

Airport Master Planning

5.1 AIRPORT MASTER PLAN: DEFINITION AND OBJECTIVES

The planner's idealized concept of the form and structure of the ultimate development of the airport is contained in the airport master plan (1, 2, 3). This plan is not simply the physical form of the ultimate development but a description of the staging of development and both the financial implications and the fiscal strategies involved. Master planning applies to the construction of new airports as well as to the significant expansion of existing facilities.

The FAA states that the goal of a master plan is to provide the framework needed to guide future airport development that will cost-effectively satisfy aviation demand while considering potential environmental and socioeconomic impacts. The FAA strongly encourages that planners consider the possible environmental and socioeconomic costs associated with alternative development concepts and the possible means of avoiding, minimizing, or mitigating impacts to sensitive resources at the appropriate level of detail for facilities planning.

Specific objectives of the master plan include (1):

1. Document the issues that the proposed development will address.
2. Justify the proposed development through the technical, economic, and environmental investigation of concepts and alternatives.
3. Provide an effective graphic presentation of the development of the airport and anticipated land uses in the vicinity of the airport.
4. Establish a realistic schedule for the implementation of the development proposed in the plan, particularly the short-term capital improvement program.
5. Propose an achievable financial plan to support the implementation schedule.
6. Provide sufficient project definition and detail for subsequent environmental evaluations that may be required before the project is approved.
7. Present a plan that adequately addresses the issues and satisfies local, state, and federal regulations.
8. Document policies and future aeronautical demand to support municipal or local deliberations on spending, debt, land use controls, and other policies necessary to preserve the integrity of the airport and its surroundings.
9. Set the stage and establish the framework for a continuing planning process. Such a process should monitor key conditions and permit changes in plan recommendations as required.

5.2 HIERARCHY OF PLANNING (1)

In the United States, airport planning is carried out by a multilevel governmental process, where plans are formulated to meet overall transport demand in coordination with other transportation and comprehensive land use planning. These levels are as follows:

- *The National Plan of Integrated Airport Systems (NPIAS)*, a 10-year plan continually updated and published biennially by the FAA. It lists public-use airports and describes the development considered to be in the national interest, making them eligible under the Airport and Airway Improvement Act of 1982 for financial assistance for airport planning and development.
- *Statewide integrated airport systems planning*, which is executed by state aviation planning agencies. This level of planning identifies the general location and characteristics of new airports and the expansion needs of existing airports in furthering statewide aviation goals.
- *Regional/metropolitan integrated airport systems planning*, which identifies and plans for large regional or metropolitan areas. Needs are stated in general terms within the context of statewide system plans.
- *Airport master plans* are prepared for individual facilities. The operators usually require the assistance of consultants for such detailed studies of the long-range development plans of the individual airport within the context of statewide plans.

5.3 ELEMENTS OF AIRPORT MASTER PLAN: FAA

The structure and content of the FAA master plan are closely aligned to the FAA's objective to establish a planning process that is uniform across the United States and is suitable for implementing development of U.S. airports within a coordinated federal funding process. As such, it is at variance with the more heterogeneous approaches of countries which plan according to ICAO guidelines. The FAA specifies a number of elements which are generally to be included in any master planning exercise (1):

1. *Preplanning*. The preplanning process includes:
 - Initial needs determination based on observed or potential deficiencies in the existing plan or airport
 - The manner of calling for requests for proposals and subsequent consultant selection
 - Development of study design, showing a scope of work that includes goals and objectives, data availability, forecast horizons, environmental considerations, schedules, and deliverables; organization of a formal structure of review committees for coordination and public involvement program; adjustment of the scope of work to budgetary requirements
 - Negotiation of consultant contract
 - Application for study funding

2. *Public Involvement.* Once the consultant team is under contract and has been issued a notice to proceed, a public involvement program is established and the key issues of various stakeholders are identified and established, ensuring:
 - Timing of public involvement that ensures that all major decisions are set before the public at an early stage of the planning process before irreversible decisions are made
 - Appropriate public involvement techniques where appropriate: technical advisory and citizens' advisory committees, public information meetings, small-group meetings and briefings, public awareness campaign, and Internet exposure with Web pages
 - Stakeholder identification, including potentially users and tenants, groups and individuals within the sponsor's (airport's) organization, FAA personnel, resource agencies and governmental units with regulatory or review authority, and other interested groups
 - Identification of key issues, broadening those earlier identified in the preplanning stage to include the stakeholders
 - Documentation of the key issues and the operation of the public involvement program itself

3. *Environmental Considerations.* It is necessary that the airport master plan demonstrate a clear understanding of the environmental requirements needed to move forward with each project in the recommended development program. One of the requirements of the Airport and Airway Development Act of 1970 is that environmental factors must be considered both in the site selection process and in the design of the airport. Furthermore, the National Environmental Policy Act of 1969 established the Council of Environmental Quality to develop guidelines for federal agencies affected by the policy law. These requirements are mandated by subsequent FAA orders. A proposed project must be considered not with respect to individual work items but from a broader program context and will be classified into one of three categories (4):
 - Categorical exclusions
 - Actions normally requiring an environmental impact assessment
 - Actions requiring an environmental impact statement (EIS)

Although relatively few airport actions require an EIS, any federal actions regarding proposals with respect to airport development that significantly affect environmental quality must be accompanied by an EIS which will cover the following areas(4):

 - *Purpose and Need for Action.* The problem being addressed, alternatives to resolve the problem, the benefits of federal action, the need for the proposed action, preferences of the applicant and agency, and the parameters for defining a reasonable range of alternatives to be considered.
 - *Alternatives Including Proposed Action.* These must be reasonable, feasible, and meet the project's purpose. Reasonable alternatives not within the agency's jurisdiction should be included.

- *Affected Environment.* The existing environmental conditions of the potentially affected geographic area.
- *Environmental Consequences.* Environmental consequences of the alternatives, including the proposed action, adverse environmental impacts which cannot be avoided, relationship between short-term use of the environment and the maintenance and enhancement of long-term productivity, and the irreversible commitment of resources.
- *Mitigation.* The EIS describes mitigation measures considered or planned to minimize environmental impact.

It is therefore suggested that any airport master plan be evaluated factually in terms of the following potential effects where applicable:

Air quality	Fish, wildlife, and plants	Noise
Coastal resources	Floodplains	Secondary Impacts
Compatible land use	Hazardous materials, pollution prevention, and solid waste	Socioeconomic impacts
Construction impacts	Historical, architectural, archeological, and cultural resources	Water quality
DOT Act	Light emissions and visual impact	Wetlands
Farmlands	Natural resources and energy supply	Wild and scenic rivers

For the full details of the requirements of the EIS for a U.S. airport the reader is referred to Chapter 17 and reference 4.

4. *Existing Conditions.* An inventory of pertinent data for use in subsequent plan elements. The inventory is a large data collection exercise that allows the airport planner to gain complete understanding of the nature and scale of existing facilities. For all potential sites, the planner needs data relating to the following: the physical and environmental characteristics of the site; the presence nearby of any existing airport; the structure of airspace and the status of air traffic management in the area and the availability and location of navigational aids; existing and projected land uses at and in the general affected area of the site; the location of utilities, schools, hospitals, and other public infrastructures; and the legislative constraints related to ordinances, bylaws, zoning, building codes, and so on, which could affect the nature and scope of any projected airport development.

All existing plant at the site is inventoried with respect to condition and remaining useful life. Data will be required on ground access, circulation, and parking. Additionally, historical data on weather conditions need to be gathered because of the weather's effect on airport operations and capacity.

Financial data are necessary for the preparation of a financial plan. Historic and current data should be available from management in the form of aeronautical and nonaeronautical revenues and expenditures as well as the structure of airport indebtedness.

To avoid unnecessary data gathering, existing data, master plans, and regional and local planning studies should be used to provide an information

base. The scope of the data-gathering exercise should be carefully examined as to its potential use in order to avoid collecting unnecessary data.

5. *Aviation Forecasts*. There is a need to develop short-, medium-, and long-term forecasts of aeronautical demand to permit well-conceived planning leading to the ultimate development of the airport site. The discussion of forecasting procedures appearing in Chapter 2 is not repeated here. The planner needs forecasts of passenger volumes as well as movement of aircraft and cargo both at the annual and the peak levels. Knowledge of annual movement is necessary for estimating the magnitude of revenues that will accrue to the facility; peak movement levels determine the scale of facility required to assure a balance of capacity to demand.

The aviation demand elements which need to be forecast for airport master planning purposes may be summarized as follows:

Aircraft operations

Itinerant:	Air carrier, air taxi, commuter, general aviation, military
Local:	General aviation, military

Where appropriate, further forecasting of operations should predict domestic/international splits, annual instrument approaches, IFR versus VFR operations, and helicopters.

Passenger volumes

Total enplanements, air carrier, air taxi, and commuter passengers.

Where appropriate, the passenger forecasting would also include domestic versus international split, general aviation, and helicopter passengers.

Based aircraft

Aircraft mix

Air cargo and mail

For master planning purposes, forecasts are usually prepared in terms of *levels of annual activity* for 5-, 10-, and 20-year horizons. In addition to this, peak load forecasts are made. It is not generally appropriate to design airport facilities to meet the full requirements of short-lived peaks of demand. Some middle ground between supplying for average and peak demands is sought. A commonly used concept in this regard is the “design hour,” which is an estimate of the peak hour of an average day in the peak month. Additional peaking forecasts may be required for special areas in the airport. For example, peak 20-min forecasts are frequently used for designing baggage facilities.

For forecasting purposes, the FAA recommends using estimates of economic growth and changes in industrial activity, demographic patterns, disposable personal income, geographic factors, alternative technology, sociological and political factors, regulatory changes, and historical air traffic data.

6. *Facility Requirements*. At this stage, having determined the levels of future demand, it is possible to assess the ability of the existing airport, both airside

and landside, to support the forecast demand. Furthermore, the planner will identify the demand levels that will trigger the need for facility additions or improvements and will estimate the extent of new facilities that may be required to meet that demand. The requirements for new facilities can be driven by a number of factors:

- Lack of capacity due to increased demand
- Changes in security requirements required by the Transportation Security Administration
- Changes in FAA standards or noncompliance with existing standards
- Changes in the nature of the airport's vision of service provision
- Outdated and unsuitable existing facilities

Future facility requirements can be estimated by simulation of future operations. These should be related to future levels of demand, so that the planner can identify what demand levels trigger the need for expansion or improvement of a particular facility.

Demand–Capacity Analysis

With knowledge of forecast demand for a proposed airport site and with different estimates of staged development beyond existing infrastructure levels, the analyst is able to test a variety of options of development through a demand–capacity analysis. The analysis should be broad and should cover the following areas of operation in sufficient detail to permit preliminary facility sizing. The planner can then compare:

- (a) Forecast aircraft operations vis-à-vis airspace capacity (5)
- (b) Forecast aircraft operations vis-à-vis air traffic control facilities (6, 7)
- (c) Forecast aircraft operations vis-à-vis airfield capacity (8, 9, 11)*
- (d) Forecast passenger movements vis-à-vis passenger terminal capacity (10) (see Chapter 10)
- (e) Forecast cargo volumes vis-à-vis air cargo terminal capacity (see Chapter 11)
- (f) Forecast access traffic vis-à-vis surface access route capacity (12)

The types of new facilities required, their scale, and the staging of their construction are determined as a result of the demand–capacity analysis. These elements are developed according to FAA standards in the United States and according to ICAO or applicable national standards elsewhere. The facilities required and the elements requiring consideration are as follows (1):

- (a) *Runways*. Orientation, length, width, clearances, clear zones, approach slopes, orientation, crosswind runway provision, grades, capacity, staged construction, cost implications of delay to aircraft, pavement design strength and cost effectiveness.

*ADSIM, SIMMOD and RDSIM referenced here are FAA simulation models which are available to the public at reasonable cost. Proprietary simulation models are also available and many planning organizations may choose to use models which they find more suitable for their purposes.

- (b) *Taxiways*. Width, location, clearances, design and location of exits, grades, effect on runway capacity, staged construction, pavement design strength and cost effectiveness.
- (c) *Electronic, Visual, and Satellite Aids to Navigation*. This provision depends on fleet mix, percent of time bad weather is present, and cost to users.
- (d) *Airspace Requirements*. This may require a detailed examination, often using simulation techniques. Major airfield reconfigurations can require significant airspace changes or redesign.
- (e) *Passenger Terminal Complex (12–17)*.
 - Gates and apron frontage: Clearances, grades, aircraft mix, number of aircraft gate positions by aircraft class, aircraft parking clearances, ground servicing equipment space requirements.
 - Passenger terminal building: Public areas required for major functions such as baggage claim, check-in, government controls etc;airline and administration offices, maintenance and mechanical services; commercial space for shops and services.
 - Curbfronts: These are a function of the modal splits used by arriving and departing passengers and the needs of service vehicles
- (f) *General Aviation Requirements*. These include a wide variety of users: business aircraft, light cargo, recreation, law enforcement, flight training, agriculture, and fixed base operators. They require aircraft storage areas and buildings for the based aircraft, transient aircraft parking areas, and terminal facilities. The terminal facilities can range from simple one-room structures to extensive terminals with many amenities for the business traveler.
- (g) *Air Cargo*. For commercial service airports and large general aviation airports, cargo operations can be very diverse. They include the following:
 - Belly freight carriers: passenger aircraft, using some of the belly space for containerized freight
 - Combination carriers: passenger aircraft with a reconfigured cabin, using some of the main deck for containerized freight
 - All cargo carriers: sell space to freight forwarders or companies and carry freight between airports
 - Integrated carriers: door-to-door services using their own aircraft and trucks, often requiring their own freight terminal
 - Freight forwarders: arrangers of transport which includes ground transport at either end of the flight and customs clearance where necessary. The air transport leg is arranged but not carried by the forwarder.
- (h) *Support Facilities*. The future requirements of the following support facilities should be examined: aircraft rescue and firefighting, airport maintenance, fuel storage, aircraft maintenance and deicing.
- (i) *Ground Access*
 - Regional transportation network: Only at the largest airports, the demand on the regional network must be examined and the impact of increased air transport demand evaluated.

On-airport circulation roadways: The added demand from passengers and their meters and senders, employees, delivery vehicles, and others will be diverse in destinations and timing of peaks.

Users of the roadway facilities requiring consideration are passengers, passenger meeters and senders, taxis, limousines, courtesy vans and buses, local buses, regional buses and coaches, rental cars, and charter bus operations.

Parking must be supplied for passengers, meeters and senders, employees, visitors, and delivery vehicles.

- (j) *Utilities*. The master plan will address the future requirements for water, sanitary sewage, stormwater drainage, deicing run-off, industrial waste, communications, natural gas, and electric power supply.
 - (k) *Other Requirements*. At many airports there are extensive areas and some developments that are nonaeronautical in character. Some are considered temporary until the land is needed for aeronautical purposes; others have been developed along with the airport. Agricultural land is an example of the first type; the newly developing airport cities covered in Chapter 16 are examples of the second. At this stage the planner needs to review the future spatial and infrastructure needs of these areas.
7. *Alternative Development and Evaluation*. Options are identified to meet projected facility requirements and to provide alternative configurations for each major component. In an elaborate three-stage process recommended by the FAA, the expected performance of each alternative is assessed against a wide range of evaluation criteria, including its operational, environmental, and financial impacts, plus consideration of best planning practice. Qualitative and quantitative measures are used. The recommended development alternative which emerges from this process is developed in the airport layout plan. The FAA-recommended procedure for alternative development and evaluation is too detailed for reproduction here but is fully documented in reference 1.
8. *Airport Layout Plan Drawing Set*. One of the key products of a master plan is a set of drawings that provides a graphic representation of the long-term development plan for an airport. The primary drawing in this set is the airport layout plan. Other drawings may also be included, depending on the size and complexity of the individual airport.

The full set of recommended drawings comprises:

- Cover sheet
- Airport layout plan
- Data sheet
- Facilities layout plan
- Terminal area plan
- Airport airspace drawing
- Inner portion of approach space drawing
- On-airport land use drawing
- Off-airport land use drawing
- Airport property map
- Runway departure surface drawing

Utility drawing

Airport access plan

Other necessary plans that are specific to the airport

9. *Facilities Implementation Plan*. This section of the master plan provides a summary description of the recommended improvements and associated costs. The actual timing of improvements depends, in large part, on the levels of demand that trigger the need for expansion of existing facilities. However, based on the output of the demand/capacity analysis, a capital improvement program can be produced that identifies expenditure and the most likely time that these will be incurred. Table 5.1 shows an example of a simple capital improvement program for the three-stage expansion of an existing facility. The scheduling of the various elements of facilities implementation is usually in the form of a time- and activity-based Gantt chart.
10. *Financial Feasibility Analysis*. The financial plan for the airport describes how the sponsor will finance the projects recommended in the master plan and demonstrates the financial feasibility of the program.

Financial Feasibility. A financial analysis must be made of the forms of capital available for carrying out the development. In the United States, these include general obligation bonds, revenue bonds, private finance, financing from specially formed non-profit corporations, industrial development authority bonds, federal grants, state and municipal grants, and retained revenues:

General obligation bonds, backed by the full faith and credit of the municipality, have been the most common funding mechanism. They bear relatively low interest rates.

Revenue bonds are backed by the revenues generated by the facility being financed. Generally, they have interest rates 1–1.5% higher than general obligation bonds. They can be used only where facilities generate a sufficient operating surplus.

Special facility revenue bonds are normally issued by the airport for the construction of a facility for a third party, backed by the revenues generated by the facility.

Industrial development bonds can be issued by states, local governments, or airports to fund construction of a facility to increase nonaeronautical revenues.

Third-party or Private financing can be arranged for facilities such as hangars, hotels, and fuel distribution systems. The availability of such financing depends on developing sufficient revenue to pay off the indebtedness. Usually available from banks, private financing is a typical arrangement for constructing facilities on land leased from the airport by a third party. The airport is, in this way, relieved of the responsibility of raising the necessary capital.

Nonprofit corporation bonds are backed by special-use taxes. In some instances, nonprofit corporations have been formed to finance improvements, with these improvements reverting to the municipality on the retirement of the bonds. Interest rates are usually lower than for revenue bonds. The method has been used for financing maintenance hangars and air cargo facilities.

Table 5.1 Outline of ICAO Master Planning Process

Planning Step	Description
Preplanning considerations	Coordination, planning procedure, planning organization, goals, and policy objectives
Forecasting for planning purposes	Requirements, forecasts required, accuracy, methods and principles of forecasting, factors, presentation of forecasts
Financial arrangements and controls	Capital costs: currency requirements, source of funds, domestic and foreign financing; operational costs: sources of income; financial control and accounting
Site evaluation and selection	Land required, location of potential sites, factors affecting airport location, preliminary study of possible sites, site inspection; operational, social, and cost considerations; environmental study; review of potential sites; outline plans and estimates of costs and revenues; final evaluation
Runways and taxiways	Dimensions, strength; aircraft characteristics, performance, and runway length; configuration; airfield capacity
Aprons	Layout of aprons, size of stands, parking, service, and hangar aprons, holding bays, security, apron accommodations
Air and ground navigational and traffic control aids	Visual aids, radio navigation aids and their buildings, demarcation of critical areas, air traffic services, search and rescue services, apron control, communications
Passenger building	Planning principles, airport traffic and service characteristics, factors affecting scale of services to be supplied, capacity and demand Connection of passenger building to access system, passenger and baggage processing, waiting areas, governmental frontier controls, airside linkages, apron passenger vehicles, transit and transfer passengers, passenger amenities and other passenger building services
Cargo facilities	Siting, building function and type, apron, facility requirements, access, parking, inspection, and control
Ground transport and internal airport vehicle circulation and parking	Private and public transport modes, traffic data, internal roadway circulation, curbside, vehicle parking
Airport operations and support facilities	Administration and maintenance, medical center, ground vehicle fuel stations, generating stations, water supply and sanitation, flight catering, kitchens, meteorological services, aircrew briefing and reporting, aircraft maintenance, rescue and firefighting, general aviation facilities, police, hotels
Aircraft fuel facilities	Safety, implications for gate occupancy times, movements of large and heavy vehicles, storage capacity, fuel storage location, aircraft fueling systems
Security	Airside security: roads, fencing, isolated parking position, security parking area, emergency explosive holding area Landside security: passenger buildings, public storage lockers

Federal grants are available to public-use airports included in the NPIAS. Such grants are partially awarded on a traffic share basis and partly at the discretion of the FAA. The funds are limited to specific types of improvements. Not all forms of improvements are eligible for federal grants.

State grants are awarded on a discretionary basis, usually through the state Department of Transportation.

Retained revenues—Some of the financing for improvements comes directly from the airport's own retained earnings from revenue-generating activities such as:

- *Passenger facility charges* paid by the passengers through the airlines. There are strict FAA limitations on what can be funded from these charges: safety, security, congestion reduction, noise mitigation air quality improvement enhanced competition, and so on.
- *Customer facility charges* are fees paid by airport customers for facilities that provide nonaeronautical services on the airport.

For further discussion of the financing of airports both within the U.S. system and in developed and developing nations, the reader is referred to reference 17.

Economic Feasibility. The FAA requires that, when possible, airports should carry out benefit–cost analyses (BCAs) as part of the master planning process. A formal BCA should be written for projects that enhance the capacity of the airport and exceed \$5 million in AIP funds. Guidelines for such an analysis according to FAA requirements are contained in reference 18.

An FAA-approved Airport Layout Plan Update (ALU) may be considered satisfactory for airport development purposes, where a full master plan incorporating steps 1–10 above is considered more than is necessary. The ALU must be considered as a substitute for a master plan only for small changes in airport planning.

Figure 5.1 shows a typical structure for the preparation of the master plan in diagrammatic form.

5.4 ICAO GUIDELINES FOR STRUCTURE OF MASTER PLAN

A planner operating outside the United States is likely to use the ICAO manual procedures or national procedures based on the ICAO manual (10, 11). In general terms, the ICAO procedure is very similar to that recommended by the FAA.*

However, since member countries of the organization range from highly industrialized states to quite undeveloped nations, the procedures outlined are less specific with respect to the form of the master plan, the methods of analyzing problems of environmental impact, and the manner in which economic analysis is to be carried out.

The ICAO manual states that the airport master plan is a guide for:

- Development of physical facilities of the airport
- Development of land uses for areas surrounding the airport
- Determination of environmental effects of aerodrome construction and operation
- Establishment of airport access requirements

In addition, the plan can be used to provide guidance on policy and decisions in both the long and short term, to identify potential problems and opportunities, to assist in securing financial aid, to serve as a basis for negotiations between the airport authority and its tenants, and to generate local interest and support. The manual identifies a

*It is interesting to note that the preface to the ICAO manual states that the material contained in the document does not necessarily reflect the views of the ICAO.

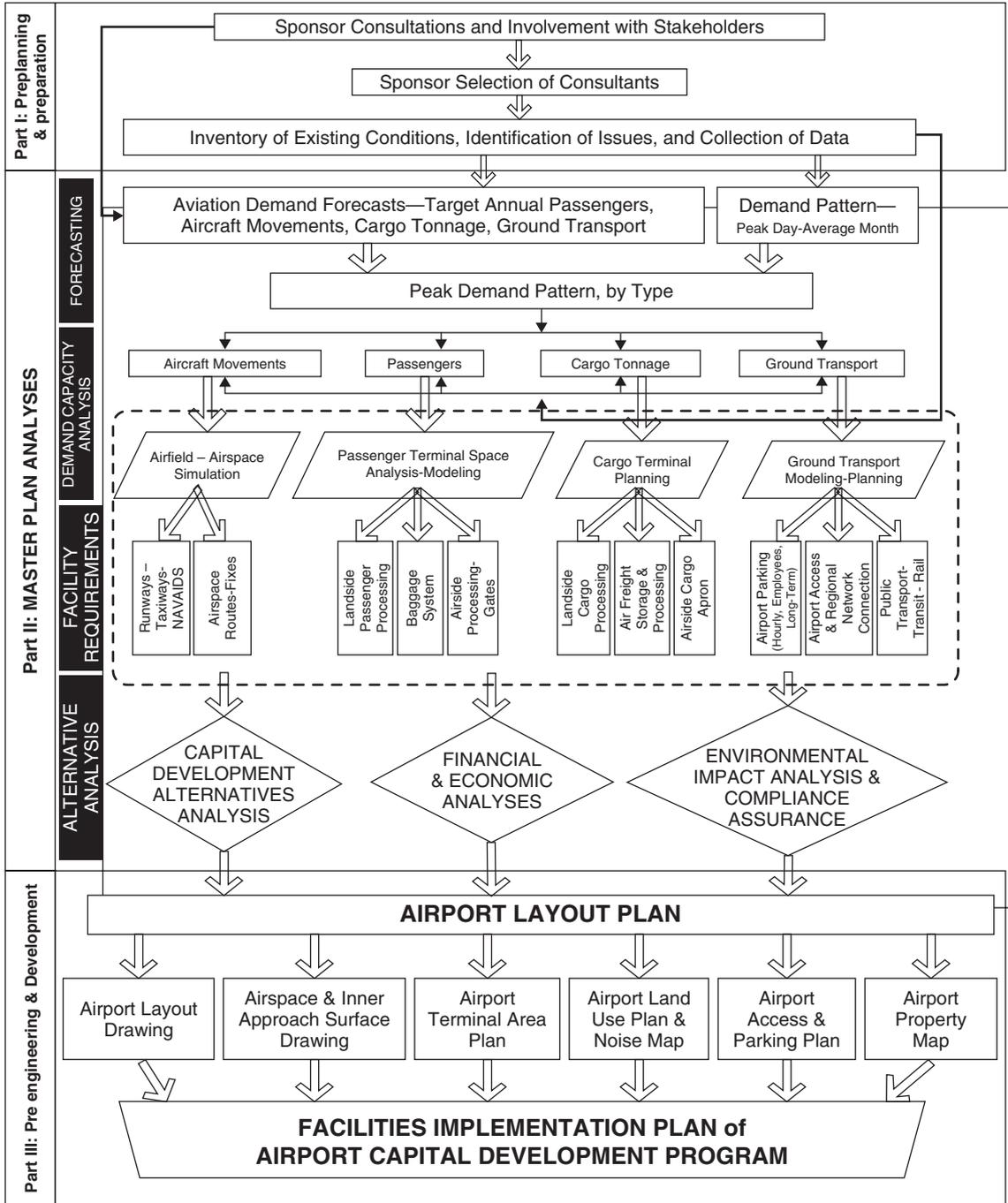


Figure 5.1 Master plan preparation process.

number of areas that will be included in any master planning activity. These are policy and coordinative planning, economic planning, physical planning, environmental planning, and financial planning. The master planning process itself is made up a number of defined steps:

1. Prepare a master work plan.
2. Inventory and document existing conditions.
3. Forecast future air traffic demand.
4. Determine scale and time phasing of facilities.
5. Evaluate existing and potential constraints.
6. Determine the relative importance of constraints and other considerations.
7. Develop a number of master plan options.
8. Evaluate and screen all plan options.
9. Select the most acceptable and appropriate option, refining and modifying it in response to the evaluation process.
10. Prepare master plan documents in final form.

The ICAO manual states that the master plan is no more than a guideline that must later be developed into a more detailed implementation program. Table 5.1 outlines the ICAO master planning process.

5.5 AIRPORT LAYOUT DESIGN

There are no firm rules which can be stated for determining airport layout. The procedure is a design exercise in which compromises in one area must be weighed against advantages gained in others. The design for each airport layout is site specific, and whereas general concepts can be moved between sites, the individual aspects of each site will almost certainly result in slightly different layouts. The layout of an airport is dependent upon a number of factors, of which the most important are:

1. Number and orientation of runways
2. Number of taxiways
3. Size and shape of aprons
4. Area and shape of available land
5. Topography and site soil conditions
6. Obstacles to air navigation
7. Required proximity of land uses within the airport boundary
8. Surrounding land uses
9. Timing and scale of phased development of the airport
10. Meteorology
11. Size and scale of airport facilities being planned

In preparing a layout plan, it is normal to examine a number of potential layouts and to select the best option from competitive solutions. This best solution is further refined by developing and selecting from suboptions.

The principal facilities to be considered in an airport plan include:

- Runways
- Taxiways
- Passenger terminals and aprons
- Cargo terminals and aprons
- Rescue and firefighting services
- Air traffic control tower
- Aircraft maintenance
- Long-term and short-term parking
- Access roads
- Rail and public transport access
- Airport maintenance, snow clearance, engineering base
- Nav aids
- Lighting
- Flight kitchens
- Fuel farm
- General aviation terminal and apron
- Sewage treatment and pumping stations
- Electrical substations
- Security fences and control gates
- Hotels
- Industrial uses

For a more detailed description of the content of the airport layout plan, the reader is referred to Appendix F of reference 1.

Figure 5.2 shows three schematic layouts of an airport with two runways of orientation 18-36 and 13-31. The *closed-V* layout is reasonably compact in its overall space requirements, has reasonable taxiing distances, and provides reasonable space for expansion of the terminal area between the two runways. On the other hand, the *crossed-runway* layout, while providing short taxiing distances and a compact overall site, squeezes the terminal into a site which offers little opportunity for expansion. The *extended-V* layout provides ample flexibility in the design of the terminal area but at the expense of a large overall land requirement and poor operational efficiency on the airside.

At large airports which are used by large transport aircraft, there is a need for parallel runways to accommodate the high volumes of air transport movements. As indicated in Chapter 3, the spatial needs of the extensive passenger terminals and the associated aprons require much greater runway separation than the minima required for IFR parallel approaches.

5.6 DATA REQUIREMENTS FOR MASTER PLANNING

Notwithstanding the method used, all master plans must be founded on assumptions and forecasts built from an extensive and valid database. The collection and validation of data are therefore important and time-consuming elements of the master