UNLEADED	8,898.5	$29,932
Totals	**8,912.08**	**$29,949**

Quarterly Work Order and Fuel Cost Statistics

WO Type	Labor $	Material $	Fuel $	Cost Per Mile
Corrective Maintenance	$2,713	$4,324	$0	$0.09
Fuel	$0	$0	$29,949	$0.37
Preventive Maintenance	$1,214	$832	$0	$0.03
Overall - Total	**$3,928**	**$5,155**	**$29,949**	**$0.49**

Figure B1-2: Example of DFW Fleet Statistics Report.

Airport Operations Call Center

All calls coming into the Airport Operations Call Center (AOC) are entered into Infor EAM using a defined set of categories to identify the appropriate nature of the call. Basic information collected at the time of the call includes the customer identification plus some call record information. The AOC handles approximately 1,000 trigger points per day, of which 10% become Work Orders.

AOC reports are usually generated automatically, but can be generated on-demand, and made available for distribution to predefined user groups.

The use of the CMMS Tool for recording call data information is a critical part of the training that AOC resources receive. When call volume gets too high so that data entry of an operator falls behind,

they are expected to record information as needed and follow up as soon as possible with updating the on-line system.

Thick binders of paper documents and manual reviews have been replaced by the efficient functionality of the Infor EAM system. It is estimated that at least 100 man-hours per week are saved between the previous, manual method of call logging versus the current automated system.

Continuous Improvement and Expansion of CMMS Use

Since the 2004 initial implementation of Infor EAM and the replacement of the legacy in-house developed asset management tool, the growth of airport assets and diverging methods for asset management and maintenance have resulted in multiple ways of leveraging CMMS. In addition to enhanced asset management functionality, in 2006 the AOC has used CMMS to replace the Call Center Logbook (a PowerBuilder application) and has moved forward in applying the functionality to address Part139 compliance tracking as well. Figure B1-3 highlights the continuous improvements and expanded use of the CMMS over time.

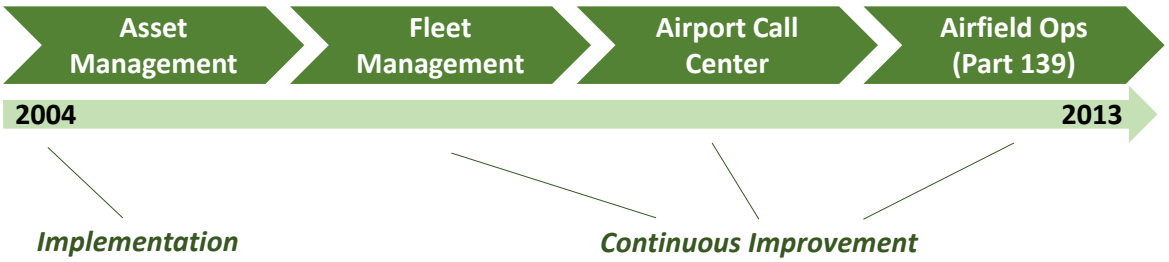


Figure B1-3: Continuous Improvement and Expanded Use of CMMS Software

The interaction between the business resources using Infor EAM and the technology support resources has generated a synergy that, through the use of user defined fields and system capabilities, has produced enhanced functionality providing benefits of efficiencies and streamlined processes.

Technical Support of CMMS

Implementation

DataStream (Infor EAM) and a contractor implemented the Infor EAM system in Development environment first. The implementation into the Test platform was also conducted primarily by the contractor at that time. DFW technical resources then engaged with the contractor in the move to the Production platform. After the first upgrade of the system was done by a contractor, the DFW technical and DBA team became responsible for conducting the implementation of all upgrades and changes.

The Infor EAM system is established in three technical environments: Development, Test, and Production. The Production system data can be replicated as needed to the Development or Test platforms. The three-platform approach enables DFW to manage changes, testing, and training thoroughly and with tight control.

Change Management

Software changes and patches, whether to multiple layer servers, the database, or the application, are applied to Development and proven first. A copy of Production is migrated to Development so that real-time conditions and data are similar for both technical validation and business user validation of new functions.

Testing

The Development platform provides the first opportunity to test changes, new releases, and/or upgrades. Once satisfactory results have been obtained, the move to the Test platform provides enhanced testing procedures. Business users engage in the Test processes as well as contractors since they must use the DFW system.

Training

DFW uses the Test environment to conduct the various training programs for Infor EAM. Testing not only includes the internal business resources, but also is used to train contractors that will be required to interact with the system. The ability to replicate production data in the Test environment provides those being trained to use data that will be familiar to them.

Business Continuity and Disaster Recovery Planning

Databases reside on Sun clusters. Storage and mechanicals are redundant. Failover processes and capabilities can be accomplished within minutes. CMMS data resides in locations near physical business user locations.

On the application side, snapshots are conducted nightly as well as transaction logs. Proof of restore capability is evidenced by the ability to restore Production to the Development and/or Test environments as needed for testing or training.

Disaster recovery planning practices and exercises are scheduled and executed accordingly.

Regulatory

The Infor EAM system has become a critical tool in the administration of FAA Compliance Part 139 reporting. The organizational structure of the Airfield Operations in place at DFW consists of:

- Assistant Airfield Operations Officer
- Airfield Operations Officer
- Airfield Agents

Inspections are generated as a Work Order through the CMMS Preventive Maintenance process or through observance by Airfield Agents. Also, AOC events may generate an inspection, if the situation warrants such. If inspection is required, a Work Order is created. For example, a bird strike requires the inspection of an airfield location and the removal of unknown debris. An “Inbox” tab presents a view of all inspections and status including those that have been completed. Through selection, each inspection record can be viewed in detail. Metrics are also available based on % complete summaries.

An inspection Work Order status can only be raised to a "Discrepancy" level by an Airfield Officer and a specific Part 139 discrepancy code is required for data entry. Codes with standard abbreviations enable consistent reporting for analysis. Maintenance resources can look at Work Orders and find references to parts, conduct work, add comments, and change the status to "Work Completed Technician". An Airfield Operations Officer, using a filtered screen of Inspection Work Orders, will check the repair for compliance. If it passes inspection, the Work Order status is changed to "Completed". If the inspection fails, comments are added and the status is changed to "Release for Rework".

An FAA inspector can ask for a particular day of inspections information including a history of a Work Order or a summary of Work Orders on a given day. These audits/reviews are now conducted electronically through CMMS and have been accepted by the FAA as sufficient, no longer requiring hard copy, signed documents.

Financial Concerns

No financial concerns were raised at DFW. However, DFW conducted due diligence in determining the best licensing method for the CMMS platform and to ensure the proper level of availability to the system users both internal and external (contractors). Licensing of the system is based on concurrent users in Production. The Development and Test licenses are not charged to DFW. The Oracle database license is based on CPUs.

Future Enhancements

Airfield Operations currently have 3 hard copy "shift" reports using Excel forms, but are looking to build these reports within Infor EAM and complete the move to "paperless" capability. Also, Airfield Operations is researching opportunities to support the Emergency Operation Functions using information and data available in their CMMS platform.

Lessons Learned

The following lists the major lessons learned:

- Building more granularity inside the configuration parameters causes more up front work, but will allow unanticipated changes to be accommodated later (this is much like leaving spaces between house numbers).
- Define data fields at a granular level as much as possible. By going general at first and then trying to go more granular later, one loses the drill down capability on historical data. It is easier to start granular and then become more general later if necessary. Example: Closing Code should be precise and exclude "Miscellaneous", "Other", etc.
- System configuration of both the System Security/Access and Asset Hierarchy should be flexible to accommodate the existing airport business environment as well as potential changes the airport may incur. As an example, the highest level of the asset hierarchy for DFW was a single organization. Group and users were defined under that single organization. When contractors were hired to manage particular assets, it would have been more convenient to put them in a separate organization, but this requires a reimplementation of the system. It is a significant enough issue that the airport is considering the reimplementation.

- Invest sufficient time to ensure naming conventions and standard methods for identifying assets are thorough, consistent, and flexible for the future.
- Workflow processes should be established and enforced at roll out or inconsistent data collection can result. Use the system to enforce compliance to the workflow. While, reports can show discrepancies or non-compliance issues, the system should embed workflow enforcement where possible and practical.
- Multiple character sets: Flexibility in design is necessary. You may not be storing data in another language character set but it may be required to support the system. For example, it became necessary for DFW to support the system with two databases due to a need for the Chinese character set which was not recognized at implementation.
- Estimated time frames to conduct upgrades vary, but typically an upgrade with no hardware changes or platform changes will take two months. Upgrades including hardware modifications may require a six-month duration.
- The original data validation did not include airport IT support. The contractor was not an airport-experienced resource and definitely not DFW experienced. Data field terms, definitions, and expected use could have been better related to DFW business. Data validation should involve airport asset SMEs to improve the data quality for migrating information from an existing system to a new system.

Keys To Success

Business Ownership & Stakeholder Engagement

From the inception of the CMMS initiative at DFW, the need for a thorough, accurate, EAM solution has been driven by DFW leadership and adopted by leaders of the various departments benefitting from an asset management tool-set. The DFW ownership has enabled the airport business to not only achieve a successful implementation and sustainable CMMS for asset control, but has also provided the momentum to broaden the use of system capabilities into other airport business such as Part 139 inspections and discrepancies as well as AOC control. DFW's commitment to its 2004 implementation of CMMS has benefitted the airport in a system that is effective and considered critical to its operation today.

Business & Technical Resource – Collaboration and Expertise

Departments using the CMMS tool-set engage in ongoing collaboration through scheduled meetings, new initiatives, and brain storming sessions to identify opportunities to improve and enhance the effectiveness of the system. The airport has dedicated technology support staff to configure, customize, and develop additional functionality as the needs are identified. CMMS users are extremely comfortable and confident in presenting problems and possible solutions to IT, knowing that IT resources can quickly understand business processes and have the necessary familiarity of the CMMS capabilities. In addition to application support, the technical support for the application includes database specialists. System upgrades are the responsibility of the database personnel, not the vendor.

Change Management

The airport has three environments for the system; Development, Test, and Production. Changes must have successfully worked in Development and thoroughly tested by system users (not IT staff) before they are implemented in production. The investment in hardware cost to establish the Development and

Test environments, the risk of problems resulting from an upgrade or enhancements are significantly reduced.

Applicability to Other Airports

Most large airports will align with DFW in the need for efficiently managing the variety, complexity of assets in their operational environment. Airports will also be similar to DFW in using multiple methods for managing and conducting asset maintenance and repairs through both internal resources and contracted vendors.

Airports will be at different stages in the use of CMMS from nothing at all, to limited functionality through application software, to full-blown CMMS platforms. DFW provides a perspective on a mature system that continues to implement added and enhanced functionality to their operational users and even new user groups. Airports will be able to leverage DFW's experience in not only a successful CMMS implementation, but also in their approach for a sustainable, continuously improving system that the DFW system users embrace and depend upon.

Case Study Report 2:

General Mitchell International Airport CMMS Implementation & Use

Synopsis

General Mitchell International Airport (MKE) is a medium-sized airport. It was chosen for a case study to provide information on an innovative implementation of Cityworks, a GIS-based maintenance management system. The implementation of Cityworks at MKE, takes advantage of the airports mature GIS to locate assets on the airport. The system is used to manage all FAA Part 139 assets, the Terminal's interior infrastructure, and through a configuration of the application, the system has replaced a number of paper reports with a digital logbook and automated reporting functions. MKE's Cityworks configuration is the first of its kind to be approved by the FAA for automated 139 reporting.

Interviewees

- Terry Blue, A.A.E. – Deputy Airport Director, Operations & Maintenance
- Timothy Pearson – GIS Coordinator
- Kathy David – Airport Operations Manager
- Jenny Tremmel – Airport Control Center Operations
- Phillip Crow – Airport Control Center Operations
- Neal Snyder – Electrical Shop
- Tony Burger – Electrical Shop
- Chris Lukas – Airport Maintenance Manager
- Tim Brown – Assistant Maintenance Supervisor
- Ken Skowronski II – Airport Maintenance Supervisor
- Holly Ricks – Assistant Airport Landside Operations Manager
- Jackie Boyd – Landside Coordinator
- Ed Cyprian – Landside Coordinator
- Kenneth Hanney – Landside Coordinator
- Mark Loach – AECOM Project Manager

Operational Assessment

MKE uses Cityworks to generate and track work orders, schedule preventive maintenance, track maintenance history, provide asset data via an embedded map service, maintain control center logbook entries, track Part 139 discrepancies, and generate automated reports including but not limited to incidents, NOTAMS, and Part 139.

Airport Description

General Mitchell International Airport is named for Brigadier General William “Billy” Mitchell, a leader in establishing the US air force during the First World War. After the war, he was made Chief of

Air Service of the Group of Armies, the top command post at the time for aviation. General Mitchell was a tireless proponent of aviation's future in its earliest days.

MKE provides nonstop flights to more than thirty cities. It serves Wisconsin, Northern Illinois & Chicago and is the only local regional airport served by all major domestic airlines. MKE is just over an hour's drive from Chicago O'Hare International Airport, providing an alternative to Chicago's airports for residents of Northern Illinois. The airport also hosts the Wisconsin 128th Air National Guard base.

MKE covers an area of 2,180 acres that contains five runways ranging in length from 4,183 to 9,690 ft.

CMMS History at MKE

Since the late 1980s, the airport managed its work orders with an underdeveloped and underutilized application (eMaint). In 2010, MKE, as part of an enterprise Geographic Information System (GIS) development, had evaluated, selected, and started to develop a CMMS based around the Cityworks software. In late 2011, a catastrophic system failure caused the loss of many work order records and the corruption of the eMaint application. Fortunately, the airport had already developed the replacement system and was within weeks of a pilot program and implementation. It took just 4 days for the airports Cityworks team to put the application into production.

One of the essential requirements for the CMMS was that it would integrate with the airports existing GIS, which was already a mature system (first implementation started in 1997). The core GIS database is built on the FAA GIS data standards (AC 5300-18B). It contains everything from lights, signs, navigational aids, security features, pavement, and other airport-specific features.

The staff utilized at MKE is comprised of a GIS Coordinator, GIS Data Specialist, and a small team of programmers from AECOM, who were contracted to support the overall enterprise system development including Cityworks configurations, custom database triggers, report development, and data support.

Business Case

The airport's Deputy Director of Operations and Maintenance realized the need for better tracking of maintenance tasks, tenant responsibilities, material and equipment costs, and, in turn, billing amounts. All of these could be configured and managed in the Cityworks application. Manual tracking was time-consuming and did not provide efficient reporting and tracking capabilities for the airport.

The Deputy Director's sponsorship of the project and his continued involvement in the development of new features is key to the project's success.

CMMS Implementation

Driver(s)

A group of airport Operations and Maintenance managers along with the GIS Coordinator, identified and championed the need for MKE to have an integrated GIS and maintenance management system. eMaint was used only to provide work orders and some maintenance tracking. Work orders were managed manually. Logbook entries were done manually in a notebook. Part 139 inspection reports were done manually at the close of each shift, printed, signed, and retained in a binder. Many copies of

reports and multiple databases were kept by various departments. As a result, it was difficult to track events, or even to correlate them. Searches were manual, and descriptions – although similar – might be different enough to determine that an event in one system was the same as an event in a different system. The integration of that existing data with a maintenance management system had the potential to improve operational and maintenance related functions.

Selection Process

MKE assembled stakeholders from multiple departments and disciplines in an effort to clearly define their needs within a CMMS. Participants included maintenance managers, operations coordinators, control center operators, property managers, and senior administrative staff. They discussed processes for events at the airport to determine system requirements to support those processes. The sessions were often conducted in front of whiteboards and requirements were captured to support MKE operational processes for maintenance management.

A consultant worked with the airport to capture requirements for a CMMS and match the requirements to available CMMS solutions. Those requirements suggested that a system commonly used by municipalities would actually work very well at meeting the needs of the airport. The consultant assisted the airport in choosing Cityworks for its CMMS. Cityworks provided flexibility towards configurations and good capability to integrate with the airport GIS, and by repurposing portions of the application, the airport was able to use a Cityworks module to provide an electronic logbook for the Operations Control Center (OCC) and automate Part 139 reporting.

Evaluation of CMMS Solutions

A consulting firm was retained to capture and develop the requirements for the airport. The consultant evaluated software to fit those requirements and provided the most cost-effective solution for the airport. The Cityworks application was recommended as the solution that could best satisfy the requirements of CMMS at MKE.

After assessment of that recommendation, MKE decided to procure Cityworks as their asset and maintenance management solution. MKE was utilizing a second consulting firm (AECOM), to develop its Enterprise GIS and invited them to assist with the Cityworks implementation. AECOM and the GIS Coordinator modified the application to meet the specific need of the airport. A large part of this modification was the conversion of a service request module into an Operational logbook.

Key Points

The success of the system is due to several factors:

- Stakeholder engagement is a critical and essential factor. The stakeholders of the system were engaged in development of the requirements through many white board sessions to identify processes and needs.
- The airport has a small technology support staff to configure, customize, and develop additional functionality as the needs are identified. However, the GIS Coordinator is enthusiastic about the project and has given unparalleled support to the airport for this project. The consultant has been instrumental in providing the functionality for the stakeholders.

- The ability to easily configure Cityworks was a deciding factor in selection. The application has been adapted to use a module (that the airport did not need) as an electronic logbook. It is used by the control center in lieu of a hand-written logbook. Part 139 asset work orders can be linked to logbook entries. A major feature of the implementation is that Part 139 inspections reports can be automatically generated. MKE performs an airfield inspection on each of its 3 daily shifts. The results of these inspections, associated work orders, discrepancy lists, and NOTAMs are all recorded in the system. This change to the MKE business processes saves a great deal of paper and time-consuming report writing.
- The airport has a large number of its assets (>30,000) in its GIS database. Many of those assets were integrated into the CMMS.
- The implementation was designed, and redesigned when necessary, to make staff functions more efficient.
- The GIS Coordinator was requested to attend the AAAE Airport Certified Employee (ACE) Operations courses in an effort to improve his understanding of operations, 139 reporting, and the daily business processes of the operational staff.
- Care has been taken to improve the efficiency of the user. If a particular form caused a user to take more time than the process that was being replaced, the GIS Office worked with the users to understand how to streamline the process and tweak the data entry to make it a faster and easier process.
- The Deputy Director of Operations and Maintenance championed the need for an improved CMMS and factored in its success.

Airport Use of CMMS

Organizations and the Use and Benefits of CMMS

The primary users of Cityworks at MKE are Airport Operations and the Maintenance staff. Operations maintains both the airfield and public spaces, including the terminals. The GIS contains not only airfield assets but also a number of terminal assets including detailed floor plans, room related assets, and associated objects such as HVAC equipment and utilities. Multiple map services can be accessed through Cityworks allowing users to see both interior and airfield assets.

The application is used by the maintenance shops to manage equipment, materials, and track labor, and at the same time provide a basis for work orders and preventative maintenance tasks, as shown in Figure B2-1 (next page).

The system is used by the OCC for specifically tracking and logging day-to-day operations. The OCC also uses Cityworks to record a number of digital logbook entries, as shown in Figure B2-2 (next page), for items such as incidents, wildlife strikes, airline issues, weather, staffing, and other data reported to the OCC. The system has been modified to meet airport-specific requirements by the use of custom fields, customized templates, and renaming of tables and records in the Cityworks database.

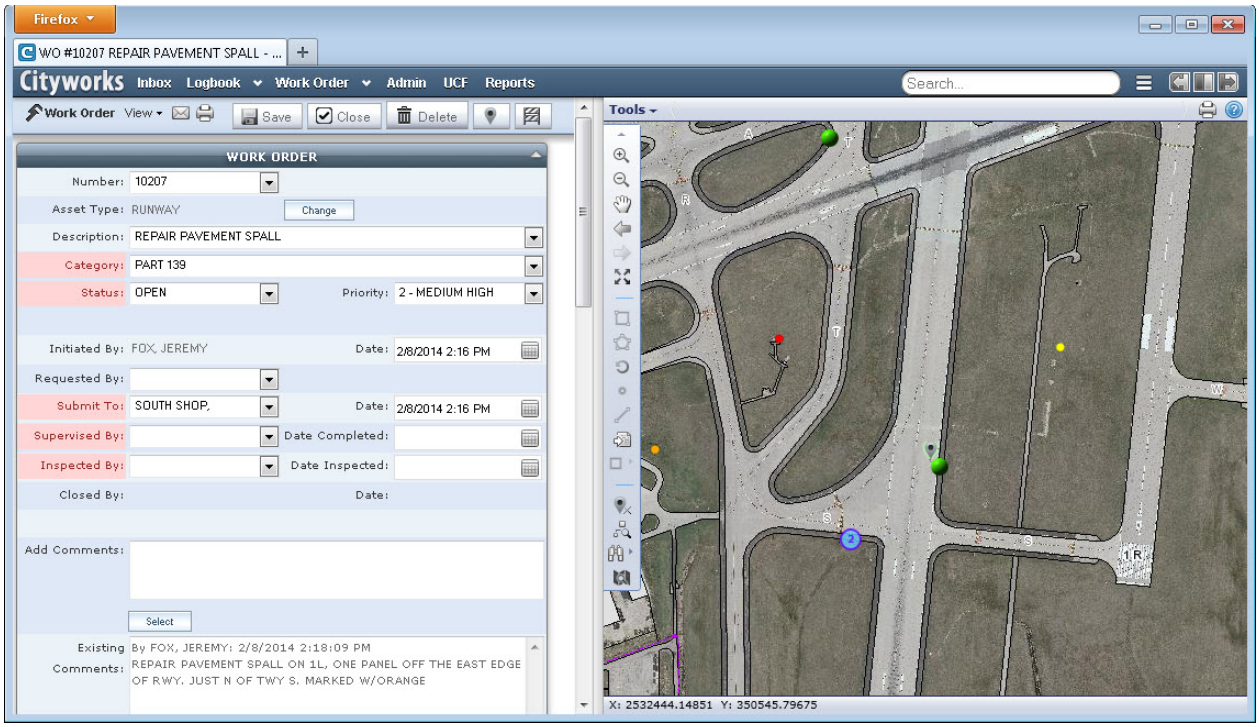


Figure B2-1. Cityworks – Work Order Sample.

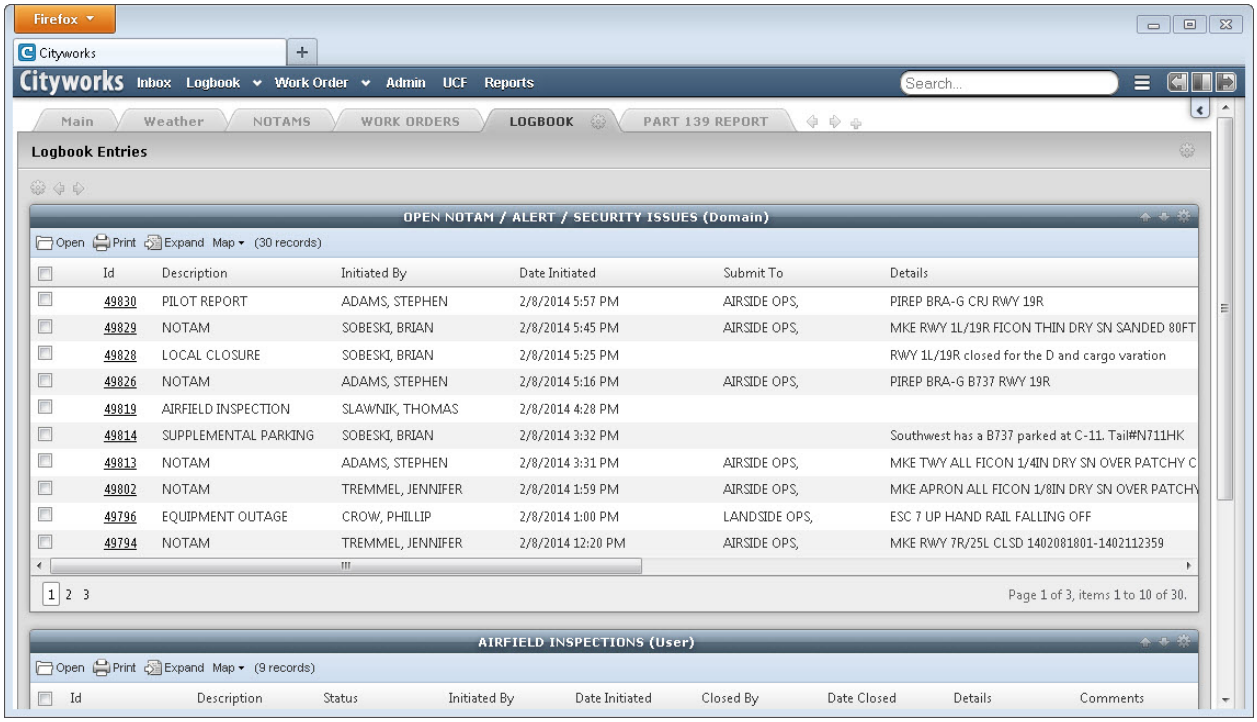


Figure B2-2. Cityworks – Logbook Entries Sample

The implementation of the logbook in Cityworks has eliminated two manual logbooks – one for Airside Operations and one for Landside Operations. In the initial implementation, the airport eliminated 22 paper reports for the Airside Coordination Center and 8 paper reports for the Landside Coordination Center.

In addition to the Operations and Maintenance staff, Airport Security, Parking Operations, Property Management, and even the IT Department utilize Cityworks for maintenance requests and tracking or work. Safety and Security personnel use the system to track security inspections and work orders for security specific assets. The IT and Properties offices utilize the system to track work performed on tenant space, monitor tenant issues via the logbook, and communicate projects to the staff. Other users of the system, primarily for work orders include Parking Administration, ARFF, Noise Management, Environmental Management, and even MKE's Accounting office.

A key element to the system is the airport's mobile components. The Cityworks application is available, wirelessly, to Airfield Coordinators using laptops and both maintenance and landside coordinators via tablets.

Continuous Improvement and Expansion of CMMS Use

The airport is planning to invest in the integration of a document management solution that ties to Cityworks, GIS, and CAD systems.

There is still data cleanup to be done in the database. Camera locations, card readers, electrical panels, and some other assets are stored in the GIS and utilized in the Cityworks application. The system is still missing attributes for some of the assets, but the system holds locations for most.

Additional staff has been added to the GIS office in an effort to develop and enhance the CMMS and GIS data. As part of the asset development process, the Cityworks application can be configured to allow end users to update both spatial and attribute information. This function allows the GIS office to concentrate on core assets while utilizing personnel that truly understand the assets to collect information on them. An example of this is allowing electricians to collect airfield lighting and signage attributes.

Currently, condition assessments are only performed on pavement assets. The Wisconsin DOT performs an annual assessment of the pavement and provides the data via MicroPaver to MKE. The airport GIS currently tracks over 46,000 separate slabs of concrete in its pavement dataset.

Technical Support of CMMS

The GIS office at MKE provides primary support to both the GIS and CMMS. MKE staff consists of a GIS Coordinator, GIS Data Specialist, 2 data technicians, & 2 IT technicians that handle hardware support. A software programmer is provided via the contract with AECOM.

Implementation

The implementation of Cityworks began in mid-2010 and went live in late 2011. The go-live date was accelerated due to the failure of the previous system. The CMMS is used for asset and work management, incorporates airport workflows, and includes operational logs, Part 139 inspections, and multiple special inspections.

Key Points

The following list the key points:

- Work orders can only be closed by maintenance supervisors or operations coordinators. The exception to this rule is that work orders for Part 139 work orders may only be closed after inspection by an airfield coordinator.
- Documenting processes and setting up workflows can save a great deal of time and paper. An example of implementing a workflow at MKE is the "Alert 4" events.
- If a person falls in the airport terminal and sustains an injury, an OCC coordinator will receive a call, enter the incident into the logbook, and then place a radio call to the on duty landside coordinator. A coordinator is dispatched and sends alerts to police and rescue. The landside coordinator adds detailed incident information to the same log entry including photos, statements, and private data. The incident is located on a map, witness statements are entered, and when the logbook entry is closed, emails are automatically sent to Risk Management, Safety, Security, and other key supervisors. This type of embedded workflow is just one example of how the system has eliminated numerous paper forms and reports from the airports daily business processes.
- Another example of streamlining work processes is the automation of daily Part 139 airfield inspections. A process that once involved the tracking of paper work orders, recording of the information on a paper record sheet, and the maintaining of this and any supporting information for 12 months is now all digital. The Cityworks application utilizes a custom Crystal Report that incorporates data from work orders, log entries, and NOTAMS to create, auto publish, and store the Part 139 inspection automatically.
- Supervisors in the system are super users with rights to create and close work orders.
- All users are allowed to customize their Cityworks Inboxes, so that the opening screen for the application is tailored to the users' needs only displaying those log entries and work orders that are relevant to their job functions.

Training

Training for Cityworks is done through three primary methods:

- Training classes and personal training by the GIS Office
- Customized training documents created by the GIS Office and their consultant
- Peer training

Change Management

The GIS Office and their consultant provide change management for the application.

Business Continuity and Disaster Recovery Planning

Databases reside on mirrored servers in multiple locations. Servers, storage, and mechanicals are redundant. Failover processes and capabilities can be accomplished seamlessly. Daily back-ups are made of the database and all servers.

Disaster recovery exercises are scheduled and executed periodically.

Regulatory

The Cityworks system has become a critical tool in the administration of Compliance Part 139 reporting. A current Safety Management System initiative will develop integration with Cityworks to attempt to comply with the upcoming release of the FAA Advisory Circular for Safety Management Systems.

Part 139 inspections are generated through logbook entries by the Airfield Coordinators. If a work order is generated to address a discrepancy, it is flagged as a Part 139 work order. The asset cannot be returned to service without inspection and sign-off by the ACO. All non-139 work orders can be inspected by maintenance supervisors. Once inspections occur, supervisors return the asset to service and close out the work order.

MKE performs Part 139 inspections for every shift, 3 shifts daily. An FAA inspector can ask for particular inspection information, including a history of a work order or a summary of work orders on a given day is indicated in the report. These audits/reviews are now conducted electronically through CMMS and have been accepted by the FAA as sufficient, no longer requiring hard copy, signed documents. The report is also configured with embedded links between the report and live logbook or associated work orders allowing the FAA inspector a quick and direct way to evaluate any item on a report.

Financial Concerns

No financial concerns were raised at MKE. However, MKE conducted due diligence in determining the most financially effective CMMS platform and to ensure the proper level of configurability required to meet the airport's needs, in the context of the available applications.

Future Enhancements

MKE plans to develop more workflow to support the maintenance processes at the airport, including addition of tracking maintenance costs (labor, asset use, inventory, etc.), as well as additional statistical and analytical reports for management. The Airport hopes to incorporate licensing and permitting into the Cityworks application and is currently in the process of tying their SMS developments to the Cityworks data.

Document management integration will likely be with the County's OnBase EDMS for plan reviews.

Lessons Learned

The following list the lessons learned:

- Disaster recovery is a key element of system planning.
- Training for staff is critical.
- Correct entry of information is essential in maintaining the underlying database and in turn, the reports and processes that come out of the system.
- Processes will change with the adoption of new workflows. Everyone must buy-in to those changes.
- Get as many users as possible involved early in the requirements process.

Keys To Success

The following list the Keys to Success:

- Stakeholder engagement was essential. The stakeholders of the system were engaged early on in the development of the application requirements. The team utilized many white board sessions and workflow process developments to identify processes, needs, and any additional data required.
- The airport has a small technology support staff used to configure, customize, and develop additional functionality as needed. However, the GIS Coordinator is enthusiastic about the project and has given unparalleled support to the airport for this project and the consultants have been instrumental in providing any additional support to stakeholders.
- The application has been configured to make use of an unneeded module as an electronic logbook. These log entries can be directly linked to additional entries and, in turn, to work orders.
- A major feature of the implementation is that Part 139 daily inspection reports can be automatically generated. Work orders, airfield discrepancies, and any associated 139 requirements can all be recalled from the database and used to generate the report.
- At the behest of the Airports Deputy Director of Operations and Maintenance, the airports GIS Coordinator was certified in ACE to ensure a thorough understanding of the stakeholder needs.

Business Ownership & Stakeholder Engagement

From the inception of the CMMS initiative at MKE, the need for a thorough, accurate, integrated maintenance management solution has been driven by MKE leadership and adopted by various airport departments to support their processes and eliminate manual data flow. The MKE ownership has not only enabled the airport business to achieve a successful implementation, but also has provided momentum to expand the system capabilities to automate Part 139 inspections reports, and to provide workflow and centralized data for numerous business processes. MKE's integration of its GIS with its CMMS provides ease of use for airport users that encourages the use of the system.

Business & Technical Resource – Collaboration and Expertise

Departments using the CMMS engage in dialog with the GIS Office on a near daily basis in an effort to improve and enhance the effectiveness of the system. Therefore, CMMS users are extremely satisfied with the efficiencies that the system provides, and are complimentary of the support from the GIS staff.

Change Management

The small staff supporting the system makes the change process simple to manage. The GIS Office maintains testing and documentation of configuration changes. Any new functionality is tested on the production system, after prime hours of use. Daily back-ups are available for rollbacks in the case of issues with changes.

Applicability to Other Airports

Airports with mature GIS will be more likely to see the possibility of integrating a CMMS with GIS. The initial investment in GIS at MKE was started 16 years ago, and the maturity of that system was a key

factor in the selection of a CMMS. The airport users universally applauded the mapping capabilities within the CMMS.

The opportunity for MKE to develop an integrated solution for Part 139 was enhanced by the lack of an electronic logbook for the OCC. There was no need to consider the implications of integration, or to retrain users to different logbook software for the OCC. The benefits of an electronic logbook were clear to most users, but did there was some resistance to change in processes within the OCC. That resistance was overcome early and all CC users were enthusiastic about the improvements. The applicability to other airports that are manually recording logbook entries is high. Airports with stand-alone logbook applications will likely also find the automation and tracking for Part 139 discrepancies to be compelling.

MKE is providing for a best effort Safety Management System integration, although it is not yet regulated. Other airports considering a Safety Management System implementation may want to include integration language in any SMS procurement.

MKE provides a perspective on an innovative implementation of a system, specifically tailored to provide functionality not provided by other applications, and to integrate with existing systems to eliminate redundant data and processes.

Case Study Report 3:

Seattle-Tacoma International Airport CMMS Implementation & Use

Synopsis

Seattle-Tacoma International Airport (Sea-Tac) is a large West Coast hub airport, with a mature implementation of a CMMS. Maximo, the software that was implemented at Sea-Tac, is prominent in the airport industry for managing and maintaining assets.

The system is used to manage: wastewater treatment plants, pump stations and ancillary systems, maintenance facilities, administration buildings, passenger-loading bridges, ramp tower, auto shop, taxiways, runways, roadways, ramp area, aircraft parking, shuttles, operations support vehicles, non-revenue, electric vehicles, snow removal equipment, security, plumbing, IT, HVAC, electrical, communication, baggage, utilities, tanks, navaids, instruments, lighting, fuel infrastructure, drainage, FIMS, CUTE, CUSS, parking revenue control system, access control, parking structure, people mover stations, passenger terminals, parking garage/lots, buses for rental car facilities and employees (80 buses), electrical car chargers, and signage.

Interviewees

- Jennifer Mims – Senior Manager Asset Management & Logistics, Aviation Maintenance
- Valarie Johnson – Planning Supervisor, Aviation Maintenance
- Brendalynn Taulelei – Manager Business Systems, Aviation Maintenance
- Krista Sadler – Manager Program Office, Information & Communications Technology
- Delmas Whittaker – Logistics Manager, Aviation Maintenance
- Deb Sorenson – Asset Manager, Aviation Maintenance
- Kelsi Pothier – Business Systems Analyst, Aviation Maintenance
- Charles Goedken, C.M. – Manager International Operations, Airport Operations
- Dave Richardson – Airport Communications Center Duty Manager, Airport Operations
- Terry Tucker – Maintenance Manager Field Operations, Aviation Maintenance
- David Sanchez – Veteran Fellow SMS Project Coordinator, Airport Operations
- David Crowner - Airport Operations Manager

Operational Assessment

Maximo is used primarily to support the Aviation Maintenance Department's (AMD) work orders, preventive maintenance, and inventory. It has a larger role in helping the airport with a comprehensive sustainable asset management program, component renewal analysis, repair management and history, maintenance management and history, and reporting and dash boarding, all key factors in optimizing total cost of ownership.

Airport Description

The Seattle-Tacoma International Airport is located in the town of Sea-Tac, Washington, about 15 miles south of Seattle. The airport serves Seattle and Tacoma, as well as the rest of Western Washington. The airport is the most visited destination for vehicles in the state. Its 13,000-car parking garage is recognized as the world's largest parking structure under one roof. In 2012, the airport was ranked 15th in passenger traffic for US airports, serving over 33 million passengers. Destinations throughout North America, Europe, the Middle East, and East Asia are serviced from Sea-Tac. The airport is the primary hub for Alaska Airlines, and operates three parallel North–South runways that range from 8,500 feet to 11,900 feet long.

CMMS History at SEA

The airport began using Chief Advantage for work orders in the 1980s. An integrated solution, Worktech, was used for payroll and timekeeping. The transition was made to MRO, which later became Maximo. Maximo was subsequently purchased by IBM in 2006. That occurred before the airport did its last major upgrade of Maximo, from version 5.2 to version 7.1.

The airport's CMMS implementation has been through several phases, with a key phase identifying work processes and requirements for the system. With the last major upgrade, the Port of Seattle (Port), which includes both the seaport and the airport, consolidated their implementations of Maximo to minimize costs and optimize resources to manage and administer the system. The process of defining the common requirements for the system was protracted, taking about two years. The Port's IT department also moved management of their assets to Maximo during that upgrade.

Business Case

The Port has taken a programmatic view of asset management, and uses Maximo to support that program's goals. Before the last upgrade of Maximo, there was a reorganization within the airport. That reorganization impacted the AMD, serving to centralize some functions to optimize resources and efficiencies. This changed some processes within the department, including planning and procurement being done centrally instead of within each of the 16 maintenance shops. In addition, an Asset Manager's position was created within the AMD. That role was created to assist the airport in analyzing the role that maintenance plays in managing the total cost of ownership for its assets. Proactive asset management for the airport focuses, not just on the total cost of facility ownership, but also on environmental performance. The capabilities of Maximo are required to perform the analysis and to provide optimal maintenance in support of Sea-Tac's goals.

On the way to understanding how to best use the system to support asset management at the airport, the Port asked the following questions of its staff:

- What are our goals in using this system?
- What do we have that we need to manage?
- What are our processes?
- Are these processes documented?
- How do we want to use the maintenance management tool?
- What information is important to capture in the system?

This evaluation resulted in change management implementation and organizational structure changes. Processes were standardized and documented. Strategic goals were established. Training and performance measurements were key. An external audit that identified issues with assets was a major driver. Transparency was a major goal to improve AMD's performance.

- The airport has focused on using the system for its intended use in the AMD. Although integrating the airport's inspection application, Airport Inspector (developed in-house) has been considered, the decision was made to defer integrations until such time as the integration would improve workflow.
- The airport has a large number of its assets (>30,000) in its CMMS database.
- FAA Part 139 work orders are running work orders on a monthly basis. Operations uses their inspection application to manage inspections and Part 139 inspections. Integration with Maximo was not done because of the large number of work orders that Maintenance would have to manage to manage fulfill the requirements of the Part 139 inspections. Integration was considered and deferred until a future time.
- Integration with PeopleSoft procurement is an important enhancement that is underway.
- There is a hosted Safety Management System for the airport. It is not currently integrated with Maximo, but exchanging data between the two systems is being considered.
- Mobile applications are available for work orders and for inventory using a third-party product from InterPro called EZMaxMobile. It is deployed on IOS devices (iPhones and iPads). The product was chosen after an initial deployment of the Maximo mobile platform. EZMaxMobile does not require a separate Maximo mobile server to be installed. It is a mobile application with caching for information so that it works offline when Wi-Fi is not available.
- Inventory and assets are tagged with 2D barcodes.
- The AMD has centralized scheduling for its 16 shops. Maintenance planners and shop supervisors use a scheduling application (AKWIRE by Solufy) that pulls work orders from Maximo to assign and distribute work.
- Current integrations are with the fueling system, vendor interface (PeopleSoft), and time and labor system (PeopleSoft). Batch transfers are scheduled periodically from PeopleSoft to Maximo for these systems.

CMMS Implementation

Driver(s)

The Port decided to consolidate its implementation of Maximo across the airport and the seaport and include Information Technology, which was using a different asset and configuration management software.

Selection Process

There has not been a new product selected in the last several years. Success with the product, investment, and maturity in configuration, and user familiarity were some of the reasons to retain Maximo.

Airport Use of CMMS

The primary user of Maximo at Sea-Tac is the AMD, which supports 16 different shops within the airport, with about 350 personnel.

Organizations and the Use and Benefits of CMMS

Aviation Maintenance

Maximo supports three key initiatives in the AMD:

- Work management
- Inventory management
- Asset management

Operations

The Operations Department uses Maximo to provide documentation on work orders for FAA Part 139 discrepancies. In addition, the Operations Department is also a significant user of Maximo in their Airport Communications Center (ACC). The ACC utilizes the Maximo Service Desk ticketing module to log and track customer calls on emergent facility and system asset issues. There is an average of 1,200 calls monthly that go into ACC for maintenance issues, that are captured in Maximo and then routed to the Maintenance department for follow-up and action. This process provides another avenue for Sea-Tac to trend emergent issues being called in and identify any gaps in their maintenance programs.

Safety Management

Safety Officer uses Maximo to provide documentation on incidents for safety management.

Technical Support of CMMS

The airport IT staff supports the hardware and operating system for all airport systems, including Maximo. The AMD has staff that are responsible for application support in the following areas:

- Configuration and change management
- Customization and enhancements
- Development of additional functionality as the needs are identified

Implementation

Data in the system is organized hierarchically by system and location on the airport. Unit costs and quantities are captured. Condition and remaining life can be assessed, based on age or observation. Condition modeling can be used to offset the high cost of observation assessments for lower priority assets.

With the last major upgrade, the Port consolidated its implementations of Maximo to minimize costs and optimize resources to manage and administer the system. The process of defining the common requirements for the system was protracted, taking about two years. The Port's IT department also moved management of their assets to Maximo during that upgrade.

The last upgrade of the system was kicked off in 2008, and completed in September 2010. The decision to upgrade and consolidate Maximo was made at the highest level of the organization. The Deputy Director of the airport was a proponent, and internal in the department the general manager and senior leaders of the AMD were champions.

The last upgrade had three components:

- Physical infrastructure upgrades, including network hardware
- Implementation of a new version of Maximo (5.2-7.1) and consolidation of Maximo instances for the Port, the airport, and IT
- Enhancements:
    - Mobility (mobile applications for work orders and inventory)
    - Interfaces:
        - Payroll system
        - Vendor interface (PeopleSoft updates vendor data in Maximo)
        - Fuel system (Fuel Master for buses, and Phoenix Software for other vehicles)
        - General ledger updates to Maximo from PeopleSoft
        - New hires are populated in Maximo from PeopleSoft

It was not possible to phase the actual upgrade of the system. The old system (version 5.2) and the new system (7.1) were running in parallel for about two weeks, but the old system was kept up in read-only mode, for reference, during that time. A hot desk, staffed by the CMMS support team, was maintained 24/7 for about a week. The hot desk was available for issue resolution and application support. Users could call a central number or show up in person for assistance.

Change Management

Testing

The upgrade of Maximo to 7.1 was operated in a test environment before the cutover to the new version. After the cutover, the previous version was kept up for about two weeks in read-only mode for users to reference.

Training

There was extensive training for every staff member. Training was held no more than two weeks before the upgrade, and was conducted 24/7 to include all staff. All staff needed training because time reporting was moved into Maximo. Training was specific to particular roles within the organization. Training was developed in-house, with a training consultant to organize the material and tailor it to the airport's needs.

Business Continuity and Disaster Recovery Planning

All systems at the airport are backed up, and are represented in a disaster recovery plan. That plan is tested periodically. This is critical since most Port systems are running on virtual machines.

Regulatory

The airport uses the maintenance management system to track FAA Part 139 discrepancies.

Financial Concerns

There were no reported financial concerns.

Future Enhancements

Sea-Tac is considering future enhancements, including integration of the airfield lighting systems, GIS, and building management systems, with Maximo.

Lessons Learned

The following lists the major lessons learned:

- The processes that resolve problems are long-term. There was a five-year change process to address the goals identified in the audit.
- Centralized maintenance planners were hired to optimize resourcing. Scheduling was done in third-party software, but is integrated with Maximo. More efficiency between the shops, as well as within particular crews, can be achieved by using centralized scheduling. Centralizing the reporting structure for the maintenance planners made sharing of information, standardizing of processes, and sharing resources between the shops possible.
- Getting projects to provide all the asset data that can be used to populate the asset database is a challenge. Some information is turned over to the airport when the assets are commissioned, but the forms that are provided to the contractors are generally not completely filled out.

Keys To Success

Sea-Tac realized that not only does software not make a maintenance management organization successful; but also that success results from having the right organization and processes in place to support the long- and short-term goals of the AMD. With the airport reorganization in 2006, the AMD was restructured to better and more effectively support airport goals. The implementation of the software was structured to support the organization's processes and goals.

The Port took the time to understand how it wanted to use the system. In 2006, the AMD took a timeout to understand how to use Maximo to support the airport processes. During that period, the Port evaluated its goals for use of the system, and made the changes required to meet its goals.

Applicability to Other Airports

Most large airports will align with Sea-Tac in the need for efficiently managing the variety and complexity of assets in their operational environment. Airports will also be similar to Sea-Tac in understanding the need to minimize total cost of ownership of assets over the asset's life cycle.

Sea-Tac provides a perspective on a mature system that has been implemented to support the maintenance organization's goals. The tailoring of the system to support the airport, instead of trying to align the airport's processes to the system, is a valuable message.

Case Study Report 4:

Southwest Florida International Airport
CMMS Implementation & Use

Synopsis

Southwest Florida International Airport (RSW) is a medium-sized non-hub East Coast airport. It was chosen as a case study to provide information on a relatively young implementation of a CMMS. Maximo is the software of record, and is prominent in the airport industry for managing and maintaining assets. The system is used to manage: passenger-loading bridges, administration buildings, cargo, maintenance facilities, other ancillary facilities, elevators/escalators, aircraft parking, ramp area, roadways, runways, taxiways, bridges, drainage, fuel infrastructure, lighting, instruments, navaids, tanks, utilities, baggage, communication, electrical, HVAC, plumbing, security, elevated bridges, parking garage/lots, passenger terminals, and signage.

Interviewees

- Marvin Buford – Director of Maintenance Department
- James Hess – Agent, Airport Operations
- James Furiosi – Senior Manager, Maintenance Department
- Robert Moreland – Air Traffic Controller
- Angie Chestnut – CMMS Manager
- Phillip Murray – Director, Information Technology
- Margaret Crame

Operational Assessment

The system is used primarily to support the Aviation Maintenance department's work orders, preventive maintenance, and inventory. The implementation is relatively young, and there is a desire for additional functionality.

Airport Description

Southwest Florida International Airport serves more than 7 million passengers annually, and is one of the top 50 U.S. airports for passenger traffic. Currently, eighteen airlines provide RSW with nonstop service throughout North America, and international service to Canada and Germany.

CMMS History at RSW

The airport used a Canadian airport developed system to issue work orders. The system was rudimentary and did not have good reporting capabilities. There was little history functionality, and the airport realized that the system did not provide the functionality needed to manage asset life cycles, preventive maintenance, and resources.

The airport began implementation of the current CMMS in May of 2008. The implementation was complete in 2009. The implementation of Maximo was done by internal staff, a consultant, and the vendor. Maximo was chosen for its features and functionality as they suited the Maintenance Department's needs. Its ease of use was also a primary reason cited. History from the previous system was not migrated to Maximo.

CMMS Implementation

Driver(s)

Maximo was in place to manage the airport's baggage handling system. Maximo was required to handle PMs from:

- Johnson Controls', Metasys Facilities Management System (FMS)
- P2000 Security Access System

The airport also required the ability to integrate with:

- IDC Inventory and IDC Purchasing System
- PROPWorks lease management system

Drivers for the system included:

- Need to manage PMs
- Reporting for airport Assistant Aviation Directors to enable better decision-making
- Need for inventory control
- Better asset history to manage costs and plan replacements

Selection Process

The airport decided on Maximo because of its prevalence in the industry as well as a current implementation of Maximo at the airport to manage the baggage handling system. RSW hired a consultant to evaluate the requirements for Maximo at RSW. The evaluation began with an assessment of maintenance and inventory practices. Topics in this assessment included:

- Asset Management
- Maintenance Work Management
- Preventative Maintenance Management
- Airfield Management (FAA Part 139 and NOTAM)
- Organizational Transformation
- Purchasing/Inventory Optimization

The consultant worked with the airport to determine the implications of the following topics on configuration and implementation of Maximo:

- Location and asset hierarchy data
- Work request and work order requirements
- Scheduled maintenance
- Purchasing/ inventory management (IDC interface)
- FAA Part 139/NOTAM inspections, reporting, start centers, and key performance indicators

- Failure hierarchy (problem, cause, remedy)
- Interface (GIS, financial, and other)
- Implementation project plan

Airport Use of CMMS

The primary user of Maximo at RSW is the Aviation Maintenance Department. Operations is a stakeholder for Part 139 work orders. Planning is a stakeholder for budgeting capital costs.

Organizations and the Use and Benefits of CMMS

Maintenance Department

Maintenance Department, and the Assistant Aviation Directors, use the system to track work, build and view historical data, and track inventory.

Operations

Operations uses Maximo to provide documentation on work orders for Part 139 discrepancies.

Technical Support of CMMS

The airport IT staff supports the hardware and operating system for all airport systems, including Maximo. The Maintenance Department has staff responsible for application support in the following areas:

- Configuration and change management
- Customization and enhancements
- Development of additional functionality as the needs are identified

Implementation

The implementation was multi-phased:

- The first phase established logistics for the implementation.
- The second phase evaluated maintenance business processes to provide the information needed to provide a blueprint for configuration and workflows.
- The third phase was the implementation of the work requests/work order.
- The fourth phase was the implementation of the preventative maintenance module.

During the assessment, the following systems were reviewed for inclusion of elements and processes in the system implementation:

- System Configuration & Administration
    - Configuration Change Process
    - Security Profiles
    - Workflow Management
    - Report & Query Development

- Equipment & Locations
  - Hierarchies
  - Failure Codes
  - Systems
  - Asset Catalogs
- Preventive Maintenance & Job Plans
- Work Orders
  - Workflows
  - Work Types
  - Status Codes
  - Priorities
- Inventory
  - Storerooms
  - Reorder Points
  - Categories
  - Asset Catalogs

The following documents were reviewed:

- Business Process Documents
- Airport Certification Manual (Airfield Safety Inspection Checklist & Process)
- Key Reports
  - Work Order Backlog
  - PM Planning
  - Inventory Utilization
- Forms
  - Work Request
  - Work Order (if different)
  - Inspection Checklists
  - Material Requisition
  - Stock Request
- Policies / Procedures
- Organization Charts

During the implementation, in phase three, asset data was entered into the system. Data in the system was organized hierarchically by system and location on the airport. Unit costs and quantities are captured. Condition and remaining life can be assessed, based on age or observation. Condition modeling can be used to offset the high cost of observation assessments for lower priority assets.

Change Management

Training

Following the evaluation of requirements, the consultant-conducted immersion training session for Maximo based on the results of the evaluation.

Business Continuity and Disaster Recovery Planning

All systems at the airport are backed up, and are represented in a disaster recovery plan. That plan is tested periodically.

Regulatory

The airport uses the maintenance management system to track Part 139 discrepancy work orders. Operations has a separate bespoke application into which work order information for discrepancies is entered. The Part 139 maintenance and airport operational reporting requirements included:

- Airfield lighting
- Navigational aids

In addition, risk management required the following reporting requirements:

- Insurance requirements
- Property
- Vehicles

Financial Concerns

There were no reported financial concerns.

Future Enhancements

RSW is considering possible future enhancements, including integration of Maximo with GIS, data exchange with Operations inspections application, and building management systems.

Lessons Learned

The following lists the major lessons learned:

- Create well-defined requirements document before the procurement to ensure that the system chosen is adequate to meet the needs of the airport.
- Create policies (e.g., who can close a work order) and procedures (to incorporate work flow in the software to efficiently manage the assets).
- Include ongoing technical support in the budget.
- Training is a critical success factor, and needs to be addressed in the implementation. Ongoing training is needed as the system and the use of it evolves.

Keys To Success

RSW realizes that software does not make a maintenance management organization successful; that success results from having the right organization and processes in place to support the long and short-term goals of the Aviation Maintenance Department.

- The airport has focused on using the system for its intended use.
- The airport has a large number of its assets (>10,000) in its asset database. There is an ongoing effort to capture additional assets for inclusion in the database.
- Asset hierarchy is important to establish in such a way that makes them easy to find and manage. System hierarchy versus location hierarchy can both be supported. In lieu of a mapping component, the hierarchy is the way that users locate assets.
- The airport uses a grid layout and includes the grid coordinates on the work request to locate issues, particularly for pavement and grass. They also use the grid coordinates for centerline lights because newer lights are difficult to engrave.
- Price and price plus maintenance cost is captured so that the total cost of the asset is known.
- Estimated replacement date and costs are used to project capital expenditures and operating budgets forecasting.
- Airport is using the annual operating cost to gauge the replacement date for the asset based on the cost to maintain it. The airports plans to have Maximo do this automatically. Currently, reports are being run manually.
- The fuel system (Megatrax) holds mileage data. Next year (2015), that system will be integrated.
- All inventory and purchase orders are supported in Maximo.
- Integration with the County's One World JD Edwards financial software is planned for next year (2015).
- The CMMS also manages inventory. When inventory drops to a minimum level, Maximo can automatically generate the purchase order. The integration with the One World JD Edwards software is expected to generate a purchase requisition within One World.
- The preventive maintenance module issues PMs based on the periodicity of the PM. PMs can be hierarchical, e.g., 12-month maintenance of a vehicle is different than the 3-month maintenance, and it supersedes every fourth PM for that vehicle.
- After four years, the Maintenance Department is still growing the capabilities of the system. There is still potential for growth in utilization of the software. While the currently used features and functions of the system have greatly improved reporting and management capabilities, the airport expects to continue to get additional benefits as the implementation matures.
- The airport spent weeks of staff hours to input asset information that was available in spreadsheets and on hard copy documentation.
- The airport has a good concept of operations for inventory management that has been almost completely implemented within Maximo.

Applicability to Other Airports

Most airports will align with RSW in the need for efficiently managing the variety and complexity of assets in their operational environment. Airports will also be similar to RSW in understanding the need to provide the right information to airport management to be able to better manage their assets.

Case Study Report 5:

Ted Stevens Anchorage International Airport CMMS Implementation & Use

Synopsis

Ted Stevens Anchorage International Airport (ANC) is a medium-sized airport. It was chosen for a case study to provide information on an innovative implementation of Cityworks, a GIS-based maintenance management system. The implementation of Cityworks at ANC takes advantage of the airports mature GIS to locate assets on the airport. The system is used to manage: ramp tower, administration buildings, cargo, hangers, maintenance facilities, aircraft parking, ramp area, roadway, runways, taxiways, bridges drainage, fuel infrastructure, lighting, instruments, navaids, utilities, baggage, electrical, HVAC, plumbing, security parking garage/lots, passenger terminals, people mover stations, and signage.

The airport actively manages all assets, but pavement condition assessments are done by the Milwaukee County Department of Transportation.

Interviewees

- John Parrott – Airport Manager
- Marilyn Burdick – IT Manager
- Martin Pezoldt – Database Analyst II
- Jonel Schenk – Analyst/Programmer IV
- Zaramie Lindseth – Airfield Maintenance Manager
- Larry Swanson – Manager, Facilities
- Richard Swoboda – Building Maintenance Supervisor

Operational Assessment

ANC uses a custom-written CMMS that has been developed to meet the needs of the Airport to provide management for maintenance facilities, operations support vehicles, fuel infrastructure, lighting, baggage, IT, and other resources. Although the airport has considered off-the-shelf options, the system has been developed and tailored to meet the needs of the airport in a way that would require a great deal of customization from an off-the-shelf product.

The Engineering Department manages pavement condition assessments with another system, Micropaver.

Airport Description

Ted Stevens Anchorage International Airport is a major airport in the U.S. state of Alaska located 4 miles Southwest of downtown Anchorage. The airport is named in honor of Ted Stevens, the U.S.

Senator from Alaska serving from 1968 to 2009. ANC is at a strategic location to serve US air traffic to Europe and Asia. It is less than 9 ½ hours from 90% of the industrial world.

Due to its strategic location, cargo is a large component of the Airport's traffic. The Airport is ranked second in the U.S. for landed weight of cargo. It is among the top five airports in the world for cargo throughput. UPS and FedEx have major distribution centers in Anchorage. To accommodate cargo, about 60 wide-bodies aircraft land at ANC every week. The airport operates 24 hour a day, 7 days per week.

Of the approximately five million passengers who travel through ANC terminals, one third of them arrive during a three months period in the summer. That requires the airport terminals to have the capacity of an airport that would handle 8 million passengers annually.

ANC also houses the world's largest and busiest floatplane base, Lake Hood.

ANC covers approximately 4,500 acres and has three asphalt paved runways from 10,600 feet to 12,400 feet in length.

CMMS History at ANC

The airport began using a CMMS that was developed in-house in 1996. It was developed in conjunction with an Airport Information System (AIS), also under development at the same time. The first application for AIS was "Lost & Found," to track items for the badging office. The first maintenance application written was "Work Orders," in 1998. Airfield Maintenance quickly became the primary stakeholder and sponsor for the project, and worked directly with Airport IT staff to define requirements.

ANC's Airfield Maintenance department provides maintenance for aircraft movement areas, public roads, walkways, and other exterior airport infrastructure. Airfield Maintenance also provides management of all vehicles and heavy equipment owned by ANC. In addition, they use AIS for preventive maintenance, tracking assets (and inventory), resource management, and other related functions. Airfield Maintenance is subdivided into Field Maintenance, Equipment Maintenance, and Airfield Electricians. Within each of these sections are several other specialized shops including the Sign Shop, Machine and Welding Shop, Radio Maintenance, Parts and Supply, and OSHA Safety. There are approximately 110 users of AIS within Airfield Maintenance. AIS was developed to address the Airfield Maintenances department's requirements and has been incrementally modified as new requirements have been identified.

The current fleet of vehicles at ANC includes 395 pieces of rolling stock of all types including snow and ice removal vehicles, aircraft rescue and firefighting (ARFF) trucks, and light duty vehicles. Every year the airport replaces 6-10 major pieces of equipment and a few more light duty vehicles. The airport's core snow removal fleet is comprised of about 20 front snowplows and snow blowers.

An airport evaluation team was formed in 2005 to investigate the replacement of the AIS. However the airport stakeholders who were vested in the AIS were not convinced that a replacement would provide the same functionality at a reasonable cost. In addition, the work that had been done to incorporate workflow and required functionality within AIS would have to be redone.

The costs for development of AIS, and all its applications, were limited to resource costs for airport IT staff. Over the last eleven years (2003-2014), approximately 80% of one full-time equivalent employee (FTE) has been dedicated to development and maintenance of the system. In prior years (1996-2002), the resource cost was approximately 50% one FTE.

Business Case

ANC has a snow season that usually lasts from October through mid-April. The snow doesn't generally melt, but remains for the duration of the winter.

The airport has been closed due to volcanic ash, a windstorm, the 1964 earthquake and, like other U.S. airports, for a few days after 9/11. There are no records that show the airport has ever been closed due to ice or snow. A maintenance management system is critical to being prepared to manage snow. In addition to having the right equipment, it is important that airports maintain their equipment and not try to save cost relating to crews and supplies necessary to managing snow and ice.

As a state that is removed from the contiguous 48 states by thousands of miles, and one that has vast areas accessible only by air, Alaska's livelihood depends on its airports. Maintaining assets is critical to keeping the airport open.

The airport's Airfield Maintenance department realized the need to track assets and preventive maintenance for those assets required to keep the runways open. When the decision to develop an internal system was made, it was replacing an obsolete system, Software Solutions Maintenance Management System. Internal development was seen as a cost-effective replacement option that could be built to accommodate the airport's needs.

The Facilities Department has responsibility for trades and crafts that operate and maintain all the terminals, buildings, vertical structures, and utilities. In order to protect the public, these facilities are required to comply with some of the most stringent national and international building codes, fire protection, ventilation, security, Federal aviation, and other regulations unique to an airport occupancy.

CMMS Implementation

Driver(s)

The airport's Airfield Maintenance department had previously maintained a database with preventive maintenance records for various pieces of equipment. However, that database was stand-alone and did not integrate with any other airport, or State, applications or systems. It was developed to work in conjunction with CMMS. The Assistant Airfield Maintenance Manager was technically savvy and realized that additional efficiencies could be attained through sharing information from other systems. He enlisted the IT department's Database Administrator to provide solutions that met his department's requirements. In working closely with the Field Maintenance department over several years, modules were developed in AIS to address the department's needs. In addition, other airport applications were developed and integrated where possible.

Selection Process

IT worked directly with Airfield Maintenance to develop requirements were captured to support operational processes for maintenance management. The staff involved in developing the requirements was initially Airfield Maintenance, but later included Airport Facilities to include terminal assets.

Evaluation of CMMS Solutions

The decision to develop an internal solution was originally based on cost. Subsequently, the customizations that had been developed in AIS became compelling factors to keep the bespoke solution in lieu of off-the-shelf solutions.

Key Points

The success of the system is due to several factors:

- Stakeholder engagement is a key factor. The stakeholders of the system were engaged in development of the requirements. The process has been incremental and addressed needs as they arose.
- The airport has a small technology support staff to configure, customize, and develop additional functionality as the needs are identified. Originally, only one database administrator/developer was available to support the system. An additional programmer/analyst was deemed critical to long-term sustainability of the system and hired for system development, documentation, and support.
- The airport has most of its assets in its asset database. Initial stock requests are issued, and on receipt of an invoice, assets automatically populate the asset database.
- The IT staff responsible for the development of the AIS and the staff's dedication to meeting the needs of the airport was another key point.

Airport Use of CMMS

Organizations and the Use and Benefits of CMMS

The primary user of the asset and maintenance management applications, and of the inventory application, is Airfield Maintenance. Other airport users are shown in Table B5-1.

	Activity Tracking	Asset Management	Inventory	Reporting	Personnel
Airfield	■	■	■	■	■
Facilities	■	■	■	■	■
Operations					■
Police & Fire	■	■	■	■	■
Badging		■			■
Safety					■
Development				■	■
Leasing	■	■		■	■
IT	■	■			■

	Activity Tracking	Asset Management	Inventory	Reporting	Personnel
Marketing				■	■
Environment					■
Engineering		■			■
Planning					■
Noise					■

Table B5-1. Airport Users of the CMMS

The implementation of the system was organic, developed as needs were identified. The gradual development over many years has allowed functionality to evolve as users identified the ways in which the system could improve their effectiveness and make their jobs easier.

That development has led to the development of other modules, as shown in Table B5-2, not specifically related to assets and management of them, but that interface with the assets and maintenance records. In some cases, AIS also interfaces with accounting applications utilized by the State of Alaska.

Asset Management	Activity Tracking	Inventory Tracking	AIS Reporting	Personnel
Assets	Work Orders	Stock Requests	Equipment Admin	Personnel
Key Master	PF Case Card	Inventory	Email Ticklers	Employee Time
Vehicle Permits	Leasing Priorities	Vendor (SR)	Equipment Adhoc	Safety Timesheets
Facilities Inventory	FMDailyLog	HazMat MSDS	Management	Time Clock
Artwork Inventory	Sign Out Board	GasBoy	AIS Reports	Dispatch
Meter Readings	Inventory		Personnel	Work Schedule
Conference Rooms	What's Due			Leave Calendar
Engineering Drawings				Mailing Lists
Fixed Assets				OT Reporting
Phone List				Training Log
Activity Tracking				Police & Fire Training Log

Table B5-2. Additional Modules

Activity Tracking allows the recording of work accomplished or any other situation in which personnel perform a duty that should be recorded. This is the most used function of AIS with more 40,000 Work Orders generated annually.

Inventory tracking records the requisition, receipt, and distribution of consumables, spares, and stock items. This generates a purchase request; but purchase orders are done through the State of Alaska procurement system. Receipt of goods is entered into AIS through the stock request module, which

populates inventory and asset databases. There are approximately 30 reports available in the AIS Reporting module. Ad hoc reporting is supported, using a third-party tool.

Personnel reporting tracks information about both personnel at the airport and associated contact information. Mobile applications are used in the warehouse; and inventory is done by scanning barcodes on parts and assets.

Technical Support of CMMS

Implementation

The IT department at ANC supports the AIS and the CMMS applications. Staff consists of a Database Analyst and a Programmer/Analyst. IT department is also responsible for additional hardware support.

Change Management

The IT department provides change management for the application.

Business Continuity and Disaster Recovery Planning

Databases reside on mirrored servers in different locations. Servers, storage, and mechanicals are redundant. Daily back-ups are made of the database and all four servers.

Regulatory

The Cityworks system has become a critical tool in the administration of Compliance Part 139 reporting. A current Safety Management System initiative will develop integration with Cityworks to attempt to comply with the upcoming release of the FAA Advisory Circular for Safety Management Systems.

Part 139 inspections are generated through process flow in Cityworks or through logbook entries by the Control Center staff. If a work order is generated to address a discrepancy, it is flagged as a Part 139 work order, and asset cannot be returned to service without inspection and sign-off by Operations. Maintenance then returns the asset to service and closes out the work order.

ANC performs Part 139 inspections for every shift. An inspection report can be generated entirely automatically. An FAA inspector can ask for a particular day of inspections information including a history of a Work Order or a summary of Work Orders on a given day. These audits/reviews are now conducted electronically through CMMS and have been accepted by the FAA as sufficient, no longer requiring hard copy, signed documents. Logbook entries and work orders are linked to the reports, so that the FAA inspector can examine the process entirely electronically.

Financial Concerns

No financial concerns were raised at ANC. However, ANC conducted due diligence in determining the most financially effective CMMS platform and to ensure the proper level of configurability required to meet the airport's needs, all within the context of the available applications.

Lessons Learned

The following list the lessons learned:

- A single resource was responsible for development and support for the system. There is risk in having a single developer. If the staff member retires or takes another job, the airport would struggle to maintain the system. Recognizing this, the airport has hired additional development and support personnel for the system.
- Documentation is important for users to buy in to the system. Departments not as involved in the development were more reluctant to use the system. That was in part due to the lack of available documentation.
- Flexibility in the system architecture is key to system enhancements, expansion, and growth. Hard-coded parameters may limit the ability to change the system as desired for additional functionality.

Keys To Success

The following highlight the keys to success:

- A key sponsor was responsible for the development of the system.
- Because the personnel developing the system was an airport resource, budgeting was not a key issue.
- The system has been in use for almost twenty years, and users are still satisfied with it because it was tailored to their requirements with continued improvements over time as requirements changed.
- The relationship between the users and the systems' support staff.
- The system has asset management and CMMS functionality, but has additional enhancements not usually seen in a CMMS.

Business Ownership & Stakeholder Engagement

From the inception of the AIS and the beginning of a CMMS initiative at ANC, the need for a thorough, accurate, integrated maintenance management solution has been driven by an internal ANC sponsor and adopted by other airport departments to support their processes and eliminate manual data flow.

Business & Technical Resource – Collaboration and Expertise

Departments using the CMMS engage in dialog with the IT department to improve and enhance the effectiveness of the system. The airport has a small but dedicated technology support staff, to configure, customize, and develop additional functionality as the needs are identified. CMMS users are extremely satisfied with the efficiencies that the system provides, and complimentary of the support from the IT staff.

Change Management

The small staff supporting the system makes the change process simple to manage. The IT department maintains documentation of configuration changes. Any new functionality is tested on the production

system, after prime hours of use. Daily back-ups are available for rollbacks in the case of issues with changes.

Applicability to Other Airports

The initial investment in CMMS at ANC was started more than in the mid-1990s, in response to the end-of-life of a previous system. The capabilities within the Airfield Maintenance and IT departments led to a collaboration that has worked well over the years. The functionality of the suite of applications within AIS, including the CMMS, is their specificity to the airport's processes. The applications were built to support more efficient operations at the airport, to eliminate redundant data entry, as well as to automate processes.

The ability to create unique software tailored to specific needs is undeniably a great benefit to an airport that can provide the development and support staff.

ANC provides a perspective on an innovative implementation of a system, specifically tailored to provide functionality not provided by other applications, and to integrate with existing systems to eliminate redundant data and processes.

APPENDIX C: CMMS Evaluation Tool – User Guide

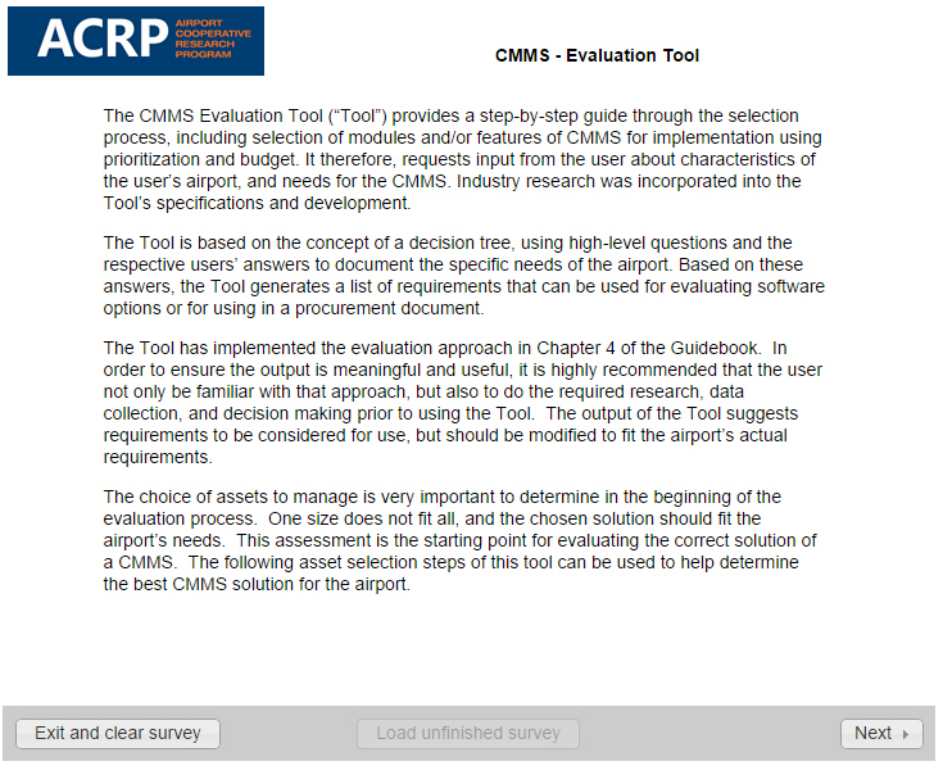
The CMMS Evaluation Tool is fully self-contained on the CD. Because it does not require that the user maintain any subscriptions to software of any kind, the tool will run locally on most personal computers or laptops "out of the box."

NOTE : Respondents can run the CMMS Evaluation Tool locally on their computers, by inserting the provided CD and running the autoplay option.

.

- A startup screen will open on the default browser.

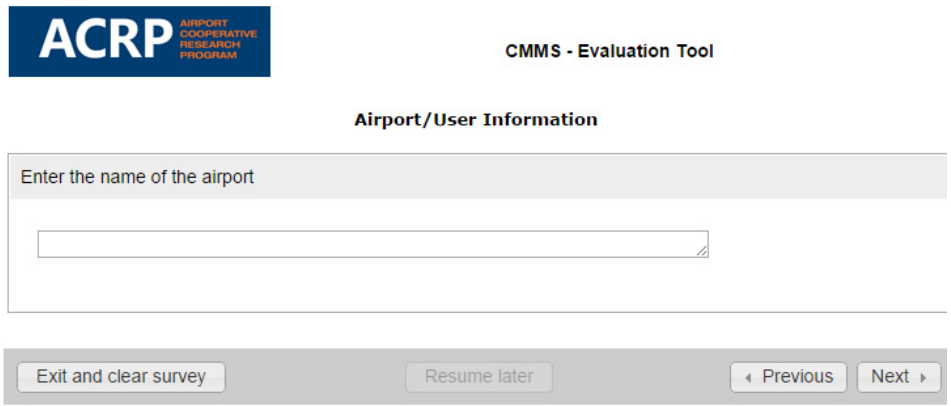
- ✓ Click the "Start Tool" button - A summary and instructions on how to use the Evaluation will show on the next screen (see screenshot following).



Introductory Questions

Every respondent will be asked the following introductory questions to initiate the interactive questionnaire process:

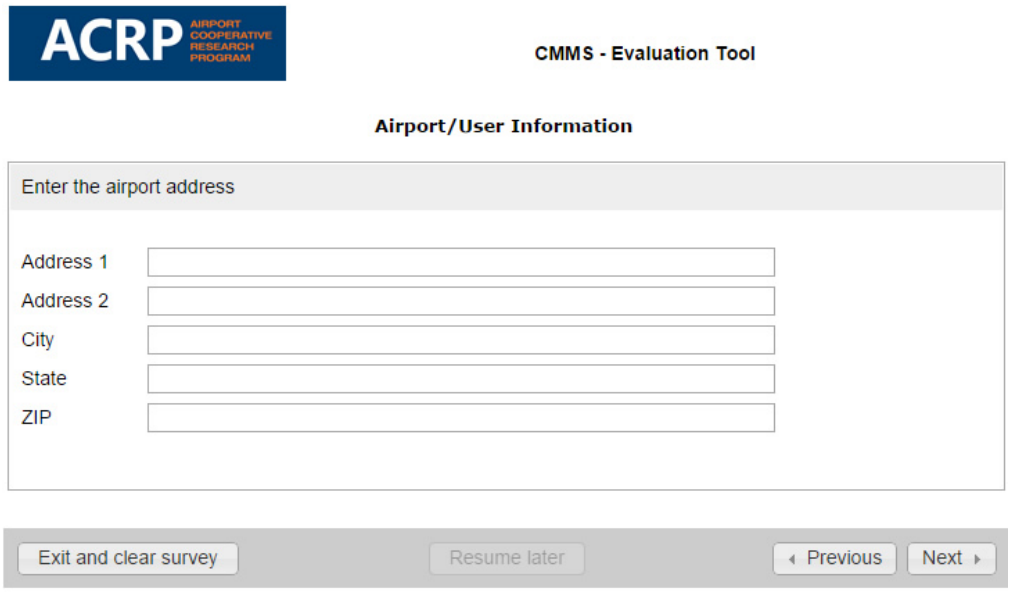
Enter the name of the airport.



✓ Click the "Next" button to show the following screen

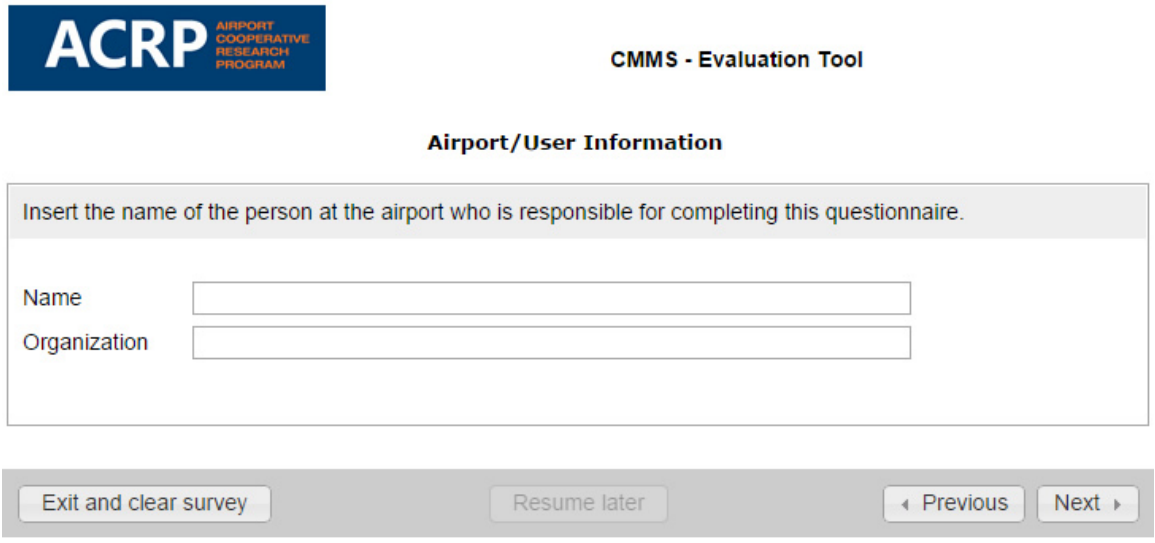
This question inserts the entity name – just as it is entered - onto the cover page of the List of Requirements that can be used for evaluating software options or for using in a procurement document.

Enter the address of the airport



✓ Click the "Next" button to show the following screen

Enter the name of the person at the airport who is responsible for completing all steps in the CMMS Evaluation Tool.



✓ Click the "Next" button to show the following screen

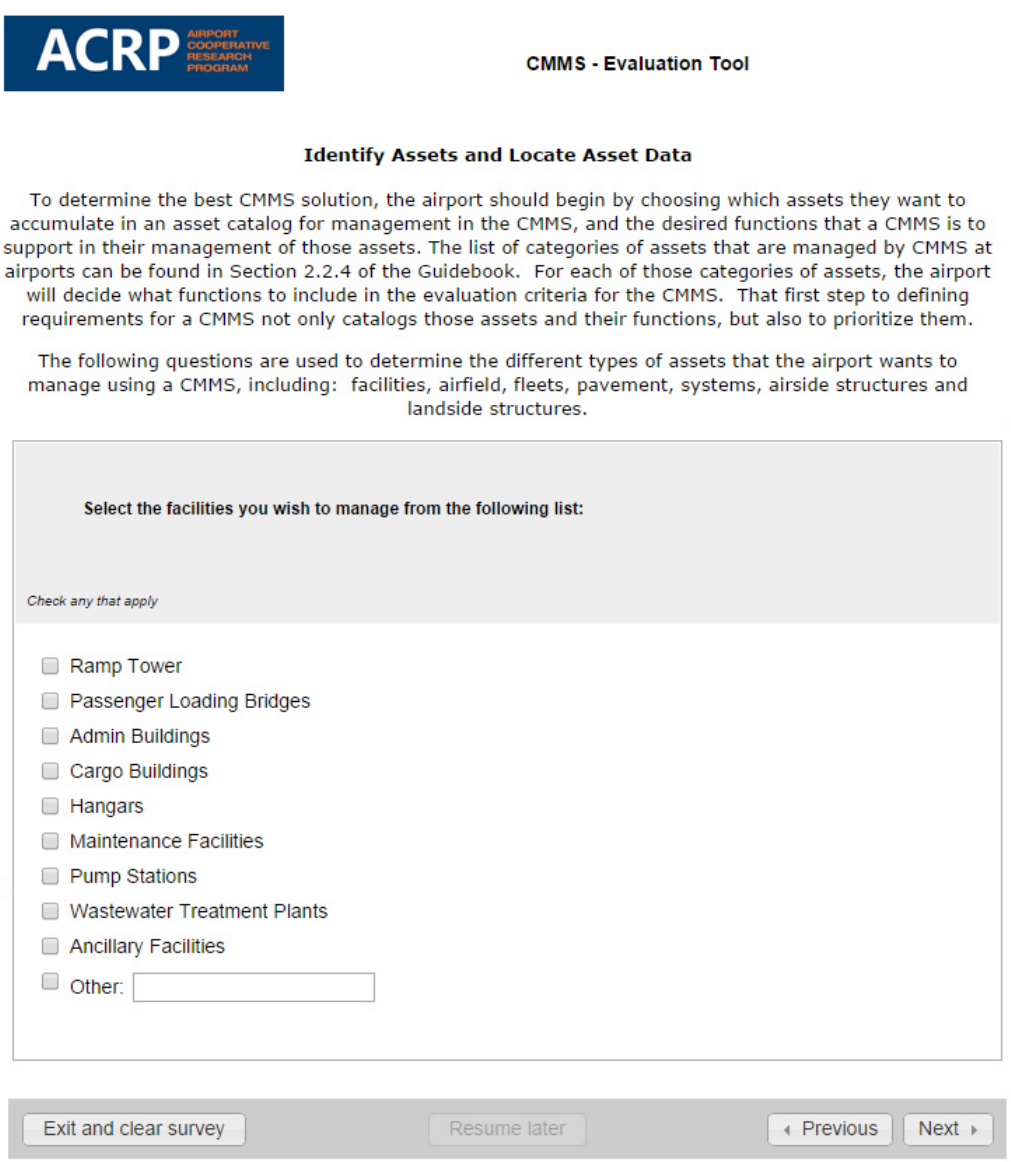
Step 1. Determine which assets the airport wants to manage using a CMMS.

To determine a best CMMS solution, the airport should begin by understanding which assets they will want to accumulate in an asset catalog for management in the CMMS, and the functions that a CMMS will support in their management of those assets. The first step to defining requirements for a CMMS catalogs those assets and functions, and prioritizes them based on a scale of the airport's choice.

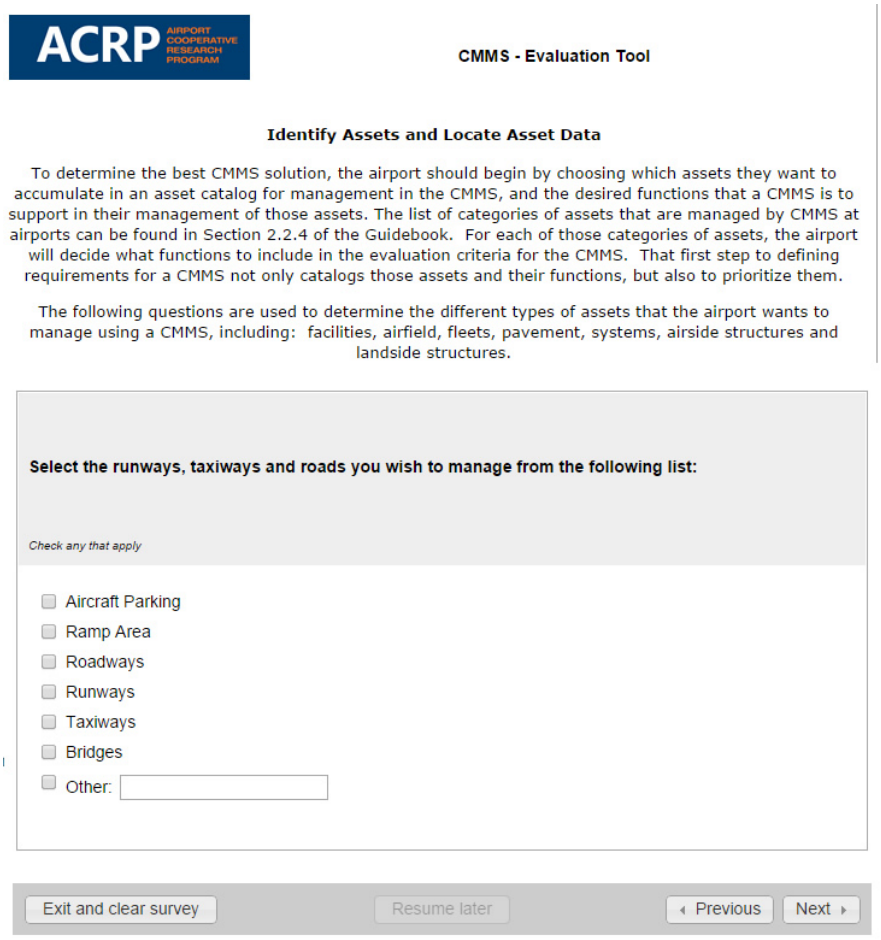
The following questions are used to determine the different types of assets that the airport wants to manage using a CMMS, including: facilities, airfield, fleets, pavement, systems, airside structures, and landside structures.

Refer to the Guidebook's Chapter 4, **Step 1: Choose CMMS Assets** for more information.

- ✓ Click the "Next" button to show the following screen

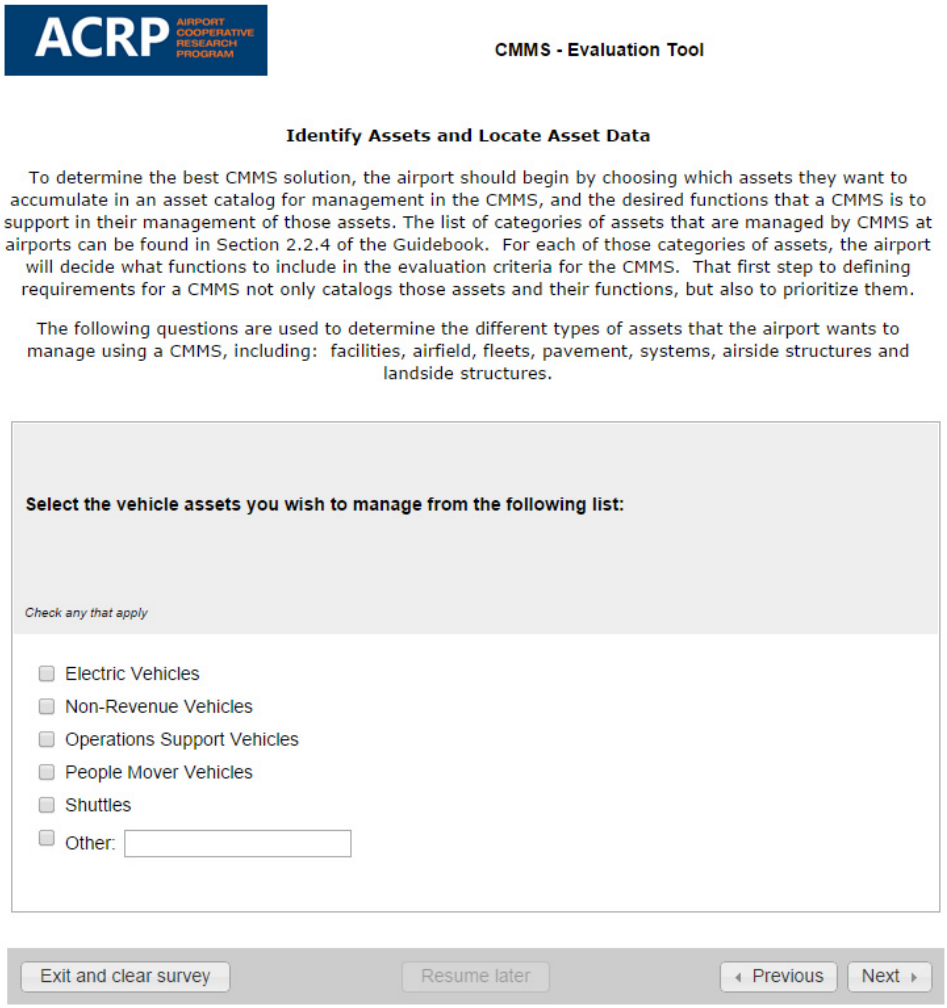


- ✓ Select the Facilities Assets that shall be managed with a CMMS.
- ✓ Click the “Next” button to show the following screen

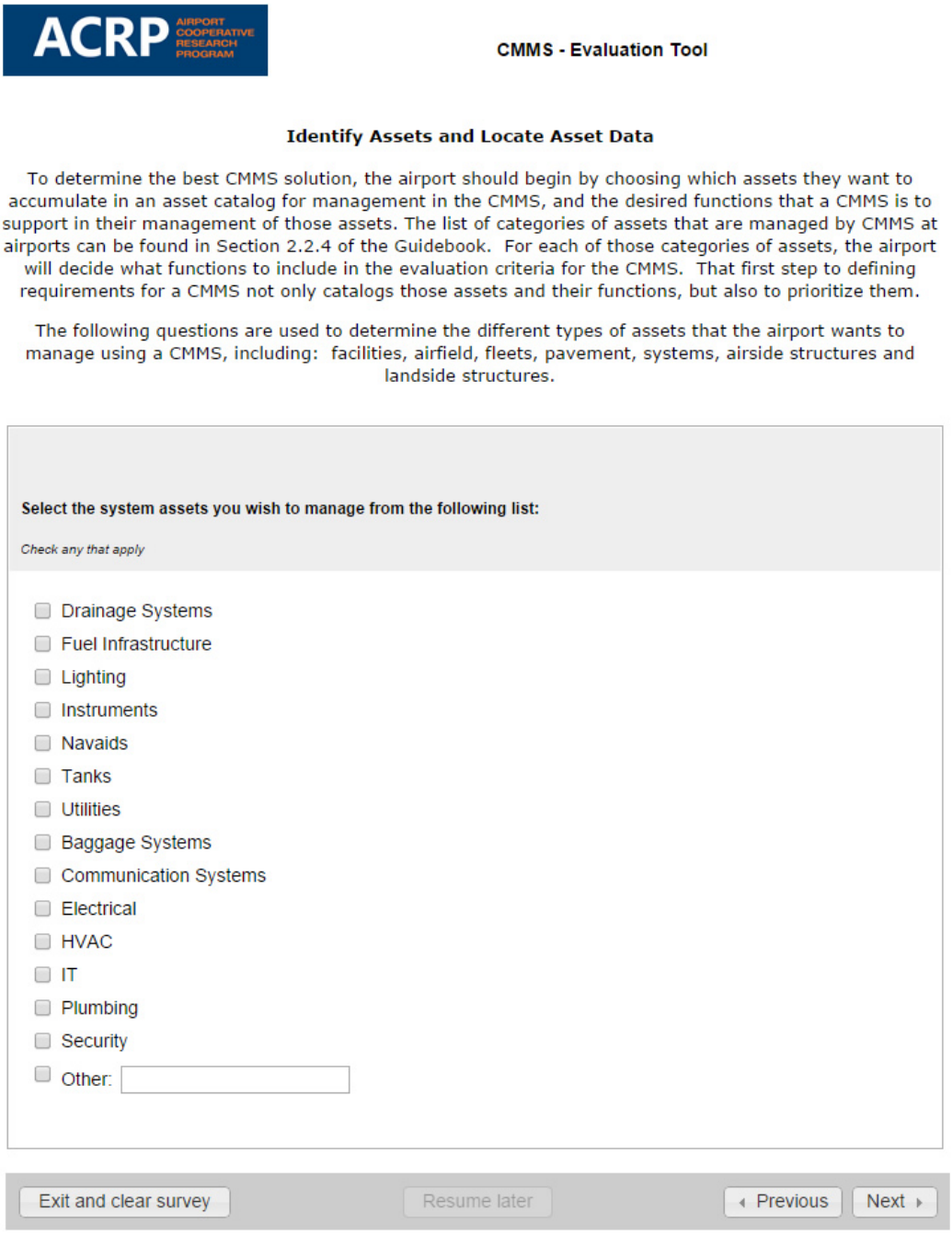


✓ Select the Runways, Taxiways and Roads that shall be managed with a CMMS.

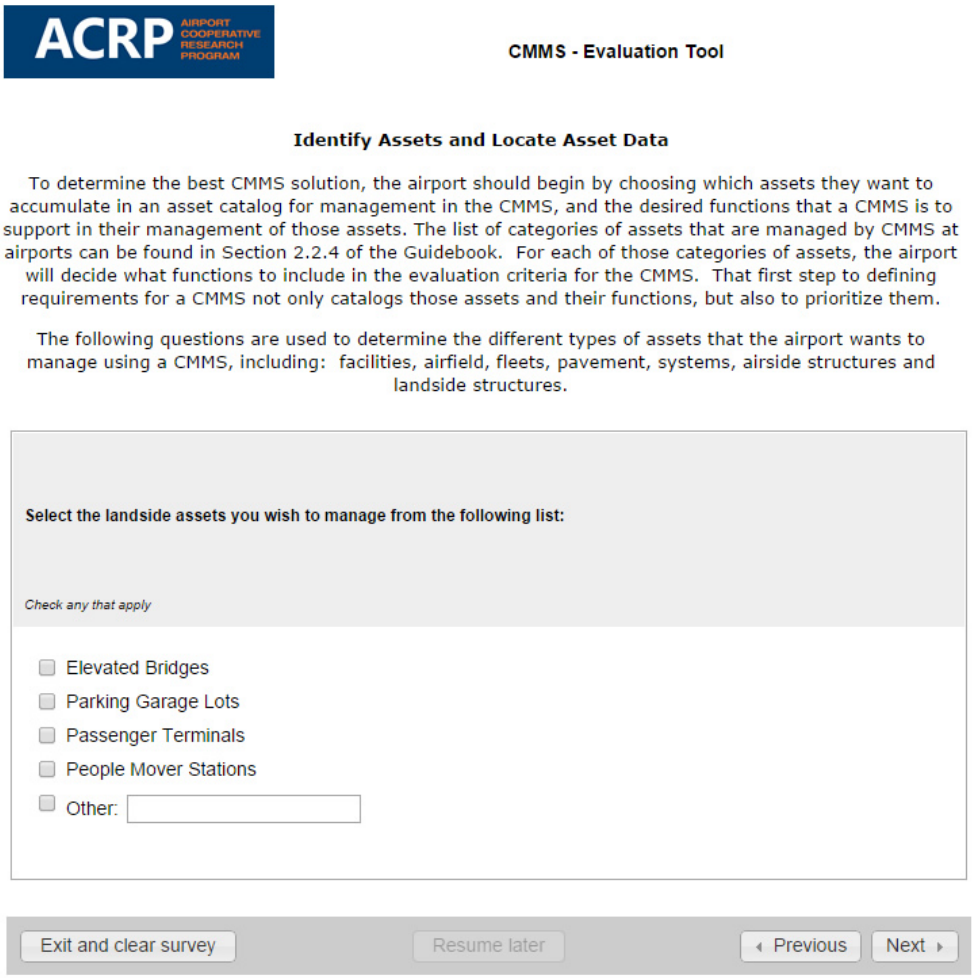
✓ Click the “Next” button to show the following screen



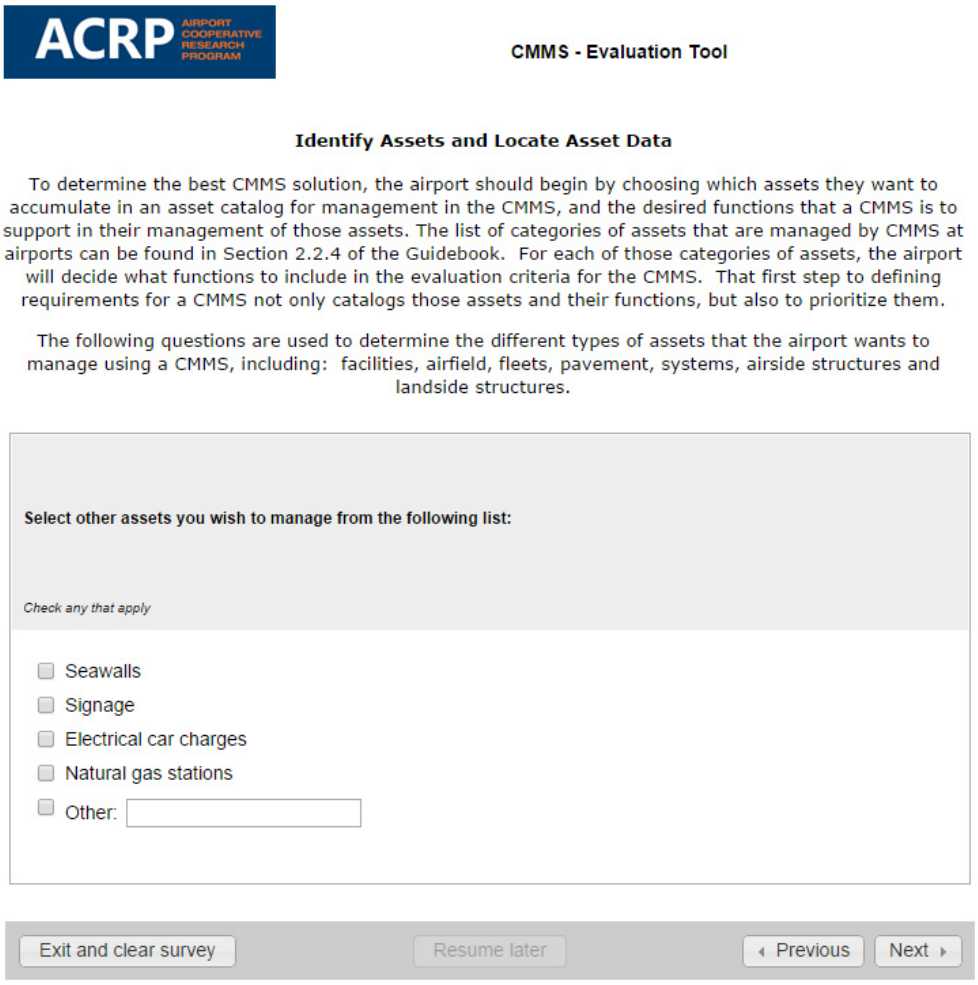
- ✓ Select the Vehicle Assets that shall be managed with a CMMS.
- ✓ Click the “Next” button to show the following screen



- ✓ Select the System Assets that shall be managed with a CMMS.
- ✓ Click the “Next” button to show the following screen



- ✓ Select the Landside Assets that shall be managed with a CMMS.
- ✓ Click the “Next” button to show the next screen



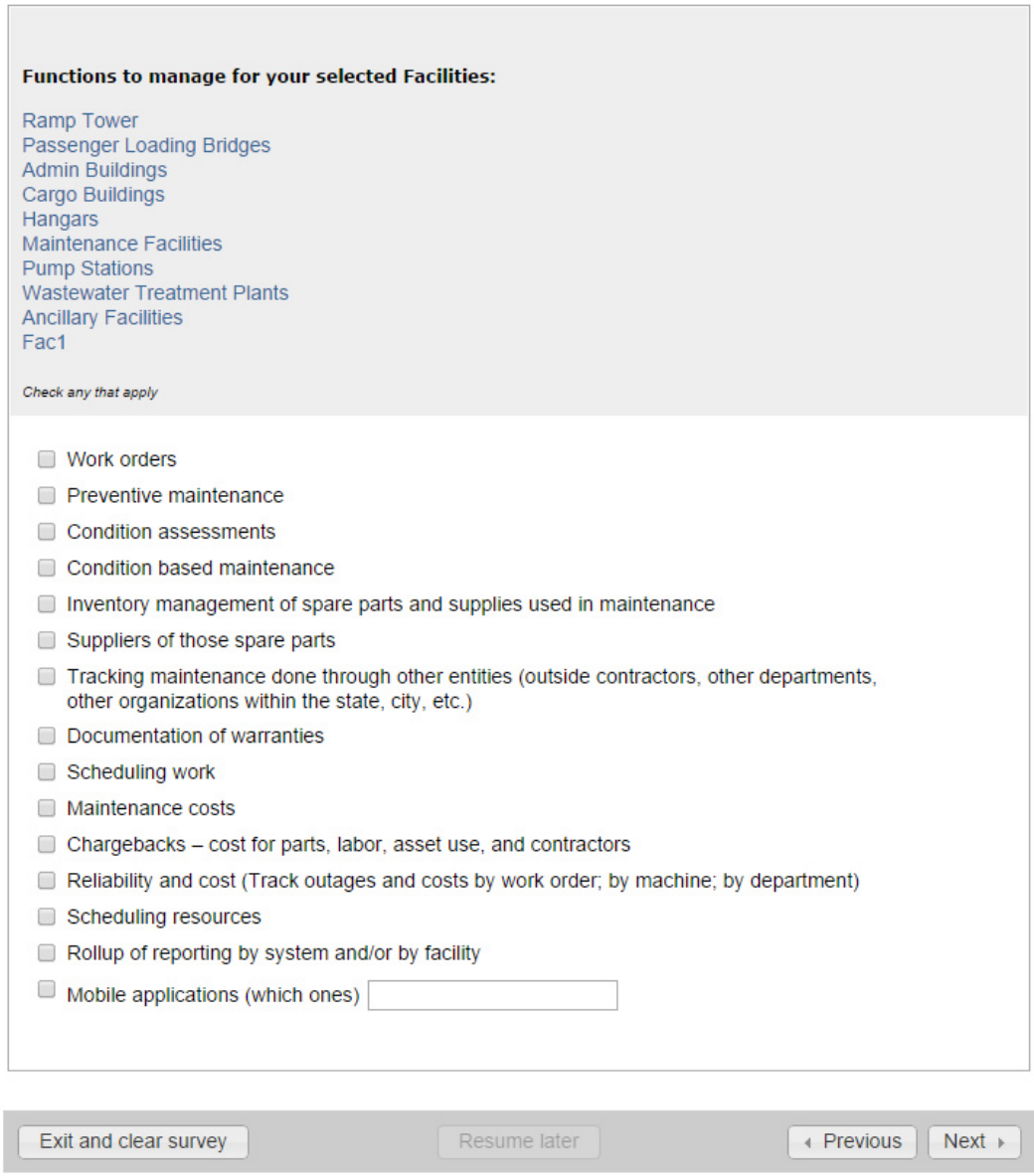
- ✓ Select Other Assets that shall be managed with a CMMS.
- ✓ Click the “Next “ button to show the following screen.

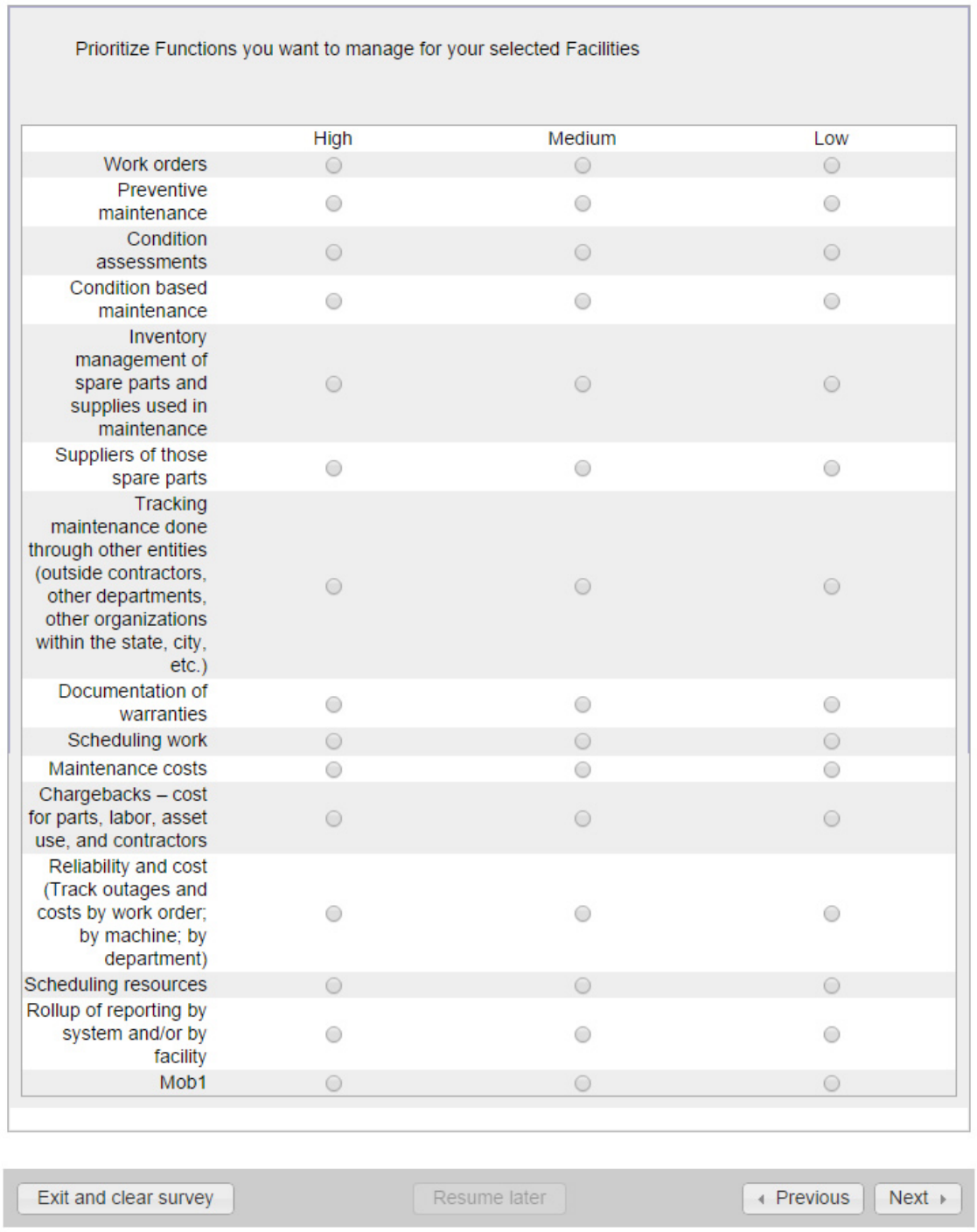
Step 2. Decide How To Manage the Selected Assets in the CMMS

From here on, the next series of windows will allow the user to identify how the airport wants to use the CMMS to manage the selected assets. For this purpose, a list of CMMS functions that can be used to manage asset will be presented. Refer to Guidebook Chapter 4 **Step Two. Decide How To Manage the Selected Assets in the CMMS** for detailed information.

- ✓ Select the « Functions to be managed » related to the selected asset group (i.e., facilities, airfield, fleets, pavement, systems, airside structures, landside structures, or other assets)
- ✓ Click « Next » to move the next group of assets

- ✓ Once the selection of functions for the last group of selected assets has been completed, the prioritization task will start in the following screen





The next task is to prioritize the “Functions” that can be used to manage the selected groups of assets.

The following table explains the scale and helps the user to understand what is meant by “High”, “Medium”, and “Low”.

High	Mission critical requirement
Medium	Required eventually but could wait
Low	A enhancement that would be nice to have when resources permit

- ✓ Select “High”, “Medium” or “Low” to prioritize the Functions for each of the group of assets.
- ✓ Click the « Next » button

Once the prioritization process is completed, a summary of all selected data will be presented, indicating if the information will be added to the List of Requirements (High priority), the list of items to be reevaluated for Cost Analysis (Medium priority) or to the Nice-to-Have List (Low priority).

The following (see next pages) are sample summaries of Functions that will be added to the List of Requirements, Functions that will be added to the Cost analysis for reevaluation based on budget, and Functions that will be added to the Nice-to-Have List. The information is grouped by Asset type.

The followng functions will be added to the **List of Requirements**

Facilities Assets
Work orders
Preventive maintenance
Condition assessments
Condition based maintenance
Inventory management of spare parts and supplies used in maintenance
Suppliers of those spare parts
Tracking maintenance done through other entities (outside contractors, other departments, other organizations within the state, city, etc.)
Documentation of warranties
Scheduling work
Maintenance costs
Chargebacks – cost for parts, labor, asset use, and contractors
Reliability and cost (Track outages and costs by work order; by machine; by department)
Scheduling resources
Rollup of reporting by system and/or by facility
Mob1

Runway, Taxiways & Road Assets
Work orders
Preventive maintenance
Condition assessments
Scheduling work
Maintenance costs
Chargebacks – cost for parts, labor, asset use, and contractors

Vehicle Assets
Condition assessments
Inventory management of spare parts and supplies used in maintenance
Suppliers of those spare parts
Tracking maintenance done through other entities (outside contractors, other departments, other organizations within the state, city, etc.)
Scheduling resources
Rollup of reporting by system and/or by facility
Mob3

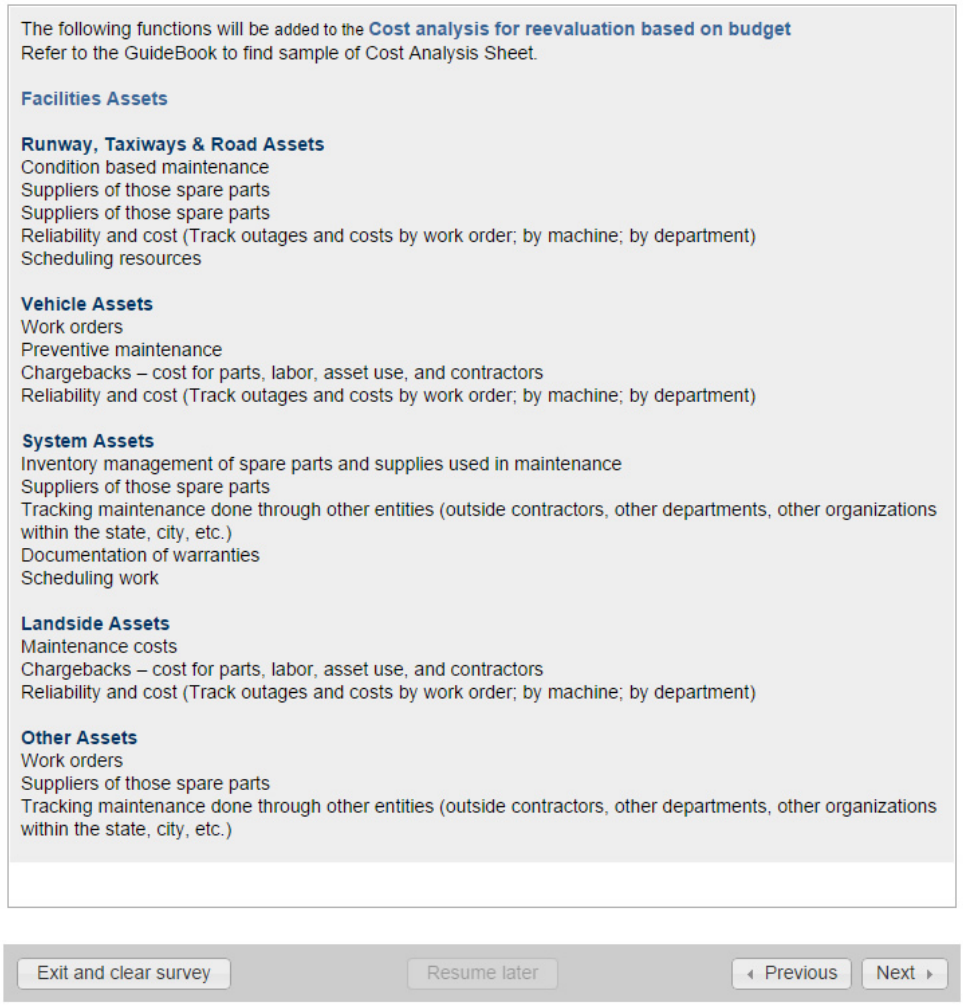
System Assets
Work orders
Preventive maintenance
Condition assessments
Condition based maintenance
Chargebacks – cost for parts, labor, asset use, and contractors
Reliability and cost (Track outages and costs by work order; by machine; by department)
Scheduling resources
Rollup of reporting by system and/or by facility
Mob5

Landside Assets
Work orders
Preventive maintenance
Condition assessments
Condition based maintenance

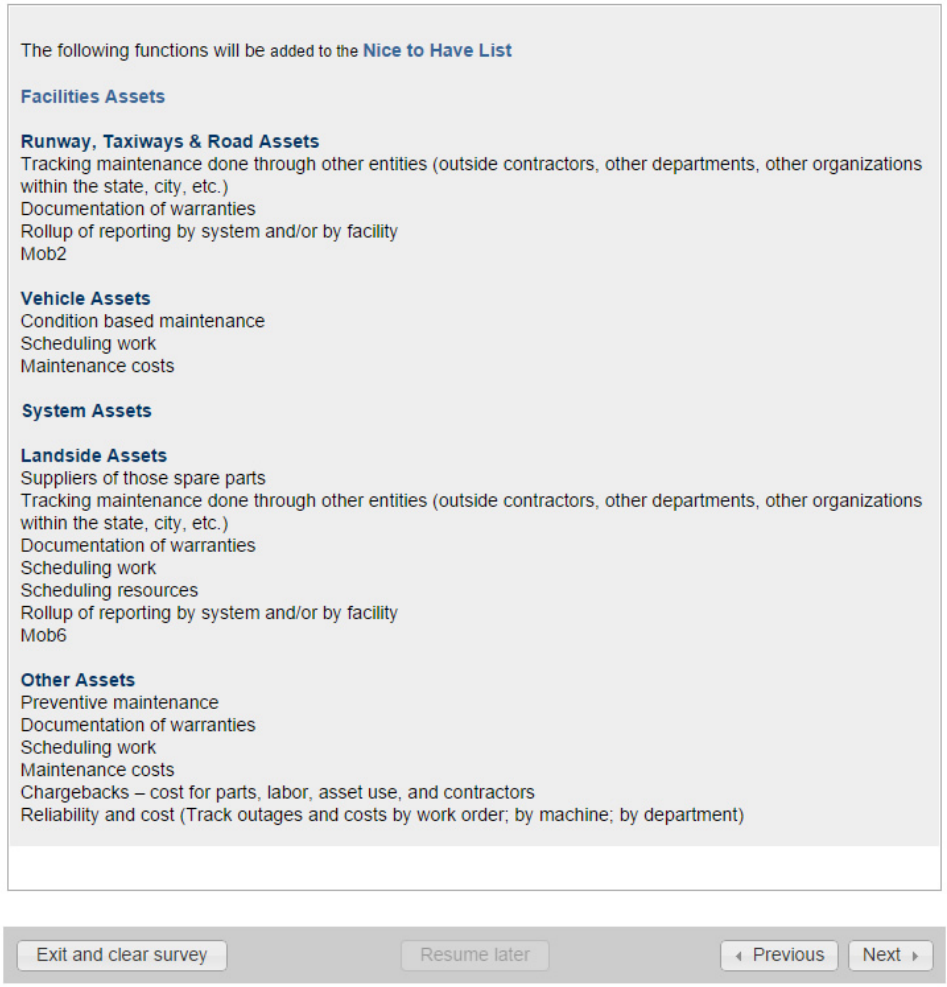
Other Assets
Condition assessments
Condition based maintenance
Inventory management of spare parts and supplies used in maintenance

Exit and clear survey | Resume later | Previous | Next

✓ Click the “Next” button to move to the summary of functions that will be added to the Cost analysis for reevaluation based on budget.



✓ Click the “Next” button to move to the summary of functions that will be added to the Nice-to-Have List.

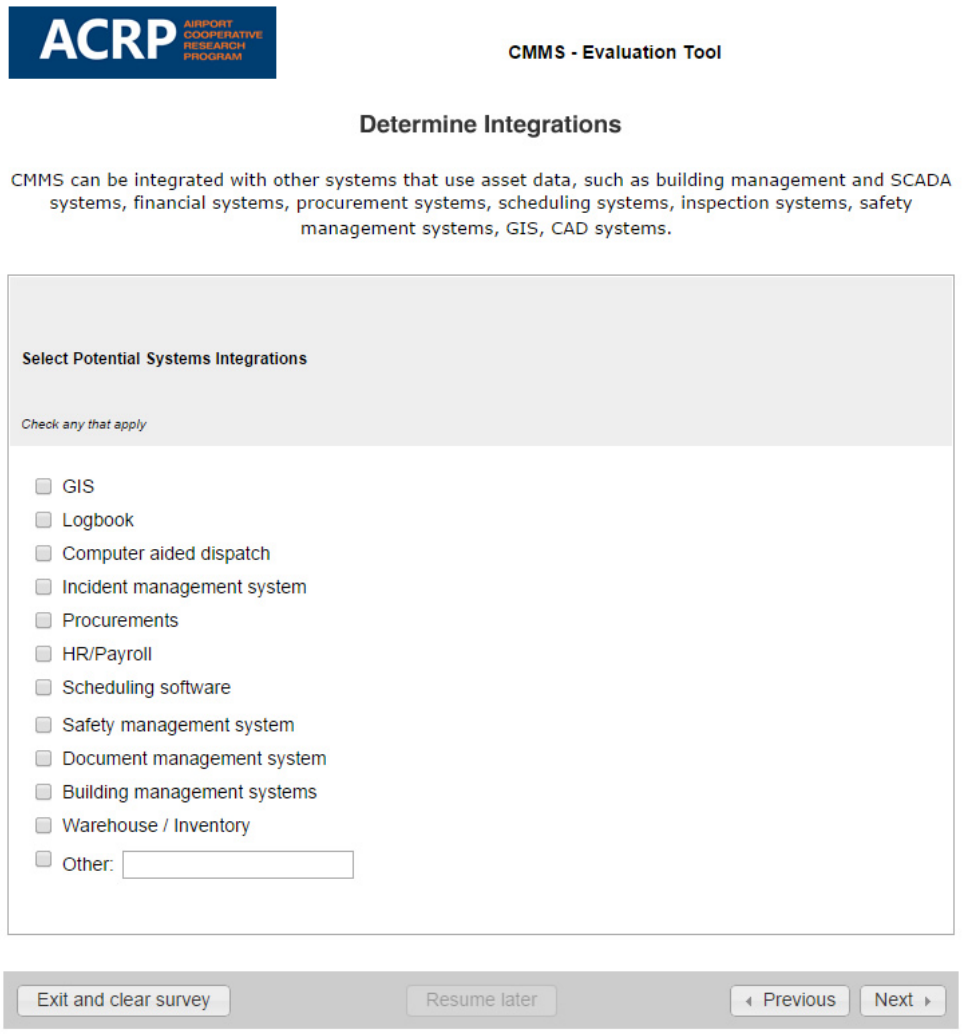


✓ Click the "Next" button to move to Step 2.

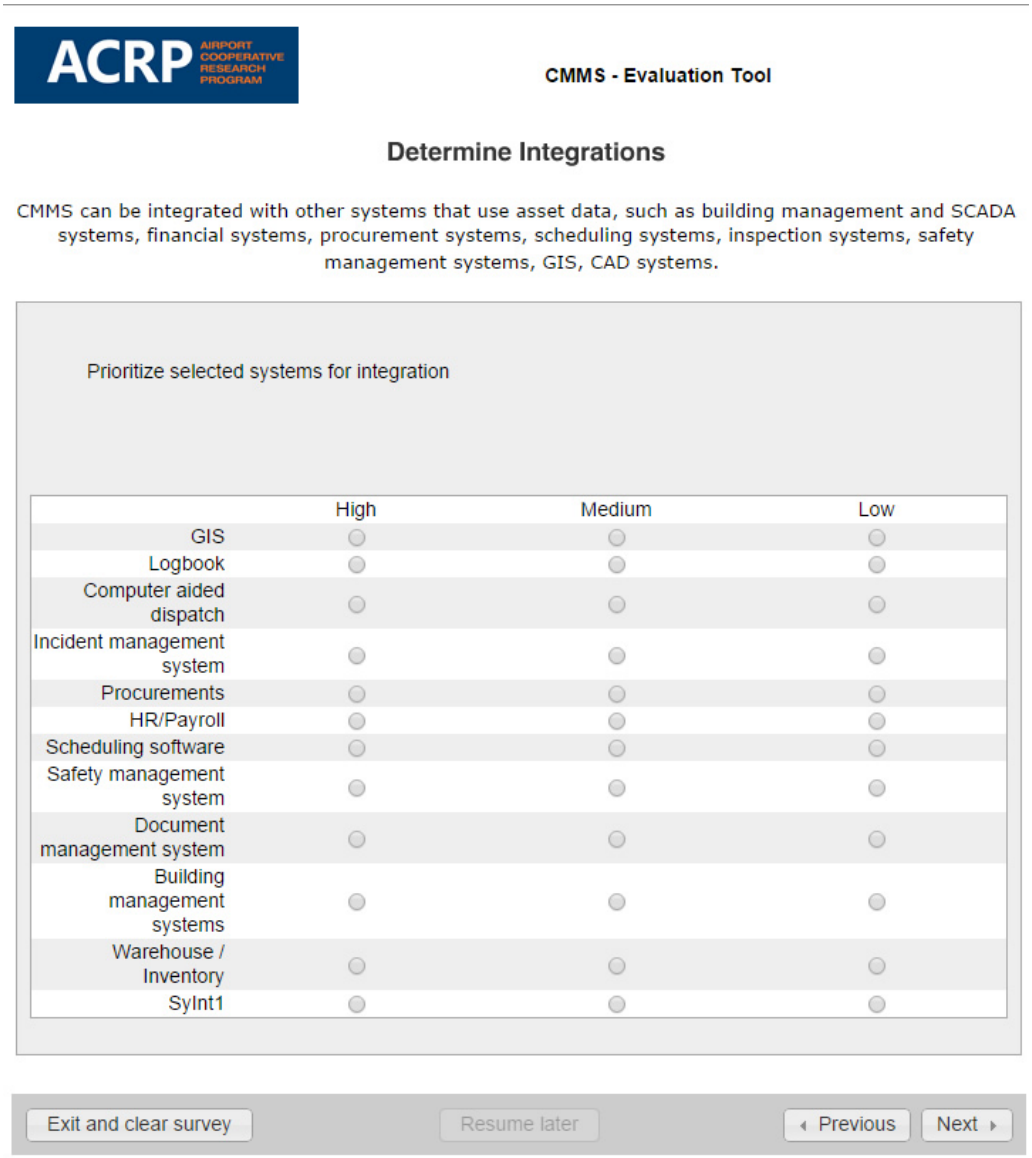
Step 3. Determine Integrations

The next step of the CMMS Tool is to Determine Integrations – see screenshot below.

The CMMS can be integrated with other systems that use asset data, such as building management and SCADA systems, financial systems, procurement systems, scheduling systems, inspection systems, safety management systems, GIS, and CAD systems, among others. Refer to Guidebook Chapter 4 **Step Three: Identify Integrations** for more information.



- ✓ Select the systems to be integrated with CMMS
- ✓ Click the “Next” button to show the following screen and prioritize the selected systems integrations

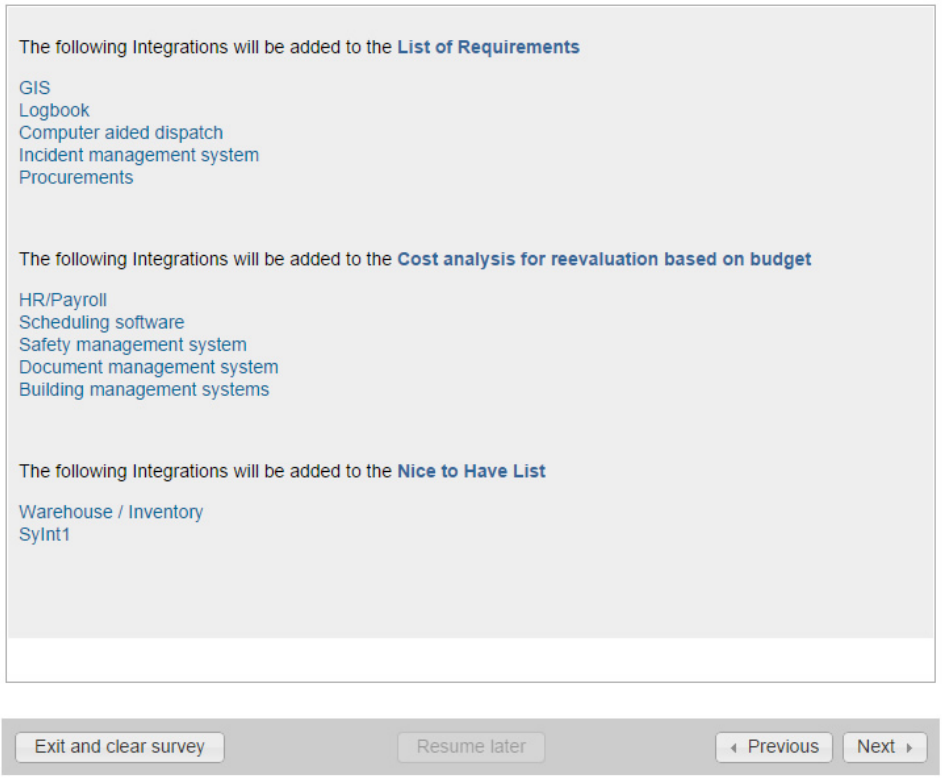


Using the same prioritization scale as during Step 1, the user can now prioritize the selected systems integrations

- ✓ Select “High”, “Medium” or “Low” to prioritize the systems to be integrated
- ✓ Click the “Next” button

Once the prioritization process is completed, a summary of all selected data will be presented, indicating if the information will be added to the List of Requirements (High priority), the list of items to be reevaluated for Cost Analysis (Medium priority) or to the Nice-to-Have List (Low priority).

The following (see next page) is a screenshot summarizing the systems integrations based on the user's prioritization.

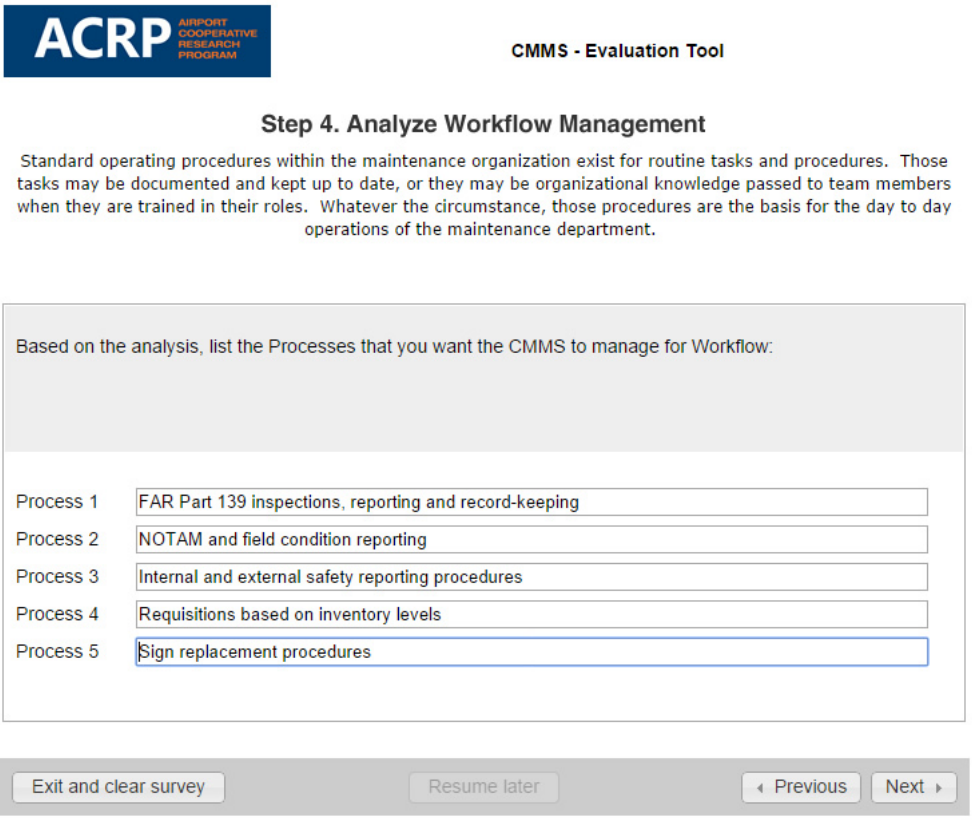


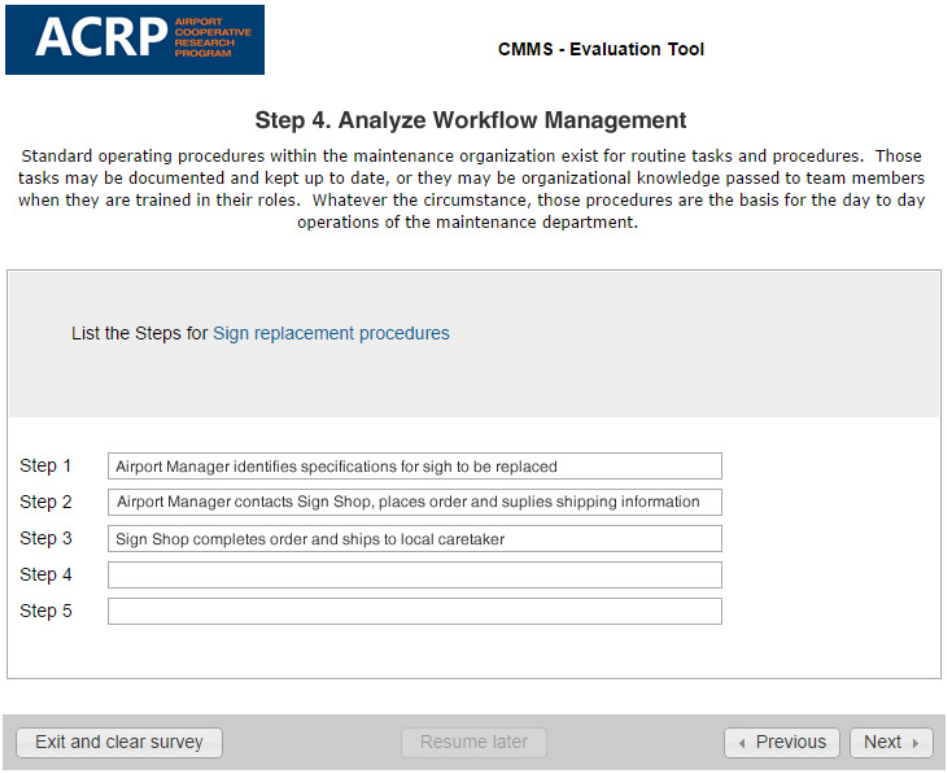
✓ Click the "Next" button to move to Step 4.

Step 4. Analyze Workflow Management

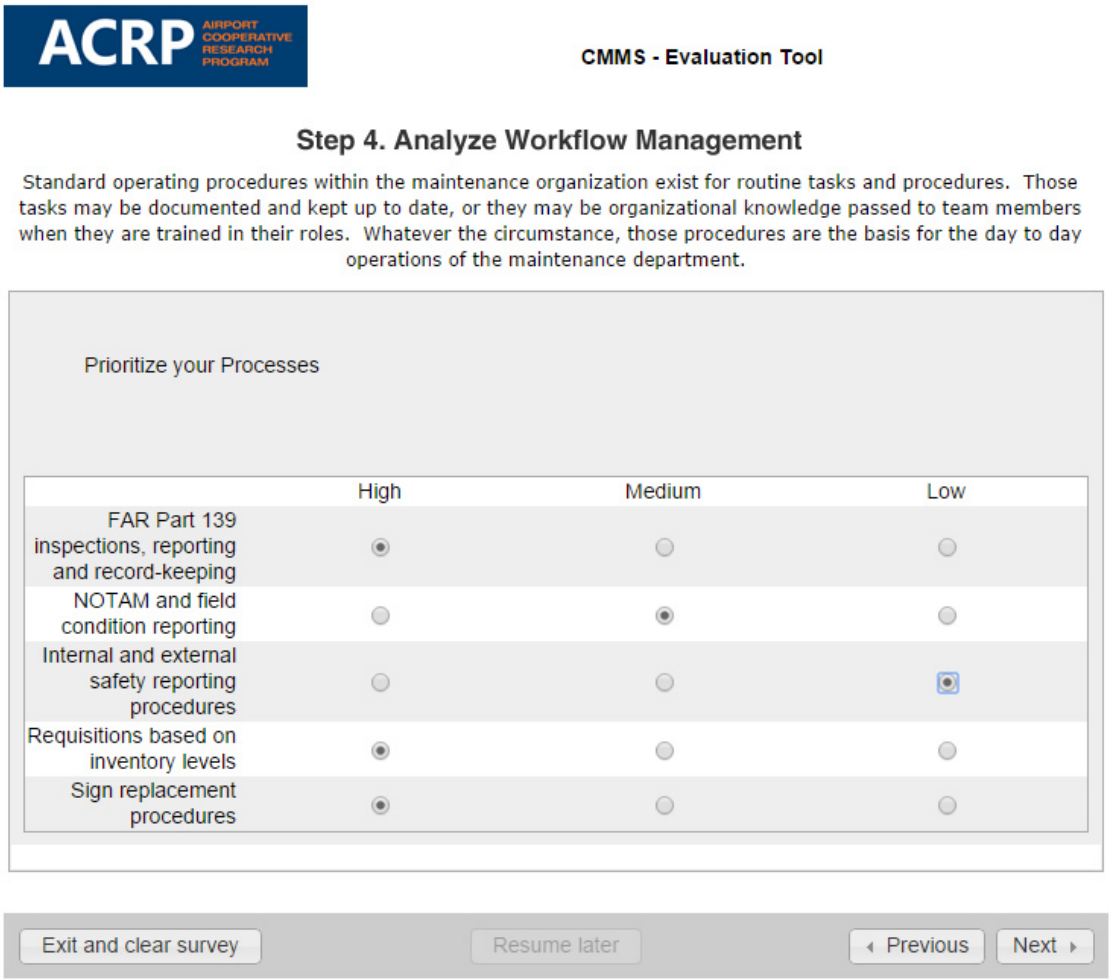
Standard operating procedures within the maintenance organization exist for routine tasks and procedures. Those tasks may be documented and kept up-to-date, or they may be organizational knowledge passed to team members when they are trained in their roles. Whatever the circumstance, those procedures are the basis for the day-to-day operations of the maintenance department. Refer to Guidebook Chapter 4 **Step Four. Analyze Workflow Management** to identify workflows that should be analyzed for potential automation in a CMMS.

✓ Type the identified processes for workflow in the following screens





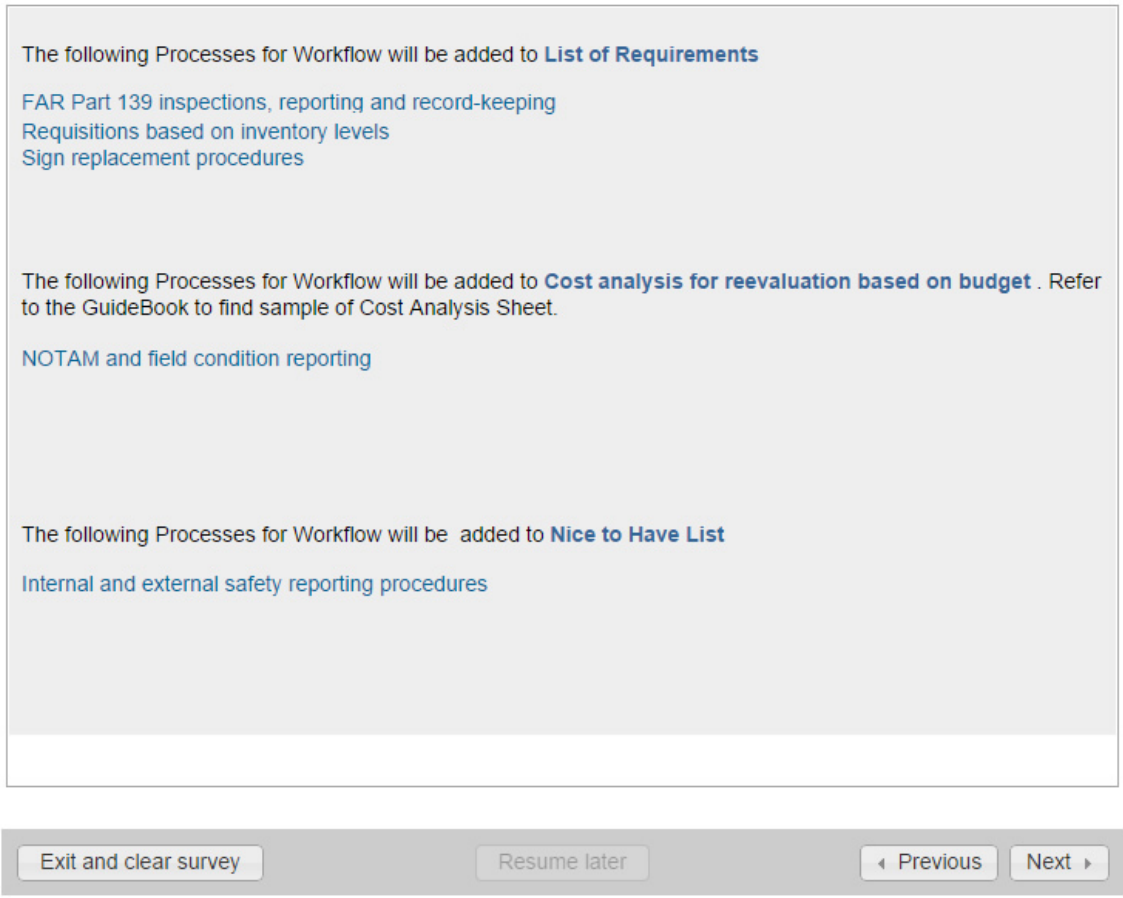
✓ Click the “Next” button to show the following screen and prioritize the selected processes for workflow



Using the same prioritization scale as during Steps 1 & 2, the user can now prioritize the selected processes for workflow

- ✓ Select “High”, “Medium” or “Low”
- ✓ Click the “Next” button

Once the prioritization process is completed, a summary of all selected data will be presented, indicating if the information will be added to the List of Requirements (High priority), the list of items to be reevaluated for Cost Analysis (Medium priority) or to the Nice-to-Have List (Low priority).



✓ Click the "Next" button to complete all steps in the CMMS Evaluation Tool

A List of Requirements is generated by the CMMS Tool. The output of the Tool suggests requirements to be considered for use, but should be modified to fit the airport's actual requirements. (Please note: In order to fit the screenshot on one page, the list is truncated by cutting out material in the middle)

ACRP AIRPORT COOPERATIVE RESEARCH PROGRAM

CMMS - Evaluation Tool

CMMS Evaluation

List of Requirements

1. Assets

A. Facilities

1. The CMMS shall provide the capability to generate Work orders for *Ramp Tower Passenger Loading Bridges Admin Buildings Cargo Buildings Hangars Maintenance Facilities Pump Stations Wastewater Treatment Plants Ancillary Facilities and other required facilities.*

2. The CMMS shall provide the capability to schedule preventative maintenance including multiple levels of scheduling based on criticality, use, condition, or calendar time for *Ramp Tower Passenger Loading Bridges Admin Buildings Cargo Buildings Hangars Maintenance Facilities Pump Stations Wastewater Treatment Plants Ancillary Facilities and other required facilities.*

3. The CMMS shall be able to track asset condition for *Ramp Tower Passenger Loading Bridges Admin Buildings Cargo Buildings Hangars Maintenance Facilities Pump Stations Wastewater Treatment Plants Ancillary Facilities and other required facilities.*

4. The CMMS shall be able to provide condition-based management of assets, including generations of backlogs for maintenance and repair for *Ramp Tower Passenger Loading Bridges Admin Buildings Cargo Buildings Hangars Maintenance Facilities Pump Stations Wastewater Treatment Plants Ancillary Facilities and other required facilities.*

5. The CMMS shall be able to track chargebacks - on cost for parts, labor, asset use, and contractors for *Ramp Tower Passenger Loading Bridges Admin Buildings Cargo Buildings Hangars Maintenance Facilities Pump Stations Wastewater Treatment Plants Ancillary Facilities and other required facilities.*

6. *The CMMS shall be able to track outages and costs by work order; by machine; by department for Ramp Tower Passenger Loading Bridges Admin Buildings Cargo Buildings Hangars Maintenance Facilities Pump Stations Wastewater Treatment Plants Ancillary Facilities and other required facilities.*

7. *The CMMS shall be able to support the levels of scheduling used at the Airport, integrate with material management functions, and provide for workload and workforce balancing for Ramp Tower Passenger Loading Bridges Admin Buildings Cargo Buildings Hangars Maintenance Facilities Pump Stations Wastewater Treatment Plants Ancillary Facilities and other required facilities.*

6. *The CMMS shall be able to provide rollup reporting by system and/or by facility and keyed to the needs of the Airport Manager well as to facilities maintenance operations for Ramp Tower Passenger Loading Bridges Admin Buildings Cargo Buildings Hangars Maintenance Facilities Pump Stations Wastewater Treatment Plants Ancillary Facilities and other required facilities.*

9. *The CMMS shall be able to support Mobile applications, including Mob1 for Ramp Tower Passenger Loading Bridges Admin Buildings Cargo Buildings Hangars Maintenance Facilities Pump Stations Wastewater Treatment Plants Ancillary Facilities and other required facilities.*

Continues on next page

PRINT this page of the Report

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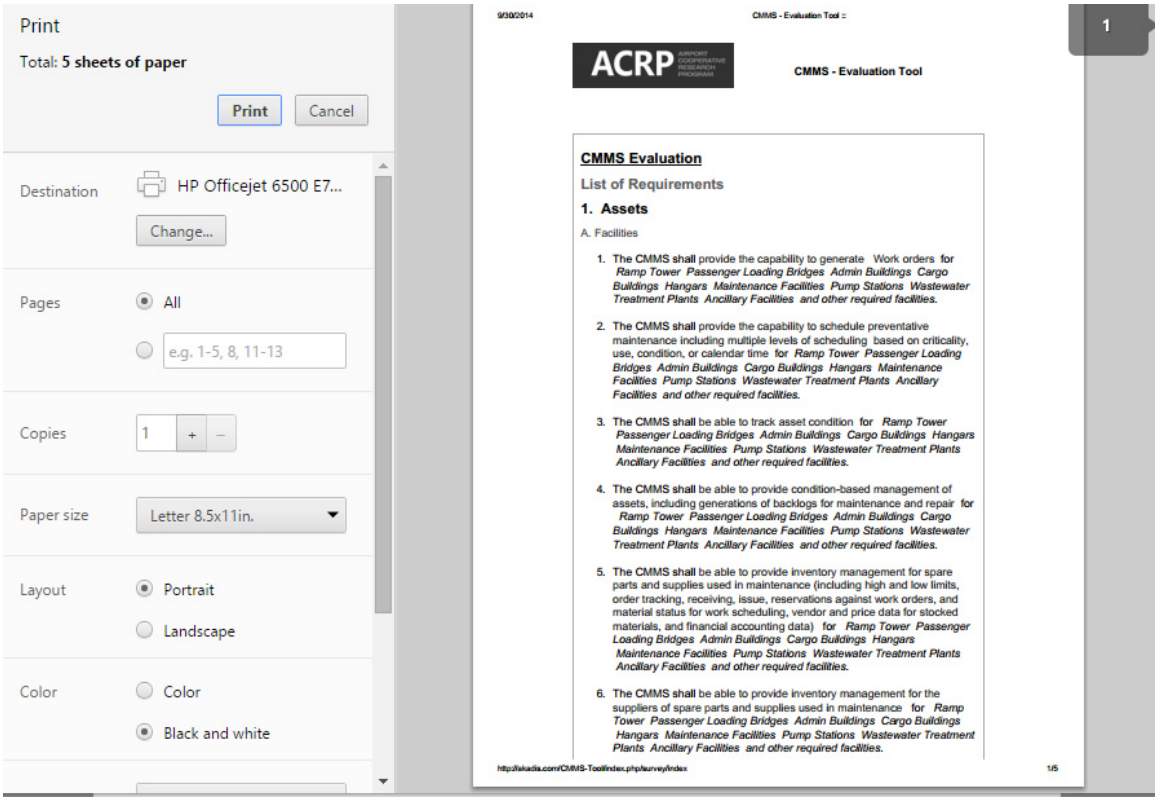
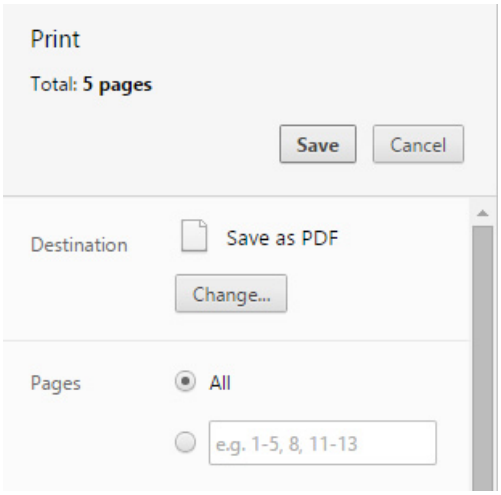
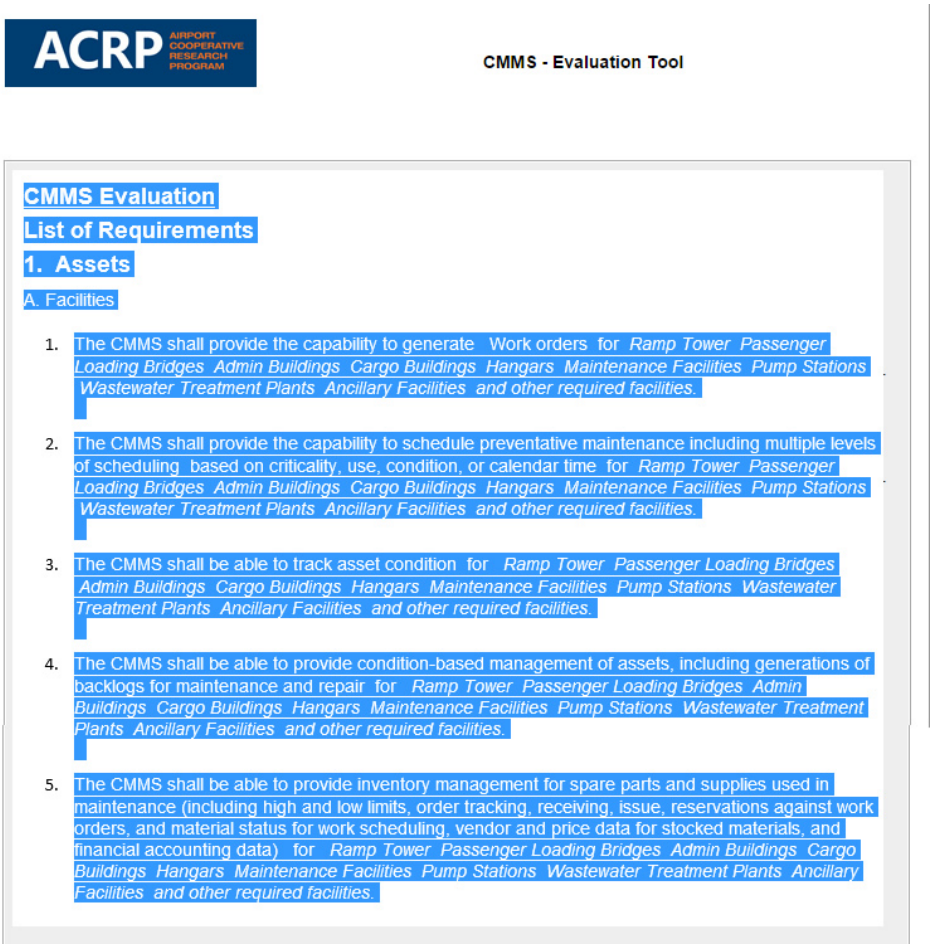
Each page of the output generated by the CMMS Evaluation Tool can be printed to a local computer by clicking the button “PRINT this page of the Report”



In addition, if supported by their local settings, users can specify if they want to save the document as a PDF file.



Tip: A useful method for saving the output generated by the CMMS Evaluation Tool is to select the entire content, save it to the clipboard, then paste it to a Word Document.



ACRP AIRPORT COOPERATIVE RESEARCH PROGRAM

CMMS - Evaluation Tool

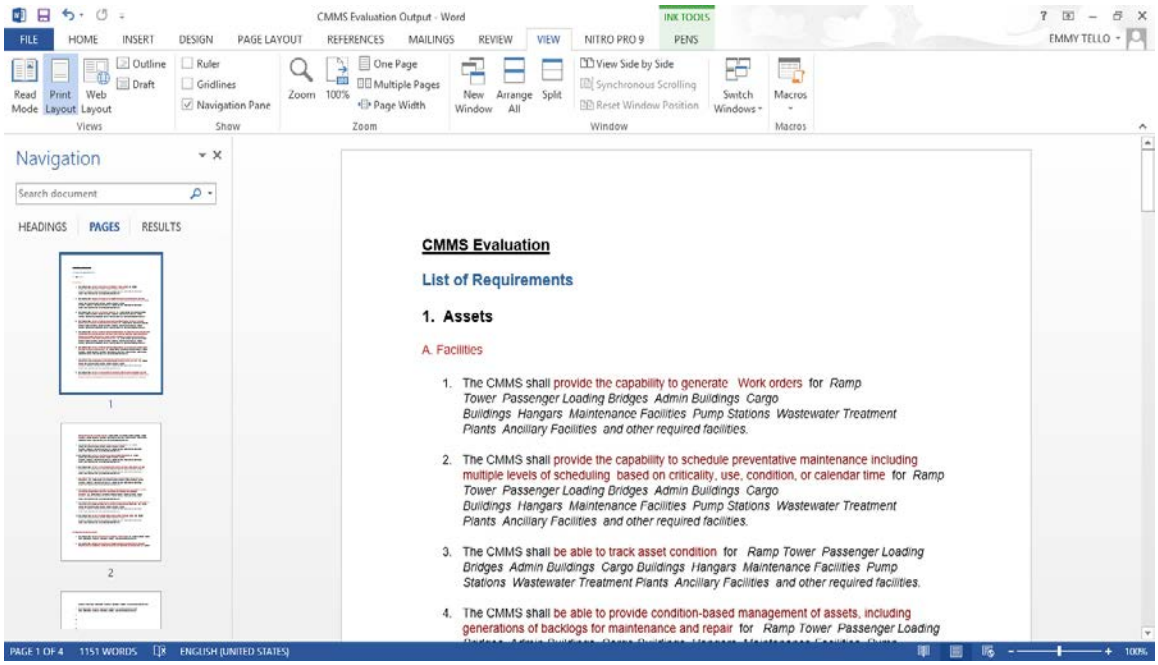
CMMS Evaluation

List of Requirements

1. Assets

A. Facilities

1. The CMMS shall provide the capability to generate Work orders for *Ramp Tower Passenger Loading Bridges Admin Buildings Cargo Buildings Hangars Maintenance Facilities Pump Stations Wastewater Treatment Plants Ancillary Facilities and other required facilities.*
2. The CMMS shall provide the capability to schedule preventative maintenance including multiple levels of scheduling based on criticality, use, condition, or calendar time for *Ramp Tower Passenger Loading Bridges Admin Buildings Cargo Buildings Hangars Maintenance Facilities Pump Stations Wastewater Treatment Plants Ancillary Facilities and other required facilities.*
3. The CMMS shall be able to track asset condition for *Ramp Tower Passenger Loading Bridges Admin Buildings Cargo Buildings Hangars Maintenance Facilities Pump Stations Wastewater Treatment Plants Ancillary Facilities and other required facilities.*
4. The CMMS shall be able to provide condition-based management of assets, including generations of backlogs for maintenance and repair for *Ramp Tower Passenger Loading Bridges Admin Buildings Cargo Buildings Hangars Maintenance Facilities Pump Stations Wastewater Treatment Plants Ancillary Facilities and other required facilities.*
5. The CMMS shall be able to provide inventory management for spare parts and supplies used in maintenance (including high and low limits, order tracking, receiving, issue, reservations against work orders, and material status for work scheduling, vendor and price data for stocked materials, and financial accounting data) for *Ramp Tower Passenger Loading Bridges Admin Buildings Cargo Buildings Hangars Maintenance Facilities Pump Stations Wastewater Treatment Plants Ancillary Facilities and other required facilities.*



- ✓ Click the “Next” button after printing or saving the output of the CMMS Evaluation Tool.
- ✓ A final screen will show next alerting the user that all the steps in CMMS Evaluation Tool have been completed.

APPENDIX D: CMMS Feature, Functionality, and Capacity

Feature/Functionality/Capability	Required
1. Inventory Database	
a. Recording of data for each facility, system, vehicle, and all collateral equipment and inventory	
b. A unique identifier for each maintained item	
c. Grouping items by systems and subsystems	
d. Provide for storing of make, model, location, custody, facilities maintenance standards reference, facilities maintenance requirements reference, financial information, maintenance manuals, and standard reports	
e. Develop policies & procedures (manual or mechanized) to facilitate new data from various sources to be added to the database as new facilities are built or modified	
2. Inspections	
a. Permit each item to have an explicit and unique inspection schedule and frequency	
b. Inspection checklists and guides, with linkages to work orders to account for any remediation needed as a result	
c. Storage for, or link within the system, to maintenance standards and drawings, prior inspection results, safety, current or pending work orders, and work requests for the system being inspected	
d. Storage for, or link within the system, to information on plans and coordination requirements	
e. Provide the means to report on inspections, their results, and associated work orders generated to remediate issues found to assess the efficacy of the inspection program	
3. Preventive Maintenance (PM)	
a. PM scheduling	
b. PM work order preparation based on maintenance requirements	
c. Multiple levels of scheduling based on criticality, use, condition, or calendar term	
d. Coupling of inventory data, maintenance checklist, parts, safety requirements and special environmental concerns, coordination/outage requirements results of the last PM, diagnostic and maintenance references, drawings, special tool or equipment requirements, and special skill or trade requirements	
e. Schedule reporting for each week to provide planning for resources and summary schedules	
f. Capability to schedule future PM dates for increments based on actual completion of a previous PM	

Feature/Functionality/Capability	Required
4. Predictive Testing & Inspection (PT&I)	
a. Analysis capabilities for PT&I results, process parameters (e.g., normal baseline temperature, pressure, flow, and other measures)	
b. Diagnose capabilities for possible causes of measures out of recommended range	
c. Display trends in test results, and schedule maintenance actions or additional inspection based on trends	
d. Automatic notification to operators and maintenance personnel for any changes, modifications, repairs, and/or improvements for equipment being maintained	
e. Monitoring capability for equipment environment, which could affect PT&I	
f. Ability to interface with PT&I equipment hardware and software	
5. Proactive Maintenance	
a. Provide for analysis of data trends that are indicative for proactive maintenance	
b. Allow entry of historical data, including life-cycle costs and failure histories	
c. Maintain reference criteria (e.g., vibration tolerances, maximum allowable slope of the baseplate, and the required accuracy instruments)	
d. Record additional information (e.g., maintenance practices, PT&I monitoring periods, maintenance materials, and vendor data	
6. Work Request (WR) & Work Order (WO)	
a. Tracking of receipt of requests for maintenance	
b. Tracking of planning and estimating, scheduling , internal execution, or execution by external contractor forces, and documentation of lapses due waiting for funding or incorporation of the work into a capital project	
c. Capability to provide WR or WO numbers with a combination of alphanumeric characters of adequate length	
d. Provide a means for all stakeholders to originate a request for maintenance	
7. Trouble Calls	
a. Permit receipt and issue of Trouble Calls (TC)	
b. Accommodate data tracked by any related system	
c. Provide the status of TC tickets pending action, in process, and completed, escalation procedures, and customer feedback	
d. Intelligent dispatch based on location data of the TC, available staff, skill sets, and time of day optimized for cost and priority	
8. Work Orders for PM, Repair, ROI	
a. Provide for the preparation of specific or one-time WOs for PM, repair, ROI, and other work that is of fixed duration and scope	
b. Integrate with WO estimating and scheduling	
c. Capability to search WOs by any field, e.g. customer, funding source, or tasks	
9. Work Order Estimating	
a. Estimates for craft, time, material, local labor and material rates, local unique cost factors, and standard work tasks	
b. Integration with current estimating system	

Feature/Functionality/Capability	Required
10. Maintenance History	
a. TC's	
b. Service Requests (SR)	
c. WOs	
d. PM history	
e. Alterations, modifications, and improvements	
f. Inspection results	
g. Productivity measurements at the individual, trade, and organization level	
h. Backlog reporting	
11. Material Management	
a. Material inventory (including high and low limits)	
b. Ordering based on minimums incl. inventory reserved for incomplete work orders	
c. Order tracking, receiving, issuance, reservations against work orders, and material status for work order scheduling	
d. Vendor and price data for stocked materials	
e. Purchase agreements	
f. Interface capabilities with t procurement systems	
g. Analysis of satellite storage areas	
h. Stock Room functions including finding parts, manufacturer contacts, parts catalog, part pricing thresholds, alternative suppliers, alternative substitute parts, part revisions, and bill on material structures	
12. Tool and Equipment Management	
a. Issuance, inventory, and accountability for specialized tools and related maintenance equipment	
13. Scheduling	
14. Backlog for Maintenance and Repair	
15. Contract Administration	
a. Support for contract preparation and administration, including tracking delivery orders, modifications, and payments	
16. Utilities	
a. Support utilities operation and management, including estimating and reporting	
b. Direct interface with building monitoring and control systems, allowing changes in equipment operating parameters to automatically generate TC's or other maintenance actions	
17. Environmental Tracking	
a. Facilitate necessary tracking, reporting, and historical record functions	
18. CAD/GIS Support	
19. Priority System	
a. Provide for assigning work priorities	
b. Allow use of priorities in automated scheduling	
c. Enable helpers to be designated	

Feature/Functionality/Capability	Required
20. Warranty Tracking	
a. Include provisions for tracking warranties on facilities and equipment	
b. Alert users when work orders (including SR and TC's) are entered on covered equipment within the warranty period	
c. Track requested warranty work	
d. Accommodate tiered warranties and multiple warranties with different expiration dates on the same item	
21. Management Reports	
a. Provide management reporting for airport managers' needs and maintenance operations	
22. User Customization	
a. Permit authorized user to modify, add, or delete reports, forms, screens, data elements, data definitions, and other features to meet individual needs	
23. Ad Hoc Query	
a. Ability to perform a specialized or one-time query	
b. Permit use of multiple conditions	
c. Support use of information from different records	
d. Perform statistical operations on the query results	
24. Data Sharing and Integration with other systems	
a. Potential interfaces include:	
i. Financial, personnel, accounting, supply, and other related automated systems	
ii. Part 139 inspections software	
iii. Safety management system	
iv. Procurement systems	
v. Personnel and payroll systems	
vi. Scheduling systems	
25. Presentation Graphics	
26. Warranty	
a. Support for patches	
b. Performance problems	
c. Annual support agreements	
27. Service level agreements (SLAs)	
a. Transaction speed established for:	
i. Preparation of reports	
ii. Printing PM schedules, PM work orders or cards	
iii. Database searches e.g., WO status	
iv. Response for ad hoc queries	
v. Estimate preparation	
b. Considerations:	
i. Degradation with database size increase	
ii. Degradation with increase in concurrent users	
iii. Hardware recommended will support the required size and number of users	

Feature/Functionality/Capability	Required
28. Transaction Recording	
a. An audit log of CMMS user and changes	
29. Data Import and Export	
a. Ability to import batch data from standard formats, particularly from a previous CMMS	
30. Bar Coding Data Interface	
a. Ability to accept data from bar code readers and print	
31. Archive	
a. Capability to archive inactive records and data based on user-selection	
32. Back-up	
a. Automated data backup and recovery features	
b. Support for multiple media types	
33. Licensing	
a. Concurrent or individual user licenses	
34. Capacity	
a. Number of records limited only by storage	
35. User Documentation	
36. Menus/User Interface	
a. Provide and easy, logical flow from one operation to another	
b. Permit keyboard shortcuts for expert users and menus for less experienced users	
c. Allow user to create custom menus	
37. Error Handling	
a. Provide comprehensive error handling	
b. Data Validation, e.g., checking against limits or a list of permitted entries	
c. Protect the data from abnormal situations	
d. Error conditions should be ‘trapped’	
e. Informative error messages should be given to user	
f. Data deletion should be subject to user verification	
38. Password Protection	
a. Multiple levels of password protection	
b. View only, modify, enter, and delete	
c. System changes	
d. Creating and modifying reports, forms and data structure	
e. Apply to each of the several functions and databases	

APPENDIX E: Functions Checklist

Functions Checklist for Each Asset Type	High	Med	Low	NR
Facilities				
1. Work orders				
2. Preventive maintenance				
3. Condition assessments				
4. Condition based maintenance				
5. Inventory management of spare parts and supplies used in maintenance				
6. Suppliers of those spare parts				
7. Tracking maintenance done through other entities				
8. Documentation of warranties				
9. Scheduling work				
10. Maintenance costs				
11. Chargebacks – cost for parts, labor, asset use, and contractors				
12. Reliability and cost				
13. Scheduling resources				
14. Rollup of reporting by system and/or by facility				
15. Mobile applications				
Runways Taxiways and Roads				
1. Work orders				
2. Preventive maintenance				
3. Condition assessments				
4. Condition based maintenance				
5. Inventory management of spare parts and supplies used in maintenance				
6. Suppliers of those spare parts				
7. Tracking maintenance done through other entities				
8. Documentation of warranties				
9. Scheduling work				
10. Maintenance costs				
11. Chargebacks – cost for parts, labor, asset use, and contractors				
12. Reliability and cost				
13. Scheduling resources				
14. Rollup of reporting by system and/or by facility				
15. Mobile applications				
Vehicles				
1. Work orders				
2. Preventive maintenance				

Functions Checklist for Each Asset Type	High	Med	Low	NR
3. Condition assessments				
4. Condition based maintenance				
5. Inventory management of spare parts and supplies used in maintenance				
6. Suppliers of those spare parts				
7. Tracking maintenance done through other entities				
8. Documentation of warranties				
9. Scheduling work				
10. Maintenance costs				
11. Chargebacks – cost for parts, labor, asset use, and contractors				
12. Reliability and cost				
13. Scheduling resources				
14. Rollup of reporting by system and/or by facility				
15. Mobile applications				
Systems				
1. Work orders				
2. Preventive maintenance				
3. Condition assessments				
4. Condition based maintenance				
5. Inventory management of spare parts and supplies used in maintenance				
6. Suppliers of those spare parts				
7. Tracking maintenance done through other entities				
8. Documentation of warranties				
9. Scheduling work				
10. Maintenance costs				
11. Chargebacks – cost for parts, labor, asset use, and contractors				
12. Reliability and cost				
13. Scheduling resources				
14. Rollup of reporting by system and/or by facility				
15. Mobile applications				
Airside				
1. Work orders				
2. Preventive maintenance				
3. Condition assessments				
4. Condition based maintenance				
5. Inventory management of spare parts and supplies used in maintenance				
6. Suppliers of those spare parts				
7. Tracking maintenance done through other entities				
8. Documentation of warranties				
9. Scheduling work				
10. Maintenance costs				
11. Chargebacks – cost for parts, labor, asset use, and contractors				

Functions Checklist for Each Asset Type	High	Med	Low	NR
12. Reliability and cost				
13. Scheduling resources				
14. Rollup of reporting by system and/or by facility				
15. Mobile applications				
Other				
1. Work orders				
2. Preventive maintenance				
3. Condition assessments				
4. Condition based maintenance				
5. Inventory management of spare parts and supplies used in maintenance				
6. Suppliers of those spare parts				
7. Tracking maintenance done through other entities				
8. Documentation of warranties				
9. Scheduling work				
10. Maintenance costs				
11. Chargebacks – cost for parts, labor, asset use, and contractors				
12. Reliability and cost				
13. Scheduling resources				
14. Rollup of reporting by system and/or by facility				
15. Mobile applications				

APPENDIX F: Sample CMMS Vendor Assessment Matrix

This is a ranking scorecard with sample requirements used to rank software from multiple vendors in a software selection process. Rank each requirement using a scale of 1-10 and tally scores for a total comparative ranking at the end.

REQUIREMENT	1	2	3	4
1. Inventory Database Management. The CMMS shall permit recording necessary information for each facility and equipment item. It shall provide for a unique identifier for each maintained item and shall permit grouping items by systems and subsystem as well as providing for the make, model, location, custody, facilities maintenance standards reference, facilities maintenance requirements reference, financial information, and standard reports.				
2. Continuous Inspection. The CMMS permit each facility or equipment item to have an individually determined inspection schedule or frequency. It shall provide inspection checklists and guides for the inspector, including appropriate facilities maintenance standards and drawings, prior inspection results, current or pending work orders and work requests for the system being inspected, information on future plans for use of the system, and safety and coordination requirements.				
3. Preventive Maintenance (PM). A CMMS shall provide complete PM scheduling and PM order preparation based on the inventory and facilities maintenance requirements entered into the system. This includes multiple levels of scheduling based on criticality, use, condition, or calendar time. The system shall couple inventory data, facilities maintenance checklist, parts required, safety requirements and special environmental concerns, coordination/outage requirements, results of the last PM, diagnostic and maintenance references, drawings, special tool or equipment requirements, and special skill or trade requirements. It shall permit scheduling to the week, be able to give resource requirement reports and summary schedules. It shall include the capability to adjust future PM dates based on the actual completion date of the latest PM is a valuable feature.				

REQUIREMENT	1	2	3	4
4. Predictive Testing & Inspection (PT&I). The CMMS shall interface with PT&I equipment hardware and software to allow for downloading data and for CMMS support to the PT&I technician in setting sequence and periodicity and providing critical information concerning equipment and/or facility history. This shall include information for continuous inspection and include the ability to analyze PT&I results, process parameters (i.e., normal baseline temperature, pressure, flow, etc.), diagnose the possible causes of abnormal readings, project trends in test results, and schedule facilities maintenance actions or further inspection based on the trends. It shall communicate to operators and maintenance personnel any changes, modifications, repairs, and/or improvements not only to the equipment being maintained, but also to the equipment's immediate environment, which could affect PT&I readings and other maintenance actions.				
5. Proactive Maintenance. The CMMS shall provide for the processing of archived data that can be analyzed to identify the trends that are critical to performing the proactive maintenance function. Besides providing program metrics upon which management can base informed decisions, the CMMS shall have the capability of providing the following proactive program support:				
6. a. Recording historical data, including life-cycle costs and failure histories of families of equipment, so that engineers can write verifiable purchasing and installation specifications for new and rebuilt equipment.				
7. b. Maintaining a library of reference criteria for a specific equipment item such as vibration tolerances, the maximum allowable slope of the baseplate, and the required accuracy of the instrument used to measure that slope to support drafting precision rebuild and installation specifications.				
8. c. Recording background information such as maintenance practices, PT&I monitoring periods for specific units of equipment, maintenance materials used, and vendor data for use by maintenance schedulers and by engineers investigating problems impacting system reliability.				
9. Work Request & Work Order Tracking. The CMMS shall provide the capability to track the receipt of requests for facilities maintenance work or other work requirements received from any source from the time of receipt through final work completion. This includes tracking its progress through planning and estimating, scheduling, execution by in-house shops or contractor forces, and while any administrative or planning actions are undertaken such as waiting for funding or incorporating the work into a capital project.				
10. Trouble Calls. The CMMS shall permit receipt and issue of Trouble Calls (TC). It also shall provide the status of TC tickets pending action, underway, and completed.				
11. Work Orders for PM, Repair, ROI, etc. Provide for the preparation of specific or one-time work orders for Repair, PGM, ROI and other work that is of fixed duration and scope. This shall be integrated with work order estimating and scheduling. The CMMS shall be able to identify the work order by customer, funding source, and work breakdown structure.				

REQUIREMENT	1	2	3	4
12. Work Order Estimating. Provide for an integrated work order estimating system. The system shall provide planners and estimators with comprehensive assistance in preparing work order craft, time, and material estimates. It shall permit including local labor and material rates, local unique cost factors, or standard work tasks.				
13. Maintenance History. The CMMS shall provide for fully documenting the facility maintenance history, to include summaries of all actions related to the facility. This includes TC's; specific Service Requests (SR); work orders; PM history, alterations, modifications and improvements; and inspection results				
14. Material Management. The CMMS shall provide for material inventory (including high and low limits), ordering based on the low limit and new work orders, order tracking, receiving, issue, reservations against work orders, and material status for work order scheduling. It may include vendor and price data for stocked materials and information on purchase agreements. Memorandum financial accounting for material purchases is desirable. In order to incorporate material availability and cost data into the CMMS, a smooth interface with the Procurement Department's program is essential.				
15. Tool and Equipment Management. The CMMS shall provide support for issue, inventory, and accountability for specialized tools and related maintenance equipment.				
16. Scheduling. In addition to scheduling inspections and RCM actions noted above, it will facilitate scheduling specific work orders. The CMMS shall support the levels of scheduling used at the Airport, integrate with material management functions, and provide for workload and workforce balancing.				
17. Backlog of Maintenance and Repair. The CMMS shall permit developing a BMAR (Backlog of Maintenance and Repair) based on condition assessment.				
18. Contract Administration. Because a significant portion of the Airport’s work is accomplished by contract, a CMMS shall provide support for contract preparation and administration, including tracking delivery orders, modifications, and payments.				
19. Utilities operation and management. The CMMS shall provide support for utilities operation and management, including estimating, reporting, and model generation and use. Some CMMS's can interface directly with Energy Monitoring and Control Systems (EMCS's), allowing changes in equipment operating parameters to automatically generate TC's or other maintenance actions. If this type of interface is desired, it will be a critical factor in the selection process.				
20. Environmental Tracking . The CMMS shall provide Environmental Tracking. The CMMS shall facilitate necessary tracking, reporting, and historical record functions.				
21. The CMMS shall provide CADD support. Access to a CADD system by the reliability engineer redesigning or modifying existing equipment designs and/or materials as a means of increasing system reliability is highly desirable.				

REQUIREMENT	1	2	3	4
22. Priority System. The CMMS shall provide for assigning work priorities in accordance with the Airport's system and using these priorities in any automated scheduling schemes employed.				
23. 2.20 Warranty Tracking. Include provisions for tracking warranties on facilities and collateral equipment. It shall alert users when work orders (including SR and TC's) are entered on covered equipment within the warranty period, track requested warranty work, and accommodate tiered warranties and multiple warranties with different expiration dates on the same item.				
24. Management Reports. Provide management reporting keyed to the Airport managers' needs as well as to facilities maintenance operations. This relates closely to the customization and ad hoc query features discussed in section 3 below. An important benefit of a CMMS is the ability to extract information out of vast amounts of data to help spot trends that might not otherwise be noticed. A CMMS shall be chosen that can provide information to the manager rather than just output data in voluminous lists.				
25. Data Import. Have the ability to read and load data from standard file formats. Formats beyond those used at the Airport may be of limited value. However, support for file formats currently in wide use at the Airport is an advantage and may be a critical factor, depending on the other systems that the Airport desires to integrate with the CMMS.				
26. Bar Coding Data Interface. Have the ability to accept data from bar code readers and print bar codes for field reader use. Bar coding has many applications to ensure that actions were performed on the correct equipment and at the time specified. Bar coding is especially useful for such repetitive tasks as equipment identification, inventory control, timekeeping, and PM task recording.				
27. Data Export. Have the ability to export all (or user-selected portions) of the database in standard file formats.				
28. Archive. Have the capability to archive inactive records and data based on user-selected criteria. For example, the Airport may wish to remove information on work orders that have been completed for over 2 years from the active data files, but still have the information available for off-line reference. Archiving systems shall provide the means to view and retrieve the data. Care shall be taken not to archive essential facility history data.				
29. Back-up. Have automated data backup and recovery features. This shall support multiple media types. Since the CMMS is being installed on a network, the network operating system may handle the backup. If the CMMS has a backup routine as well, the potential for conflict between the systems would have to be investigated.				
30. Number of Users. Software is typically licensed for a specified number of users or for use on a specified number of computers. Programs designed to operate on a network or with remote terminals may limit the number of simultaneous users. The capability of the program shall be determined. CMMS cost may vary with the number of users. It shall be possible to add additional users at a later date when expansion is required				

REQUIREMENT	1	2	3	4
31. Capacity. Capacity refers to the number of entries or records (and the maximum size of each record) that are permitted in each of the databases of the CMMS. The better CMMS's permit a number of records that is limited only by mass storage. However, some systems may be limited or require the purchase of modules adding capacity. The CMMS shall have sufficient capacity in each function to accommodate the Airport's facilities maintenance management requirements, including projected growth.				
32. Speed. Speed refers to how quickly the CMMS can perform required operations on the database. Such operations include preparation of reports, printing PM schedules and PM work orders or cards, searching the database for the status of a work order, responding to an ad hoc query, or preparing an estimate using the work order estimating database. Database manipulation is a very processor-intensive operation. Speed tends to degrade as the size of the database increases and as the number of simultaneous users increases. Systems perceived as slow by users will fall into disfavor and shall be avoided. Speed is very dependent on the hardware used for the CMMS as well as on the data structure and software. To the maximum extent possible, speed evaluations shall be based on tests using the hardware configuration, database size, and operations planned for the installed CMMS.				
33. User Help/ Documentation. Provide an adequate level of documentation and an effective on-line help system to assist users after initial training and installation. Documentation shall be clear, concise, and comprehensive, covering all aspects of the CMMS. The on-line help facility shall be available at all times and shall be context sensitive, providing assistance and suggestions to the user for the current operation. A user shall be able to find the answer to most routine questions in the on-line help module. The ability to edit or add to help screens is an advantage.				
34. Menus/User Interface. Provide an easy, logical flow from one operation to another permitting rapid, direct movement by expert users as well as providing a methodical menu system for less experienced users. Use of the keyboard, mouse, digitizer, light pen, track ball, or touch-screen are possible methods to access menu items. The ability of the user to build custom menus is a desirable feature.				
35. Error Handling. Provide comprehensive error handling. This includes a capability for data validation; i.e., checking against limits or a list of permitted entries. It shall also protect the data from abnormal situations, giving the user the opportunity to correct situations such as a printer out of paper or off-line, floppy disk missing, telephone connection lost, drive error, or similar event. Error conditions shall be "trapped" and informative error messages given to the user, permitting the user to save current data and exit the program if necessary. Data deletion shall be subject to verification.				
36. Password Protection. Have levels of password protection to control the ability to view only, modify, enter, and delete data. It shall also control system changes such as creating and modifying reports, forms, and data structure. This shall apply to each of the several functions and databases.				

REQUIREMENT	1	2	3	4
37. Cost. In evaluating cost, the CMMS modules and options within functions as well as all recurring system operation, maintenance, and support costs shall be considered. The initial cost of the system will be negligible compared to the manpower savings resulting from fully implementing a CMMS.				
38. Hardware Platform. The computer type or types on which the CMMS may be operated. One CMMS may be limited to one vendor's product or standard while another may operate on a broad range of hardware. When existing equipment is to be used for the CMMS, this will be a critical factor that eliminates some CMMS's from consideration.				
39. Operating System. This is the core program that provides the software communication interface between the manufacturer's hardware and the developer's software.				
40. Input/output Support. The ability of the CMMS to support the desired range of input and output devices shall be evaluated. Typical devices include a mouse, digitizing tablet, modem, light pen, optical disk, bar code readers, floppy disk, laser printer, dot matrix printer, backup media, and plotter. Special software drivers are often required for different brands and models of printers and plotters. These are usually built into the software, but may be provided as part of supporting software such as with WINDOWS. This may be a significant or even critical evaluation factor.				
41. Years in CMMS Business. A longer term can imply a successful business that addresses the needs of the CMMS market and one that will be available to provide support into the future. However, be alert for past mergers, takeovers, or spin-offs, which could distort this factor. "New" does not necessarily mean a poor product. Conversely, "old" does not imply a good product, because it may not have been updated to reflect current advancements in CMMS technology.				
42. 5.3 Installed Customer Base. The number of users of the CMMS system is an indicator of market success and the developer's potential to stay in the CMMS market. Check to see how many sites are using the current versus prior releases. Include checking their type of business, how they are using it (e.g., for PM only, material management, Repair work orders, etc.), and points of contact.				
43. Other CMMS-related Products (list). The vendor may offer other products related to the CMMS that would be of interest to the Airport; for example, utilities management, motor vehicle management and dispatch, or project management software. These may offer an advantage in terms of a common user interface, shared data, and lower first cost and support costs if bought as a package.				
44. Support/ Upgrade Policy. Look for a vendor that provides solid, after-market support and offers upgrades or updates at a reasonable cost. Because CMMS is not a mass market (installed bases are typically less than 1000), user support is normally not free. However, there shall be a period of "free" support after installation and a warranty period to provide for adjustment if the product does not prove satisfactory in actual use.				

REQUIREMENT	1	2	3	4
45. Customized Releases. The vendor may offer customized releases structured to meet the Airport's unique needs. This would include modifications to screens, standard reports and forms, and data structure. Additional cost would depend on the extent of the modifications required. However, this factor is offset to some extent by the ability to make end-user modifications to the CMMS system discussed under Program Features above. Since Airport requirements may change over time, buying a CMMS that allows customization by the user is generally preferable to buying a customized CMMS.				
46. Training. The vendor shall provide training support, onsite or offsite as meets the Airport's needs. Examine scheduling and costs. Consider the experience of current users with the training offered. Note that programs with an intuitive, user-friendly interface that conforms to a facilities maintenance management model similar to that used by the Airport will require less training support. Training is an essential element of a successful CMMS installation. The Airport shall recognize that training is not a one-time event. Users will need refresher training. After a period of familiarization, some users will need training on advanced techniques such as custom menu, macro, and report generation. New employees will require initial training. A training plan needs to be developed to address all these needs.				
47. Installation Support. The developer shall offer installation and initialization support. This may include initial data entry and conversion. Some vendors provide full-scale systems integration services, including hardware procurement and setup. This will simplify the Airport's tasks, at some additional cost. There will be a tremendous amount of effort that will be required to implement a new CMMS. Many CMMS installations have been "doomed to failure" from day one because the new user tried to implement the system with existing personnel “in their spare time" while still expecting them to accomplish				
48. List of Users/ References. The vendor shall be willing to provide information on other users who the Airport can contact for first-hand impressions of the product. These references shall be contacted to determine their opinions on the product and how their application matches the Airport's planned use. A visit to their facility to see the CMMS in operation shall be made.				
Total				