ACRP

REPORT 13

AIRPORT
COOPERATIVE
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Integrating Airport Information Systems

TRANSPORTATION RESEARCH BOARD
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AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP REPORT 13

Integrating Airport Information Systems

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), and the Air Transport Association (ATA) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

Once selected, each ACRP project is assigned to an expert panel, appointed by the TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

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The members of the technical advisory panel selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and while they have been accepted as appropriate by the technical panel, they are not necessarily those of the Transportation Research Board, the National Research Council, or the Federal Aviation Administration of the U.S. Department of Transportation.

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FOREWORD

By Michael R. Salamone
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ACRP Report 13: Integrating Airport Information Systems is a handbook that provides valuable analysis and recommendations that can help lead airports toward fully integrated information systems in the near future. The handbook describes a vision for the future and a series of steps that can lead to eventual and successful integration projects. It explores myriad information sources and their unique data elements, the value to the airport decision-maker, and strategies that can help capture this business-critical information for use in synergistic ways.

The handbook examines new technology such as facial recognition kiosks, smart board passes, intelligent wireless sensors, advanced wireless technology, and intelligent video recognition software. The report is not intended to present specifics for integrating information systems for any airport; rather it suggests a path to successful integration by educating airport decision-makers on the value of integration and inspiring adoption and adaptation of basic concepts and best practices that can help airports integrate portions of their data/information environment.

The handbook will be of interest to airport managers and information technology professionals.

The accurate, properly formatted, and timely reporting of airport activity and financial data is critical to managing today's airports effectively. These data are necessary to meet operational needs properly and to make informed business decisions. Currently, industry practices for gathering and processing this information vary significantly across airport category or even among airports within the same category.

A lack of consistent, accurate, and timely information is a direct result of a lack of applied technology and overall standardized industry practices to define and gather information. In addition, although large, complex airports need more sophisticated data, airports of all sizes need certain minimum data to manage their facilities effectively. Demonstrated issues related to collecting, processing, integrating, and defining data keep airports from realizing the full value of completely integrating information.

Under ACRP Project 1-03, Aero Tech Consulting, Inc. (ATCI) was asked to describe a vision of how this business-critical information can be fully integrated (e.g., cross-utilized between different information systems). ATCI presents a broad summary of current practice and plotted a course to such an integrated IT future.

CONTENTS

SUMMARY

Integrating Airport Information Systems

This Handbook, *Integrating Airport Information Systems,* one of the products of Airport Cooperative Research Program (ACRP) Project 01-03, provides the basis for an airport to integrate information systems successfully. Chapter by chapter, this Handbook provides the guidance needed to develop the level of integration required to ultimately develop a computer desktop interface to access the information and metrics that create a big-picture mosaic of the airport—the *manager's dashboard* of the future.

Good decision-making is facilitated by good information. At an airport with integrated information systems, senior managers can access desired information from their desktops by use of a dashboard, which the managers have customized to provide the level of information needed to efficiently and effectively address the most business-critical decisions of that airport. Information such as the following could be available and reviewed at will on the manager's dashboard:

- The airport's current financial picture;
- Current operational issues and the immediate effect on the budget;
- Return on investment analyses for alternative development proposals;
- Projected arriving and departing passenger counts, by hour, day, and week;
- Percentage gate usage by airline;
- Current and forecasted airfield conditions; and
- Percentage delays by terminal.

Senior managers could identify metrics of business-critical information calculated from key data. The ability to review the chosen metrics as desired would be coupled with the ability to drill down to the level of detail required for any analysis needed to assess the effect of business decisions before they are made.

For example, one senior manager might choose to review the non-airline actual revenues received to date as a percentage of planned revenues. Another senior manager might wish to see, on a daily basis, the current outstanding work orders. Another senior manager might want to see the current Notice to Airmen (NOTAM), while the chief executive officer (CEO) might want to view automatically calculated significant metrics derived from business-critical information, as well as the status of any significant security issues and wait times at passenger screening. Figure S-1 is an example dashboard that demonstrates what the CEO at a major airport might like to see on his or her desktop.

Many data points are useful to all airport managers and CEOs; however, depending on their various sizes, volumes of traffic, and operational levels, different airports require different information and reporting. The dashboard should be customizable to fit the specific needs of each CEO and should exist in a configuration that provides the most necessary information while filtering out that which is not as useful. For example, CEO A might require a deeper level

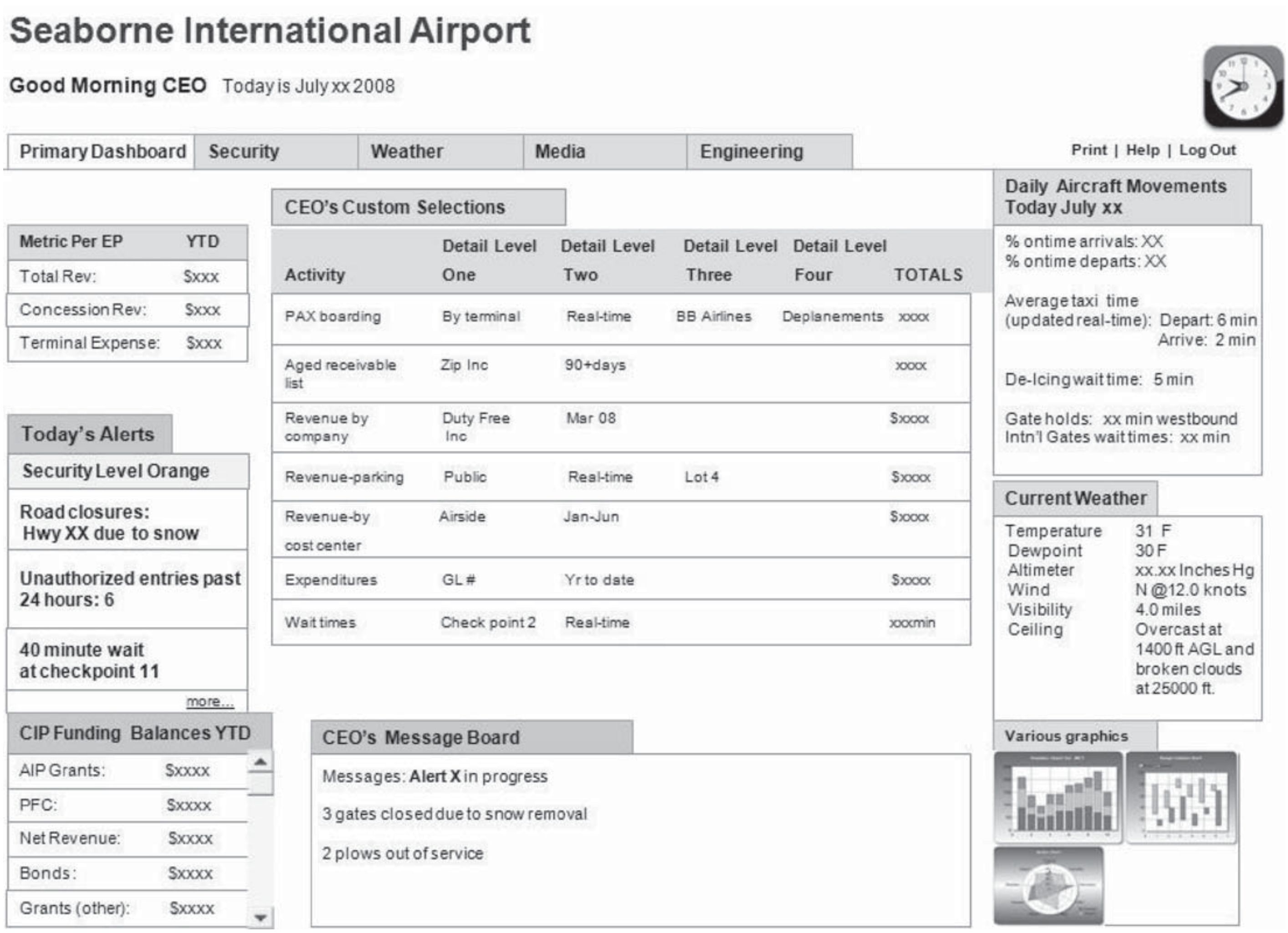


Figure S-1. Dashboard executive summary.

of detail than CEO B. The dashboard, as shown in Figure S-1, provides the ability to drill down through the information to get at the various levels of data. On the other hand, the dashboards shown in Chapter 7 reflect high-level views for a CEO who only needs summary information.

Public airports combine elements of various business enterprises and serve diverse functions. A public airport may function as a transportation infrastructure, a public utility, an engine for developing community economics, an airline supplier and partner, and more. However, U.S. airports are generally operated as publicly owned businesses—but mandated to be as financially self-sufficient as possible. Managing the complexities of an airport in today's crisis-oriented environment requires a myriad of daily financial and operational business decisions, as well as proactive business planning, problem prevention, and problem-solving. The successful integration of information facilitates decision-making and problem-solving at an airport.

In some cases and in some organizations, full integration may not be feasible. Some legacy systems and infrastructure may be so old that it is not cost-effective, or even possible, to collect the necessary data. Cost restrictions and closed architecture systems can make integration difficult; however, some level of information integration will be necessary. The goals are to integrate in ways that allow an airport to minimize unnecessary costs, increase the likelihood for success, and ensure that integration will provide real benefits to the decisionmakers. Each situation and each dashboard should be analyzed and addressed on a case-by-case basis. This Handbook provides the information to make these goals a reality. Using the information in this Handbook, airport management can

- Analyze the state of information integration at their airport,
- Develop a vision,
- Plan for future integration efforts,
- Incorporate the best practices into the integration process, and
- Proceed to successful integration.

CHAPTER 1

Vision for a Fully Integrated Airport

Introduction

This Handbook was developed as a result of Airport Cooperative Research Program (ACRP) Project 01-03. The research project had the following objectives:

1. Assess the current state of the industry in relation to managing appropriate data from business-related financial and operational activity;
2. Develop guidelines and current best practices to fully integrate such data and the business-critical information that they indicate;
3. Develop functional specifications for procuring open-architecture systems for integrating the data; and
4. Describe a vision of an airport with fully integrated business, operational, and financial information systems.

To meet these objectives, this Handbook has been designed to lay the foundation, chapter by chapter, for developing an airport manager's computer desktop dashboard, from which to access the information from their integrated airport systems. As the reader moves through each chapter, it is possible to shape a dashboard for the future that is appropriate to the specific airport operation. This Handbook does not provide the dashboard itself, but rather its building blocks.

This chapter describes the vision for a fully integrated airport and provides an overview of the Handbook's organization.

Vision

Managing the complexities of an airport requires numerous daily business decisions, financial and operational, as well as proactive business planning and problem-solving or problem prevention. To make these decisions, senior managers need accurate, timely information. On any given day, a manager might want to know the airport's current financial picture as indicated by annual cost per enplanement, percentage of non-airline revenue generated, or budget-to-actual operating costs. Management might also need to know what operational issues are affecting the budget and what processes are generating the highest number of customer complaints. In analyzing the issues, senior managers might like to know what the potential return on investment might be for alternative proposals or whether proposed new facilities would affect the competitiveness of the airport by raising the average cost per enplanement or perhaps by changing the gate usage for only one airline.

Complex decision-making, such as whether or not to finance a new gate expansion, would be easier if the costs to construct and the costs of operating and maintaining the expansion, along with the effect on the airlines' rates and charges in the first year of operation, could be quickly accessed for review. If senior management could also look at and add to their evaluation the trends of various airline passenger counts over the past year and then calculate the effect of a significant reduction in passengers on gate usage demands, then the decision might be clearer. If the customer service complaints trend analysis indicated that additional gate capacity would solve one of the top areas of complaint, and this information was paired with all of the above metrics presented on the desktop dashboards of senior management, decision-making would be faster and more likely to result in sound business decisions.

If an airport could generate the information and integrate it as necessary to bill airlines for landing fees and other variable charges immediately at the end of the month, rather than waiting 30 days for airline-reported data, amounts due the airport would be received in days, instead of weeks from month's end. Such a result could put an airport in a far better position during airline industry upheavals.

The information necessary to answer these questions might well be available in one or more functional areas of the airport and in one or more disparate systems. In the ideal situation, senior management could access the information each manager desired from the computer desktop, mobile phone, or Personal Digital Assistant (PDA). In this best of worlds, the key data needed for the business-critical information would be seamlessly integrated or transferred from each airport information system and the metrics that a particular manager has identified as necessary to provide the best picture of that airport would be automatically calculated. The ability to review the chosen metrics as desired would be coupled with the ability to drill down to the level of detail required to assess the effect of business decisions before they are made. Ideally then, this technology would provide immediate access to the metrics data, as well as insight into the business rules behind the metrics. This Handbook is designed to help bring this idealized vision to life for different CEOs. One CEO may require the intensive assessment of the details that constitute each section of data. Another CEO may only be concerned with the effect on business decisions. Others may want to assess the context of the data, seeing where it comes from, how it is calculated, and who is responsible. This Handbook is meant to address these situations so that the manager's dashboard is flexible and customizable.

Information systems in airports contain data that crosses functional areas; the data might be collected in various divisions, used by several different divisions, and only available to senior management in bits and pieces. Today, information data can reside in legacy systems, which are difficult to integrate, in systems that are kept manually, or in software systems that are proprietary. Regardless, the ability to *integrate* the data for decision-making is growing with each improvement in information strategies and technologies. The integrated airport of the future will use technology to bring information from separate systems together to provide a single, cohesive view of the data.

Although the long-range vision for airports is to achieve full integration of all essential data, or as much as an individual airport finds useful, through information technology, ultimately, the role of information technology in airports will evolve as the technology itself evolves and changes. Like most businesses, the pace of change in an airport depends on financial resources, the actual benefits to the business, and the ability of the airport to take advantage of the technology changes cost-effectively. However, planning and preparing for such changes by developing the vision for the airport, ensuring that each new information technology (IT) project moves the airport toward the vision, developing specifications for IT projects that enhance the ability to integrate existing data systems, and demanding that the technologies and strategies employed be flexible and have an open architecture, can only help in reaching the long-range vision for integration.

Handbook Overview

Readers can use this Handbook to develop a long-range integration plan for their airports—by identifying where the airport is today and what integration projects would most advance the overall vision, prioritizing those projects, and creating a phasing strategy to achieve the overall vision. This Handbook will assist an airport in developing plans and processes to achieve successful integration of airport information systems. The Handbook is intended to enable airport managers to develop their own visions for long-range integration based on the needs of their particular airports. This Handbook provides information on best practices for integration and explains the current state of airport integration, as well as current integration strategies and technologies, in user-friendly terms to ensure that the Handbook is relevant to all levels of the organization.

For the purposes of this Handbook, the term *integration* means the *process of evaluating and implementing information processes and information technology systems to provide accurate, real-time business-critical information.* Thus, integration encompasses more than transferring data from one software system to another—integration is any process that allows information to be transferred, shared, or seamlessly related. Further, integration covers the broad spectrum of information at an airport—information as varied as data from maintenance logs, security lines, and parking lot entrances, as well as departing passenger counts. Thus, *integration* as used in this Handbook should be embraced by the entire airport organization—not just the IT division.

CHAPTER 2

Current State of the Industry

In the aviation industry, airport "integration" has been a buzzword for a long time. Initially, the integration effort in airports, as in many other industries, focused solely on the technology. It was common practice to try to make the data fit into the integration technology. Today, airports focus more on data and information processes to ensure that these processes provide accurate, useful information.

To assess the current state of the industry and create this Handbook, several research tasks were conducted. These tasks were designed to illustrate the current state of the industry relative to the following factors:

- Level of integration of airport systems,
- Data related to systems integration, and
- Business-critical information such integration delivers.

This chapter provides the research team's findings and describes current standards related to the delivery of business-critical data and information.

Research Findings

Phased Integration

Airports tend to integrate in phases, usually by division or functional area. Airports might start the integration process with one area, such as Flight Scheduling or Maintenance. Data rules are applied through an airport information hub to "scrub" clean the data from that area. Then the airport brings another division or functional area into the integration effort. Specific integration efforts that address both technology and information processes vary widely from airport to airport—sometimes, from department to department within an airport.

Integration of Financial and Operational Data

Airports have had varying degrees of success in integrating their financial and operational data, and the size of the airport does not necessarily indicate the level of integration achieved. Some airports have engaged in significant integration, particularly those airports that are moving into a common-use environment. Some airports have successfully integrated the Maintenance work order systems with the Human Resources (HR) payroll system, ramp data with gate management systems, and landside activities with Security and Finance. Some airports have achieved benefits by integrating their financial systems with those of HR. Many airports have not successfully integrated operational activities with financial activities. For example, flight information management systems typically do not feed financial management systems.

Common-Use Environment

The trend in the airport industry is toward a common-use environment, which draws on multiple sources of information to compile and display the most up-to-date data. The airport provides the systems, and the airline tenants access these common-use systems through facilities, such as ticketing, as well as passenger check-in and boarding equipment. One reason for this trend is the failure of many airlines to maintain systems upgrades. For example, most airlines have not updated their legacy flight information display systems (FIDS), leaving airports in need of current, accurate integrated flight information for operational and financial activities.

A common-use environment enables airports to control and upgrade systems such as FIDS. Airport-owned FIDS solutions, including Recommended Practice initiatives for flight information management systems or the new airport information data exchange solution, offer state-of-the-art technologies to tenants and passengers. Many airports are moving toward common-use systems as new use and lease agreements are negotiated.

Data Gaps

Some airports benefit from airport-owned FIDS solutions by using multiple feeds from various software systems and services and then funneling the data through airport operational database systems to validate the information received directly from the airlines. However, airports have encountered a problem using FIDS—gaps in the data feeds. For example, a gap can exist when an airline has planned a maintenance-related landing or takeoff at an airport. Because this information is not identified as a scheduled flight, it is not downloaded into the FIDS. Nor will the data feed from the Official Airline Guide (OAG) normally include this flight. The airport must still rely on self-reported information from the airline to bill them for this landing or takeoff.

Airports rely on aircraft tail numbers to track the financial activities associated with each aircraft at an airport. The types of data that can be collected include aircraft equipment model and type, tail number, airport arrival and departure times, airline flight number, passenger counts, aircraft weight and balance data, and whether a flight is scheduled or non-scheduled and domestic or international. Every aircraft transmits a signal from its transponder to the Federal Aviation Administration (FAA) radar systems. These real-time data are collected and disseminated by the national aeronautical database, which is maintained by the FAA National Flight Data Center (NFDC). NFDC is responsible for collecting all aircraft flight data. Direct feeds into airport systems can be set up through the NFDC. **However, the FAA censors its data, which can create significant data gaps. For example, aircraft tail numbers for commercial flights may be transposed. The airport receives a fictitious number instead of the actual tail number, even though FAA-certificated landing and takeoff weights of an aircraft are denoted by tail number, and most airports charge airlines based on those weights.**

Some airports struggle with these gaps in data. Of critical importance to any airport's decision-making process is that senior management should have a good understanding of the systems, the sources of the data, and the rules of the data. (Chapter 5 offers further discussion about the systems, the various sources, and the rules.)

Billing from Flight Data

Using flight data from information systems for real-time billing has not been entirely embraced by the airlines. Some airports purchase financial software that captures aircraft tail numbers—without realizing that their contractual obligations prohibit them from using the resulting data as a billing tool, and thus can only use the software results for audits.

Before purchasing the software, airports should check with their legal department to determine if there are contractual constraints, which might affect the usefulness of the software and, if so, how these contract issues can be addressed.

Passenger Fees

Some airports use airport-driven data sources, such as common-use kiosks, check-in systems, ticket readers at the gate, and passenger manifests, to capture passenger counts needed to bill for passenger fees. These sources can automatically capture the passenger counts for arriving and departing flights. Automatic capture eliminates the need for airline self-reporting, and thus alleviates the typical delay for payment to the airport.

Further, airports are testing video analytic technology to report and analyze passenger information, including counting passengers as they enplane and deplane the aircraft. This technology allows airports to audit payments based on airline self-reporting or to automatically and accurately bill airlines for each passenger fee—fees for enplaning and deplaning, common-use fees, and international passenger fees.

If airport-airline agreements do not preclude it, the ability to generate immediate billing of passenger fees would allow airports to reduce the current 60- to 90-day grace period airlines usually have for payment of such fees. In the current financial state of the industry, this shortening of the payment grace period might reduce the potential for significant bad or pre-petition bankruptcy debt resulting from several months of unpaid fees and charges. Should the airline seek bankruptcy protection, this may strengthen the position of the airport by increasing the regularity of the payments, suggesting the payments were made in the ordinary course of business, and increasing the likelihood that these payments will be retained.

Space Planning and Physical Facilities

Information needed for effective planning and space use decisions is rarely integrated. Information about land ownership, Master Plans, current construction, blueprints, and as-built construction might not be in a format that is readily available or easily integrated into financial and operational activities. Airports are proprietors and calculate returns on airport land investments. Calculations rely on data such as land cost, other investment expenditures, and effects on new development that are not in the Master Plan.

Senior managers may not have ready access to accurate information about the physical reality of their airports—facilities, raw land, land under development, buildings, and infrastructure, such as underground cables or plumbing. Without this information, an airport's finance and engineering reporting might not provide accurate and meaningful data for senior management in a timely manner.

Concessions

Airports have typically performed cost-benefit analyses and determined that integrating concession information is an arduous process and the results may not be worth the cost. Concession reporting is often done manually. Cashier systems differ widely from concessionaire to concessionaire, with as many as 30 or more different types at some large airports. Further, these concessions are often part of a franchise or store network, each with their own reporting systems and requirements. As the retail industry settles on common standards, information integration may become easier.

Airports need to examine these concession systems, watch for standardization in the retail industry, and explore integration of these systems. For example, Singapore Changi (SIN) airport has integrated their concession information in a common-use system that feeds information into their financial management system.

Intelligent Sensor Technology

Intelligent sensor technologies are increasingly available to airports. Imagine a passenger goes directly to a kiosk check-in. The kiosk uses advanced facial recognition algorithms and the passenger's fingerprint and iris are scanned. **The passenger is issued a smart boarding pass that contains a smart chip. This chip contains all the information about that passenger, the flight, and gate, and allows access through the international access control points all the way through to the gate. The passenger's passport is scanned and the data are integrated with the border control agencies software system.**

Once at the gate, intelligent wireless sensors, with built-in memory, collect the data indicating the passenger has gone through the gate access control door and is boarding the aircraft. These advanced sensors contain plug-in functions (called intelligent nodes) including advanced wireless communication technology and intelligent video recognition software (Bluetooth®, sonar, radar, and camera input). These software solutions are fully integrated with the airports access control systems, advanced wireless networks, and the border control agency.

Radio Frequency Technology

Airports are also beginning to adapt to emerging technologies and, in some cases, melding old with new. RF technologies can be paired with newer systems and emerging software to enable airports to track equipment, baggage, commercial vehicles, parking data, and many other aspects of an airport's operation. With radio frequency identification (RFID), radio waves transmit data from a small tag embedded in equipment, products, and vehicles. A technology called "chip-less RFID" allows data to be written directly on the tag to track history, parts, maintenance, and access.

Bar Coding

Some airports are using two-dimensional (2-D) bar codes to encode data in standardized formats. The standardization of bar code technologies enables data transfer to many different systems. Airlines can send 2-D bar codes to a passenger's mobile phone to serve as the passenger's boarding pass.

Historically, bar code applications for mobile phone technology have been restricted because mobile phone companies used data technologies that were not compatible. **However, the International Air Transport Association (IATA) Resolution 792 specified the use of Portable Data File 417, and IATA developed a standard for 2-D bar codes. This data format standard for 2-D bar codes makes data exchange technology cost-effective and readily available and enables single-scanner types and mobile devices to read data from the three proven and widely used technologies—Aztec, Datamatrix, and Quick Response.**

Video Analytics

Airports are also using innovative technology such as video analytics to capture data. For example, some airports are testing the use of video analytics to analyze behavior, objects, or attitude. Video analytics algorithms are integrated with systems called Intelligent Video Software. This technology can evaluate the contents of video to determine user-specified information about the content of that video. It has a wide range of applications including airport safety and security. Video analytics applications are used at today's airports to perform the following data capture tasks:

- Count the number of pedestrians who enter a door or geographic region;
- Determine the location, speed, and direction of travel;
- Identify suspicious movement of people or assets;
- Inventory license plates; and
- Evaluate how long a package has been left in an area.

As mentioned earlier in the discussion of passenger fees, airports are also using video analytics technology to count the number of enplaning and deplaning passengers.

Next-Generation Air Transportation System

The Next-Generation Air Transportation System fully integrates information that airports and airlines need. Decisionmakers can see beyond the airstrip and monitor the activity on concourses, in the parking lots, and at the gates. This level of integration and various software tools could enhance security and increase revenues as rates and charges become more accurate.

Airport Surface Detection Equipment–Model X (ASDE-X) pulls information from several surveillance sources including radar, Automatic Dependant Surveillance-Broadcast (ADS-B) sensors, and transponders on the aircraft themselves. New enhancements and the introduction of Global Positioning Systems (GPS) capture the positioning of aircraft and surface vehicles at airports.

ASDE-X can also be used with the FAA's new software management tools (such as FAA's Surface Management system, which extends surface monitoring beyond the runways to the ramp areas of an airport). This enables an airport to capture the activity of aircraft and vehicles on the ramp and at the gate. This Surface Management system essentially extends ASDE-X to provide a detailed understanding of the areas in and around an airport. These technologies can result in the integration of information so that all areas of the airport, not just the runways, are under constant monitoring, assessment, and analysis.

The FAA toolbox of new technology also includes satellite-based approaches called Area Navigation and Required Navigation Performance. These tools enable precise approaches at airports when the proper procedures are in place. The FAA has authorized over 200 new Area Navigation procedures at 62 airports.

The Next-Generation Air Transportation System provides decisionmakers with a deeper level of understanding by monitoring and assembling key data points from all areas of the airport. With a detailed understanding of all movement and activity, airports can more effectively and efficiently charge for their services. Part of this plan includes ADS-B.

The FAA upgrade solution for improving the present Air Traffic Control system is the Next-Generation Air Transportation System, and ADS-B technology is at its heart. For airports, the implications of this system are profound. The system, based on satellite positioning of both aircraft and ground-based equipment, enables operators of planes and vehicles to immediately ascertain the location of all others in their vicinity.

From an operational perspective, emergency response vehicles and operations vehicles can safely move across the airfield in minimum visibility conditions. Likewise, aircraft taxiing on the ground will ultimately be aware of all other aircraft and ground equipment maneuvering airside when all software solutions have been implemented.

Logistically, when all vehicles and aircraft are equipped with ADS-B, airlines as well as airport operators will be able to dispatch necessary resources on a just-in-time basis. This will translate into lower costs and operations that are more efficient.

ADS-B will also have a favorable impact on noise contours around the airport. The airport operator working in cooperation with the FAA and the airlines serving the community will identify preferred routes, preferred altitudes for inbound aircraft, and minimize noise and pollution over the most congested areas.

With the integration of such information, a manager's dashboard could easily depict anticipated arrival and departures delays, related weather conditions, and the resources available to address airfield anomalies.

Adaptive Compression

Adaptive compression refers to the application of a complex algorithm that dynamically adjusts to the subject matter of the data being used. Using advanced technology, the FAA has been applying this technique to minimize ground delays at airports and has deployed it in more than 11 locations. The FAA Adaptive Compression software scans for available slots at airports. During aircraft-delayed operations, it automatically fills the slots and reassigns new slots for the delayed flights. This increases customer satisfaction and minimizes ground delays that cause congestion on the taxiways and at airport gates, especially during serious weather events. This also minimizes the Department of Transportation (DOT) reporting of flight delays attributable to an airport. The FAA uses adaptive compression in conjunction with its airspace flow program to share data with the airlines and airports. This gives the airlines and the airports the option of accepting delays due to weather and gives the airlines the additional option of accepting longer routes to maneuver around the weather. This provides airlines and airports with multiple options when dealing with delays and inclement weather.

Disadvantaged Business Enterprise Program

The percentage of Disadvantaged Business Enterprises (DBE) is an important consideration that affects concessions and many airport contracts. The Department of Transportation DBE Plan requires airports to calculate the percentage of the total construction contract amounts paid to qualified subcontractors, suppliers, or joint partners for federally funded contracts, and the percentage of concession program revenues generated by DBE concessionaires. These calculations must be reported annually to the DOT and FAA in the airport's required reporting on its compliance with its approved DBE Plan. Key data necessary to generate the required calculations must be manually tracked, or the systems that contain the necessary data must be integrated. The easier and faster these calculations can be performed, the more responsive airport management can be when queried by elected officials and interested community members, and the more accurate the federally required reporting can be.

Airport Lease Agreements

The use and lease agreements at airports usually provide how the rates, fees, and charges are to be determined and what rate-making methodology will be followed. Frequently, the agreements establish the source of the data necessary to calculate the rates, fees, and charges. For example, the agreement might state that, within a set number of days from the end of the month, each airline will self-report for billing purposes the number and type of aircraft landings, number of enplaned and deplaned passengers, and number of originating and departing passengers.

Many airports have use and lease agreements that cover such diverse issues as who is responsible for the flight information data, what access and control each party has over the technology and telecommunications infrastructure, and what rights the airlines operating at that airport have to approve or veto capital projects, including IT projects.

As airports undertake efforts to integrate, these contractual rights and duties must be understood and managed. When new leases are being negotiated, future integration plans should be considered and flexibility provided in the use and lease contracts, as necessary to achieve the full benefit of integration.

Rates and Charges

Airports could realize substantial cost savings and operational efficiency by integrating financial management systems with operations. Finance is the heartbeat of the airport's data system and powers the rates and charges, budgets, and Capital Improvement Program (CIP). Many airports have implemented some type of rates and charges software system but have had difficulty with some of the complex rules surrounding the rate-making methodology. Airports use differing methodologies—usually some form of residual, commercial compensatory, or hybrid—as their use and lease agreements provide, and many use different methodologies for different cost centers within the airport, making development of software systems a challenge. Solutions that combine the following functions are just in the beginning stages of development:

- Encapsulate all rates and charges,
- Update the CIP and the Master Plan, and
- Provide real-time budget and planning tools.

Whether the airport is large or small, it has the same interest in ensuring that any integration effort is justified by saving money, improving data accuracy, or improving customer service. Therefore, more airports are analyzing the cost-benefit before undertaking an integration project.

Standards for Communicating and Using Airport Information

Aviation industry groups as well as international standards setting organizations are creating global standards—agreed-on formats and methods—for transferring data. These standards are crucial because they provide uniform, consistent methods to communicate data. Industry members unilaterally agree to use these standards to increase their ability to integrate. System developers do not have to purchase these standards, just as writers do not have to purchase English.

The standards are updated as new technology becomes available. Standards usually contain open-architecture specifications controlled by objective third-party associations and organizations. No single developer or vendor has control over the specifications. (For a discussion of open architecture, see Chapter 6, Architecture, Strategies, Technologies and Contracts.)

Software vendors can use these standards to develop systems that are compatible with other systems. Other vendors can create customized functions to add onto these systems. Anyone can develop add-in applications to improve the software for their purposes without obtaining permission from the vendor.

This next section briefly describes some additional accepted standards for the aviation industry:

- Recommended Practices,
- Common-Use Passenger Processing Systems (CUPPS),
- Airport Operational Databases, and
- Extensible Markup Language (XML).

Recommended Practices

In aviation, industry consortiums that consist of airports, airlines, and other organizations develop similar standards but refer to them as "Recommended Practices" or various requirements-setting documents. IATA and the Air Transport Association (ATA) are global aviation industry leaders in developing Recommended Practices, technical requirements, resolutions, and general business requirements, specifically for airlines, airports, and aviation service providers.

Common-Use Passenger Processing Systems

Together, IATA and the Airports Council International-North America (ACI-NA) began the complete overhaul of the Common Use Terminal Equipment (CUTE) systems still used in many airports today. The CUTE Recommended Practice relied on standardized equipment, rather than using a standardized technology, and had not been updated since 1984. **As a result of a 3-year collaborative effort of aviation industry groups, CUPPS, using XML technology, emerged as a Recommended Practice in the fall of 2007 as specified in the following documents:**

- International Air Transport Association Recommended Practice 1797,
- Air Transport Association Recommended Practice 30.201, and
- Airports Council International Recommended Practice 500A07.

CUPPS, as a technology, is more flexible and can be used in many different types of equipment and software systems that drive the FIDS, dynamic signage, airport messaging, kiosks, and display boards. The architecture lifecycle illustrated by CUPPS is evolving with input from many organizations, developers, and vendors. As the technology continues to develop, compliance tests certify that specifications are met until finally the technology becomes a standard that gives users, vendors, and developers consistent and reliable access to the technology.

Moreover, CUPPS provides a common foundation on which airports and vendors can build customized software—as long as the software uses the CUPPS Recommended Practice. CUPPS can be used in an airport to integrate all passenger data; airports that do not have a common-use environment can translate data from many airline systems into the CUPPS Recommended Practice to use in a common software system. These types of standards will facilitate the following benefits for airports:

- Flexibility around peripheral deployment and updates,
- Ease of platform deployment,
- Support for added security and remote management, and
- Defined network requirement documents.

Airport Operational Databases

Aviation software vendors have developed a strategy for integration using XML technology, airport operational databases (AODB) that act as a sort of clearinghouse for data from other software solutions, allowing for data to stream from one system to another. These types of airport operational databases use various strategies for collecting, storing, and transmitting information.

Extensible Markup Language

XML is a technology used for tagging, interpreting, and transmitting data between applications. Most standards for industry and government use XML to transfer data between hardware and software systems. Data are stored in plain text, which does not depend on software or hardware. XML is also a way to describe and display data in a common language for standardized data exchange. Translators using these standards can also help pull information from legacy systems. System developers do not have to purchase XML or any standards based on XML, just as writers do not have to purchase English to write a handbook.

Electronic business XML, commonly known as e-business XML or ebXML, is a family of XML-based standards that translate data into data packets that can be transferred via the Internet.

Sponsored by the Organization for the Advancement of Structured Information Standards (OASIS) and United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT), ebXML standards provide a common method to exchange business messages, conduct trading relationships, communicate data in common terms, and define and register business processes.

Collaboration and Sharing Information

The elements discussed in this chapter reflect the growing movement toward a more collaborative approach to integration at airports. The Next-Generation Air Transportation System, 2-D bar codes, adaptive compression, Recommended Practices such as CUPPS, and innovations in video analytics, intelligent sensors, and XML technologies—**All of these illustrate the shift toward systems that have an open-architecture, integrated and collaborative environment.** CUPPS is an especially valuable example of the integration efforts taking place. CUPPS applies a specific XML schema within a recommended practice, creating standardized processes for integration. CUPPS uses information from many outside sources, including airlines, the FAA, and other agencies, and is an initiative that all parties can embrace. These developments represent a shift toward a standardized integration approach, where information is shared and integration is now more feasible than ever before.

CHAPTER 3

Best Practices for Integration

A successful integration project reflects the time and effort taken beforehand to prepare for the integration properly. Unless care is taken to set the goals and objectives, identify the existing processes and systems, clarify the vision of a successful outcome, and evaluate all of the benefits and costs of integration, the resulting project will not meet the desired outcome. Instead of setting up a plan to succeed, an airport might inadvertently set up a plan to fail. Airports that have integrated several systems and achieved results that met the expectations of managers, users, and customers have developed a series of best-practice integration steps that led to their success. This chapter describes the steps those airports have taken.

Whether the airport is a small, medium, or large airport, the thousands of complex information processes and millions of pieces of data are similar. Adding to the equation are sophisticated technical systems, some old and some new, which can make the integration process overwhelming. **Therefore, using a phased approach by department or by functional area helps airports realize success.** Integrating airport systems using this phased approach has proven more palatable than the integration of the entire airport. Another way to look at it is: If your desk is full of paperwork, how will all the work be completed in a timely manner? A best practice is to review all the documents, prioritize the workload, and start with a small part of the paperwork before moving on to the next.

Part of using a phased approach is performing a financial cost-benefit analysis of the proposed integration effort before beginning integration and updating that analysis along the way. The financial cost-benefit analysis can help an airport determine which functional area to include in the first phase and how much integration makes sense. Throughout the steps, the analysis is updated to reflect new information and the financial feasibility of the project is continually revisited. For example, it might become apparent that, although it originally seemed sensible to integrate the existing financial and maintenance systems, it turns out that it would be more cost-effective to get a new maintenance system that already has a built-in integration with the current finance system.

By creating a long-range plan and using a phased approach that adequately reflects the priorities of the airport's business needs and objectives, airports have achieved positive results. After the objectives and information needs are identified, the data are scrubbed clean and data rules are then applied. Identifying specific business-critical information that is important to senior management can help define into what phase and priority the particular integration process falls.

Within the stakeholder group described below, airport middle managers can help identify and deliver what senior management needs. If the integration effort is embraced throughout the airport and is based on basic problem-solving approaches, integration is more likely to occur. The integration process involves many people working together for a common goal and exchanging information between systems accurately, in context, and on time.

Stakeholders

Although the following stakeholder descriptions may not reflect all airports, these descriptions define the categories used in the steps detailed in this chapter.

- **Airport Senior Managers.** For this Handbook, an airport senior manager is a high-level executive responsible for the airport, functional area, or division/department, such as a Chief Executive Officer (CEO), Chief Operations Officer (COO), Chief Information Officer (CIO), or Chief Financial Officer (CFO). These senior-level managers provide the vision for integration projects.
- **Airport Middle Managers.** Department and division heads who run daily operations ensure that information flows are smooth and accurate, and they maintain the IT network infrastructure. These managers need detailed information about their divisions or areas of responsibility. They manage the intermediate steps needed for the integration process.
- **Data Owners.** The staff who input data and calculate information are the data owners. They need to understand the context of their data and how the information is used. These staff need the inputs and outputs to calculate their information. They work with middle managers to identify processes and make the changes needed for integration. The involvement of the stakeholders is often the key for success through the integration phases.

Integration Steps

The rest of this chapter describes each step in detail, including the stakeholders involved in each step and the relative intensity of their involvement. Figure 3-1 shows the sequence of steps toward integration. In Figure 3-2, senior management is heavily involved, as indicated by the four-person graphic in the first column, first row.

Throughout the steps, a graphic of four people in a column represents the greatest involvement, while three people represent slightly less involvement, and so on. Stakeholder groups not directly involved in a particular step (as indicated by blank space) should be kept informed of

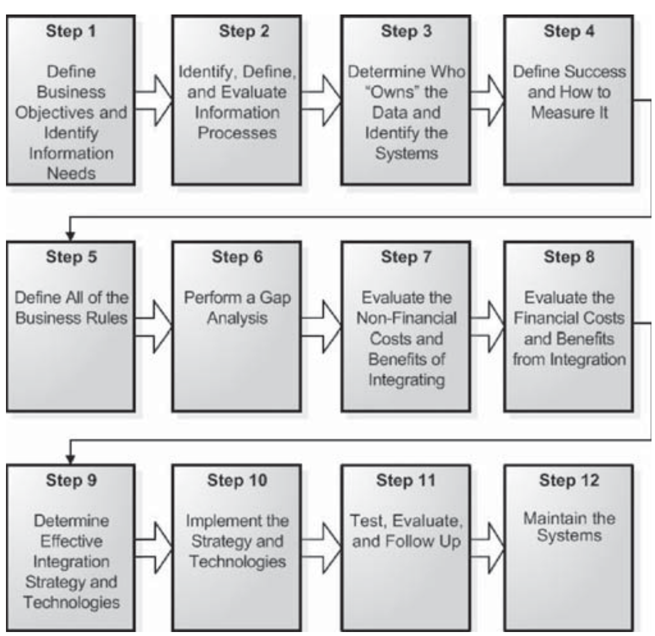


Figure 3-1. Best practices for integration: sequence of steps.

Stakeholder:	Airport senior managers	Airport middle managers	Data owners
Involvement:			
Tasks:	Define ... Identify ...	Identify ... Identify ...	Identify ...

Figure 3-2. Sample of the steps.

the progress and results, as appropriate. From these charts, readers can quickly find their roles and concentrate on the tasks needed to help make the airport integration a success.

Case Study Examples

In the following sections, the steps to prepare for integration are further illustrated using a hypothetical case study to track the activities that might accompany an integration effort. Each step of the case study illustrates how a mid-sized airport might undertake to improve airline rates and charges calculations. To do this, the airport chose to integrate information that previously had been handled manually. For the sake of brevity, the case study tracks the general direction of an integration effort and only summarizes the many actions that would be needed.

Case Study Introduction

Angelo International Airport (AIA) is a medium-size hub airport enplaning 4.7 million passengers, with 213,000 operations annually. It is served by twelve domestic and two international carriers. AIA's use and lease agreement has an airfield residual cost center structure, while the terminal complex generally is classified as commercial compensatory in its rate-making methodology.

Step 1: Define Business Objectives and Identify Information Needs

Figure 3-3 indicates the level of effort of the stakeholders for this step.

Define Objectives

The first step in any integration process, and the most important, is for senior management to define clearly what airport goals will be furthered by this integration and what objectives manage-

Step 1: Define Business Objectives and Identify Information Needs

Airport senior managers	Airport middle managers	Data owners
Define the overall objectives. Identify the metrics associated with the objective and business-critical information.	Identify intermediate objectives needed to achieve the overall objectives. Identify business-critical information and its context.	Identify the key data elements of the business-critical information.

Figure 3-3. Step 1.

ment wants to achieve. If the airport has already developed a vision and created a long-range integration plan, then based on those priorities, the project can be scaled using a phased approach that reflects the priorities and objectives defined in the airport's business needs and objectives plan.

To help define the business objectives for an integration project, management needs to identify priorities in the following areas:

- **Business.** For example, is the priority to generate higher levels of revenue, provide better service to the public, or reduce duplicative staff effort? If all three are priorities for the project, identify which has the highest priority.
- **Sensitive Areas.** Review the potential for sensitive issues that require the involvement of senior management. Such issues can include control of media information and the timing of such data releases, or how the integration may affect staff.
- **Political.** Determine if the political climate may affect achieving the goals of the integration and what information is required to meet political objectives. An airport authority may have different political issues than a government-owned and -operated airport. For example, a municipality may want financial information from all city departments, including the airport, to be integrated and consolidated for auditing and reporting purposes.
- **Planning.** Determine the area with the largest projection of growth and prioritize the integration efforts to mirror the Master Plan. For example, an airport might be planning to gear its facilities to a more common-use environment.

Identify the Need for Integration and Why

For each individual integration project, it is important to start with a clear understanding of the reasons behind the integration effort. These objectives can be broad, such as "Understand the components of and reduce the cost per enplanement." However, they should be part of the airport's overall objectives. Answering the following questions can aid in reaching these objectives:

- What problems are we trying to solve with this integration effort? Example: the manual calculation of rates and charges.
- Who are going to be the primary users of the integration effort? Example: all of senior management.
- What tasks are the users going to perform with this system, and how often? Example: senior managers will access the data from their dashboard.

Every other step of the integration process should relate directly to these business objectives. Reviewing the overall objectives periodically throughout the process will help keep the integration process on track to achieve these objectives. If the objectives change, the steps may have to be repeated to achieve the new objectives.

As with other initiatives, it is easy to be too ambitious with the objectives for an integration project. It can help to prioritize the objectives and recognize that it may be necessary to defer some objectives in order to accomplish the main goal in a reasonable period and at an acceptable cost.

Identify Business-Critical Information

After senior management has established the metrics associated with the business objectives, identify the business-critical information and key data elements necessary to calculate the metrics. For a guide to the business-critical information and key data elements common to most airports, see Chapter 4, Airport Information. However, an airport's particular operations and procedures may require additional information not addressed in that chapter. To complete an airport's data needs, answer the following questions:

- What successes has the airport had? What data and information led to these successes?
- In the past, what problems have arisen because of the lack of proper data and information? What data and information are needed to prevent problems in the future?

- What data do particular reporting circumstances require? For example, an airport can be part of a municipality that requires certain fiscal data reporting.

Case Study Step 1

AIA's CFO approached the CEO with a concern that the airport's current method of calculating rates and charges was cumbersome, prone to errors, and time consuming. As a result, the CFO felt it would be appropriate to explore the possibility of integrating one or more of the systems that feed data into the rates and charges calculations. The CFO's objective was to improve the process of calculating some or all of the rates and charges by making the process faster, more accurate, and less expensive than the current process. She mentioned several systems and manual procedures that contribute to the calculations.

The CEO Agreed and told the CFO to proceed with the initial steps. He noted that major airport goals would be supported by increasing efficiency and reducing costs to the airlines. The CFO identified the intermediate objectives as reducing both staff cost and lost revenue.

Step 2: Identify, Define, and Evaluate Information Processes

Figure 3-4 indicates the level of effort of the stakeholders for this step.

Identifying, thoroughly understanding, and evaluating the information processes are key for any successful integration—after all, this information is the core of the integration effort. First, trace each piece of information identified in Step 1 by answering the following questions:

- What is the source of the information?
- How is that information calculated?
- How accurate is that information?
- What is the context of that information?
- Where is that information stored?
- How is that information tracked?
- What systems use that information?
- What people use that information?
- Why and how do people use that information?

Information processes that are sound and provide accurate data before integration will be sound and provide accurate data after integration. Likewise, any information or process that is inaccurate or out of context before integration can provide inaccurate and possibly misleading data after integration. Identify any problems in information processes before taking any other steps

Step 2: Identify, Define, and Evaluate Information Processes

Airport senior managers	Airport middle managers	Data owners
Refine and clarify the information identified in Step 1 as needed. Coordinate with the airport's customers. Examine the data input required to achieve the objective.	Determine whether the process is good and worth integrating. Chart information processes from the traces produced by data owners, and coordinate identifying information processes that flow across departments.	Trace the processes needed and the data identified in Step 1.

Figure 3-4. Step 2.

to integrate. Work with data owners to ensure that the processes for collecting, calculating, storing, and using data provide accurate, effective data. Flag data with the following characteristics:

- **Redundant Entries.** Often the same data comes from multiple sources and is used in different contexts and circumstances. Identify what information is being input more than once. Who enters this? Where do they get the information? How do they enter it?
- **Manual Entries.** Identify what information is entered manually, such as shift logs or information someone types from one software system to another. Identify which manual entries might be automated to discuss later with an IT vendor. For now, just get information. Who enters this? How? What does it do for us?
- **Incorrect Data.** Data derived from calculations that depend on the incorrect information will also be incorrect. Incorrect data used in calculations will result in incorrect information in the various systems that use the data. Finding these errors can save millions of dollars a year.

Identifying the correct data needed is not enough. Evaluate how well the existing processes are working. If a particular process works fine the way it is, the process need not be changed. If, after the analysis, the consensus is that the process should change, it may be beneficial to bring in a specialist accustomed to facilitating process changes. **The inertia of having "always done it that way" is a tremendous force, and it needs to be worked *with*—not against. Changing processes is extremely difficult and might be one of the most challenging aspects of the integration process.** Ask the people involved with the entire information process to help fix the problems. If the people who use the process help change the process, they will be much more likely to accept the new process.

Case Study Step 2

The CFO asked the staff in Finance and Administration, Maintenance, IT, and Operations to document the source, location, accessibility, purpose, and calculation method of each key piece of data. The CFO noted the person who was responsible for collecting, calculating, and transmitting the data. The CFO discovered that there was often more than one source for key data elements and the data from different sources conflicted at times.

The CFO also found that several sources of data needed further investigation. For example, the airport relied on the airlines to report their number of operations and passengers carried, and this data then was used to bill the airlines for their landing and passenger fees. This reliance represented a possible weakness in the process that needed attention. The CFO made a request to the airlines that they provide the source and systems used to provide their reported data.

The CEO agreed that the project should proceed and the CFO identified the next steps as appointing a Project Manager and building an airport-wide cross-functional team that would collaborate on the project.

Step 3: Determine Who "Owns" the Data and Identify the Systems

Figure 3-5 indicates the level of effort of the stakeholders for this step.

Understanding the data's context and where it resides is also essential to understanding information processes. This means identifying which system or systems contain each piece of data that the effort identifies as being necessary to meet the business objectives. Some pieces of data might actually be tracked in multiple systems. There might be pieces of information currently not tracked at all, tracked informally on paper, or in some isolated electronic file (such as a spreadsheet). This Step requires delineating the systems and how data are used in the system. This information and the way it is obtained varies from airport to airport.

Step 3: Determine Who "Owns" the Data and Identify the Systems

Airport senior managers	Airport middle managers	Data owners
Review the results of the systems architecture; reassess the financial costs and benefits based on these findings.	Use the information processes in Step 2 to identify staff who work with the data and the current systems. Identify the systems that generate the data. Collaboratively agree on who will own the data and the systems. Negotiate conflicts when more than one owner is identified. Determine the airport systems and architecture. Identify legacy systems and the ability to integrate these systems.	Work with managers to determine ownership. Document work procedures for the data. Match the data to each system and report to department managers. Determine the existing system architectures and their integration characteristics.

Figure 3-5. Step 3.

In this context, ownership of the data and the systems means the person in the organization who is primarily responsible for the correctness of the data and the corresponding system. The data owners are the people who are directly responsible for maintaining, calculating, and understanding the context of the data reported to middle and senior management. Although IT divisions will always be involved in ensuring correct data and system operation, IT divisions rarely own the data. Also, when referring to a *system,* the definition is more than the computer systems; the entire data information process can include a software solution, a manual paper-based process, and a workflow that includes verbal communication and notification.

Functional area managers can play a large role in tracing data. When there are multiple sources, such managers need to identify the data that should take precedence, and what data will be used from what system, under what conditions, and in what contexts. Each system identified and tracked should be accompanied by a list of how the data are stored, the architecture of the system that stores that data, and whether there is an area to store that data in the new system.

In many cases, ownership for most data and systems is not clear cut. Systems might be shared or duplicated across departments. Similarly, many pieces of data might be viewed as critical by different departments. Identifying owners of the systems and pieces of data is important to the integration process, because the owner is the final arbiter for any questions or discrepancies that arise. Without these clear lines of ownership, the integration process can stall in endless meetings, with multiple stakeholders arguing about each individual decision instead of advocating the success of the overall project.

Case Study Step 3

The CEO and CFO selected a Project Manager who was knowledgeable in the business practices of the airport and well respected throughout the organization. The CFO and the Project Manager formed a project team that worked with the key data every day, including employees from each of the functional areas of the airport. The Project Manager assigned employees as "owners," which meant they were responsible for inputting, updating, understanding, and ensuring the accuracy of the data. Discussions with the team identified alternate sources for the data that could be more accurate and timely, as well as the use of the data in each functional area. The team identified over a dozen different systems throughout the airport that needed to integrate to produce the rates and charges. The team decided to recommend integrating these systems in phases.

Step 4: Define Success and How to Measure It

Airport senior managers	Airport middle managers	Data owners
Review the overall definition of success for the project.	Define the overall success for the project. Develop a plan to measure success. Empower the owners of the data and systems to become an integral part of the integration plan.	Define success for this project at a detailed level.

Figure 3-6. Step 4.

Step 4: Define Success and How to Measure It

Figure 3-6 indicates the level of effort of the stakeholders for this step.

One of the keys to success in an integration project is first creating the definition for success for the project. The middle managers will create the overall definition for success. This definition draws on the priorities defined in Step 1, Define Business Objectives and Identify Information Needs, but should consist of measurable items. The data owners defined in Step 3, Determine Who "Owns" the Data and Identify the Systems, will be responsible for the data and the integrated system and will eventually drive the reporting. Thus, they are the best people to define success for their individual data and systems. Examples of successes at this level

- Reducing the delay before a particular piece of information is available and
- Increasing the accuracy of a piece of data.

After the successes are defined, create a plan to measure success. This plan should detail, for each individual system or piece of data, how to test the integrated system to measure success as defined by the stakeholders. Create the plan at this step in order to drive the rest of the integration process. The plan will be revised as new information comes to light in future steps, but changes to the plan should be reviewed to ensure that such changes are consistent with the overall priorities of the project.

Case Study Step 4

Because a major goal for the airport was to reduce the airlines' cost, the overall success would be measured by a reduction of the average cost per enplanement. The team decided that this overall success would be achieved by reducing the unnecessary staff time spent correcting errors in the data, entering data more than once, rebilling tenants, and re-calculating the rates and charges as data was updated. The team defined one of the measures of success as: "Successfully integrating flight data and airport-generated passenger counts, resulting in decreased reliance on airlines' self-reporting." This would also support the airport's overall goals by reducing the cost of auditing and bad debt write-off. Based on the Project Manager's estimates of the potential reduction of cost after the successful implementation of the integration, the CFO and CEO agreed that the project should proceed.

Step 5: Define All of the Business Rules

Figure 3-7 indicates the level of effort of the stakeholders for this step.

Data alone do not tell the full story of any large enterprise, especially an airport. Airports deal with complex contracts that drive complex business rules, and understanding these rules

Step 5: Define All of the Business Rules

Airport senior managers	Airport middle managers	Data owners
Review a summary of the business rules. Confirm with airport customers the complex business rules that affect their contracts and operations.	Work with other divisions to ensure the business rules and the data are compatible and correct.	Define the business rules for the data and systems being integrated.

Figure 3-7. Step 5.

is pivotal to the integration process. The business rules for an organization help describe how it goes about achieving its goals and the restrictions that apply. For the integration effort to be successful, the business rules that apply to the data being integrated need to be thoroughly understood and documented. Although the integration effort might involve multiple complex processes, only the business rules that pertain to the pieces involved in the integration effort need to be collected.

An airport's use and lease agreement delineates the space and facilities leased by a particular airline, as well as the rights and responsibilities to use the public and common-use space and airfield facilities. Additionally, rates, fees, and charges can be calculated in accordance with a rate-making methodology contained in or referenced by the use and lease agreement. The contracts might also vary from customer to customer, which further increases the complexity. Understanding and documenting these business rules can save an airport millions in the purchase of expensive software that does not fit the airport's complex contract structure.

The following is an example of a business rule related to airline contracts at an airport: A few individual airline agreements provide incentives to attract aircraft maintenance work to the airport. Some of the airline agreements call for not charging for the landing fee related to maintenance ferries, provided that the aircraft does not occupy a gate or carry inbound passengers or cargo. The agreements further provide that these ferries would be noted on the carriers' monthly reports. The resulting business rule was that airport staff will normally deduct the weights of these landings from the airlines' reported total gross landing weight before billing the airlines for the standard fee.

After the rules are clearly defined, some airports bring in consultants who prepare a requirements analysis. For some of the processes being integrated, a pre-existing requirements analysis might be available. In this case, review the business rules pertaining to the integration effort for completeness and accuracy because information processes can change over time. Also, the information process being integrated might have conflicting business rules, which requires that the appropriate data owners meet to resolve the conflicts.

When a requirements analysis is not available for data or a process, it might be necessary to create a new one. This analysis usually takes the form of a document that lists in plain English each of the rules pertaining to a process or piece of data. This document answers the following questions:

- What are the inputs to the process?
- What are the preconditions necessary for the process to begin?
- What are the outputs from the process?
- What is necessary for the process to be completed?

- What are the standard workflows through the process?
- What are the alternate workflows through the process? When do the alternates occur?

Only the business rules that pertain to the pieces involved in the integration effort need to be collected. Also, some of the business rules that need to be collected might pertain to data not currently collected or systems not yet in existence. After the business rules have been collected, review them to ensure they are

- Consistent with each other;
- In line with the priorities defined in Step 1, Define Business Objectives and Identify Information Needs; and
- Complete.

Case Study Step 5

The Project Manager added a member of the airport's legal staff to the team to ensure that the requirements of the airlines' use and lease agreements were understood and incorporated into the business rules for the data. The CFO reviewed the draft business rules and found that the contractual rate-making methodology required that the landing fee be calculated using airline self-reported landing counts. Because this business rule would preclude using airport-generated flight data, and thus reduce the potential benefits of the integration project, the CFO flagged this problem for resolution by the CEO. The CEO agreed to try to negotiate a change in the rate-making methodology in the upcoming re-negotiation of the airlines' use and lease agreements.

Step 6: Perform a Gap Analysis

Figure 3-8 indicates the level of effort of the stakeholders for this step.

A gap analysis defines the gap between where the systems are today and where the integrated system should be. The gap analysis defines missing systems, processes, and data needed to achieve project success as previously defined. The gap analysis starts with the rules and requirements collected in Step 5. Determine for each requirement whether there is a gap between what is available and what is required for success. Gaps can take the following forms:

- Missing data or business rules,
- Inaccurate data or business rules,
- Incomplete data or business rules, and
- Systems with conflicting business rules.

Step 6: Perform a Gap Analysis

Airport senior managers	Airport middle managers	Data owners
Review the gaps and process changes.	Identify the overall gaps in information, rules, and processes. Develop process changes.	Determine what information is missing that you need for your information process.

Figure 3-8. Step 6.

After these gaps have been identified, create a plan for addressing them. Some gaps can be addressed simply, by process changes. For example, a missing piece of data can be collected and entered into an existing system. Other gaps can require some attention during the integration process, such as resolving conflicting business rules when two systems are integrated. Larger gaps can require additional systems to be built or acquired.

Next, estimate the costs of each of the steps necessary to address the gaps. Some of these cost estimates might be straightforward or negligible because they are a natural outcome of the integration process. Others might not be so straightforward, such as developing custom systems or acquiring commercial off-the-shelf (COTS) software. In these cases, a detailed build-versus-buy analysis must be performed to determine whether a custom system should be built or a COTS system is more appropriate. For more information on build-versus-buy analysis, see Chapter 6, Architecture, Strategies, Technologies, and Contracts.

Case Study Step 6

In Step 5, the AIA integration team identified dozens of business rules that applied to the calculation of the rates and charges and defined the data required to comply with the rules, as well as the sources of the data. Their gap analysis showed that the data from the maintenance work order system was frequently in conflict with the labor rates data in the HR payroll system.

The team members from each division met to find a way to resolve the conflict. The resolution called for integration of the payroll system with the work order system and re-defining the business and data rules. After the gap analysis was complete, the Project Manager created an updated project plan and cost estimate for the project. After reviewing the project plan and cost estimate, the CFO agreed that the project should proceed.

Step 7: Evaluate the Non-Financial Costs and Benefits of Integration

Figure 3-9 indicates the level of effort of the stakeholders for this step.

Understanding the non-financial benefits of integrating can enhance decision-making and help an airport justify an integration effort. Examples of such benefits include improvement in the customer service complaint areas or the ability to become more proactive in an industry accustomed to rapid changes. Ask the data owners how integration will make them more efficient. For example, will it reduce the amount of time spent correcting or re-entering data from one system to another and free them for more complex work? If the data owner is a part of the process, it might be easier for him or her to champion the integration efforts. As noted in Step 2, Identify, Define, and Evaluate Information Processes, when a process is going to change, it will be more positively received if the change benefits the stakeholder.

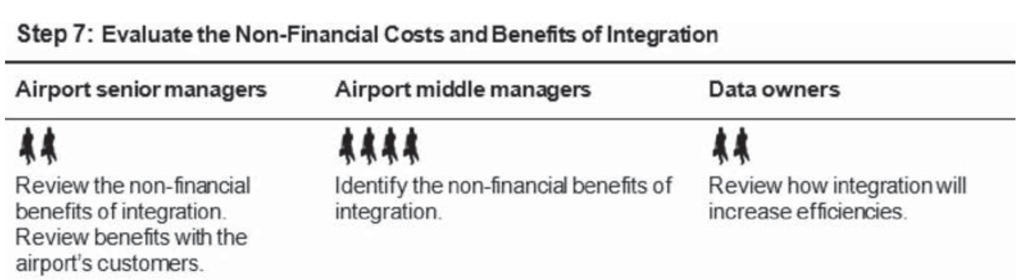


Figure 3-9. Step 7.

The integration phase should benefit the entire airport, including an increase in the non-cost benefits. As part of any airport evaluation, every process that will change should be identified and listed. The benefits of integration will generally fall into three categories: increased accuracy of information, improved timeliness of information, and increased efficiency.

Case Study Step 7

The CEO, CFO, and Project Manager jointly identified the non-financial benefits of the project. To make this assessment, the combined experience of these leaders and their knowledge of all facets of the organization were leveraged.

The non-financial benefits included the prospect for improved relationships with the airlines. The airlines' property officers had often complained that errors in, and re-calculation of, the rates and charges created significant budgeting impacts on the airlines, as well as a fair amount of concern by the airlines' senior officers. The project would directly address the cause of these complaints. It would also simplify the staff's related tasks and reduce the time required.

Step 8: Evaluate the Financial Costs and Benefits of Integration

Figure 3-10 indicates the level of effort of the stakeholders for this step.

Most of the information needed to calculate the direct financial costs of the integration project has been produced in previous steps. In this step, along with compiling those costs, the indirect costs of integration need to be reviewed and tallied. Direct financial costs can include hardware, software licensing, consulting, staff allocation during integration, and additional staffing after integration. Indirect costs include the following:

- **Inefficiencies During Transition.** When a new system is brought on line, there may be a period when two systems are run in parallel with one another, or when the transitioning items need to be checked manually. This can result in overtime or increased staffing levels.
- **Training.** When an airport implements a new system that is replacing a manual process or a legacy system, the airport can experience increased training time and lower productivity that results in overtime. As the stakeholders become more familiar with the newer systems and are properly trained, productivity will increase.
- **Computer Upgrades.** A contributing factor to evaluating the financial costs is to ensure that the hardware specifications for the software are adequate and planned for. The types of issues that arise range from simple to complex, such as the need for dual monitors to view the manager's dashboard or for updates to the network bandwidth.
- **Maintenance.** With the purchase of software, continuing maintenance costs may have been overlooked in the cost analysis. Capturing and understanding these charges before implementation

Step 8: Evaluate the Financial Costs and Benefits of Integration

Airport senior managers	Airport middle managers	Data owners
Review the financial costs and benefits.	Identify direct and indirect financial costs of the integration project. Delineate the potential financial benefits.	Assist in determining the financial costs.

Figure 3-10. Step 8.

is important to proper budgeting. (For further detail of these types of charges, see Step 12, Maintain the Systems.)

- **General Infrastructure.** Several elements of the general infrastructure need to be evaluated before integration begins. Will the current network infrastructure support the integrated system being proposed? Is there enough power and backup power for the solution? With answers to these questions, decisionmakers can modify the approach to integration, and additional network infrastructure can be factored in as a cost of the project.
- **Backups and Disaster Recovery.** Is there an existing backup and disaster recovery plan? Does that plan need to be modified to accommodate the integrated system being proposed? If the new system will be relied on for daily operations, this reliance may introduce significant backup and disaster recovery needs that did not previously exist.

At this point, most costs are known and the benefits should be well defined. The evaluation of the costs and benefits should be rigorous and thorough. The following steps in integration will require major financial commitments for hardware, software, and outside services. It is imperative that this rigorous evaluation result in a *go-no-go* decision. The costs and benefits to the airport as a whole should be analyzed because costs and benefits probably will not be equal for each of the individual divisions. Often, one division will gain more of the benefits while other divisions will bear a larger share of the cost. However, if all the airport-wide benefits outweigh the costs, the project is justified and reasonable.

Case Study Step 8

The CFO and Project Manager prepared an assessment of the estimated financial costs and benefits of the projects. Their assessment answered the following questions which they knew would be posed by the CEO:

- Will we reduce spending in personnel and equipment costs when the integration process is completed, and if so, by how much?
- Are you able to quantify the cost associated with errors and untimely completion of the landing fee calculation?
- Do we have the staff to implement the system or will consultants be required, and if so, what will they cost?
- What will be the cost of the new hardware and software, and what are the 5-year estimates of the maintenance and operations costs?
- Will the airlines support paying for this investment, and if not, how do you propose to finance this effort?

After a detailed cost-benefit review was complete to the satisfaction of all parties, the CEO agreed to move forward with the project.

Step 9: Determine an Effective Integration Strategy and Technologies

Figure 3-11 indicates the level of effort of the stakeholders for this step.

As the actual system integration effort begins, the tasks become more technical in nature and will probably require professional consulting and IT resources. During Step 3, Determine Who “Owns” the Data and Identify the Systems, each system was identified and the system architecture delineated for each process and data requirement. In Step 9, the stakeholders evaluate the integrated system architecture.

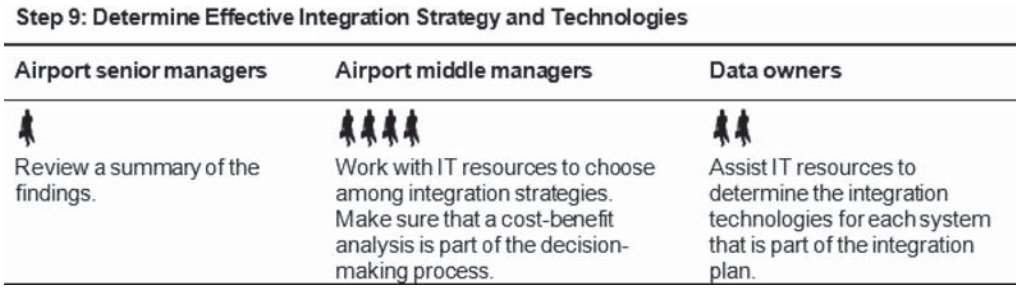


Figure 3-11. Step 9.

To evaluate the system architecture, the IT resources look at each system and identify the technologies available to use in the integration process. (For more information on integration technologies, see Chapter 6, Architecture, Strategies, Technologies and Contracts.) This can include evaluating system architecture for any COTS that will be purchased, as well as any COTS or custom software already in place. The result will be that, for each system identified, the IT professionals have evaluated what different technologies are available to use to integrate this particular system. This is also an appropriate time to determine any costs associated with the integration technologies.

Now all the information necessary to choose an integration strategy has been collected. There are many different strategies for integration (some of the most frequently used are listed in Chapter 6). Before stakeholders evaluate an integration strategy, determine the following aspects of the strategy:

- How is this strategy commonly used?
- What are the strengths and weaknesses of this strategy?
- What technologies are usually used to support this strategy?

Then answer the following questions:

- Do the strengths and weaknesses of the integration strategy match the business objectives?
- Does each of the systems identified have available technologies that support the integration strategy?

During this evaluation process, many tradeoffs probably will need to be made. For example, a specific business objective might have to be sacrificed in choosing an integration strategy that, while it meets many of the other objectives well, does not allow for integration of important data to meet that specific objective. Another example is that, while the integration of a particular system is possible, the licensing costs are out of line with the benefits.

Case Study Step 9

Having analyzed the complexities and architecture of each of the systems, the Project Manager next reviewed the technologies available and discussed with the team and the IT professionals which strategy would be the most appropriate to use. After examining the advantages and disadvantages of Data Warehousing, Enterprise Information Integration (EII), and Enterprise Application Integration (EAI), the team elected to acquire EII software, to enable the airport to access multiple systems in an integrated manner, while not disturbing data stored in each of the systems. This *distributed data* approach permits the divisions to operate their systems on their equipment with only that data necessary for integration leaving and entering their local environment.

Step 10: Implement the Strategy and Technologies

Airport senior managers	Airport middle managers	Data owners
Monitor the integration status. Review training results.	Manage the integration effort and report status to various stakeholders. Implement training programs.	Assist the technical team. Attend training programs.

Figure 3-12. Step 10.

Step 10: Implement the Strategy and Technologies

Figure 3-12 indicates the level of effort of the stakeholders for this step.

Now the actual system integration can take place. During this step, software is constructed and configured using the strategy and technologies identified in the previous step to create an integrated system. Depending on the software management approach used by the team, opportunities may arise during the construction to test various pieces of the integrated system and verify that things are moving in the right direction. It is important to monitor the integration and evaluate its progress. This information will help show the return on investment for the integration effort and pinpoint areas to improve during future integration projects. During the implementation process, training on all new equipment, systems, and procedures is critical to the success of the project.

Case Study Step 10

The project team acquired the EII software along with the necessary hardware and performed the initial installation and configuration of the software. The project team then began using the EII software to integrate the data from the various airport systems previously defined. During one of the bi-weekly status meetings with the Project Manager and CEO, it was decided to bring in outside expertise in the EII software package selected due to specific problems the project team was having with the project. This contingency was previously identified as a possibility and was included in the overall project budget. Bringing in this expert allowed the project to proceed according to schedule.

Step 11: Test, Evaluate, and Follow Up

Figure 3-13 indicates the level of effort of the stakeholders for this step.

After the integration is complete, a final start-to-finish test of the integrated system should be performed so that all stakeholders have a chance to validate that the integrated system is working properly before the system is put into production. After testing is complete, including any necessary fixes or modifications, the system goes into production. Testing should continue for a short period after the system is in production to ensure that no unexpected issues will arise in production.

When the integration is complete, a project debriefing review should be conducted to understand what went well, what went wrong, and what could be done to improve the integration process in the future. This should be done at every level in the organization and summarized for senior management.

To monitor the success of the integration, a return-on-investment analysis at the end of the project is important. Table 3-1 provides some criteria for the evaluation. This information will help show the actual return on investment of the integration plan and pinpoint areas to work on for future integration.

Step 11: Test, Evaluate, and Follow Up

Airport senior managers	Airport middle managers	Data owners
Review the project debriefing and direct any necessary procedural changes.	Ensure that stakeholders validate the system before it goes into production. Conduct and document a project debriefing.	Validate the system before it goes into production.

Figure 3-13. Step 11.

Table 3-1. Return-on-investment evaluation.

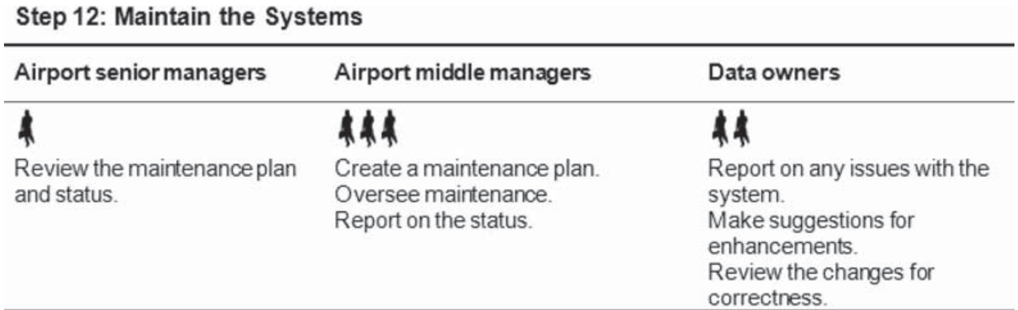
Criterion	Problems solved ("before")	Benefits gained ("after")
Manual data entry	How much manual entry of data was required at the airport (measured in staff time needed)?	How many instances of manual data entry have been replaced by automatic processes? Amount of financial savings?
Accuracy	What was the level of accuracy before integration (measured in error rates)?	Has the level of data accuracy increased? Amount of financial savings?
Timeliness	How fast was the data reaching management, operations, finance, and legal (measured in time from occurrence to the appropriate desktop)?	Has the time for data to reach management decreased? Have proactive measures been taken rather than reactive measures? Amount of financial savings?
Coordination	What data was previously shared between airport systems (measured in data fields electronically transferred from one software to another)?	What data is now shared? Amount of financial savings?
Duplicate data collection	How many pieces of data were collected multiple times by different departments and/or in different systems?	How much of the duplicate data collection has been eliminated? Amount of financial savings?

Case Study Step 11

After the project team finished their testing, the data owners were brought in to perform acceptance tests to make sure the system performed as planned. The data owners had previously been trained on the system and were anxious to see how the system worked with real-world data. Any problems identified were researched and solved by the project team, and the system was moved into production. The project team and the data owners continued to test and monitor the system after it was put into production to make sure nothing unexpected occurred.

The project team met first internally then with the data owners to discuss the project and how things could be done better next time. It was decided that overall, the project was pretty smooth, but that the data owners could have used more training leading up to the testing period.

The Project Manager and the CFO worked to create a return-on-investment analysis a couple of months after the project was completed. They determined that the reduction in cost per enplanement was slightly under what they had projected at the beginning of the project, but still well within the range necessary to make the project provide a benefit above and beyond the project cost.



Step 12: Maintain the Systems

Airport senior managers	Airport middle managers	Data owners
Review the maintenance plan and status.	Create a maintenance plan. Oversee maintenance. Report on the status.	Report on any issues with the system. Make suggestions for enhancements. Review the changes for correctness.

Figure 3-14. Step 12.

Step 12: Maintain the Systems

Figure 3-14 indicates the level of effort of the stakeholders for this step.

After the system is in production, there will be issues that should be addressed regularly, as well as periodic changes that are desired. A plan should be instituted to address the maintenance and to ensure that any changes to the system are correct and appropriate. Although small changes probably can be made with a minor review process, big changes to the system probably will require their own integration projects to follow each of the steps identified in this chapter.

Case Study Step 12

After the system was firmly in place, the data owners met monthly with the IT team member in charge of maintaining the system. Throughout the first year the system was in use, they made minor changes to some of the business rules based on feedback from various departments. At the end of the first year, they recommended to the CFO and CEO that the second phase of the integration project be funded based on the success of the first phase.

Setting Milestones

Milestones for the long-range integration plan will be specific to a particular airport and project. Completing the preceding steps in this chapter can be considered a milestone, or even one of the steps alone can be a milestone. Some organizations set milestones specific to the project, such as finance or resource allocation milestones. An airport should begin to develop these milestones as early as possible. First, define the vision for the airport, and set realistic goals to achieve the long-range vision and the short-range vision. This might mean prioritizing the goals after an airport has reviewed the stakeholder availability.

Consider the availability and schedules of managers and personnel chosen to support management through the integration plan. The scheduling and timing of resources should reflect the airport's overall objectives and the airport's schedule for other projects. Airport personnel need to understand from the beginning how the integration will affect daily operations. Set critical training deadlines and incorporate these dates in the overall resource planning schedule. Defining the stakeholder involvement early can assist in refining and prioritizing the short- and long-range vision and its success.

After the resource allocation plan has been delineated, it is a good time to review the system integration challenges and plan appropriately to meet those challenges. Closed-architected systems may not allow for the business-critical data to be retrieved from one system to another, or such systems can require third-party vendors to assist in extracting data in a usable format. Part of resolving such challenges can involve updating a system or maybe even replacing a system, depending on the importance of the business-critical data and key metrics that the system produces. It is at this point that airport personnel may need to regroup and refine the business-critical data and key metrics.

Reviewing who, what, and why specific business-critical information is important and how such information shapes the overarching goals for integration and prioritizing the key metrics can facilitate such decisions. Identify the benefits and key outcomes of the integration project.

When setting milestones, review the current infrastructure of the airport. Consider a timeline of acquisition requirements that includes systems, network infrastructure, IT outsourcing for complex integration projects, construction such as facility changes, external consultants, and timing of such for this integration project.

If other integration projects are in progress at the airport, especially if simultaneously, understand the effects and how to resolve them early. Understanding the requirements specifications and setting realistic goals for accomplishing those requirements can set a clear path to a successful integration project.

CHAPTER 4

Airport Information

Airport information is collected, used, and maintained by the various functional areas of an airport. To provide useful business information to management through integration, the following basics for the airport should be identified and understood:

- What information needs to be integrated,
- From which existing system, and
- Where in the organization the system and data reside.

Although airport organizational structures differ, the broad-based functional areas for which business-critical information has been identified are Finance/Administration, Operations, Maintenance, Engineering, Security, and Public Relations. Airport organizational structures are based on the needs of the particular airport; functional areas and divisions can be combined or separated in different ways. The functional areas and the divisions described are representative of a typical airport; these samples are meant to illustrate an airport organization within the context of this Handbook.

Each functional area and division of an airport organization requires a different set of business-critical information and key data elements. Some values are important to all division managers within an airport, including personnel statistics, budget to actual, scheduled to actual, and deliverables met. Two sets of tables are associated with this Handbook—one set of four-column tables (Tables 4-1 through 4-18) and one set of nine-column tables. Samples of the condensed, four-column tables are presented in the appropriate functional area later in this chapter. The larger nine-column tables are attached to the Summary of the Final Report and are incorporated here by reference (http://www.trb.org/news/blurb_detail.asp?id=10154). Figure 4-1 presents a limited snapshot of a nine-column table for illustrative purposes.

Finance and Administration

Overview

Finance and Administration include the following divisions: Accounting, Administration, Human Resources, IT/Telecom, and Properties.

Airports that accept Federal Airport Improvement Program (AIP) grants are required to be as self-sufficient as possible, and most airports are government enterprises that must generate all or most funds necessary to operate and maintain the airport. All expenditures made and revenues received from any source must be entered into the financial management/cost accounting records, which are usually maintained by the Accounting division. Financial information is required to calculate annual budgets, airline rates and charges, necessary rate adjustments, and the like and to determine how well the airport is meeting its financial obligations.

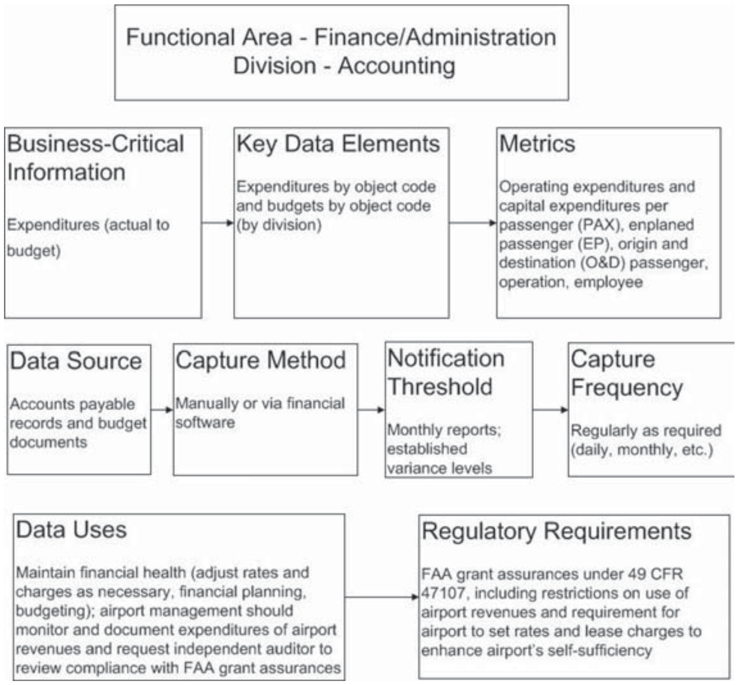


Figure 4-1. Sample finance/administration accounting division.

This financial information is tracked by Accounting regularly. Revenues are compared with the amounts due to the airport under use and lease agreements and concession/tenant leases managed by Properties. Expenditures are tracked against approved budgets. Reserve fund levels, accounts receivable, and planned capital programs are also tracked.

Airlines might report traffic statistics, such as the number of enplaned passengers, originating and deplaning passengers, and connecting passengers, to the Accounting division. Often, airlines use a gate management system to track this gate usage, and the information is forwarded to airport Accounting. The Operations functional area might track aircraft operations (landings and takeoffs), gate usage, and international activity, and transmit this information to Accounting to bill the rates and charges and to make adjustments as necessary. Frequently, such activity is self-reported by the airlines. Properties might track concession revenues (usually self-reported) and transmit such data to the Accounting division.

The Administration division can include a purchasing group that tracks service contract expiration dates, which the contract administration group uses to plan for new contract issues, including terms and anticipated budget impacts. Insurance information (such as accident rates, claims, and injury trends) are often tracked and used to ensure safety and reduce financial impacts.

Although legal can be a separate functional area at larger airports, legal services are frequently provided by the municipality or considered part of the function of Administration. Many mid-sized and smaller airports contract out their legal services, and the contracts are managed by the CEO, Finance, or Administration. Senior management generally wants information on the status of litigation, settlement discussions, pending contracts, and the associated budget impacts.

The Human Resources division tracks personnel data, such as number of employees, vacant positions, overtime hours, and salary changes, and transmits the data to Accounting for payroll and budget use. Unless the timekeeping system is integrated with the payroll system, this information is tracked manually. HR systems can be used to provide additional information, such as the number of vacant positions and turnover rates. Frequently, this information, as well as grievance information and significant personnel actions, are manually tracked and reviewed regularly by senior management. The Human Resources division tracks DOT and FAA training requirements. Drug testing results of safety-sensitive employees and those with commercial drivers licenses are recorded, tracked, and transmitted to the appropriate senior manager for any required follow-up or disciplinary action. Annual budgeting for personnel costs can result from manual entries or might include downloaded data from the HR systems.

Data regarding use and performance of IT and telecom resources is tracked, usually by automatic reports generated by those systems. The status of efforts by unauthorized persons to access secure or confidential information is increasingly monitored by airport staff and transmitted to senior management.

The Properties division manages and tracks concessions and tenant lease information and transmits the lease and revenue data necessary for billing and financial reporting to Accounting. Some airports have lease management systems that track the data, but frequently, the data are transferred manually for billing purposes. Commercial development may need land and infrastructure information from Engineering; such information is available from a computer-aided design (CAD) system and from sophisticated financial return-on-investment analyses using data from the Accounting division.

Throughout the Finance and Administration functional area, information is entered into one system and is frequently re-entered in another system. Unless these systems can integrate or feed data to the airport's overall Financial Management System, much of this critical information must be manually re-entered by airport personnel. Self-reported data increases the chance of error or underreporting and requires additional auditing. Delays in receiving critical information, such as traffic statistics or accounts receivable data, increases the risk of financial loss—especially in the event of a tenant airline's bankruptcy.

It is essential that accurate statistics be kept for mail and cargo shipping, especially when airfield projects are federally funded. Accurate and timely reporting of cargo and mail metric tonnage is important to an airport in many ways. Airports that are heavily engaged in cargo and mail handling have a financial stake in accurate reporting because the AIP criteria allows for federal funding. Additionally, cargo movement statistics serve as valuable data points for future development of cargo facilities. Finally, this type of data is important when presenting a marketing plan to potential new domestic and international airlines.

Although RFID technology has become quite common in the past few years, it is just now emerging as an important tool for software applications in airports. Cargo, in particular, could use RFID technology to collect data important to an airport, such as aircraft and cargo weight, aircraft destination, and content of the cargo and its origin. As the FAA and the Transportation Security Administration (TSA) continue to place greater security responsibilities on airports, these applications and integrated technologies will facilitate the secure movement of cargo and mail.

Significant Metrics from Finance and Administration Business-Critical Information

Metrics developed from business-critical financial information are frequently used by airport management to gauge the financial health of the airport. Typical calculations that use various airport financial and traffic data include cost per enplanement, cost per passenger, cost per employee, and cost per flight operation. Similarly, actual revenues generated by airline sources, such as landing fees, ground rents, and terminal rents, are compared with planned revenues to provide important information for proactive decision-making by airport management. When calculated as a percentage of total revenues received and shown on a per-activity basis, non-airline revenues received from concessions and non-airline tenants can provide management early feedback. Traffic statistics are critical information that affect the airport's financial status and facilities planning and are essential to senior management. Trust indentures or bond ordinances usually require management to calculate specific formulas to ensure that the revenues being generated are sufficient to cover all obligations including debt service. For many airport managers, return-on-investment metrics are helpful for master planning and commercial development issues. Customer service metrics, such as the number of complaints per airport process, security wait times, and international arrival delays, can drive the allocation of scarce resources to the areas of greatest need.

All these metrics require accurate and timely access to the Finance and Administration business-critical information presented in Tables 4-1 through 4-5.

Operations

Overview

The Operations functional area includes the following divisions: Airside, Landside, Ground Transportation, and Parking. Often security badge processing and law enforcement fall within the Operations functional area. These Operations divisions are line functions of the airport, which frequently represent Operations senior management when they are not present. Information technology used by these divisions normally involves data collection and display, rather than computation. Operations will normally have direct access to FAA and National Oceanic and Atmospheric Administration (NOAA) databases, as well as terminal FIDS, to track changing conditions on the airfield. Some airports have successfully instituted telemetric systems where actual observations of airfield conditions are relayed to key airport personnel using wireless technology.

The Airside division of Operations is responsible for ensuring that all aspects of the aircraft movement area remain in an airworthy and safe condition. This includes the obligation to maintain the airport's certification under Title 14 Code of Federal Regulations Part 139. To obtain a certificate, an airport operator must agree to certain operational and safety standards and provide for such things as firefighting and rescue equipment. The Airside Duty Officer coordinates the joint responses of police, fire, medical, and airfield emergency operations and understands that safety is the most important responsibility. The Airside division also delivers reports to the appropriate agencies, files reports in the form of a NOTAM, maintains the facility in a safe condition, and closes any unsafe areas. This division also ensures that those permitted access to the movement areas of the airport are properly trained and equipped and understand their responsibilities.

This division is also responsible for several activities, training exercises, and planning efforts such as

- Preparing ecology plans to minimize bird hazards,
- Writing emergency plans for any incidents associated with aircraft operations,
- Developing plans for the handling and storage of hazardous materials,
- Writing snow removal plans,
- Hot fire drills,
- Emergency exercises, in coordination with fire officials, and
- Ensuring that contractors working within the AOA abide by rules and regulations that pertain to movement, marking, and voice procedures.

Table 4-1. Business-critical information for accounting.

Business-critical information	Key data elements	Metrics	Data source
Expenditures (actual to budget)	Expenditures by object code and budgets by object code (by division)	Operating expenditures and capital expenditures per passenger (PAX), enplaned passenger (EP), origin and destination (O&D) passenger, operation, employee	Accounts payable records and budget documents
Revenue (actual to budget)	All revenues by source; budget forecasts by source; sources of revenues (components) include (1) Non-airline/other: other-interest income; federal and state grants; commercial paper and debt proceeds; security reimbursement from Transportation Security Administration (TSA); non-airline (concession revenue, parking revenue, rental car facility revenue, commercial development revenue) (2) Airline: airfield ramp and service charges, landing fees, building and ground rental revenue, terminal rent and charges, passenger facility charges (PFCs), fuel charges and taxes	Gross revenue per PAX, EP, O&D, operation, employee Concession revenue per PAX, EP, O&D, square footage of leased space Airline revenue as percentage of gross revenue Non-airline revenue as a percentage of gross revenue Parking revenue per EP, O&D, parking space Ground transportation revenue per EP, O&D, employee	Accounts receivable records and budget documents
Reserve fund levels	Operating, capital, bond, or debt reserves	Bond covenant requirements	Financial management system; audited financials
Accounts receivable	Amount of accounts receivable by carrier; percentage of accounts receivable 90 days past due; results of collection efforts	NA	Accounts receivable records and budget documents
Annual budget(s)	Total operating budget; capital budget and annual debt service requirements	Expected total cost per enplanement, per PAX; expected operating revenues-to-debt service ratio (debt service coverage)	Accounting division records; financial management software
	Total debt; percentage of variable rate debt; bond rating	Debt-to-capital ratio; debt per EP; debt-to-revenue ratio	Accounting division records, financial advisor reports, rating agencies
Key rates and charges	(1) Landing fee: components of the key data (assuming residual rate-making) are airfield operating and maintenance costs from budget source, annual airfield debt service, miscellaneous airfield revenues by source, number of estimated aircraft landings by certificated weight (2) Terminal rental rate components of the key data are terminal complex square footage by category (such as airline leasable, concession, public, etc,); terminal complex operating and maintenance costs from budget sources; budget forecasted terminal complex revenues by source	All metrics using airline costs (cost per enplanement, airline revenue as a percentage of total revenue, etc.) will use these airline rates and charges as a base	Accounting division records, financial management software, planning subdivision analyses

(continued)

Table 4-1. (Continued).

Business-critical information	Key data elements	Metrics	Data source
Plan of finance for capital projects	(1) Anticipated project costs by project(s): estimated design/construction cost; other anticipated costs including financing costs (2) Project funding by source: anticipated federal grants and PFCs; interest earnings anticipated during construction; debt to be issued, cash, etc. (3) Feasibility: forecasted annual gross revenues during feasibility period	Debt-to-capital ratio; debt per EP; debt-to-revenue ratio; projected impact on cost per enplanement; coverage ratios	Financial and feasibility studies
Advance warning of a possible air carrier bankruptcy	Financial reports on airlines; overdue account receivables; substantial decrease in passenger traffic or air operations; costs per enplanement by airline; market share analyses		Airline financial reports (SEC reports); consultant reports; account receivable and cost per enplanement reports from accounting; activity reports from operations division (passenger and flight operations)
Traffic statistics	(1) PAX data: total passengers; EP; deplaned passengers; connecting passengers by airline; O&D passengers by airline (2) Operations data: aircraft landings by aircraft type; aircraft departures by aircraft type; total aircraft operations; aircraft gate usage (turns) by airline; aircraft gate usage by type of equipment; on-time arrivals/departures by aircraft; deicing time	All metrics using passenger counts (PAX, EP, O&D), aircraft operations (landings, takeoffs, total aircraft), or gate usage (operations per gate)	Airline self-reporting; operations records of aircraft landings and departures; gate management systems; financial billings

Several systems, under development or in full operation, will improve situational awareness for operations at an airport. These systems include ADS-B, Automated Radar Terminal System (ARTS) III, Surface Management System, and ASDE-X. For a detailed narrative on these emerging technologies, see Chapter 2, Current State of the Industry.

The Landside division of Operations typically allocates airport-controlled facilities, including remote hard-stand parking, ticket counters, gates, aprons, and baggage facilities. Some airports create spreadsheets after receiving scheduling data from the airlines, OAG, and FIDS. However, some airports use relatively sophisticated gate management software to access and record schedules, reallocate gates and aprons, assign gate-related support equipment, and monitor passenger activity passing through the Federal Inspection Services (FIS). This division also ensures that any unauthorized entry through passageways that lead to the AOA is quickly detected and resolved. This division relies heavily on the access control system, including Closed Circuit Television (CCTV), security sensors, Automated Vehicle Identification (AVI), and direct observation by airport staff. Transponders are issued to vehicles that are part of the system, and billing originates from Finance, based on the type of vehicle and frequency with which that unit passes through the

Table 4-2. Business-critical information for administration.

Business-critical information	Key data elements	Metrics	Data source
Purchasing information	(1) Requisitions by budgeted amount, actual cost, time in process (2) Contracts for major services by expiration date, budgeted amount, actual cost	Efficiency metrics, such as operating costs per employee, cost of delay in acquiring goods or services	Contract and purchase tracking records
Competitiveness of airport	Sampling of rates/fees at similar airports, such as landing fees, terminal rent per square foot, baggage system fees, train fees, costs per enplaned passenger, operating costs per employee	Comparative metrics, cost per enplanement, landings fees, etc., to gauge strength of competition for air service	Airport industry benchmarking surveys, staff research, airline reports
Risk and safety information	Accident rates by division; insurance claims by number and amount; injuries by type; vehicle damage by type and amount; workers' comp claims by type and amount; trend graphs	Costs per accident; injury rates per activity; injury/accident trends	Risk and insurance records

airport sensors. The Landside division ensures that all vehicles are in fact using these devices or paying through another manual system.

The Ground Transportation division of operations is responsible for monitoring the activity of all commercial vehicles in and around the airport. The responsibilities of this division overlap considerably with the Landside division, with emphasis on access control systems, tracking of movement, and security of commercial vehicles and their drivers. AVI technology is frequently used to control commercial vehicle movement on airport property, track the number of visits, and generate accurate billing.

Table 4-3. Business-critical information for human resources.

Business-critical information	Key data elements	Metrics	Data source
Personnel statistics	Personnel budget (total and by division); budgeted full-time employee positions (total and by division); filled full-time employee positions (total and by division); contract employee positions (total and by division); actual overtime-to-budgeted	Total annual PAX per full-time employee; labor cost per full-time employee; maintenance expense per full-time employee; non-airline revenue per full-time employee; operating net revenues per full-time employee; revenue per full-time employee; total airport cost per full-time employee	HR records
Training performance measures	Number of on-site employee training classes, average class evaluation rating, compliance training	Training costs per full-time employee; compliance training by employee	HR records
Personnel actions	Grievances; turnover; personnel actions (disciplinary, drug and safety test results, etc.)	Turnover ratios; costs of turnover per new employee; trends of significant personnel actions	Finance and/or HR records

Table 4-4. Business-critical information for IT/Telecom.

Business-critical information	Key data elements	Metrics	Data source
Systems reliability information and security statistics	(1) Reliability statistics: IT equipment downtime hours by system; help desk calls per system (2) Security information: number of unauthorized attempts to access IT systems (successful and unsuccessful)	Return on investment of various systems; systems security trends; systems reliability trends	IT records
IT performance and maintenance	(1) IT maintenance: number of information system ports maintained; number of FIDS screens, jetways, visual paging displays, baggage carousels, and flight departure displays maintained; personal computers maintained per staff; network servers maintained per staff (2) IT performance: percentage of time network is available; number of personal computer problems resolved	Efficiency metrics, such as percentage of systems downtime; cost and time for system recovery in event of disaster	IT records
Amount of unauthorized or personal use of computers	Number of instances of inappropriate email content or internet use; percentage of network capacity devoted to personal use	Percentage of systems capacity available at peak periods; percentage of employees engaged in inappropriate internet use	IT records

Typically, the Landside division presides over any emergency communication system. Using digital telephone switches and voice over internet protocol (VOIP), the communications activities under this division's control include paging, relaying tower information to interested parties, processing work requests, emergency notification, and CCTV and access control monitoring. Gate and counter assignments can also originate from the communications center.

Airport parking is typically the responsibility of Operations. Parking activities can also be accomplished through a contractor or concessionaire but are typically operated by airport employees. Facility count systems provide line supervisors and senior management with real-time occupancy levels of each parking lot and enable staff to adjust staffing levels in response. As a division, Parking also uses various techniques to record the license plate data of all cars that remain overnight in the parking facilities. Data are typically collected with electronic handheld devices that record plate number, location, and first time and date of occupancy. Data from these devices can be downloaded into a database available to many other divisions within an airport, providing assistance to the public and an additional level of revenue control and security.

Significant Metrics from Operations Business-Critical Information

Along with the Planning, Properties, and Accounting divisions, Landside shares an interest in relationships between passengers moving through an airport complex and time spent while there. Hence, the public's dwell times in concession areas, ticket counters, parking lot entrances and exits, and airport-controlled gates are key indicators noted by Operations, which, when used properly, become useful tools for staffing, reallocation of resources, reassignment of facilities, tenant notification, deployment of police, and dispatch for additional vehicles.

Table 4-5. Business-critical information for properties.

Business-critical information	Key data elements	Metrics	Data source
Tenant lease data	(1) Leased space: amount and location of square footage of space leased by tenant by type (exclusive, non-exclusive, common use, etc.) (2) Lease rentals: annual space rentals by tenant; other annual lease payment obligations by tenant (3) Lease terms: term (length) of lease by tenant; usage requirements	Public space square footage per PAX; return on investment calculations; vacant-to-total space ratio; airline revenue as a percentage of total revenue	Lease summaries with contract terms from Properties division, CAD
Concessions data	(1) Leased space: leased square footage by concession type (food and beverage, news and gift, duty free, advertising, hotels, services, etc.) (2) Concession revenues: gross concession revenues by concession type; net concession revenues by type; minimum annual guarantee by concession location or lessee (3) Other: number and type of concessions; concession locations that will be available for lease by month; number of customer complaints by concession location	Concession space per PAX, per EP, per O&D PAX; concession revenue (total, food and beverage, news and gift, advertising, services, other) per PAX, per EP, per O&D, per square foot of terminal space; non-airline revenue as a percentage of total revenue	Tenant self-reporting, lease summaries, point-of-sale systems; accounts receivable records

Security has become a critical component of Operations. Because unauthorized entry onto the AOA has security and financial implications, trends in the number of unauthorized entries by tenant, location, and time are valuable indicators of the effectiveness of the airport's security program.

Working with Accounting, constant review of metrics (such as revenue required per period of use for loading bridges and other equipment compared with actual utilization history) can result in modification of charges to ensure full cost recovery. Similar analysis can occur as revenues from commercial vehicles are compared with actual cost so that the airport can provide facilities and support services to this segment of the airport vehicle population. Parking metrics, such as revenues per O&D passenger, usage analyses, and net revenues per parking space (return-on-investment analyses), are valuable in the planning and financing of facilities. The Operations divisions, as well as the Planning and Accounting divisions, are interested in the percentage utilization of such assets as runways, taxiways, and aprons related to wind direction, time of day, and air carrier hub complex scheduling. From this information, maintenance of such facilities can be scheduled, planning for additional facilities initiated, and resources reallocated. Similarly, monitoring of ceiling and visibility conditions enables the Airside division to anticipate the required activation of Category (CAT) II and CAT III procedures and to alert other airport agencies of potential airport delays. Finally, contractor performance records become important when trend analysis suggests poor safety practices are evident.

All these metrics require accurate and timely access to the Finance and Administration business-critical information presented in Tables 4-6 through 4-9.

Maintenance

Overview

The Maintenance functional area includes the following divisions: Facility Maintenance, Maintenance Control, Fleet Maintenance, and Materials Management. Maintenance represents the largest single operating expense normally present at an airport. To manage this functional area efficiently, airports may have several processes—on occasion, automated, and sometimes manual—in place to track information such as costs, time to complete tasks, labor expended, status of projects in the pipeline, energy consumption, in-commission rates, inventories, accident history, and so on. At smaller airports, these actions are accomplished by individual line divisions.

The Facility Maintenance division normally has the largest staff on an airport and will include the Electrical division, Airfield and Grounds, Building and Plant Maintenance, and Custodial Services. Tracking of these workforces includes data such as labor dollars expended overall, overtime, budgetary comparisons (including year-to-date actual against

Table 4-6. Business-critical information for airside.

Business-critical information	Key data elements	Metrics	Data source
Runway availability	Hours of availability for runways, jetways	Percentage of time runways are available for aircraft, percentage of jetways available for airline use, etc.	Staff notations
Equipment availability	Equipment designation (e.g., aircraft rescue and fire fighting truck 1, emergency generator 7, etc.)	In commission, out of commission	Fleet maintenance, FAA, direct observation
Weather data	Current and forecast weather conditions; wind velocity, snow and rain amounts, ice accumulation, temperatures, etc.	Ceiling and visibility that falls below prescribed minimums; weather conditions that trigger response plans; runway temperature sensors that indicate freezing conditions	U.S. Weather Service, flight service station, airline meteorological department, contract weather services, runway visual range, wind indicators, etc.
Airline schedules (arrival, departure)	Gate, airline, flight number, tail number, arrival and departure times	Ratio of scheduled arrivals and departures to actual (on-time arrival and departure)	FIDS, direct tie into airline databases, paper records, gate operations application software, OAG, FAA secondary radar
Contractor performance	Contractor's name, contact information, on-site supervisor, contract terms regarding operations on the AOA, location of work to be performed	NA	Contact, CCTV, direct observation
Current airfield, terminal, and roadway conditions	Weather (wind, temperatures, rain, snow, ice), runway braking action, safety alerts,; pavement temperatures, chill factor, etc.	Critical operating information	Actual observations; systems embedded in pavement that report temperature, ice accumulation, etc.

Table 4-7. Business-critical information for landside.

Business-critical information	Key data elements	Metrics	Data source
Information of import with a shift log that has been recorded by the operations officer over a shift period	Incidents listed	NA	Running narrative done by shift supervisor or operations officer
Delays that occur at cashier booths, ticket counters, commercial vehicle lanes, and departure levels; occupancy levels of parking lots; TSA lines, FIS areas, etc.	Queuing times at parking entrance and exit lanes, ticket counters, concession areas, security check points, baggage claims, FIS area, etc.; parking lot name, lot capacity, current car count	Number of cars, passengers, customers, etc., multiplied by minutes of dwell time provides metric of delay time per minute, hour, or other unit	Parking facility count systems, roadway sensors, direct observation, CCTV, etc.
Public complaints, how or if conflict is resolved	Written and/or verbal complaints, severity of complaint, outcome, action taken	Number of complaints per shift, day, or other time period; degree of severity of complaint by time period; time in which to respond to complainant	Information counter, suggestion boxes, police reports, operations logs, citizens' direct contact with representative of the airport
Current airfield, terminal, and roadway conditions	Snow accumulation, temperature, wind speed and direction, etc.	NA	Actual observations; systems embedded in pavement that report temperature, ice accumulation; airlines, FAA, U.S. Weather Service, etc.
Unauthorized entry onto the air operations area	Door or gate location, time of penetration, company and individual's name and authorization level, time to respond to violation, etc.	Number of violations per period, duration of penetration	CCTV, FIDS, controlled-access computerized systems and associated databases, direct observations, etc.
Gate, apron, support equipment, and counter availability; particularly important in international arrivals facility or at airports that have common-use gates	Gate designation, gate capacity, apron configuration, gate schedules, airline arrival/departure information	Dwell times at gate, counters, etc.	CCTV, FIDS, direct observations, preexisting schedules, FAA secondary radar, telephone, direct contact with airline user, etc.
Utilization of facilities (gates, apron, 400 Hz, preconditioned air, ticket counters, FIS, etc.)	Duration of use, number of passengers, weight and type of aircraft, company name, domestic or international, signatory vs. non-signatory user, rate per use, etc.	Revenue and cost per passenger, per system, and per unit or location	CCTV, FIDS, direct observations, preexisting schedules, FAA secondary radar, telephone, direct contact with airline user, etc.
Contractor's performance in non-aircraft-movement areas	Number of incidents	NA	Direct observation, engineering division
Commercial vehicle movement through the terminal complex	Company name, date, vehicle number, time, per-trip charge, vehicle condition, insurance company name and amount of coverage, etc.	Cost per trip multiplied by number of trips per unit of time	AVI systems, ticket dispensers, cab starters, self reporting by companies under contract with airport, direct observation relating to condition, etc.

Table 4-8. Business-critical information for ground transportation.

Business-critical information	Kev data elements	Metrics	Data source
Availability of ground transportation	(1) Traffic flow: taxi-cab, hotel shuttles, rental car shuttles, remote parking shuttles, limos (2) Availability: taxi-cab, hotel shuttles, rental car shuttles, remote parking shuttles, limos (3) Staffing and queuing of ground transportation (4) Weather: snow removal, closures, ice, etc.	Commercial vehicles available per period of time; wait times for taxis, shuttles, etc.	Direct observation, CCTV, AVI
Employee bus frequency	Time between departures for employee bus transportation, employee parking, employee vehicles	Number of vehicles passing a point per period of time (headway)	Direct observation, CCTV, AVI
Congestion in commercial vehicle lanes	Commercial vehicle throughput; number of vehicles in commercial holding lot	NA	Direct observation, CCTV, police reports, operations logs, AVI, controlled access systems, etc.

Table 4-9. Business-critical information for parking.

Business-critical information	Key data elements	Metrics	Data source
Inventory	Number of spaces, number of cars, license plate, origin of car, location, car (date and time first noted)	Activity per parking lot, facility count system	Facility count systems, manual tabulation, CCTV, induction loop counters, video detection, ultrasonic counting devices, RF transmitters, space occupancy detectors
Number of parking transactions processed	Transaction time, cashier inventory, and cash receipts	Revenue	Parking revenue control system, kiosks
Time incidents	Queuing time, exit wait time, cashier wait time, roadway congestion, accidents causing wait times on and off airport, road conditions and closures, snow removal progress reports	Wait time for exit	Cashier reports, CCTV, roadway congestion
Source of traffic delays		Wait times, expense	CCTV, roadway congestion, incident reports
Passenger wait times for terminal bus, rental car		Wait time	
Transactions	Ticket transactions, transaction journals, audit trails, register's transaction log, number of cars (loop detector sensor), cash receipts, cash inventory	Revenue	Automated parking revenue control systems installed in each booth
Sum of incidents by date, shift, and time		Problems per shift	Shift supervisor

yearly budgets), recurrent training requirements, and license currency (of elevators, escalators, fire extinguishers), to name a few. Software applications exist that can combine not only the facility maintenance activities, but also those of materials management (supply) and fleet maintenance.

At larger airports, the Facility Maintenance division is directed through a Maintenance Control Center. Using a work order system, this group can establish priorities, track work in progress, allocate material costs and labor to appropriate cost centers, and schedule work to be performed. Many application software products exist that automate these business-critical elements to handle what at any given time can be as many as 1,500 work requests in various stages of planning, execution, and inspection. This division is responsible to appropriately code work requests that ultimately feed into the airport's cost accounting system and rates and charges calculations. Additionally, preventive maintenance is essential in any good maintenance program. This requires the extraction from manufacturer's specifications of all required maintenance tasks for equipment owned by the airport, with inspections and repairs completed on a scheduled basis.

Generally, the rolling stock used by the airport, as well as certain stationary equipment such as electrical generators, are the responsibility of a Fleet Maintenance division. Management might use fleet maintenance application software that can track in-commission rates, original cost of acquisition, recommended preventive maintenance schedules, fleet replacement programs, and estimated times required to perform types of repair. Supervisors can determine from these systems not only the status of the equipment, but also how efficiently staff is performing their duties.

The responsibility to requisition, receive, code, value, store, issue, and replace parts and materials is frequently assigned to a separate Materials Management division. Working with the other Maintenance divisions, items expensed out of supply ultimately show up in cost accounting systems and in the rates and charges calculation. The Materials Management division tracks its own activities and works closely with Maintenance Control in planning a maintenance project, ordering material, and storing materials received until the project is scheduled to occur.

Significant Metrics from Maintenance Business-Critical Information

Facility Maintenance uses numerous metrics to manage their areas of responsibility. Such metrics might include ratios regarding budget to actual in the area of salaries, energy consumption, contract services, and overtime. This division has high exposure regarding accident rates and will, therefore, monitor injury rates by classification, as well as workers compensation claim trends. Utility consumption lends itself to the development of metrics to suggest the efficiency of the division's energy conservation program. Such metrics might include natural gas, electricity, and water consumed per square foot of building space. Also of interest is comparison of water usage by month and by year related to irrigation on the airport. Finally, benchmarking custodial service cost per square foot of space maintained can indicate the efficiency of the program and might drive the decision to contract out parts of the work to more efficient operators.

Because Maintenance Control plans, schedules, and allocates limited resources and tracks and ensures the quality of completed work, metrics are used to help achieve these ends. Time for completion of work orders, labor hours expended by skill set, time to respond to high-priority repairs, and costs associated with performed work are examples of information critical to the operation of the airport. Many airports use a form of telemetry or hardwiring to transmit equipment data to a central monitoring point. The current status of elevators, escalators, and other mechanical systems that must remain operational are examples of this new data transfer.

Those responsible for maintaining an airport's mobile equipment can use metrics to collectively measure the status of the fleet and the efficiency of the division's staff. Many of the metrics have been developed by agencies that operate fleets of vehicles numbering in the thousands. Sophisticated organizations have developed metrics that combine historical cost of a vehicle, its age, and total miles (or hours), and, from this, they can develop formulas for vehicle replacement. More standard metrics include in-commission rates, operating cost per mile, and standard times allocated for specific tasks, such as brake repair or engine overhaul.

Inventory values above a prescribed level are a red flag to management that too much might be invested in unnecessary inventory. Supply specialists need to analyze appropriate stock levels to ensure that critical parts are always on hand or readily available through local vendors. Key concepts to capture include minimum stock levels, reorder points, historical consumption, and the cost to store items.

All these metrics require accurate and timely access to the Finance and Administration business-critical information presented in Tables 4-10 through 4-13.

Engineering

Overview

The Engineering functional area includes the following divisions: Design/Construction, Environmental, and Planning. These divisions are responsible for an airport's ongoing construction program, which normally represents the largest set of (capital) expenditures occurring on an airport. These divisions also provide technical support for the other line divisions of the airport. It is not unusual for a medium hub airport to be involved in a capital program with a value that will exceed a half billion dollars over the life of the program. Such programs are often made up of scores of projects that each cost millions. Monitoring and control of the projects benefit from a certain degree of information technology.

Probably the largest user of computerized data, the Design and Construction division is adopting CAD systems to maintain and control plans, files, and specifications. For years, airports have investigated the feasibility of digitizing all physical characteristics, which might include topographical features, physical structures, utilities—types and locations, building footprints, legal descriptions, and manufacturers' specifications including recommended maintenance procedures for mechanical, electrical, and plumbing systems, and making these databases available for integration with all functional units of an airport. To date, few if any airports have succeeded, although other entities such as the U.S. Armed Forces have been partially successful in this effort. In a fully integrated airport, Real Estate could have all metes and bounds descriptions along with lease terms included in a layer of the graphics database; Maintenance could easily access mechanical systems with part numbers and recommended maintenance procedures for repair purposes; and Operations could dispatch fire trucks under zero visibility conditions to points along a runway depending entirely on digitized depictions of the airfield integrated with satellite ground positioning systems for vehicles and aircraft locations.

Some vendors have developed software to control and track Capital Improvement Programs, particularly expenditures. Some systems go so far as to monitor contractor performance covered by the prevailing wage requirements. Unfortunately, few of these systems have been fully

Table 4-10. Business-critical information for facility maintenance.

Business-critical information	Key data elements	Metrics	Data source
Work reported on shift logs that represents information of importance to senior management (e.g., major water leak)	Conditional variations from normal deemed significant	NA	Building maintenance, equipment sensors
Budget	Divisional expenditures by object code	Percentage above or below budget, cost to maintain per passenger per square foot of leasable space, cost per square foot	Budget documents, general ledger
	Budget to actual (personnel)	Ratio of budget-to-actual expenditures (e.g., after 6 months, 44% of approved budget expended)	Budget documents, general ledger
	Budget to actual (parts and material)	Ratio of budget-to-actual expenditures	Budget documents, general ledger
	Budget to actual (contract services)	Ratio of budget to actual expenditures	Budget documents, general ledger
	Budget to actual (capital, etc.)	Ratio of budget to actual expenditures	Budget documents, general ledger
Accident history	Number of accidents, severity of injury, cost per incident; OSHA violations	The number of accidents as a ratio of the number of employees engaged in a craft; workers' compensation claims compared to national standards; OSHA violations compared to other airports	HR databases; facility maintenance internal records; OSHA
Personnel statistics	Number of positions filled, budgeted, approved	Percentage of positions filled	HR
Training requirements and records of completion	Hours of training required by employee per period per skill level	Percentage complete	Training specialist within division, HR
Preventive maintenance program	Number of items requiring inspection, frequency of inspection, name of agency qualified to perform inspections (e.g., perform inspections of such equipment as fire extinguishers, elevators, escalators, boilers, chillers, transformers, etc.)	Date inspection due compared to actual date, percentage complete, etc.	Databases maintained by maintenance
Utility usage	Period of use; unit of measurement (gallons, kilowatt hours, cubic feet, etc.)	Electricity, water, gas used per square foot, power factor, etc.	Meter readings, telemetry, etc.
Pending work orders	Total work orders, estimated time to complete, work requests, material on order	Ratio of work requests to pending work orders; ratio of work orders completed in current period compared to similar period one year prior; ratio of work order by craft compared to number of employees in particular section	Maintenance control, HR, industrial standards and manufacturers' recommendations delineating times required to complete specific tasks
Status of critical equipment	Equipment designation, location, criticality classification, status (on/off), etc.	Percentage on line	Incident reports from maintenance staff

Table 4-11. Business-critical information for maintenance control.

Business-critical information	Key data elements	Metrics	Data source
Established priority policy (e.g., airfield safety, terminal public areas)		NA	Priorities usually are established by senior management and provide direction for the scheduling of resources
Number of systems maintained	Bag claim conveyors, matrix readers, parking ticket spitters, parking toll booths, etc.	NA	
Total work orders in progress, status, time to completion, etc.	Work order, number, description of task, date initiated, estimated time to complete, work orders completed per staff	Ratio of pending work orders to those completed during a period of time, etc.	Manually and/or via automated work-order system
Incidents from shift logs (incidents that occurred over an 8-hour period gathered from the perspectives of different divisions)		NA	Entered by supervisor on duty; may be in retrievable flat file format or in written log
Safety related work orders	Work order number, description, anticipated completion date	NA	
Airfield, terminal, roadway status that might impact airport operation	Runway status, roadway status, status of various parts of terminal	NA	Originates initially from division level but flows to maintenance control for scheduling and implementation
Upcoming maintenance events	Preventive maintenance schedule		Manually or via software
Service delivery	Service deadlines	NA	Manually or via software
Expiring agreements; service over/under expected level	Service level agreements	Expiration date of contract compared to current date	Manually or via software

integrated into the Financial Management Information Systems of airports. An optimum package would integrate accounts payable, description of the CIP originally envisioned in a Master Plan, budgetary provisions of the bond issuance Official Statement (if applicable), Plan of Finance, asset journal, and compliance records by contractor and then merge engineer's estimates with actual bids received, sources and uses of funds as adjusted, and change orders as they are proposed.

Software exists for project management. From the earliest renditions of Program Evaluation and Review Technique to today's most sophisticated, proprietary program management software products, airports continue to adapt these improved management tools to control their construction programs.

Engineering and construction projects at airports also have to consider the environmental impact of design and implementation. At some airports, a separate Environmental division plans, implements, and maintains systems designed to minimize the impact of the airport on its surrounding environs. Several tools are available to meet these goals. Airports have successfully integrated parts of FAA's radar tracking systems with ground sensors that can measure aircraft-generated sound levels, temperature, ambient noise levels, and wind conditions. Output of these systems often includes noise contour maps, single-event occurrence reports, perceived noise level calculations, and correlation of noise complaints from an individual with a specific occurrence. Other systems designed to monitor air and groundwater quality, while not as sophisticated or as automated as those related to noise, are commonly used at airports.

Table 4-12. Business-critical information for fleet maintenance.

Business-critical information	Key data elements	Metrics	Data source
In-commission rates by type of vehicle	Total number of vehicles, number out of commission, vehicle classification	Ratio of in-commission to total	Superintendent (fleet maintenance or designee)
Critical equipment status	Total number of vehicles defined as critical, number out of commission	NA	Superintendent (fleet maintenance or designee)
Budget (budget-to-actual) parts, materials, capital , etc.	Dollars expended, date, dollars budgeted, etc.	Ratio of budgeted to actual	Various sources: time clocks, paper records, all flowing through either Finance or HR
Personnel statistics	Hours worked, labor rate, Federal Insurance Contributions Act (FICA), retirement contribution, positions approved, positions filled, etc.	Percent vacancy	HR database. Many airports have centralized time clocks which record and calculate data
Contractual services: cost of services, expiration date, year-to-date expenditures, etc.	Company name, contract value, contract term, work description, etc.	Budget to actual	Finance
Capital expenditures (rolling stock)	Budgeted amount, expenditures to date, etc.	Budget to actual	Finance
Parts and material expenditures	Budgeted amount, expenditures to date, etc.	Budget to actual	Finance
Positions filled, budgeted positions	Approved budgeted amount, positions filled	Percentage filled	Operations and maintenance budget
Approved vacancies for hire	Senior management's approved positions (may be different than approved budget)	NA	HR database, normally generated from senior management, sometimes external limits (e.g., agency-wide hiring freeze)
Unplanned downtime	Unforeseen mechanical problems		Incident reports, work requests, tenants, public, etc.
Underutilized vehicles	Hours or miles driven	Utilization compared to industry standards	Fleet records

Engineering's Planning division specializes in using forecast data and comparing it with existing capacities of airport systems to calculate the physical requirements of the airport. Examples of databases commonly used include those that support the airport's Master Plan, parking facility count systems, Federal Census Bureau, and National Plan of Integrated Airport Systems. Additionally, Planning uses the Design/Construction CAD system to develop layouts for apron parking of aircraft, circulation patterns for public parking lots, and concession placement within terminal facilities.

Significant Metrics from Engineering Business-Critical Information

Metrics available from Engineering information include the status of a design or construction project shown as a percentage of completion. This information is essential, particularly when a project such as site preparation must be completed before the next phase of a program. Using project management techniques, engineers can calculate costs per day to accelerate the design or construction process and, by doing so, make informed decisions as to whether an investment provides the necessary return. Senior management is particularly interested in federal funding levels as a percentage of the total project cost because it is not uncommon for additional

Table 4-13. Business-critical information for materials management.

Business-critical information	Key data elements	Metrics	Data source
Inventory valuation	Warehouse units, value of each type of unit, bench stock inventory, date	Number of units multiplied by value	Supply inventories
Accuracy of inventory	Valuation prior to manual inventory by commodity vs actual valuation confirmed by inventory process	Comparison of results of perpetual inventory to physical inventory	Periodic or perpetual inventories
Incidents reported on shift logs	Sum of incidents by date, shift, and time		Building maintenance
Budget to actual: personnel, contractual services, parts and material	Vendor management and analysis can pinpoint costly off-contract buying	Ratio of budgeted to actual	Finance
Personnel statistics	Number of employees	Percentage vacancy	HR
Personnel statistics	Approved vacancies for hire	Comparison of approved positions to budgeted positions	HR
Excess or obsolete inventory	Inventory transactions, carrying costs, invoice/purchase order	Time in inventory without activity	Finance and/or supply

federal dollars to become available at the end of a fiscal year. While sometimes misleading, the percentage of change orders in both dollar value and number provides insight into how well the project has been managed or the completeness of the plans and specifications. CAD systems lend themselves to numerous calculations and metrics due to the nature of digitization. Formulas are easily developed to calculate total square footage of a leased area, revenues per square foot of concession space, and number of turns per space in a public parking facility. Table 4-14 lists business-critical information for Engineering.

Larger airports have automated noise, water, and air quality data collection devices that can develop a set of metrics that monitor and analyze the status of each of these areas. For example, criteria for noise violations, decibel (dB) level, and time above threshold can be calculated and reported to managers so that immediate remedial steps can be taken. Air quality and water quality data can be compared with defined acceptable standards to determine whether corrective action is necessary. For example, particulates per million levels might represent a violation of the State Implementation Plan, and thus result in the introduction of new regulations regarding types of vehicle operated on airport property. Smaller airports might rely on the number of public complaints about noise to determine the success of their noise abatement program. Table 4-15 lists business-critical information for Environmental.

The Planning division might use many of the metrics referenced above, as well as many developed by the Finance and Administration area, as some of their tools to predict the future. Using the financial data from the Master Plan as the base year, personnel can track annual operations, enplanements, vehicle traffic, and so forth to validate the original findings of the Master Plan study. As conditions change and demand for facilities rises and falls, capital and financial programs are adjusted accordingly. Table 4-16 lists business-critical information for Planning.

Security

Overview

Although many airports place the oversight of police, law enforcement, and some, if not all, security activities in a division reporting to the Operations functional area, the increasing importance of these activities has caused some airports to create separate departments for this function.

Table 4-14. Business-critical information for engineering.

Business-critical information	Key data elements	Metrics	Data source
CIP	Project numbers, description, engineer's estimates, source of funding, change orders, etc.	Percentage complete, current status to budget, status of budgeted federal funding level to current projection, engineer's estimate to actual	Engineering and Finance
Construction and design schedules	Original estimate, current projection, liquidated damage/bonus provisions	Cost per calendar day to accelerate project	Contract (contactor, architect, or engineer); specifications; field engineer's estimates; capital budget; etc.
FAA grant status; state and local, if applicable	Project description, grant approval (yes/no), percentage funded, funds received to date	Ratio of federal funding to total cost of project; ratio of original plan of finance, projections for federal funding to current anticipated funding	FAA, congressional delegation, airport's lobbyists, bids, and expenditures to date on federally funded projects
Change orders (approved, pending, disapproved)	Project number, change order number, price of change, status (approved, disapproved, pending), original requestor, scale of importance	Ratio (percentage) of the sum of all change orders in project-to-base contract price	Originated from one of several sources: tenant, engineering group, field engineer, FAA (regulatory change), etc.
Construction and design contracts, grant requests, and other obligations of the airport that require approval from higher authority (e.g., council, board). Schedules for such submissions should be available to senior management	Name and action required for project, grant, contract, etc.		Engineering design and construction
Plans, specifications, utility depiction, legal descriptions (metes and bounds, etc.). Documents frequently written using CAD software	Digitized points, plans, alphanumeric	Infinite potential using CAD (e.g., when terminal building physical characteristics are digitized, calculation of square feet within any given boundary is easily calculated)	Existing plans and specifications, contractor's drawings, manufacturers, master plans, etc.
Engineering-related critical items (e.g., federal, state, and local regulations mandate corrective action for discrepancies deemed unsafe or environmentally unacceptable)	Project name, description of requirement, estimated completion date, etc.		Engineering design and construction

For the purposes of this Handbook, Security is a separate functional area due to its critical nature and the need for senior management to have immediate access to the key information.

The Department of Homeland Security (DHS) is a federal department that oversees the TSA, all federal security issues, and all customs and immigration activities. Although airports do not have direct access to sensitive DHS data, they work closely with DHS to oversee and influence these areas. Similarly, significant actions by law enforcement officers (LEOs) are essential information to those whose responsibilities include the safety and security of the traveling public and all airport facilities. Security issues affect operational planning and budgets. Customer wait times are a significant concern to airports and airlines, especially when it increases passenger frustration and causes traffic flow issues.

Table 4-15. Business-critical information for environmental.

Business-critical information	Key data elements	Metrics	Data source
Flight tracking information	Flight number, altitude, location, company name, etc.	NA	Near-real-time flight-tracking software that ties into FAA's secondary radar system
The number of noise violations based on FAA Part 150 criteria	Digitized noise contour maps, single-event and multiple-event decibel levels, flight number, altitude, location, company name, etc.	Number of events per quarter, per year; duration of violation over maximum allowed decibels	Devices installed on and around airports that display flight activity and single-event noise levels that occur during aircraft passage; public complaints; FAA radar
Noise complaints	Number of public inquiries on noise issues; number of noise complaints by area	Percentage of public inquiries on noise issues responded to within 10 business days of inquiry; percentage increase/decrease in noise complaints	In-person, email, or recorded phone messages
Water-quality or air-quality compliance	Information is collected, sometimes with sensors or with actual measurements taken by staff	Water, air, and/or noise measurements out of tolerances established by regulation, permits, etc.; status of corrective actions	Storm sewer, potable water, air sampling devices, etc.

Table 4-16. Business-critical information for planning.

Business-critical information	Key data elements	Metrics	Data source
Forecast data	Current enplanements; aircraft operations; vehicles on roadway; parking occupancy; passengers by terminal by 15-minute segment, etc.; maximum airfield practical annual capacities (PANCAP); maximum number of cars on roadway per 15-minute segment; maximum throughput per 15 minutes in terminal; peak parking occupancy possible per 15 minutes; utility capacities (water, gas, electric, sewage, storm water); forecast enplanements and aircraft operations; future parking requirements; utility requirements; terminal requirements; and roadway needs	Percentage anticipated rate of growth in enplanements, aircraft operations, passengers, vehicles, etc., over forecast period	Forecasts come from the following sources: master plan, plan of finance, capital improvement program, Part 150 study, FAA forecasts, chamber of commerce forecasts, Department of Commerce, airline forecasts, etc.
Development permits	Number of development permits reviewed for aviation impacts	Number and type of developments with potential airfield impact	From tenants and city/county building permit databases
Current airport layout plan (ALP)	Depiction of runways, taxiway, Wind Rose, planned land uses; existing and planned physical facilities	NA	Master plan, planametric databases, photography, National Weather Service, FAA, etc.

Security information is gathered and processed manually. Certain reporting is required by local, state, or federal law; for example, the number of arrests made and how they are handled must be recorded per state and/or federal law.

Passenger wait times at screening might be tracked by Operations personnel, customer service staff, and/or from TSA reports available on the Internet. Wait times for international arrivals processing can be manually tracked by Operations or customer service staff. TSA or DHS directives are usually manually tracked and significant ones transmitted to senior staff.

Controlled access is mandated federally by Federal Aviation Regulation (FAR) 1542, and federal agents inspect access practices and issue fines. Controlled access is vital to prevent crimes and terrorism. Controlled access includes an approved badge, which requires fingerprinting and a 10-year criminal history, and security access control systems that allow only authorized personnel to access the secured areas of the airport. Badge requirements, including renewals, depend on the type of airport; authorization to the Security Identification Display Area (SIDA) requires additional training and clearances. Perimeter access also requires controlled access systems.

Law enforcement records and record-keeping requirements and standards depend on whether the LEOs are employed by the airport, city, or state, and the rules of that employer. Information available to security and LEOs includes controlled access data, National Crime Information Center data, and State Crime Information Centers data.

Airport Security might use the following types of systems:

- Operations daily logs,
- Police incident reports,
- TSA website,
- Controlled access systems, and
- Badge systems.

Having budget, facilities, and operational information readily available and easy to manipulate improves the Security area's ability to respond quickly to incidents and customer service problems or engage in contingency planning. The ability to enter logs and other written information into a system that organizes and categorizes the information and allows it to be easily accessed at the desktop of senior management would facilitate senior management's ability to have appropriate information for rapid decision-making, identify anomalies, and take proactive action.

Significant Metrics from Security Business-Critical Information

The critical business information generated in the functional area of Security allows senior management to determine critical customer service metrics as well as assess the current security environment. TSA alerts, contacts, directives, and threat assessments must be promptly analyzed and can require immediate response. Metrics that provide budget and operational impacts permit management to understand and address those aspects. Metrics such as passenger security wait times and international arrival delay times focus management on the highest priority customer issues and provide the framework for planning and problem resolution. Table 4-17 lists business-critical information for Security.

Public Relations

Overview

Customer complaints and media contacts can indicate areas that need management attention. The number and type of customer complaints and media contacts are usually tracked manually but can be entered into and tracked by customer service/response software.

Table 4-17. Business-critical information for security.

Business-critical information	Key data elements	Metrics	Data source
Police/LEO			
Shift log/incident or significant law enforcement activity	Incident or significant law enforcement activity	Critical information	Shift log/incident or daily police reports
Training records	Successful completion of required training	Total hours per employee spent in training per required subject	Personnel records
Screening wait times and delays	Length of passenger wait times by screening location by hour; number of open (manned) screening stations by hour; TSA staffing levels by hour and location	Passenger wait times	TSA, airport terminal operations, passenger services
U.S. Customs and Border Protection (airport security coordinates and monitors)			
Processing wait times and delays for international arrivals	Length of international passenger wait times for processing per hour; number of open (manned) customs and immigration processing stations per hour	International arrivals delays	Customs and immigration, operations, passenger services
Homeland/Airport Security			
DHS alerts	Contacts by TSA/DHS	Critical information	TSA staff or industry alerts
New security directives (major changes)	TSA/DHS directives; proposed changes to approved security plan	Percentage impact to budget; operational impacts	TSA staff or industry alerts
Breach of access or perimeter control systems	Details of breach (who, where, when, and how)	Operational and financial impact	Access control systems, perimeter control systems, security camera analytics

This information comes from many sources and is difficult to gather or track with automated systems. Most information in this area is gathered manually from staff notes or complaint cards and processed manually into a report for senior management. A few airports are beginning to use customer complaint service software to track and manage complaints and responses. If this information could be automatically transmitted to the airport divisions or staff who can resolve the source of the complaint or address the budget and planning issues raised by the complaint, airports would function more effectively and could proactively address problems.

Air service information and indications of new or expanded services drive facilities and operational planning, impact capital needs, and can affect operating budget significantly. Airline requests for new or expanded service are usually tracked manually and conveyed to senior management as soon as possible. Data on existing air service, such as number of airlines, routes, frequencies, fleet mix, and airfares, can be tracked manually and reported to senior management regularly. Staff might track new or pending aviation legislation or regulations and give the information to senior management as needed.

Table 4-18. Business-critical information for public relations.

Business-critical information	Key data elements	Metrics	Data source
Complaints by issue	Number of customer complaints by issue	Trends, complaints per airport process	Passenger service records and complaint-tracking systems
Media contacts and issues	Media phone contacts by issue	Trends	Contact log
Airline requests for new or expanded facilities	Letters or calls regarding new or expanded facilities by airline	Usage (turns per gate) by airline; return on investment of new facilities; airport-caused delays resulting from facilities or equipment problems	Air service development contacts
Quality of community airline service	Number of airlines, airline routes and frequencies, aircraft types and fleet mix, airline competition and airfares	Changes in airline service per period	Staff or consultants reports, operations division reports, industry newsletters and study data
New or pending aviation legislation or regulations	New federal legislation; new federal regulations or notices of rule-making affecting aviation	Potential impact analysis, trend analysis	Industry emails, newsletters, alerts to government affairs staff

Significant Metrics from Public Relations Business-Critical Information

Customer service is a major issue for airport management and is critical to how the airport is viewed by the community, the traveling public, connecting passengers who might have a choice of airports, and public officials. Metrics derived from the Public Relations functional area can help to resolve service issues, prevent customer frustration, and proactively plan and manage the changing environment of an airport. Using the data in trend metrics, usage reports, and planning analyses allows senior management to reduce delays, increase passenger satisfaction, and budget resources more effectively. Table 4-18 lists business-critical information for Public Relations.

CHAPTER 5

Airport Systems

Airports can have over 1,500 systems with various degrees of automation. The migration of data from one system to another can be challenging, especially when legacy systems are involved. This chapter presents some background information about airport information systems.

Data Processes

A common element to all airport systems is data. When integrating data from multiple systems, managing the information is key to understanding airport systems. Understanding how to collect the data, the source and distribution of the data, and the tools to begin that process help an airport understand and manage complex information.

When integrating systems, identify key design issues early to ensure that the data required for integration has a proper storage area in the new system. Data can be lost during integration if the new system does not have a placeholder for that data, especially when migrating from one system to another and, even more challenging, when the system involved is a legacy system. Consider the following example of how data can be lost without placeholders.

A company uses a mail merge program similar to Microsoft® Word's mail merge. Placeholders are set for the name, company name, and address. If the company name placeholder is left out, then the data has no clear path to travel and it gets lost. Many integration failures result from not properly identifying the data and not planning for data placeholders to store the information properly.

Integration Failure Example

Integration projects can be problematic and costly. One example is the experience of the State of Colorado.[1] The State had contracted $325 million for five new software systems and upgrades and experienced failures for each one that culminated in 2007. The State was unable to (1) pay welfare benefits on time, (2) accurately pay road crews overtime, (3) track voters or unemployment benefits, and (4) issue license plates.

The Colorado Department of Motor Vehicles, which serves 64 counties at 107 locations—all having different requirements and systems—experienced irregularities in the transfer of data from

[1] Imse, Anne and Alan Gathright. "Ritter seeks to bring order to computer chaos: Denver tech exec to steer systems' design, purchase." *Rocky Mountain News* July 23, 2007. http://www.rockymountainnews.com.

the legacy systems to the new systems. Because the different business and data requirements for each location were not considered, business rules for the data were not properly applied before implementation. After the system had been deployed to only one county, these irregularities were discovered.

For the State of Colorado, the experience was costly and is an indication that any organization can experience integration problems surrounding disparate legacy systems similar to those found in many airports today.

The remainder of this chapter discusses typical airport systems and the problems inherent in trying to integrate data from them, in the following sections:

- Research Conclusions,
- Disparate Data Sources,
- Systems Examination, and
- Information System Samples.

Research Conclusions

During the research for this Handbook, the project team examined lessons learned in various industries, including the aviation industry. The suggestions that follow are drawn from some of the more important lessons learned.

Data

Airports should own the data in a format usable for the airport and should identify the current systems that use the data as well as the format, structure, and architecture of each.

Data Processes

Data processes have multiple levels of maturity, therefore understanding and identifying each level helps ensure successful data rule implementation. Understanding processes that are parallel with each other but housed in different systems also helps identify the rules and set the priorities of the processes and systems.

Standards

Worldwide standards organizations provide central repositories where terminologies and definitions are maintained and assist in data interchange format standards, which are technology driven. Using data standards, such as metadata registries, enables airports to set standards for communicating between systems and government agencies. Some of these standards-setting organizations have teamed with the FAA to facilitate aviation standards. When an airport is planning the integration of many systems, these standards should be taken into account.

Phased Approach

As discussed in Chapters 2 and 3 of this Handbook, when an airport is considering many systems in its integration plan, **using a phased approach, rather than trying to integrate all systems at an airport, can increase success rates.** In addition, an airport should look at the systems identified in the vision and evaluate each system within each phase. It might not be necessary to integrate every system to achieve the vision. Everything from all systems might not be the best approach for an older airport with many disparate legacy systems.

An airport that does not have the budget to replace all the legacy systems should consider an overarching system, such as a data *hub* that receives only the pertinent data that decisionmakers need. This type of hub does not interfere with the needs and requirements of a functional area system. Rather it allows those systems to remain untouched, but pulls out of the system only the data relevant to the hub. The hub transmits that business-critical data to the senior managers' dashboards.

For example, there might be 15 or more systems that house the different data necessary to calculate airlines' full rates and charges in compliance with the rate-making methodology employed at an airport. However, gathering bits of data from each of these systems can give the data needed to calculate the metrics for senior management, so only that data needs to be pulled into the hub. In other words, do not attempt to integrate everything in those 15 or more systems; there is no need to do so.

Data Rules

The steps in Chapter 3 discuss the business and data rules. Identifying how those data rules apply to the systems and how the rules are handled within the system are equal in importance. When using the central data hub approach, it is useful to also identify how the hub handles the rules and whether or not the rules can be set by airport decisionmakers.

Disparate Data Sources

Establishing the proper data rules—by defining and understanding the data from all parties and how information is used within the different divisions of an airport—is pivotal to successfully integrate the various sources of flight data. This section provides an example of the discrepancies among the following different sources of flight information:

- Official Airline Guide,
- Airline Direct Feed,
- FAA Direct Feed, and
- Flight Information Display System.

Official Airline Guide

This service is updated every 30 days using a format called a Standard Schedules Information Manual (SSIM) file. (The SSIM file guide and formatting requirements document can be obtained directly from the OAG.) If the flight schedule changes within the 30-day period prior to a departure or arrival, flights might not be updated by the OAG downloads into FIDS. Even if an airport has paid for an additional subscription service provided by the OAG for continuous updates of the flights, an airline's flight information is only as good as the last time that airline updated the data. The process relies heavily on each airline sending updates to OAG for each changed flight, and most airlines do not use a direct feed from their system into the OAG system. Therefore, airlines that do not update the data until the day of departure might bypass the OAG entirely.

Airline Direct Feed

Airlines and airports are working together to help bridge some of the information gap between them. In some cases, participating airlines can provide direct feeds to airports by using XML technology to integrate flight data. The data generated by these feeds comes from the airline's flight center. Airlines typically maintain two systems to manage flights—one that the public (including airports) is allowed to see and another that is real-time operations data controlled by the airline's dispatch center.

One of the many advantages to these direct feeds is the advance flight information provided to an airport for operational and financial planning. A disadvantage of airline feeds is that real-time flight information might not be shared in a timely and accurate manner, because the publicly available information is often censored by an airline. Also, such information is not consistent with what the FAA provides from its real-time radar feed.

FAA Direct Feed

One of the most reliable sources of information is provided by the FAA through the NFDC, which can directly feed an airport's system. These feeds track aircraft in real time and provide some of the most accurate reporting data to an airport. The data collected by the FAA is also the most comprehensive for an airport because all information originates from the FAA radar.

One of the most important pieces of data for an airport is the aircraft tail number. Currently, however, the FAA substitutes the tail number with the flight number and that number is transmitted to the airport. Without all the information associated with a specific tail number, an airport cannot accurately record gross landing weight for a specific flight. But the FAA does allow third-party vendors to scrub the flight data using various algorithms and transmit the data to an airport. These vendors use tertiary radar feeds to gather the data from the FAA radar.

Flight Information Display System

At some airports, the airlines own and operate the FIDS. The airline is directly responsible to update, maintain, and inform both the airport and the public of its flight activity in real time. When an airline is in the midst of a system-wide delay, updating the FIDS at each airport is probably not the airline's top priority, even though the delay could affect the other airports. Often FIDS are legacy systems that are updated manually. Sometimes airports are compelled to assist with the flight information updates. When airlines feel the effect of a financial downturn, FIDS equipment may not be well maintained or updated.

Summary of Data Sources

If an airport uses more than one of the data sources described above, the airport must determine rules for the data—rules that provide which information should be used, how it should be used, and by whom. If the OAG is used, when does it override the direct feed? How would conflicts in the data be resolved? If the airport adds another flight data system and source, such as the FAA and the tertiary radar system, into the equation, four different types of data are now coming into the airport operational database, and each different source of data is important to one or more of the airport's divisions.

Agreed-to parameters, such as when to post flight data in the case of delays, which source governs when there is a difference in the data, or flagging information when it is outside of a triggering level, are examples of critical rules that might need to be set. The need to define, understand, agree to, and apply rules to the data is critical. The flow of information is captured in Figure 5-1.

Systems Examination

Unless an airport explores all its systems, the airport cannot integrate successfully. It is extremely useful for an airport to examine the systems in place at the airport to evaluate the following:

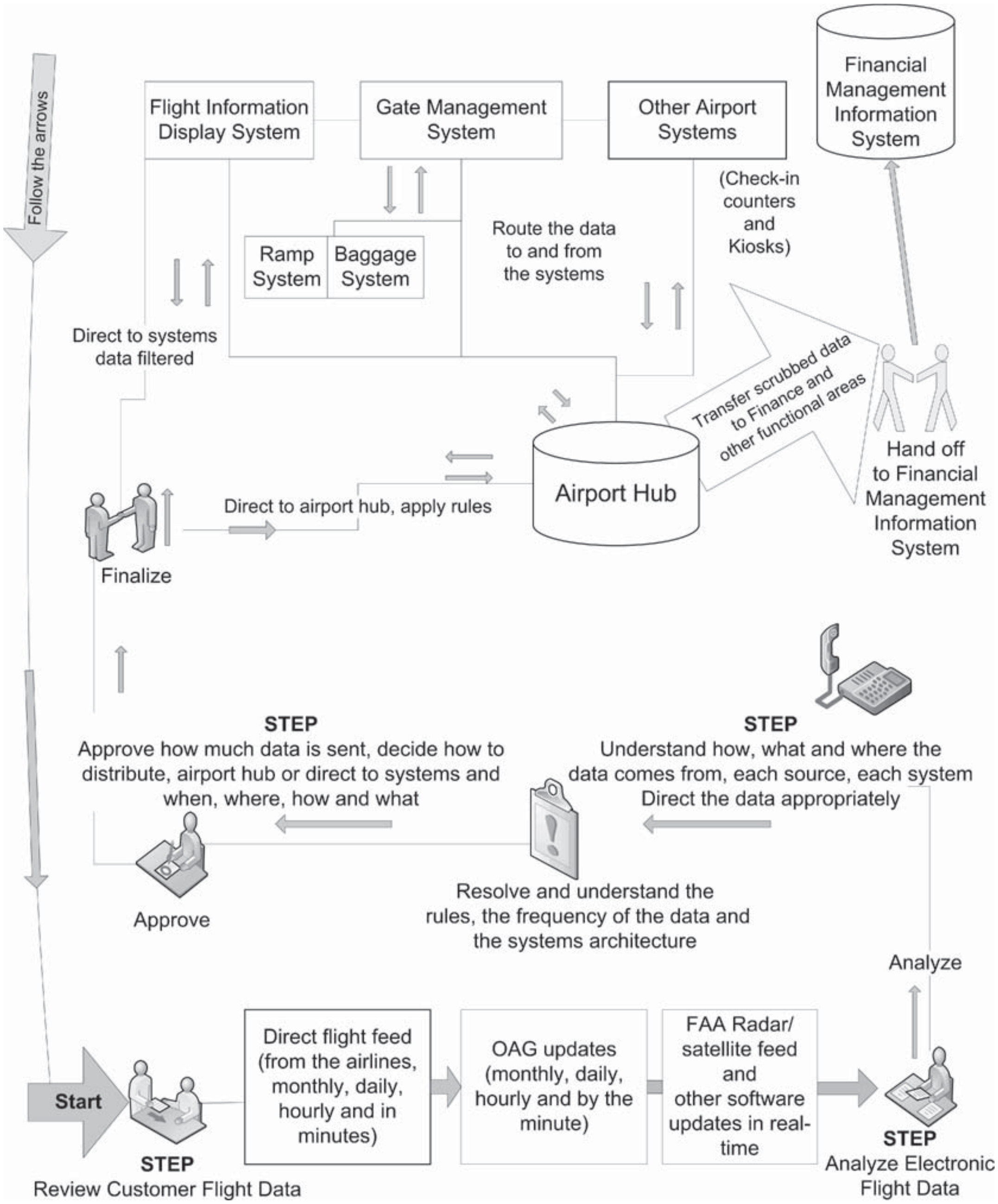


Figure 5-1. Sample airside operation system.

- What information is kept in each system and how is that information used?
- What information is duplicated in different systems?
- What data needed to provide critical business information is not currently accessible?

Although this process can be time-consuming and difficult, the resulting understanding of the systems and how those systems need to relate or integrate to form a larger information system is invaluable and greatly enhances the potential for successful integration.

Table 5-1 shows the results of one such systems examination. A Financial Management Information System, for example, would include a number of smaller systems. Figure 5-2 is a sample Financial Management Information System.

Table 5-1. Financial management information system examination.

Financial Management Information System	Business-Critical Information	Data Elements
Financial Management System		
General Ledger	Status of airport finances	Revenues and expenditures allocated by cost center
Rates and Charges	Dynamic modeling of each airline's cost to operate: historical, real-time, projected	Operating and maintenance costs: equipment, personnel and resources, utilities, materials and supplies Capital cost: cost of land, capital improvements, debt service including financing costs Projected revenues: non-airline, interest income, PFCs, federal grants Forecasted aircraft landings and passengers by airline and type Square footage of space by category and leased status
Debt Management	Status of debt	Debt by category Cost of financing Debt reserve funds Bond rating Planned financing
Budget and Forecasting	Continuous budget and forecasts Operating and financial metrics drivers	Projected operating and maintenance costs and capital equipment costs Forecasted revenues Debt service requirements Projections of future passenger traffic, aircraft landings, revenues, expenditures, debt financings, reserve levels
Accounts Receivable and Payable	Alerts: status of payments to the airport, status of airport expenditures	Detailed balances and billing status for all revenue generating entities by customer, budget to actual expenditures Letter of credit, aging, historical
Asset Management	Value versus investment	Historic cost Depreciated value Location Condition of facilities Equipment Inventory
Property Management System		
Lease Management	Space management Percentage of tenant lease Renewable timeline Return on investment	Amount of, and rentals from, leased space by type and tenant Return on investment for capital expenditures, tenant facilities, and infrastructure Cost to provide services (including administrative overhead)
Point-of-Sale	Concession revenue statistics	Gross concession revenues by type and location
CAD	Continuous space statistics: planned verses actual	Location and square footage of leased space and facilities: "as built" data, utility locations
DBE Tracking	Percentages: local and federal programs	Amount of space leased to, revenues generated by, contract sources Percentage of gross concession revenues controlled by DBE companies

Systems Examination Exercise

An airport can develop this kind of chart for every system involved in its operation. In Table 5-2, use the blanks as an exercise related to the Human Resources Management and Procurement Systems in your airport. For example, determine whether the same information is collected by multiple systems. If there are data overlaps between systems, identify the potential conflicts and the possibility for data corruption.

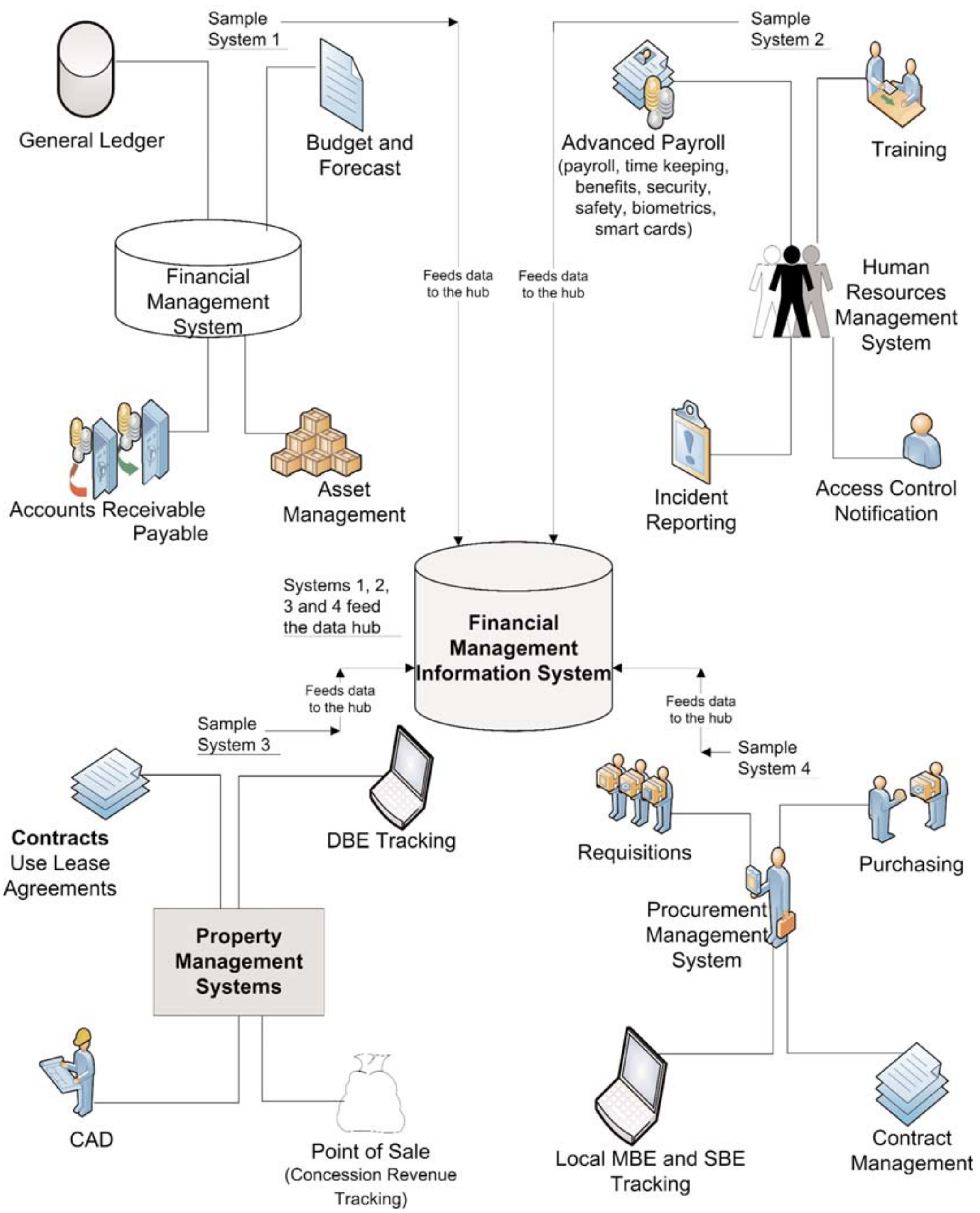


Figure 5-2. Sample financial management information system.

Table 5-2. Systems examination exercise.

Financial Management Information System	Business-Critical Information	Data Elements
Human Resource Management System		
Advanced Payroll (payroll, timekeeping, benefits, security, safety, biometrics, smart cards)		
Incident Reporting		
Access Control Notification		
Training		
Procurement Management System		
Requisitions		
Purchasing		
Vendor Contract Management		
Local DBE		

Information System Samples

To depict the complex interdependencies of the information systems and the data would create a diagram too large for this Handbook. Therefore, this section provides smaller versions based on enterprise resource planning (ERP) methodology. Because these systems are voluminous, both in quantity and size, the diagrams show only a few systems as follows:

- Sample Financial Management Information Systems;
- Sample Landside and Parking Management System (refer to Figure 5-3);
- Sample Engineering Systems (refer to Table 5-3 and Figure 5-4); ad
- Sample Asset Management Information Systems (refer to Table 5-4 and Figure 5-5).

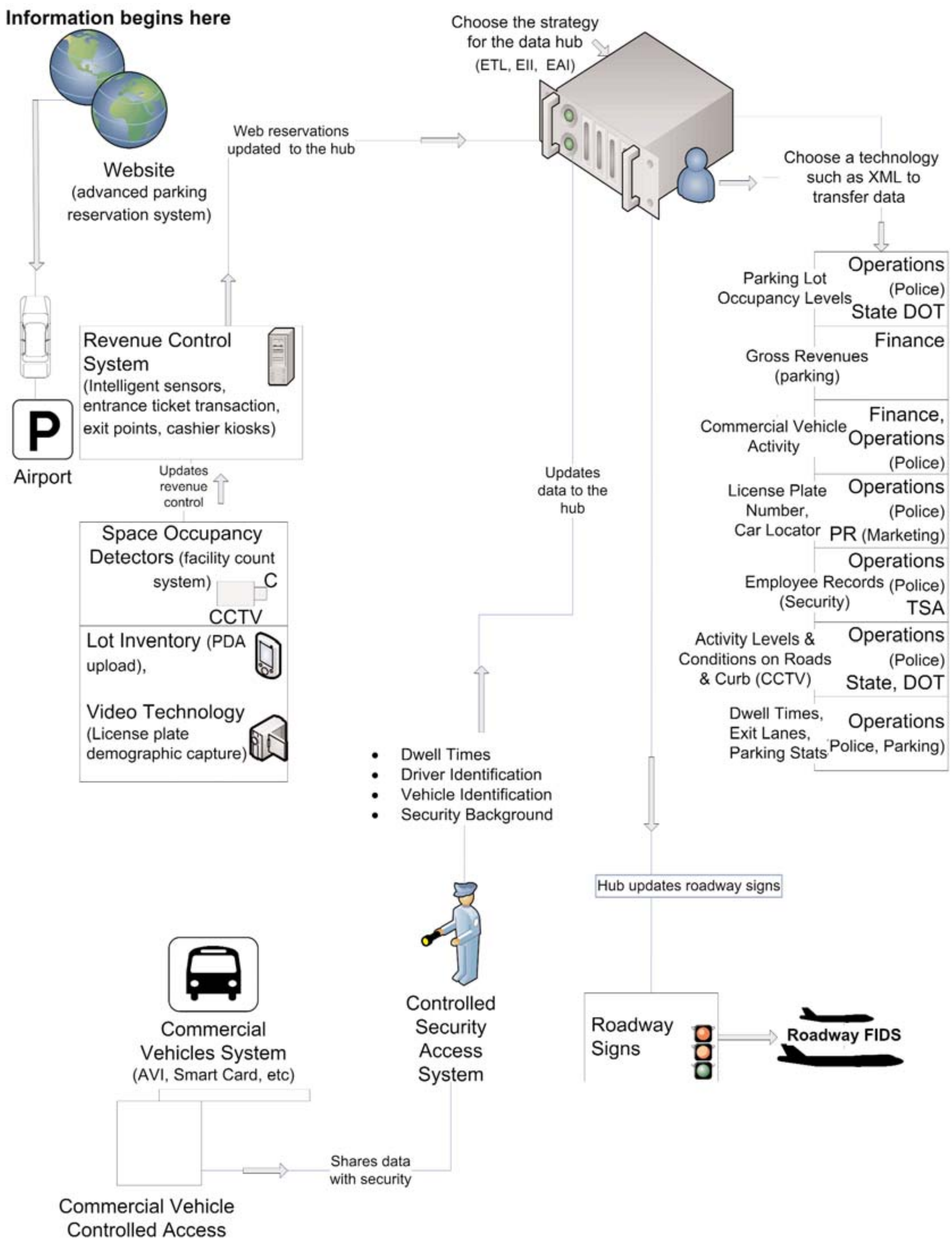


Figure 5-3. Sample landside and parking management system.

Table 5-3. Engineering management information system.

Engineering Management Information System	Business-Critical Information	Data Elements
Forecasting	Anticipated increases or decreases in use of facilities, roadways, terminals airfield and utilities	Projected growth in: traffic (passengers, aircraft landings, vehicles), concession and other non-airline revenues Current capacity of roadways airfield and utilities
Airport 3D Simulation System GIS	Deficiencies in the existing facilities and future design	Simulation of aircraft spacing Load bearing capacity of the runways Protected airspace (FAR Part 77) Linear space of curbs terminal side, parking spaces, existing roadway capacity Analysis of the airport's existing and future runways, taxiways, terminals, support facilities, roadways, and other land uses Simulated real-time data for existing facilities and future demand (gates, ticketing, check-in, baggage, train, security processing, FIS, parking)
CAD GIS	Physical characteristics of the airport	Development permits, impacts of requested development, and tenant improvement requests. Metes & Bounds descriptions Preventive maintenance requirements
Airport Capital Improvement Program	Status of Funds and schedules	Identify, prioritize, assign and track multiple funding sources, critical development of airport projects, and the distribution of the funds to contractors Proposed schedule and funding sources
Construction Project and Contract Management Systems	Status of project budget and schedule	Contract estimates, project budgets, funding sources by project Critical dates, project documents, change orders, schedules and plans Design changes by project, invoice and purchase
Environmental Monitoring Systems	Compliance with air and water quality standards and environmental impact compliance	Air quality below or ground water contamination above acceptable levels chemical or fuel spill event storm sewer or potable water issues Standards outlined by environmental regulatory bodies
Aircraft Noise and Operations Monitoring Systems (ANOMS)	FAA Compliance Part 150 noise monitoring levels. In compliance or not. Number of complaints exceeding tolerance levels, and issues of complaints	Day/night or single event decibel levels above standards Number of public complaints and responses Flight tracking information during noise event FAA Part 150 Noise Monitoring Environmental Monitoring Units (EMU)

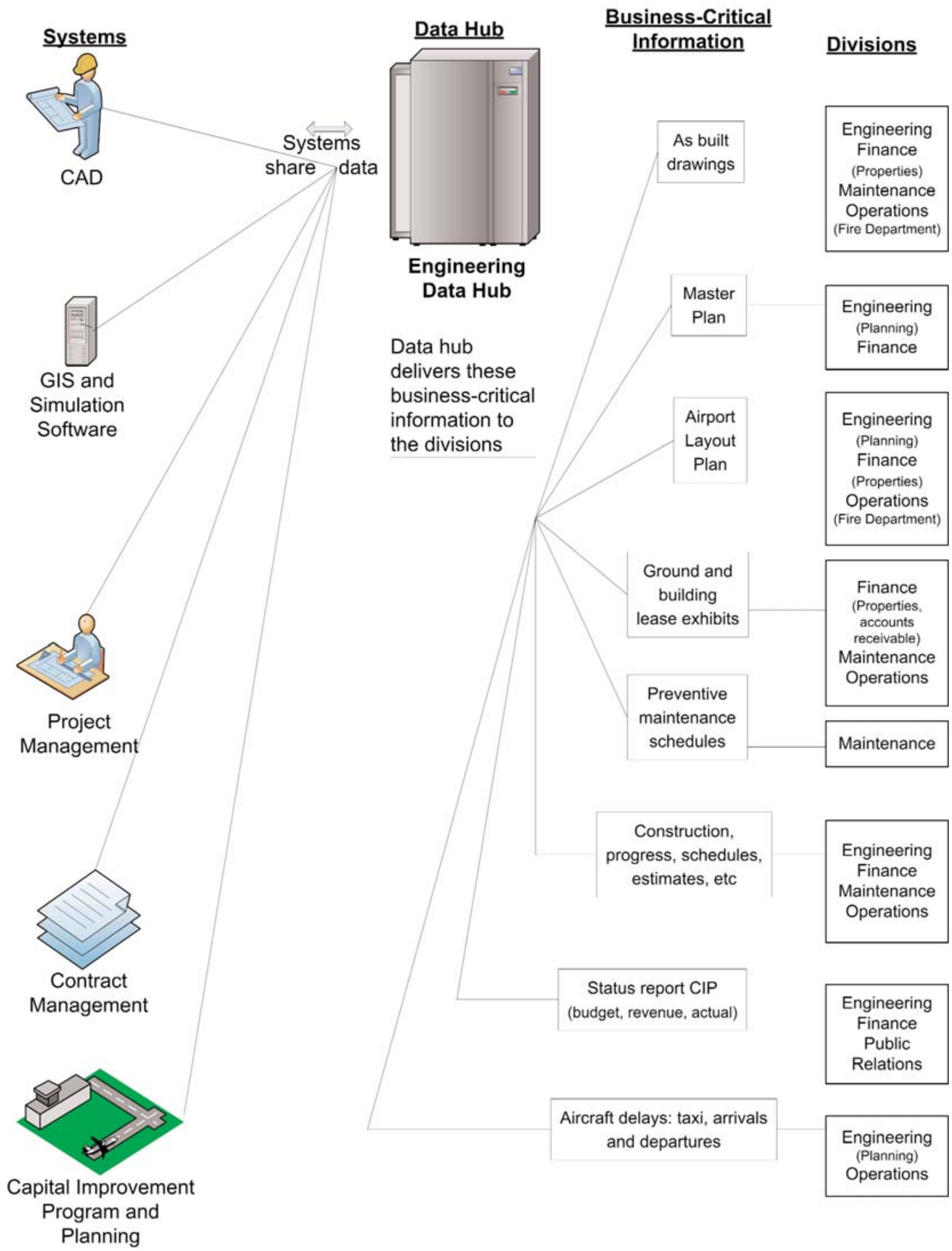


Figure 5-4. Sample engineering system.

Table 5-4. Asset management information system.

Asset Management Information System	Business-Critical Information	Data Elements
Asset Tracking System	Quantity, value, location, condition of the asset	Rolling stock such as snowplows; and facilities such as, plumbing, electrical, materials and equipment
	Critical security breaches	Real-time vehicle information within a secured area matched to resources
	Incidents reflecting closures	Runway, roadway, taxiway, terminal etc.
Warehousing Management System	Gross value of inventory	Warehouse units, value of each type of unit, bench stock inventory, date record of parts and materials dispatched from warehouse
	Internal auditing	Valuation prior to manual inventory by commodity vs. actual valuation confirmed by inventory process
	Critical items above or below set stock levels	Reorder points, costs and shelf life
	Pipeline critical time lines from reorder to receipt	Reorder of parts and materials received from suppliers and the timeline to receipt
Maintenance of Asset System	Purchases unmatched to tenant or vendor charge-backs	Contractual service requests, work orders, parts and material, resources, etc
	Triage approach organized by priority of work orders, resources	Safety related work orders, work orders by: number, description of task, date initiated, estimated time to complete, work orders completed by resource
	Unexpected increase of expiring contracts	Expiring contracts including DBE status
	Critical equipment status	Number of mission critical vehicles, snow removal, snowmelt, escalators, parking ticket dispensers, generators, bag claim conveyors, badge readers, etc., that are out of commission
	Critical incidents	Summary of incident reports and shift logs by date and time
	*Airside compliance - FAA Part 139. (Handled by Operations, maybe tracked through a maintenance system)	Inspection of airfield, runways and other physical elements of an airport. Any findings related to Notice to Airmen (NOTAM). Inspections of alarm and security systems
	Lost time within a pre-set tolerance level	Injury, security, safety and illness statistics by contractor and employee
*Systems crossover to other functional areas such as Operations, Finance, etc.		

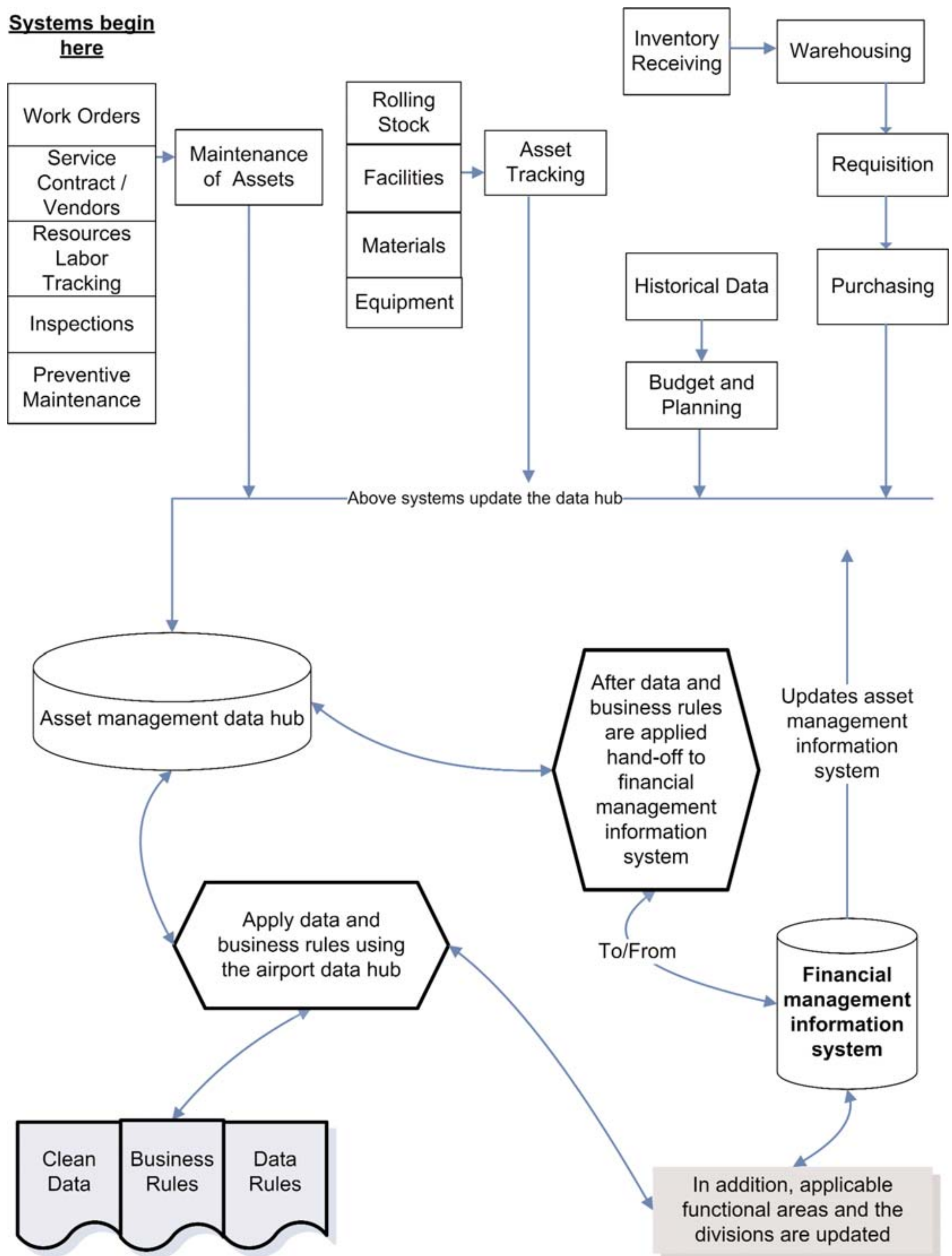


Figure 5-5. Sample asset management information system.

CHAPTER 6

Architecture, Strategies, Technologies, and Contracts

To determine an appropriate integration strategy, including what technologies to employ, airport management needs to have a basic understanding of current system architecture. This chapter provides discussions of the following:

- Systems Architecture, including discussions about open architecture, protocols, and legacy systems;
- Integration Strategies and Technologies, including discussions and an assessment of the strengths and weaknesses of various strategies; and
- Software Contracts, including descriptions of several standard types of contracts in the context of an airport enterprise, along with some provisions the contracts typically contain.

Systems Architecture

Open Architecture Systems

When a system is said to have an *open architecture,* it means that the system can be added onto or integrated easily because the inner workings (architecture) of the system are transparent to everyone. System developers can accomplish system transparency in many ways, including the following:

- Conform to standards that are approved by various trade organizations, such as the International Organization for Standards (ISO) and American National Standards Institute (ANSI);
- Create an Application Programming Interface (API) and publish a reference guide that describes how to interact with the system;
- Use relational databases to store system data along with documentation of the database schema (how the data are organized into tables and columns); and
- Rely on a built-in standard scripting language to customize and enhance the system.

A *closed architecture* system, on the other hand, is one that does not allow for easy modification or integration, because the inner workings of the system are not transparent. Many times though, closed architecture systems make sense for an airport, such as when the software vendor allows for data to be extracted and easily integrated into other systems. Typically, closed architecture systems have some or all of the following characteristics:

- Data storage in a proprietary format that is not documented and cannot be accessed by other software,
- Little to no mention of or conformance to standards,
- No published APIs,
- No scripting capability, and
- Proprietary scripting language used to customize and enhance the system.

There can be confusion between the terms open architecture and open source. *Open source* refers to the legal ownership of the programming language source code used to build the software. An open source system is one where the program source code is freely available to everyone and can be used and modified at will, provided that certain legal conditions are met. Open source systems are, by their very nature, open architecture, because the necessary transparency is more than adequately provided by the public availability of the source code.

On the other hand, a system does not have to be open source to be open architecture. A company can develop an open architecture system while still keeping the source code private. Following are some of the many benefits of using open architecture systems:

- It is easier to integrate between open systems.
- People can add features as they become necessary in the future.
- It is easier to find technical resources to maintain open systems.

When procuring software systems, answer the following questions to ensure that the system is based on an open architecture:

- Are the data stored in a relational database, and is there documentation on the database schema?
- Are there documented APIs for integrating with this system?
- What industry standards does this system support?
- Are there any built-in mechanisms for customizing or enhancing this product? Do the mechanisms use a proprietary programming language or a standardized scripting language?
- Are there other software systems that integrate with this system out of the box? What technologies are used in that integration?

Protocols

A significant piece of most system architectures is the protocols the system uses. A *protocol* is a set of rules that allows multiple systems to exchange information. A protocol is like a dictionary that helps you communicate in a foreign language when traveling. If you need to find a restaurant, you can use an English-French dictionary to find the French phrase to ask "Where is the nearest restaurant?" But just as these translation dictionaries are limited, most protocols do not allow for every conceivable piece of information to be communicated.

As with system architectures, protocols can be open or closed. An open protocol is one that follows a published standard, such as TCP/IP, the set of communications protocols used by the Internet. Open protocols allow multiple vendors to build systems that interact with each other because they speak the same language. A closed protocol is a protocol that is specific to one vendor and is not published or standardized. Closed protocols allow multiple systems from the same vendor to communicate, but if you buy a new system from a different vendor, it will not support that protocol.

Legacy Systems

The term *legacy system* refers to an old computer system that is still in use well past its original life expectancy. Many legacy systems in use today were created before the popularity of open architecture computing. Some legacy systems might have been built on an open architecture that was valid when they were built, but the standards used then are so old that newer systems do not support them today. Any legacy system, whether open architecture or not, can hinder integration because of the following:

- Lack of resources with knowledge of the system architecture,
- Hard to find or non-existent documentation on the system and/or standards, or
- Difficulty or impossibility of upgrading.

With these drawbacks, why are legacy systems still in use? Some reasons not to replace a legacy system are as follows:

- The cost of replacing the system is too high.
- No one knows exactly how the system works or everything it does, so replacing it is risky.
- The system was built to be highly available and cannot be taken down.

Integration Strategies and Technologies

In this Handbook, *strategies* refers to a specific software systems integration approach. Each strategy has different strengths and weaknesses and is appropriate for different situations. Understanding how these strategies work is key to determining the most effective strategy for a particular airport's situation.

Technology refers to the tools used to build and integrate software. Integration technologies include the following:

- Standards used to format and store data, such as Structured Query Language (SQL) and XML;
- Software techniques such as relational databases and online analytical processing (OLAP); and
- RP, such as CUPPS.

The use of a specific technology does not imply the use of any particular strategy. For example, XML is a technology that is widely relied on to integrate software systems, and it can be used to implement all of the strategies described in this Handbook.

Integration Strategies

This section describes popular software systems integration strategies (i.e., data warehousing, enterprise information integration, and enterprise application integration) and compares their strengths and weaknesses.

Data Warehousing

This strategy gathers data from different software systems and puts the data in a central location called a *data warehouse*. The warehouse uses software to scrub the data—apply preset business rules and analyze the data—to use the data in preset calculations to provide needed information. Other systems then go to this central location to get the data as input for their calculations, or in the case of a large data warehouse, data is first distributed to departmental *data marts,* such as a financial data mart or operations data mart.

Think of the data in a data warehouse as the items sold by a large retail chain. All of the items (data) are received from the different manufacturers (software systems) in the central warehouse (data warehouse). The employees (data scrubbing routines) of the central warehouse ensure that the items received meet the standards of the retail chain. The items are organized and distributed to the retail stores (data marts) based on which stores need what items.

When IT people discuss data warehousing, they often mention an associated strategy called Extract, Transform, and Load (ETL). This strategy typically uses technologies like open databases, flat files, and XML to extract the data from various sources before transforming or scrubbing the data so that it can be loaded into the data warehouse. The data warehouse and data marts are usually made up of one or more databases. These databases identify relationships between data and provide for open communication of data between databases. The data in a data warehouse or data mart are read-only, so they cannot be modified. Therefore, this strategy is used only for viewing and reporting on data; it does not allow software systems to interact with each other.

Figure 6-1 shows how a typical airport's information process would look using a data warehouse strategy. The strengths and weaknesses of data warehousing are as follows:

- **Strengths.** Good for analyzing historical data, analyzing trends, and finding hidden correlations in data.
- **Weaknesses.** To the extent that making real-time decisions is important, this strategy may not be as appropriate.

Enterprise Information Integration

This strategy leaves data in the various software systems and a central EII software program gets data from those systems when data are needed. The information in these various systems is termed *distributed data.* The EII software presents a single, unified model of the distributed data so that queries and reports can be written against this central model, regardless of in which system individual data elements reside.

Think of an EII system as a multi-restaurant delivery service. The customer (a report or query) calls the delivery service (EII software) and orders Chinese food (accounting data), pizza (maintenance data), and an apple pie for dessert (flight data). The delivery service picks up the food from three different restaurants (software systems) and delivers it to the customer.

In discussing EII software, people often mention technologies like Open Database Connectivity (ODBC), Java Database Connectivity (JDBC), and Web Services. These technologies are used to access data from the various distributed sources.

Some of the strengths and weaknesses of EII are as follows:

- **Strengths**
  - Because data are left in the original software system, reports are always up to date.
  - Users can access data from multiple systems in an integrated manner.

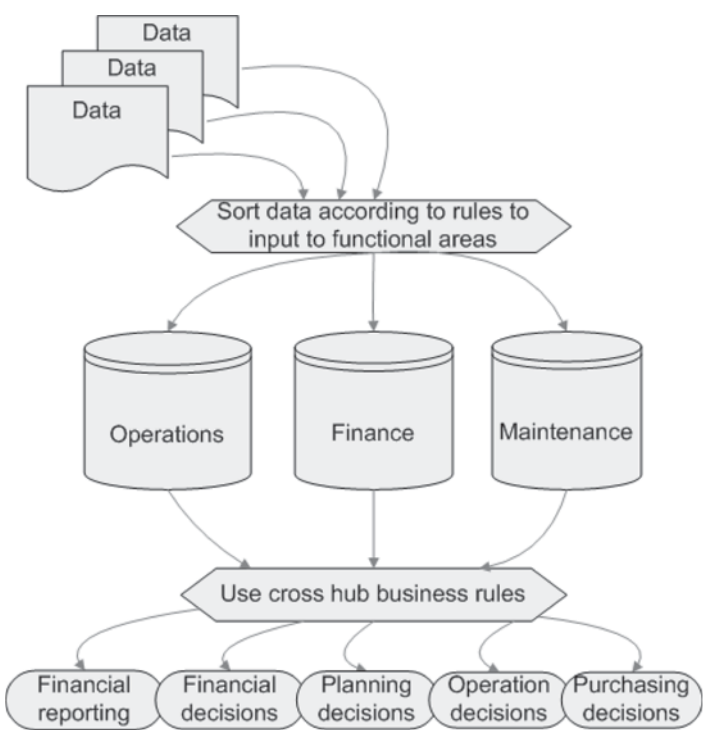


Figure 6-1. Schema for data warehousing strategy.

- **Weaknesses**
  - Because the data are not stored in a central location, how much and how historic data are captured is up to the original software. Thus, queries and analyzing past data can be a problem.
  - Performance can be a problem because each system is last accessed in real-time.
  - Configuration of the EII system (deciding where data comes from, which data to ignore, etc.) can be complicated.

Enterprise Application Integration

This strategy links various software systems to form a single, integrated system. This type of integration is on the far end of the integration spectrum, integrating not just data but systems and processes. From the viewpoint of a user, systems integrated using EAI can appear to be a single piece of software, although multiple different software systems are behind the scenes.

Think of an EAI system as a large Broadway production. A member of the audience (user) sees a coordinated performance of people, props, lights, and sound (various software systems). From the audience point of view, it seems like everything is coordinated perfectly according to plan. Back stage, a director (EAI software) is making sure that the people in charge of the cast, lighting, sound, and props are all coordinated properly.

Technologies often associated with EAI software are Web Services and Service Oriented Architecture (SOA). These technologies are used to provide integration, not just at the data level, but at the functional level. For example, business processes might dictate that a specific action in the accounting system (marking an account as delinquent) causes an action in the operations system (marking all work orders for that account as on hold). Web services that allow manipulation of work orders in the operations system might be used to accomplish this kind of integration.

Some of the strengths and weaknesses of EAI are as follows:

- **Strengths.** EAI is the strongest form of integration techniques because it leads to what appears to be a single system from the user's perspective.
- **Weaknesses.** In most cases, EAI is the most complex integration approach and is usually cost prohibitive or impossible with old or proprietary systems; also, because of its ambitious nature, EAI is the most risky integration approach.

Integration Technologies

This section describes technologies that an airport enterprise can use to implement a chosen systems integration strategy:

- Relational Database,
- Online Analytical Processing,
- Open Database Connectivity and Java Database Connectivity,
- Flat Files,
- Extensible Markup Language, and
- Web Services.

Relational Database

A relational database is the most common type of database in use today. A relational database is normally built using a Relational Database Management System (RDBMS). Data in a relational database is stored in tables. A table in a relational database is like a spreadsheet, with columns to define the attributes for each data point and each row representing a data point. Another important aspect of relational databases is their ability to enforce constraints on the data (ensures validity of the data) as well as referential integrity (ensuring that tables that refer to each other are consistent).

Online Analytical Processing

OLAP is an approach to provide quick answers to queries of multidimensional data (data about more than one facet of an item, such as name, address, city, and state rather than simply a name). To facilitate these queries, OLAP data are organized into multidimensional OLAP cubes that aggregate the facts across the different dimensions of the cube. For example, a sales data cube could be created with dimensions including sales date, region, and product category. The facts contained in this cube could include quantity sold, dollar amount sold, and gross margin. This cube would enable someone to very quickly answer questions like the following, which can take quite a bit of processing power and development time on a relational database:

- What were the top selling product categories in the east region in Q4?
- What product categories increased in sales from Q3 to Q4?
- Did the product categories that increased do so in all regions?

The users of OLAP data are typically business people looking for answers on what is going on in their business. Most OLAP software is meant to enable those business people to find the answers themselves, bypassing the need for IT staff to write complex queries.

Open Database Connectivity and Java Database Connectivity

ODBC and JDBC are standard APIs for accessing data stored in RDBMS. Although ODBC was meant to work with any programming language, JDBC is an API specifically for the Java programming language.

Flat Files

A flat file, or text file, is a simple mechanism for storing data that can only be last-accessed sequentially, or from beginning to end. Flat files originated in the early days of software development, but are still used primarily for importing and exporting data between different systems.

Extensible Markup Language

XML is a *markup language* used to describe data. The primary use of XML is to facilitate the sharing of data among software systems. XML has gained wide use on the Internet and is the basis of many other technologies, including Extensible Hypertext Markup Language (XHTML), Really Simple Syndication (RSS), and Extensible Stylesheet Language (XSL).

XML schemas are a way to specify validation rules for XML documents. For example, an XML schema can specify that an order document contains at least one order line. U.S. Government standards for XML include the Federal XML Developers Guide and the Federal XML Group Update.[2]

Web Services

Web services are XML APIs that can be accessed over a network, commonly using the World Wide Web Consortium (W3C) standard, Simple Object Access Protocol (SOAP). Web services differ from traditional APIs in that, due to their use of XML and HyperText Transfer Protocol (HTTP), web services can be used to communicate between software on different operating systems.

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[2]U.S. Federal Chief Information Office (CIO) Council. *Draft XML Developers Guide.* Architecture and Infrastructure Committee, XML Working Group, April 2002.

Software Contracts

Certain provisions occur frequently in software purchase and maintenance contracts. This section describes several standard types of contracts in the context of an airport enterprise, along with some provisions the contracts typically contain. This information is provided to help identify and understand the basics of such provisions. No legal analysis or opinion is offered or intended; an airport that enters into any software or other technology contract is urged to review the specifics of the offered contract with legal staff experienced in such contracting. This section addresses the following types of software contracts:

- End-user object code software license,
- Software maintenance,
- Software escrow, and
- Enterprise software.

End-User Object Code Software License Contract

In an end-user object code software license, the purchaser is the *licensee* and is restricted as to the number of users, number of installations, and number of copies. The software company is the *licensor* and normally retains all source code and rights to the source code. The contract provisions normally prohibit an airport as licensee from reverse-engineering the code or trying to copy or disseminate it in any way. All intellectual property rights are retained by the software company. This is normally reflective of a closed architecture software solution, but the solution can have protocols for easily extracting data for integration purposes.

Software Maintenance Agreement

When an airport enters into a licensing agreement with a software vendor, a software maintenance agreement accompanies that agreement. This type of agreement should explain how the software will be maintained on an ongoing basis and the cost of that maintenance. Monthly maintenance costs are charged for a set period and sometimes are based on a tiered structure. The agreement also details the process for upgrades or enhancements to the software and updates to fix software glitches. It is important for an airport to understand, as defined in the maintenance agreement, how software upgrades and patches will be deployed and how patches can affect the software and its data. Sometimes the cost of upgrades or enhancements is in addition to monthly maintenance fees, and if the airport does not accept an upgrade, patch, or enhancement, support restrictions can be imposed by the software vendor.

Software Escrow Agreement

Escrow agreements allow for the software source code and relevant architecture documentation to be escrowed with an objective third party. The software vendor/depositor agrees to deposit the source code and all development documentation in the care of the escrow agent for the benefit of the airport. These agreements can delineate how disputes are resolved and what happens if the software vendor files for bankruptcy. This type of agreement, if structured correctly, can add a level of security during any software acquisition, especially if the data might not reside with the airport or might not be in a usable format. The escrow agreement should contain language to explain the amount and type of knowledge transfer documentation, the source code, and how documentation and code are periodically updated to the escrow agent. Just receiving the source code does not mean that anyone will understand it without the necessary documentation for knowledge transfer.

Enterprise Software Agreement

In enterprise agreements, the purchaser of the software is the licensee, and if the purchase is based on a large number of users, an airport should have greater leverage to control and negotiate lower rates and more favorable terms for the license agreement. Because these application installations are at an enterprise level, hardware, infrastructure, and an implementation plan are normally included in the agreement. Enterprise software agreements should detail every aspect of the implementation and installation of the software, and these aspects should be negotiated into the contract. Because of the complexity of the solution, a phased approach using phased agreements might be considered. When purchasing enterprise-level software solutions, open architecture or specific data integration extraction technologies should also be negotiated into the agreements.

CHAPTER 7

Manager's Dashboard

A manager's dashboard is a graphical user interface (GUI) that an airport manager can easily access on a computer desktop. The technology behind a self-configurable dashboard exists today. But the level of data integration needed to deliver the desired data has not been widely implemented, although such integration does exist on a small scale, as noted in Chapter 2. This chapter does not provide instructions to create a specific dashboard; rather, as the culmination of this Handbook, it presents the lowest level detail to help managers understand the vision for a fully integrated airport in the form of their own desktop dashboard. This chapter discusses key considerations when configuring the manager's dashboard and provides some example images, in the following sections:

- The Dashboard,
- Dashboard Indicators,
- SMART Indicators, and
- Sample Dashboards.

The Dashboard

The manager's dashboard provides information from many different sources. Managers can use these pieces of information to create a coherent picture of the overall business situation. The manager's dashboard, like the gauges on a pilot's instrument panel, gives a general picture. It is up to the manager to use this information to keep the airport on a successful course.

The saying "If you have seen one airport, you have seen one airport" can also apply to dashboards: If you have seen one manager's dashboard, you have seen only one manager's dashboard. Airport managers should be able to customize (or configure) their own dashboards because every manager deals with different priorities, problem areas to monitor, reporting requirements, and so on.

Developing the manager's dashboard is a key part of the early integration process. In Step 1 of Chapter 3, Best Practices for Integration, airport senior and middle managers listed their objectives and identified what business-critical information they needed to work effectively. This list is the foundation for any self-configurable dashboard. In a fully integrated airport, each manager can configure his or her own business-critical information, and airport software systems work together to provide that information. To configure a dashboard, the manager needs to identify parameters such as the following:

- Data that constitute the information. For example, what data are needed—and in what format—to calculate landing fees?
- Time frames. Real-time data, daily, weekly, or monthly?
- Thresholds of information needed. At what amount of a cost overrun should senior management be informed?

Dashboard Indicators

An airport is a complex conglomeration of many different systems, variables, and actions. It is a huge task to keep tabs on every tiny piece. Manager's dashboards become more manageable if they present *indicators* that represent only key pieces or the whole system at a glance, rather than the entire array of information available. Indicators need to be chosen carefully to be sure that they actually represent a wider array of information. Like the warning lights on a pilot's instrument panel, the indicators closely monitor information that is sensitive to change and signal a problem long before it becomes apparent in other ways. Alternatively, indicators can be the pilot light on a gas stove—a driving force or a precondition, just as without that pilot light, the stove will not light.

SMART Indicators

When deciding what indicators to view from the manager's dashboard, use the acrostic SMART to remember the following characteristics of useful indicators:

- **Specific.** Information on the dashboard can be used not only to convey useful information at a glance to managers, but also to communicate an airport's status to the public, planners, and others. A specific number might be easier for these groups to understand. For example, "2,309 more flights this year from Terminal A than last year," is more readily understood than "The number of flights from Terminal A increased by 13 percent."
- **Measurable.** Use a measurable indicator that is not vague. "X percent of gross revenues" paints a far more vivid picture than does "pretty good." If it is not easy to readily collect, measure, record, and use a piece of information, then consider how useful—or how potentially dangerous—that information is. If everyone interprets the same data in different ways, this leads to confusion. To develop an effective indicator, determine what data are readily available or can be measured directly at that site (gate, point-of-sale, security line).
- **Accurate.** Accurate information goes well beyond simply getting the numbers right. Show these numbers in context; be able to explain why and how that indicator is used, what it means, and how it is checked.
- **Relevant.** An indicator should be relevant to an airport's overall set of information. Make sure that the indicator comes from the appropriate pool of information.
- **Timely.** Although monthly and weekly reports provide good information to identify and solve chronic and long-term problems, real-time decision-making requires real-time information—whether it is the cumulative impact of construction change orders or overflowing parking lots. Be proactive instead of reactive. Determine when the information is needed and how often—in real time, daily, weekly, or monthly. Be sure the indicator can depict the airport's status when and how it is needed.

SMART indicators also need to be reliable. To test reliability, build in comparisons, which are also a good way to ferret out potential problems with the data.

Even when using indicators, the information each manager wants to appear on her or his dashboard can be unwieldy. To refine these indicators, identify priorities among them. Priorities should dictate the information hierarchy—what information is shown on the first screen and what information is available by drilling down through the dashboard data layers.

Sample Dashboards

Figures 7-1 through 7-4 are samples of manager's dashboards for Finance and Administration, Operations and Security, Engineering, and Maintenance. Managers can use these examples to help determine what they need to see on their own dashboards.

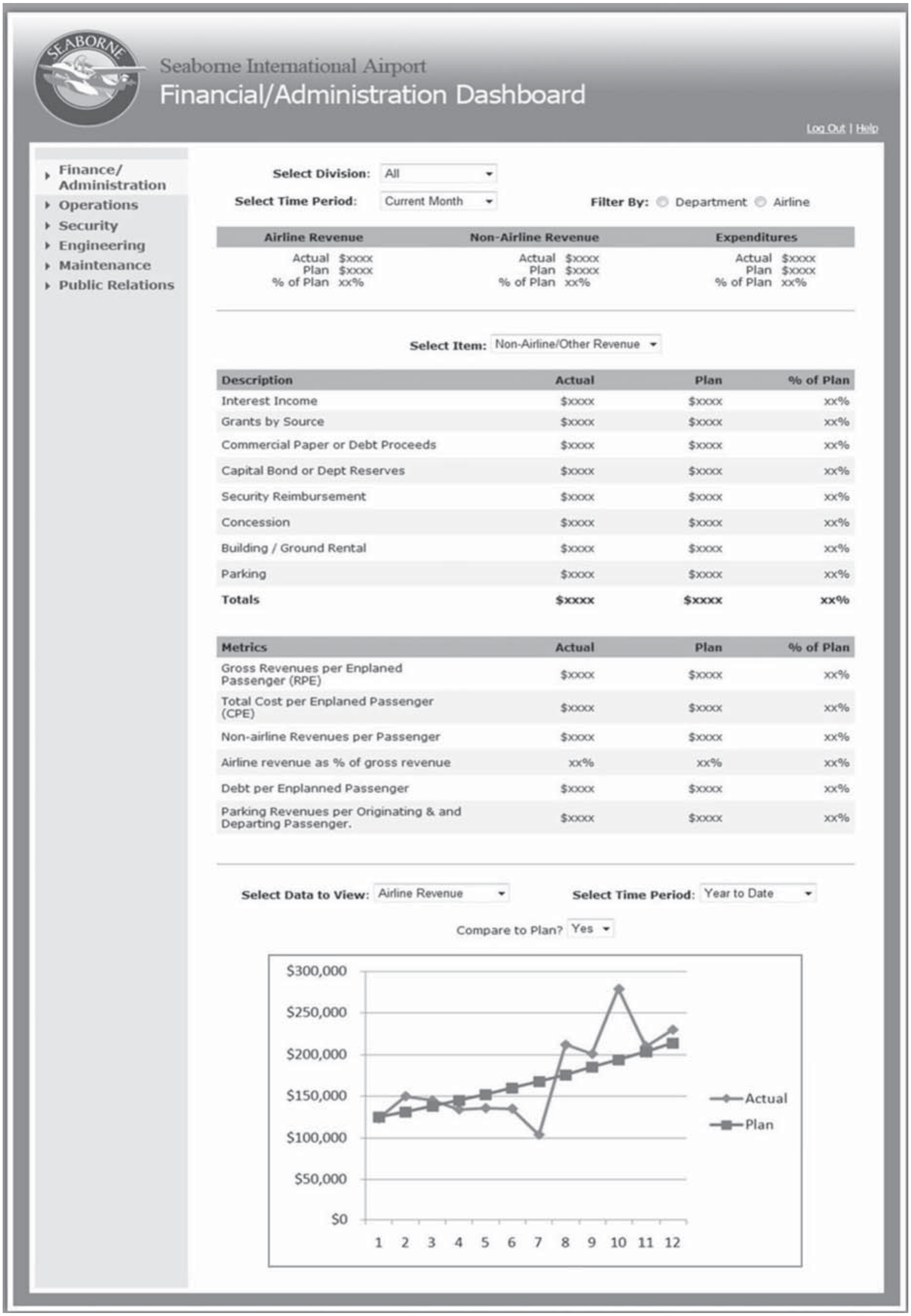

Figure 7-1. Example of finance/administration manager's dashboard.

Seaborne International Airport
Operations and Security Dashboard

Log Out | Help

- Finance/ Administration
- Operations
- Security
- Engineering
- Maintenance
- Public Relations

Select Division: All

Select Time Period: Today

Airfield	Terminal / Landside	Security
Status No Delays	**Status** 3 Wait Time Exceed Standard	**Threat Level** Orange

Select Item: Terminal / Landside

Description	Prior Shift	Real-time
Critical Incidents	Fuel Spill	Fuel Spill Cleanup
PAX Wait Times		
Security Processing	Normal	Exceeds Standard 60 min.
Ticketing / Checkin	Normal	Exceeds Standard 30 min.
International Arrivals	Normal	Normal
Parking		
Garage	Full	Exceeds Standard Exit Queue 10 min.
Shuttle Lots	Available	Available
Roadways	Road #2 closed for repairs	Road #2 closed for repairs
Gate Usage	2 gate RON holdovers	3 gates out of commission

Metrics	Prior Shift	Past 30 days
PAX Wait Times Exceed Standard		
Security Processing	2	20
Ticketing / Checkin	1	5
International Arrivals	0	1
Parking Exits	1	5
Shuttle Bus (Remote Parking)	0	0
Gate Usage Efficiencies		
Unscheduled Gate Use	1	6
Holdovers	2	12
Unused City Gates	0	5
Average Turns / Gate	5	4
Average Turns / City Gate	5	3

Figure 7-2. Example of operations and security manager's dashboard.

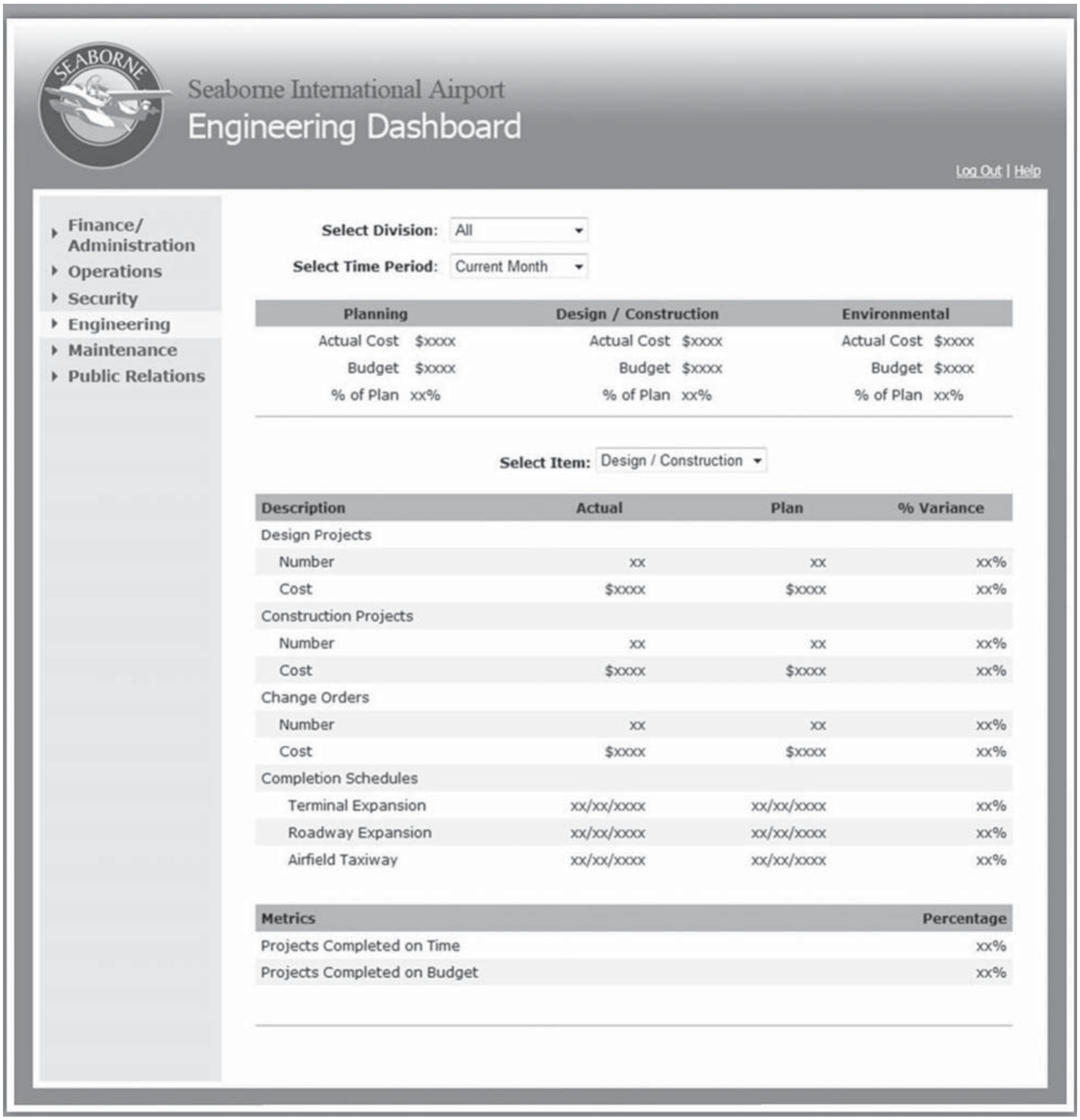

Figure 7-3. Example of engineering manager's dashboard.

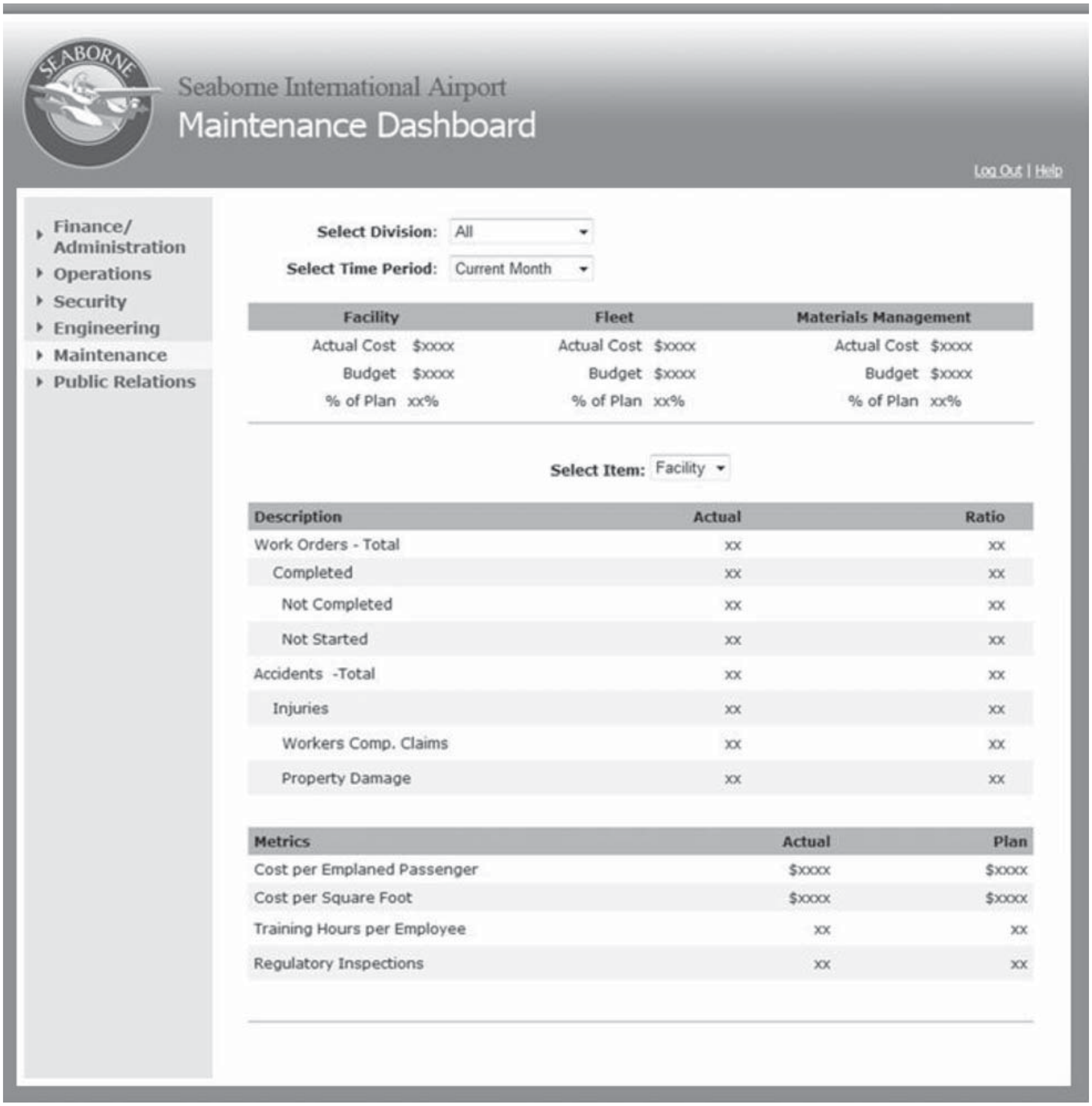

Figure 7-4. Example of maintenance manager's dashboard.

GLOSSARY

2-D	Two-dimensional
AAAE	American Association of Airport Executives
AC	Advisory Circulars
ACARS	Aircraft Communication Addressing and Reporting System
ACD	Automatic Call Distribution
ACI	Airports Council International
ACI-NA	Airports Council International–North America
ACIP	Airport Capital Improvement Program
ACRP	Airport Cooperative Research Program
ADS-B	Automatic Dependent Surveillance-Broadcast
AIDX	Airport information data exchange
AIP	Airport Improvement Program
AIXM	Aeronautical Information Exchange Model
ALP	Airport Layout Plan
ANOMS	Aircraft Noise and Operations Monitoring Systems
ANSI	American National Standards Institute
AOA	Air Operations Area
AODB	Airport operational database
AOSC	Airport Obstructions Standard Committee
API	Application Programming Interfaces
ARFF	Airport Rescue and Fire Fighting
ARTS III	Automated Radar Terminal System III
ASC	Airport Services Committee
ASDE-X	Airport Surveillance Detection Equipment–Model X
ASRS	Aviation Safety Reporting System
ATA	Air Transport Association
ATC	Air Traffic Control
AVI	Automated Vehicle Identification
BCBP	Bar coded boarding passes
BCM	Business-Centric Methodology
BTS	Bureau of Transportation Statistics
C/ACAMS	Constellation/Automated Critical Asset Management System
CAD	Computer-aided design
CAT II	Category II
CBP	United States Customs and Border Protection
CCTV	Closed Circuit Television
CDL	Commercial driver's license
CEO	Chief Executive Officer

CFO	Chief Financial Officer
CFR	Crash, Fire, and Rescue
CGM	Computer Graphics Metafile
CI/KR	Critical infrastructure/key resource
CIO	Chief Information Officer
CIP	Capital Improvement Program
COO	Chief Operating Officer
COTS	Commercial off-the-shelf
CSTARS	Colorado State Titling and Registration System
CUPPS	Common Use Passenger Processing Systems
CUSS	Common Use Self Service
CUTE	Common Use Terminal Equipment
db	decibel
DBE	Disadvantage Business Enterprise
DEN	Denver International Airport
DHS	Department of Homeland Security
DOT	Department of Transportation
DTD	Document Type Definition
EAI	Enterprise Application Integration
ebxml MS	Electronic Business Extensible Markup Language Message Service
EDI	Electronic Data Interchange
EII	Enterprise Information Integration
EMT	Emergency Medical Technician
EP	Enplaned Passenger
EPA	Environmental Protection Agency
ERP	Enterprise Resource Planning
ETL	Extract, Transform, and Load
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FBI	Federal Bureau of Investigations
FICA	Federal Insurance Contributions Act
FIDS	Flight Information Display System
FIMS	Flight Information Management System
FIS	Federal Inspection Services
FMIS	Financial Management Information System
FMS	Financial Management System
FSIMS	Flight Standards Information Management System
FSS	Flight Service Station
FOD	foreign object damage
GIS	Geographic Information System
GOA	Government Accountability Office
GPS	Global Positioning Systems
GUI	Graphical User Interface
HCM	Human Capital Management
HL7	Health Level Seven
HR	Human Resources
HTTP	Hypertext Transfer Protocol
IA	intelligent agent
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IEC	International Electrotechnical Commission

IEEE	Institute of Electrical and Electronics Engineers
ILS	Instrument Landing Systems
ISO	International Organization for Standardization
IT	Information Technology
ITIL	Information Technology Infrastructure Library
JDBC	Java Database Connectivity
JPSC	Joint Passenger Services Conference
LEO	Law Enforcement Officer
MBE	Minority Business Enterprise
MDM	Master Data Management
MDR	Metadata Registry
NFDC	National Flight Data Center
NGO	Non-governmental organizations
NIPP	National Infrastructure Protection Plan
NISS	National Institute of Statistical Sciences
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notice to Airmen (plural NOTAMs)
NPIAS	National Plan of Integrated Airport Systems
OAG	Official Airline Guide
OASIS	Organization for the Advancement of Structured Information Standards
O&D	origin and destination
ODBC	Open Database Connectivity
OLAP	Online Analytical Processing
ooEDI	Object-oriented EDI
OSHA	Occupational Safety & Health Administration
OTA	OpenTravel Alliance
PANCAP	Practical Annual Capacity
PAX	Passenger
PERT	Program Evaluation and Review Technique
PFC	Passenger Facility Charge
ppm	particulates per million
PR	Public Relations
QR	Quick Response
RDBMS	Relational Database Management System
RF	radio frequency
RFID	radio frequency identification
RFP	Request for Proposal
RP	Recommended Practice
RSS	Really Simple Syndication
RVR	runway visual range
SBA	Small Business Administration
SEC	United States Security and Exchange Commission
SERC	Software Engineering Resource Center
SIDA	Security Identification Display Area
SIN	Singapore Changi
SIP	State Implementation Plan
SMS	Surface Management System
SOA	Service-Oriented Architecture
SOAP	Simple Object Access Protocol
SSIM	Standard Schedules Information Manual
SSPs	Sector-Specific Plans

StB	Simplifying the Business
SQL	Structured query language
TRB	Transportation Research Board
TSA	Transportation Security Administration
UML	Unified Modeling Language
UMM	UN/CEFACT's modeling methodology
UN/CEFACT	United Nations Centre for Trade Facilitation and Electronic Business
USOAP	Universal Safety Oversight Audit Program
VOIP	Voice Over Internet Protocol
W3C	World Wide Web Consortium
Wi-Fi	Wireless Fidelity
XHTML	Extensible Hypertext Markup Language
XML	Extensible Markup Language
XSL	Extensible Stylesheet Language
Z	Zulu Time Zone

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation