Meeting the Continuing Growth of Air Transport

NANCY HSU and
RONALD W. PULLING

FIGURE 1 Proposed renovation and expansion of Eastern Air Lines terminal building at J. F. Kennedy International Airport.

Airport planning in the United States has been in a continuing state of evolution. The changing problems that airports have experienced in their development have led to a shift in the emphasis of airport planning during the past 20 years.

The 1960s was an era of rapid growth for aviation as airports adapted to major technological innovations within an expanding economy. Forecasting techniques were developed and refined, and master plans for new airports were drawn up in anticipation of booming demand.

The technological advances of the 1960s that affected the quality of air, water, and community life were reflected in the 1970s by a growing public concern for the environment. Airport planners conducted environmental and community impact assessments, evaluating the effects of airport-generated noise, pollution, and traffic congestion, with the realization that unmanaged growth at individual airports would eventually impair not only the national aviation network but also the quality of life in general.

In the 1980s airports and commercial aviation are becoming a mature industry. In the 1960s "green-field" planning was common—planning theory and design concepts were applied to the master plans of totally new airports such as Dallas–Fort Worth and Dulles International. However, such planning in the United States is gradually becoming obsolete.

In this decade, previous forecasts have been monitored and adjusted, and planning theory has been tested in the real world. Situations not anticipated by the forecasts or the theories of the earlier planning stages are now confronting airports—situations created by the complexities of national and world economies, airline deregulation, and continued technological change.

FIGURE 2 Improvements are being made to the interior and exterior of the British Airways terminal building at Kennedy International Airport in New York to enhance the aesthetics of the building and create a more contemporary British atmosphere.

Current concerns focus on upgrading, renovating, expanding, and streamlining existing facilities and their operations. Relieving ground and air traffic congestion, providing more efficient interairport connections and intra-airport flows of people and materials, and maintaining flexibility to accommodate changing airline tenants are current issues common to most major hub airports (Figures 1 and 2).

Airport security as it is known today began to influence airport planning rather dramatically in the late 1960s when Cubans commandeered aircraft to return to their homeland. During the next decade in the United States, 88 highjackings occurred. Concern for the safety of innocent passengers and crews resulted in immediate national action to reduce and possibly eliminate this new threat to air safety. Cuban officials also cooperated by jailing all those engaging in this illegal activity. These actions were successful, and the number of domestic highjackings was dramatically reduced.

Extensive research has resulted in new scanning devices to detect metal weapons. From 1973 to 1979, 19,000 weapons were detected and confiscated. Airfield and terminal design has changed also. Visitors were restricted to certain areas, incoming and outgoing passengers were segregated, closed-circuit TV scanning was installed, and many other design, construction, and operating changes were included in renovation and expansion programs.

Recent developments have changed the complexion of the problem. Plastic explosives have complicated the process of weapons detection, and the use of the passengers as hostages to gain political objectives has increased. The criminal possession of air transport is no longer perpetrated only by individuals and small groups. Internationally, the highest levels of government are interested in the research and implementation of new security procedures, equipment, and operating practices. The task of providing a fail-safe system of airport security is formidable. More than 300 million person trips per year are conducted through more than 500 major airports. Research

Nancy Hsu was a project architect, Tippetts-Abbett-McCarthy-Stratton, and is now project manager, New York Transit Authority. Ronald W. Pulling was deputy associate administrator of the Federal Aviation Administration, and is now a consultant with Tippetts-Abbett-McCarthy-Stratton.

requirements exist in weapons detection, airport design, surveillance, human behavior, motivation analyses, and systems integration.

This effort is also being complemented in many countries by other technology to improve security at embassies and other government facilities. The integration and coordination of these efforts represents an additional new level of research activity.

All airport systems have increased in complexity, from computerized ticketing and sign systems to people movers. Decision making includes considerations of initial cost, operating and maintenance costs, and adaptability to system expansion or revision in the context of level of benefits anticipated.

An increased cost consciousness is inherent in all planning. The complexities of programming physical expansion projects have been further augmented by the increasing need of airports for new ways to generate revenue and decrease life-cycle costs while providing greater operating efficiency and passenger comfort to a more sophisticated traveling public. Successful space and resource management must achieve a reasonable balance among the operational, functional, and financial ingredients of the airport system as a whole.

Systematic planning is mandatory as a means of promoting a manageable growth process that will allow the airport to function at its maximum potential in an orderly manner. Many airports that have grown piecemeal on an as-needed basis over the past two decades are now struggling with complicated terminal layouts and circuitous circulation paths that not only create passenger confusion and inconvenience but also contribute to high maintenance and operating costs. It has become increasingly difficult to accommodate any further functional revisions in these facilities because a point has been reached where there is no more room to add on. Furthermore, existing space often dictates operational procedures, which can only be made more efficient by a major program of demolition and reconstruction. The underutilized potential of an airport site can be permanently lost through an inefficient and improperly managed accumulation of short-sighted adjustments made without a well-informed view toward long-range goals and objectives.

FIGURE 3 International passenger terminal at Kimpo International Airport in Seoul, Korea, designed to accommodate the projected increase in traffic. The design provided for 8 gate positions and is expandable to 11 gate positions to handle a maximum of 2,475 peak-hour passengers projected for 1990.

Although guidelines and standards are required for many elements of an airport, each airport in the system is unique, and planning solutions for one location may not be applicable for another. The great variation in the demand for air activity from location to location requires knowledge and experience in adapting standards and requirements to site-specific goals and objectives (Figures 3 and 4).

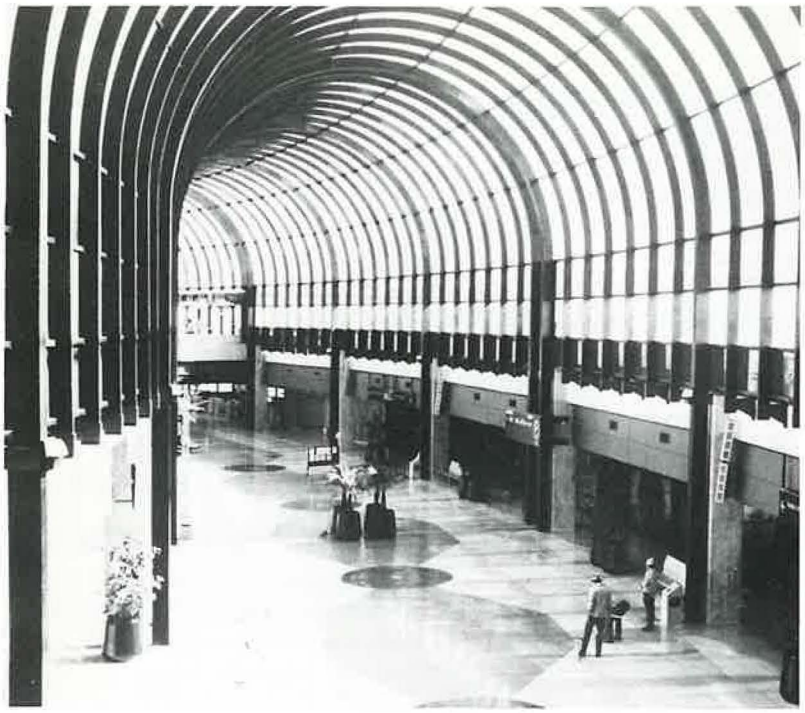

FIGURE 4 Passenger terminal at the Cordoba Airport in Medellin, Colombia, under construction (*photograph from Colombia Information Service*).

The Planning Process

Systematic planning is a continuing planning process and should not be confused with a master plan, which is a product of the planning process and, once created, serves as a tool in further planning. The master plan also requires periodic updating when the realities of change differ from the forecasts of change.

In today's increasingly complex airport system, no individual airport can be planned and developed in isolation. With each new wave of technology, the interdependence among airports increases. The systematic planning and master plan for each airport must thus take into account the problems and optimum responses of the airport system as a whole. The aim should be the most productive use of the nation's resources as a whole. This is the greatest challenge facing aviation today.

During the early stages of planning, the two major categories of information needed are factors that measure capacity and those that measure demand. Planning parameters are derived from the forecast demand, and the planning process continues with the following steps:

- Identify problems,
- Determine causes,
- Set goals and objectives,
- Identify alternative solutions for short- and long-range needs,
- Evaluate alternative solutions,
- Select preferred alternative, and
- Evaluate funding sources.

Measuring Capacity: Facilities Inventory and Capacity Analysis

The facilities inventory accounts for all components of the airport—environmental, architectural, engineering, and operational. For some elements such as utilities, service buildings, and parking areas, capacity determination is fairly straightforward, being directly related to size and function. However, for other elements such as the airfield, terminal building, roadways, and cargo areas (areas that process a constant flow or throughput of commodities, whether people, materials, or aircraft), the capacity is also dependent on operational procedures, management policy, and nature of the commodity being processed. Therefore, all information relative to capacity determination should be included in the inventory.

Capacity assessment is not an exact science and is particularly subjective in areas such as the terminal building, where people are the main commodity being processed. Unquantifiable factors including cultural conditioning and passenger expectations and perceptions influence processing and circulation time, serving to make capacity assessments more judgmental than simply adding up a standard unit space allotment for furniture, equipment, and people. The desired level of service to the traveling public affects capacity determination, and design efficiency also plays a part. An inefficient design could require much more space to process the same number of passengers than a well-organized design.

In spite of these judgmental variables, a fairly reasonable capacity assessment can be made with adequate information. Because passenger processing is a linearly dependent series of activities, each component of the processing chain must be assessed individually. Limitations in any one component will cause it to be the weak link that will affect the entire processing chain.

The airport as an entire system will most likely be made up of components that all have different capacities. A major objective of the planning process is to bring all related component capacities into reasonable balance with expected demand as development approaches its ultimate limit, so that maximum utility can be obtained from the system as a whole throughout its entire life cycle.

Measuring Demand: Air Traffic Forecast

The air traffic forecast should contain all information concerning past, present, and projected air traffic trends related to the specific airport and the general region. The level and type of demand anticipated will determine the airport's planning for future growth.

To be useful for planning facilities and their operation, demand data must be

broken down into specific categories that relate to specific planning needs:

1. Passengers: commercial air carrier and commuter, scheduled and nonscheduled; general aviation; annual, seasonal, and peak by month, day, and hour; originating, terminating, transit, and transfer; international, domestic, and local; and business, vacation, long haul, and short haul.
2. Operations: commercial air carrier and commuter; general aviation; local, instructional, and all cargo; annual, seasonal, runway peak, apron peak, and ramp or gate peak; average aircraft load factors; and aircraft fleet mix.
3. Cargo: annual tons; inbound, outbound, and transit; cargo type or mail; domestic or international; peak by month, day, or hour; and percentage of all cargo versus mixed passenger and cargo aircraft.

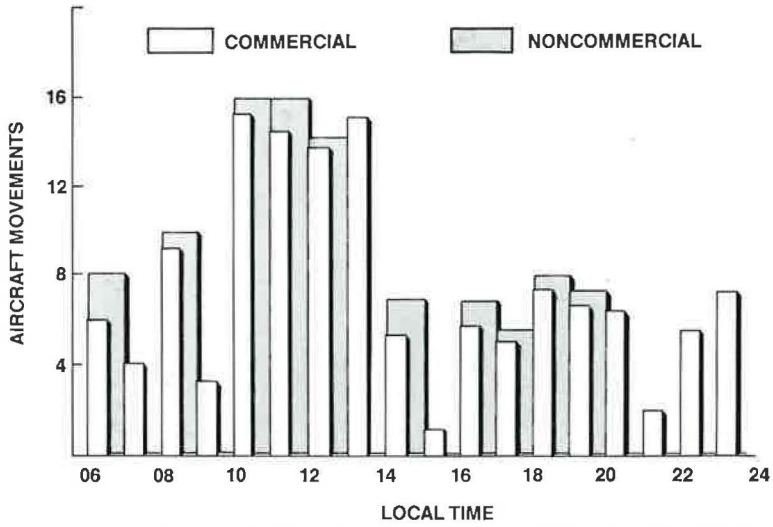

FIGURE 6 Nonsymmetrical hourly aircraft movements (actual typical day of peak month).

Traditional methods of forecasting are no longer useable in the deregulated environment. The development of hubs, the rapid growth of small package express, mergers, and fare wars have changed the shape and form of the airport system. Demand is more equated with geography and available capacity than it is with the straight-line point-to-point movement of people and goods. New research is required to better assess demand potential.

Because projections are always subject to uncertainties and unforeseen events, some assumptions will be necessary in making any forecast. Regardless of the methodology used, judgmental factors are always present in a forecast and it is necessary to take this into consideration when forecast figures are used for planning. Flexibility should be built into the planning as much as possible, and the forecasts should be monitored on a regular basis. Fortunately, long-range investment decisions need not be governed entirely by the imprecise long-range forecasts. Effective planning establishes "building-block" expansion, which can be implemented sooner or later according to actual monitoring of forecast demand.

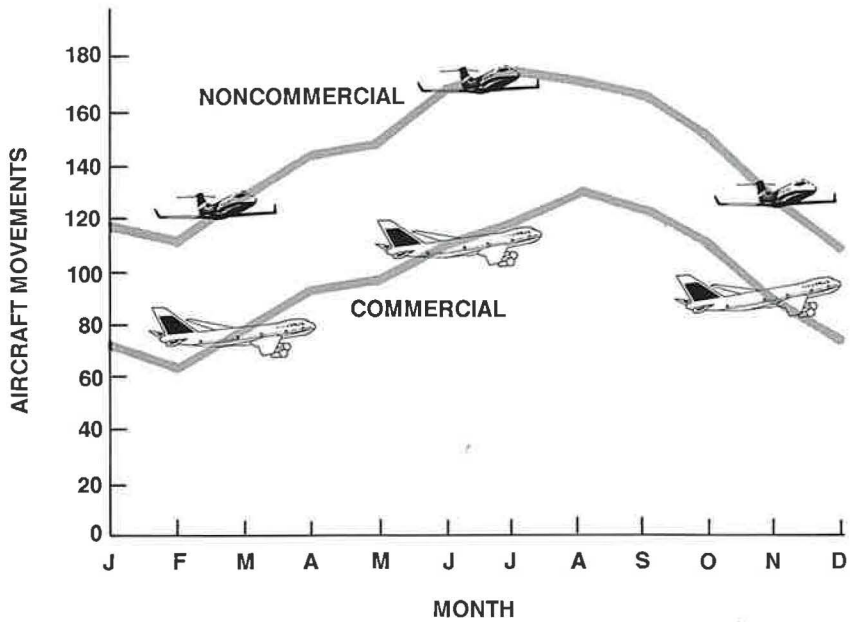

FIGURE 5 Average daily aircraft movements (typical).

Translating Forecast Demand into Planning Parameters

Annual projections for traffic growth indicate whether overall demand is expected to increase and at what rate. This growth projection, however, is too general to be useful for detailed planning because traffic differs in distribution during the year. For example, an airport whose annual traffic load is concentrated during 3 or 4 months of the year may require larger facilities to handle this seasonal peak than another airport that has an equal annual traffic load evenly distributed throughout the year. An actual daily distribution of aircraft movements by month (Figure 5) shows that daily movements at this location are higher during July, August, and September, which constitutes a seasonal peak, although not an extreme one.

An hourly distribution of aircraft movements at another airport throughout a typical day during a peak month (Figure 6) shows that peaks do not always

occur in the morning and evening. Peak-hour projections, though subject to some definitional interpretation, are key demand references for determining required capacity. Increased peak-hour loads will affect all elements of the airport, the most critical of these being the airfield, passenger or general aviation terminal, and ground transportation system. The air traffic forecast must be broken down into the passenger and operations categories in order to determine the exact nature of the impacts.

Airfield

The airfield, for instance, can be affected by increased passenger traffic in several different ways: the number of operations could increase; the aircraft fleet mix could change and larger aircraft could be used to carry more passengers per operation; or the aircraft load factors could increase, which means more passengers per aircraft. Figure 7 shows an actual operations forecast through 2010 for a specific airport; anticipated increases in aircraft movements are graphed according to aircraft size category.

Planning for physical expansions of the airfield should be directed toward the nature of increase expected. More operation of similar aircraft might require additional runways, taxiways, and apron space or it might require installation of navigation aids to increase efficiency and hourly throughput. On the other hand, using larger aircraft might avoid the necessity of expanding the number of runways but apron and ramp or gate areas might require resizing.

The feasibility of any of these solutions must be measured against existing conditions and trade-offs because there are always system impacts. Boundary limitations may preclude the possibility of airfield expansion; existing airfield geometry, as well as the current planning for the national airspace system, will affect the feasibility of installing navigation aids; and existing apron and terminal location and layout will affect the potential for increasing apron areas and gate clearances.

The alternative nonphysical solutions to accommodating increased demand also produce system impacts. Smoothing out traffic peaks by revising airline schedules is one commonly discussed alternative. This is extremely difficult to accomplish, however, because aircraft arrivals and departures also affect and are affected by the origins and destinations. Smoothing out peaks at one airport may result in inconvenient arrival and departure times, if not congestion, at other airports. Such actions may also affect the efficiency of the air carrier in using its equipment and crews. The added costs may decrease demand and thus limit the overall effectiveness of the system.

Another nonphysical alternative would be to set a limit on demand altogether. This solution would have regionwide impacts, and the effect on other nearby airports should be taken into account.

Terminal

The varying effects of increased passenger loads on the terminal building and associated functions are of greater complexity than those affecting the airfield. Each airport has its own traffic characteristics, and each processing area of the terminal building is affected differently.

For example, if larger aircraft are used so that the rate of passenger increase is greater than the rate of operations increase, the size of holding area per gate must take this into account. In other processing areas, traffic characteristics such as whether there is a predominance of business or vacation traffic or whether the airport is located in an urban or suburban-rural area will affect curb lengths, parking provisions, baggage handling, public space allotment, types and quantities of concessions having profit potential, and general security provisions.

Ground Transportation

Traffic characteristics also affect such aspects of planning for the ground transportation system as intra-airport transit (e.g., people movers or shuttle buses between terminals and remote parking areas), interairport connections, airport–city connections, and roadway capacities.

It is important to note that capacity can often be planned to generate increased demand if this is deemed desirable. For example, an airport that provides adequate capacity and a high level of service for general aviation and transient traffic and promotes their smooth interrelationship with air carriers and commuters may attract more

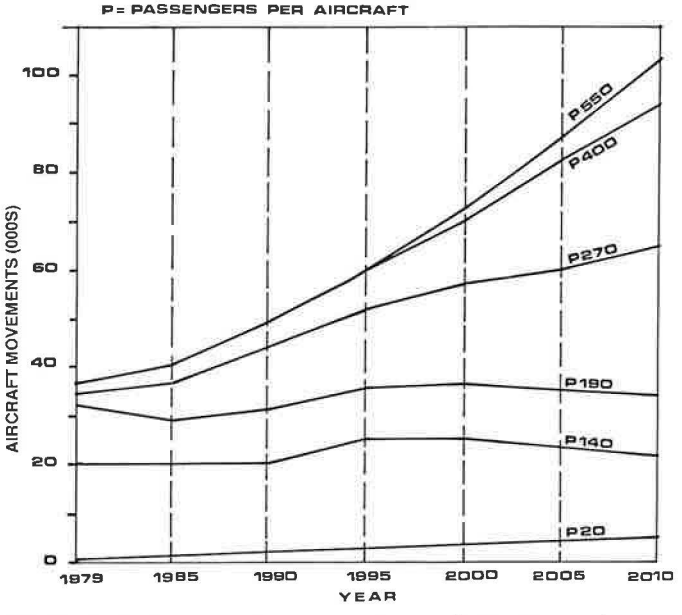

FIGURE 7 Forecast of commercial aircraft movements by size category (for one particular airport).

FIGURE 8 Remote satellite passenger boarding facility, designed for the Los Angeles International Airport, is capable of accommodating all sizes of aircraft. The facility includes four loading bridges, concourses to the ground level, and bus parking facilities to transport passengers to and from the terminal.

transient traffic and generate more revenue from sales of food, fuel, and services. Capacity and demand can be mutually generative or limiting, and the planning process seeks to bring the airport as a system into reasonable balance with respect to both.

Identify Problems

Primary problems are usually manifested as congestion and delays in the airfield, terminal building, or ground transportation routes, possibly with an added dimension of passenger and visitor confusion at parking, roadway, and terminal areas. Secondary problems not directly associated with passenger processing, although related, include those experienced with support and ancillary facilities, security systems, and cargo handling. All of these landside components are analyzed in the TRB study described in the May–June 1986 issue of *TR News*.

Determine Causes

It is frequently difficult to establish one particular cause for each problem because a network of factors may be involved. Similarly, one factor might be the cause of a series of problems, particularly in the passenger-processing functions, which are linearly dependent. Generally, problems result from facility deficiencies and space limitations, operational procedures or equipment use, management policies, and outside influences. It is important for the planner to understand the capacity limitations of the existing airport, what these limitations consist of, and which are fixed or variable. (The fixed or variable aspects are often difficult to assess, particularly when they relate to budgets, policies, or both.)

Set Goals and Objectives

The planner should understand past, present, and future air traffic trends, both airport specific and regional. A solid data base and forecast form the essential foundation for determining immediate and long-range needs for matching capacity to demand. The forecast demand must also be evaluated against the ultimate capacity potential of the airport system as a whole in order to assess the impacts and desirability of operating the airport at forecast traffic levels. For example, at large hubs it may be more desirable to plan for multi-airport development rather than expand the present facility to meet long-range demand. Every airport has boundaries and an ultimate growth limit; these seemingly remote issues must be addressed early enough so that staged growth is given an aim and a heading, or the eventual saturation of capacity may occur on its own at a much lower level of service for the passenger and at lower levels of efficiency with greater cost to the airport operator. The scope of the development program will evolve from a well-defined set of goals and objectives. Establishing the ultimate level of development will also determine the extent and detail of study required so that study techniques and associated expenses can be economically matched to the need.

Identify Alternative Solutions for Short- and Long-Range Needs

Solutions can be physical, operational, managerial, or a combination of all three. Definition of "short range" and "long range" can vary according to the rate of growth anticipated for a particular airport, and sometimes an intermediate

growth stage between short and long may also be appropriate. Alternative solutions usually respond to alternative scenarios or emphasize different variables of a particular problem. Thus for each alternative solution a set of priorities should be defined, the trade-offs and compromises implicit in its implementation should be recognized, and all relevant considerations should be identified.

Evaluate Alternative Solutions

Often solutions that appear obvious for existing problems may not adapt to longer-range needs. Therefore, it is important to assess the functional, operational, environmental, and financial compatibility of short-range and long-range solutions so that any immediate investment can yield optimal benefit when coordinated with future growth. Again, trade-offs and compromises must be recognized and assessed. Alternatives should also be evaluated for their flexibility in allowing for inaccuracies in the forecast and their potential effect on off-airport systems, which may include transportation and environmental and community impacts such as noise considerations.

Select Preferred Alternative

The selection made should be a package of short-range and long-range solutions. In some cases, construction may be an ongoing process for a number of years, particularly when complex staging is necessary to allow airport operations to function as normally as possible. Detailed cost estimates and cash-flow projections performed during this planning phase are affected by the complexity of staging, because construction around an existing and functioning facility cannot always be done in the most straightforward and cost-effective manner.

Evaluate Funding Sources

Because implementation of any plan is contingent on adequate funding, the physical planning may be influenced by the source and availability of financing. Because of recent uncertainties in the bond market, which has traditionally been a primary source of expansion funds, airport development plans have become more subject to funding availability. As airport managers explore new ways of obtaining concessions and service revenues, airport planners are also becoming increasingly involved in this aspect. Many potential revenue sources, such as industrial parks, free trade zones, or agricultural leasing, are integral elements of development planning.

Role of the Airport Planner

The entire planning process draws heavily on the capacity and demand analyses as an information base for making well-founded judgments. Formulating and assessing alternative solutions also requires a knowledge of the state of current technology, awareness of solutions implemented by other airports and how they are working, lessons learned from other airports' mistakes and successes, and familiarity with operators and regulatory agencies and their standards, procedures, attitudes, and planning policies.

As airports are confronted with increasingly complex social, economic, and technological considerations, airport planners have also expanded their expertise beyond the airport boundary. Planners are involved in assessing social, environmental, and economic impacts related to the airport system; they work closely with community and regulatory agencies.

Although knowledge and experience on a broad base are essential elements of good planning, knowledge and experience of the individual locality are equally important. The ideal planning vehicle is a combination of the two.

Planning represents a small cost when compared with the construction and maintenance costs of the expanded plant. Careful consideration needs to be given to the qualifications of the planning team and its individual members. Because a wide variety of technical disciplines are involved in both the aviation and nonaviation specialities that make up the airport complex, versatility and multidisciplinary talents are required.

Good planning has always been important to orderly development, and it is becoming more critical as more airports approach capacity saturation. People tend to think in terms of 10-year, 20-year, or 30-year forecasts, but the actual life expectancy of an airport can be unlimited. Investment in serious comprehensive planning will produce long-term benefits obtainable through the increased utility and efficiency of a well-balanced system.