Airport Planning and Terminal Design

presented by

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Outline

✈ An overview of Airport Master Planning based on ICAO planning guidelines
✈ What an airport master plan entail
✈ Emphasis on concepts and considerations from the executives’ perspective
Definition of Airport Master Plan

- Concept of the ultimate development of a specific airport, graphically presented with written report to effectively convey the research and logic from which the plan was evolved (ICAO Manual)
- Long-term development concept of an airport; an embodiment of the airport’s strategic framework and concept depicted graphically and documents the data and logic upon which the plan is based
- Guidelines for future airport development to satisfy aviation demands in a financially feasible manner, while addressing aviation, environmental and socioeconomic issues in the local community

Airport Master Plan

- Airport Master Plan serves as a guide for:
  - Establishing short and long range policy/decision
  - Developing physical facilities of an airport – aviation and non-aviation
  - Developing land uses surrounding airport
  - Determining environmental effects of airport construction and operation
  - Establishing access requirements of the airport
  - Identifying potential problems as well as opportunities
  - Securing financial aid
  - Establishing basis for negotiations of interests and needs among aerodrome authority, businesses and community
Stakeholders of Airport Master Plan

- Airports are multi-faceted facilities, impacting a wide spectrum of people and businesses
- Need for consultation and coordination of planning with stakeholders concerned:
  - Airlines
  - National and local government planners
  - Government control authorities (immigration, customs, health)
  - National and local transport authorities
  - Aircraft and equipment manufacturers
  - International aviation agencies and businesses
  - Concessionaires
  - Local business and residential communities
A good Airport Master Plan represents the most efficient framework with flexibility, expandability and optimum balance of all individual airport facilities/services to provide the required capacity for aircraft, pax, cargo and vehicular movements with max facilitation for pax, operator and staff at lowest capital and operating costs and max revenue.

Generates higher capacity and efficiency through a series of compromises than would otherwise be attained without reconciliation of individual facilities plans.

IN ALL CASES, COMPROMISES DO NOT AFFECT SAFETY
Airport Master Planning Process

- Involves preparation of broad and specific policies, plans and programs
- Goals of Planning process to:
  - Orderly and timely develop airport to meet present and future air transportation needs
  - Coordinate local, regional and national plans
  - Protect and enhance environment (noise, pollution)
  - Establish effective airport organisation for implementation
  - Ensure compatibility with state/country aviation, ICAO and IATA standards

Airport Master Planning Process

- Coordinate national and regional airport systems
- Coordinate plans for nav. facilities, airspace and air traffic control procedures
- Optimize use of land and airspace resources
- Policy/Coordinative Planning
  - Project goals, objectives
  - Develop work programmes, schedules and budgets
  - Prepare and evaluation and decision format
  - Establish coordination and monitoring procedures
  - Establish data management and public information system
Airport Master Planning Process

**Economic Planning**
- Prepare analysis of aviation market characteristics and forecasts of aviation activity
- Determine representative benefits and costs associated with airport development alternatives
- Prepare an assessment of impact on area economy of various alternatives

**Physical Planning**
- Airspace and air traffic control provisions
- Airfield configuration (including approach zones)
- Terminal complex
- Circulation, utility and communications networks
- Support and service facilities
- Ground access systems
- Over-all land use patterns
Airport Master Planning Process

Environmental Planning

- Prepare an assessment of natural environmental conditions associated with the airport “impact” area (plant and animal life, climate, topography and natural resources, etc)
- Document present and projected development patterns of relevance to the impact area
- Determine community attitudes and opinions

Financial Planning

- Determine airport funding source and constraints
- Prepare a financial feasibility study of various airport development alternatives
- Prepare preliminary financial plans and programmes for the finally agreed upon concept
Airports Master Planning Process

- Reviews
  - Annually and adjust plans according to prevailing conditions
  - Thorough evaluation and modification every five yearly or more often if changes in economic, operational and environmental and financial conditions dictates

Steps in Planning Process

- Prepare work program and identify responsibilities
- Inventory and document existing conditions
- Forecast future air traffic demand
- Determine facility requirements and preliminary time-phased development
- Evaluate existing and potential constraints
- Prioritize considerations (constraints, airport type)
- Develop concepts
- Assess operational, financial and environmental impact of concepts (reiterations)
- Select most acceptable and appropriate alternatives, modify and finalize
**Air Traffic Forecasts**

Forecasts parameters
- Annual pax, cargo, mail throughput (int'l/dom; scheduled/ non-scheduled; arrival/departure, transit/transhipment)
- Typical peak hour aircraft movements and pax, cargo, mail throughput (arrivals/departure/combined)
- Average day of peak month aircraft movements and pax, cargo, mail throughput
- No. of airlines, fleet mix, load factors, route structures
- No. of base aircraft (scheduled/non-scheduled/GA)
- No. of visitors and airport workers

**Forecast Relationship vs Master Plan**

- Objectives of airport
  - Revise objectives if nec.
  - Airport master plan → Traffic forecasts
  - Capital and recurrent Cost → Facility requirement
  - Navigation aids, Runway, Taxiway, apron, Terminal, access system → Comparison of results with Objectives (and Cost/benefit analysis)
  - Income evaluation
  - Revise plan if nec.
**Forecasts Techniques**

- **Informed judgement**
  - Depends on experience and credibility of forecaster, subjective, immediate term

- **Trend extrapolation**
  - Assumes all past factors influencing aviation traffic demand will continue to operate with same impact in future, best fit curve, short term

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**Forecasts Techniques**

- Linear projection: $Y = aT + b$
- Parabolic projection: $Y = a + bT + cT^2$
- Exponential projection: $Y = a(1+b)^T$
- Gomperts projection: $Y = ab^{cT}$
Econometric modelling
- Based on derived quantitative relationship between traffic and important underlying factors affecting traffic
- A few quantifiable major factors influencing air transport demand can explain most of traffic demand variation
- Real economic growth, real air fares, real energy prices, tourism growth and consumer demographics deemed to be most important factors impacting aviation growth
- Relatively effective for short and medium term forecasts

Market survey (Cross Classification Method)
- Obtains primary data from source of airport demand
- Surveys covering extensive user network to eliminate bias, expensive and needs proper structuring
- Assumes stable relationship between travel pattern and socioeconomic characteristics
Forecasts Factors to Consider

- **Economics**
  - GNP, GDP
  - Income distribution
  - Import/export levels
  - Local economic activities

- **Trip Purpose**
  - Business
  - Leisure
  - Personal

- **Geographical Attributes**
  - Distances between towns
  - Physical and local attractions

- **Demographic Pattern**
  - Population
  - Age
  - Education level, occupation

- **Transportation system**
  - Competing modes (fares, service, freq, timing)
  - Airport ground access

- **Other External Factors**
  - New traffic rights/routes
  - Government taxes + fees

Source: FAA, Various national statistics providers, Booz Allen Hamilton analysis
Airport Master Plan Objective

- Developing an airport plan with a layout that yields optimum airport capacity within available land to meet future demand and international operating standards.
- Delay and processing times associated with different facilities and components in the master plan impact capacity.

Factors that affects capacity include:
- Airfield configuration (runway, taxiway, gates/parking positions)
- Operating environment
- Navaids and ATC facilities (availability of navaids, airspace, arrival and departure routes, extent of ATC facilities approach/departure control tower)
Airfield Configuration

- Runway Configuration
  - Orientation
  - Number of runways
- Taxiway Layout
- Terminal / Apron Area
- Aircraft Parking Configuration
- Cargo Terminal

Airfield Configuration Concept

Runways

- No. of runways depends on volume of aircraft movements
- Orientation of runway depends on direction of prevailing winds
- Runway length is influenced by temperature, runway slope, airport altitude, MTOW, runway pavement condition, visibility
- Airspace around airport should remain free of obstacles to permit safe aircraft operations
Runway Orientation

✈ Aircraft are not directed over populated areas and avoid obstructions
✈ Oriented in the direction of the prevailing wind and cross wind is not too excessive

<table>
<thead>
<tr>
<th>Reference field length</th>
<th>Allowable crosswind components</th>
</tr>
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<tbody>
<tr>
<td>&gt; 1500 m</td>
<td>20 knots</td>
</tr>
<tr>
<td>1200 – 1499 m</td>
<td>13 knots</td>
</tr>
<tr>
<td>&lt; 1200 m</td>
<td>10 knots</td>
</tr>
</tbody>
</table>

Runway Orientation

✈ Annex 14 specifies that runways should be oriented so aircraft may be able to land at least 95% of the time with cross wind components
✈ Good visibility
Runway Configuration

Achieve safe aircraft operations, ensure:-
- Adequate separation between air traffic streams
- Obstacle clearance
- Crosswind provision

Ensure least interference and delay to operations
Avoid noise and sensitive areas

<table>
<thead>
<tr>
<th>Single runway</th>
<th>215 – 761m</th>
<th>&gt; 1311m</th>
</tr>
</thead>
<tbody>
<tr>
<td>VFR</td>
<td>51-98</td>
<td>94-197</td>
</tr>
<tr>
<td>IFR</td>
<td>50-59</td>
<td>55-60</td>
</tr>
</tbody>
</table>

Runway Configuration

<table>
<thead>
<tr>
<th>Cross runways</th>
<th>Hourly capacity (ops/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VFR</td>
<td>72-98</td>
</tr>
<tr>
<td>IFR</td>
<td>56-60</td>
</tr>
</tbody>
</table>
Runway Configuration

- Single runway
  - preferable to locate terminal equi-distance to runway ends or shift it if there is predominant direction of operations

- 2-parallel runways (single orientation)
  - Optimum capacity and best air traffic control efficiency
  - Mid-field terminal between runways preferred
  - Terminal on one side of runways lead to longer taxiing distances and runway crossing problems
  - Runways may be staggered

- Runways with 2 alignments
  - Open configuration preferred with diverging operations used whenever possible
  - If intersecting configuration is unavoidable and there is predominant direction in aircraft operations, runways should have a rear intersection for that direction
  - Centrally located terminal to minimize taxi distance
### Airfield Configuration

- Taxiways to be arranged to minimize interference between landing aircraft and aircraft taxiing to takeoff
- Parallel taxiways increase runway capacity
- Shortest taxi distance from passenger terminal apron to runway ends

### Taxiway Layout Guidelines

- Efficient connection between runways and terminal / service areas
- Avoid conflicts between aircraft operations
  - Arriving and departing taxi routes
  - Holding passes and bypasses
- Avoid crossing of active taxiways over active runways
- Minimize runway occupancy time of arriving aircraft (e.g., strategically located rapid exit taxiways enable landing aircraft to leave runway quickly for other aircraft)
Taxiway Layout Guidelines

- Terminal/Apron location
  - Minimum taxiing distance to and from runways
  - Avoid locations under aircraft approach or departure paths
Typical Airport Configuration

Diagram showing typical airport configuration with runways and terminal areas labeled (a), (b), and (c).
Airfield Configuration

- Account for the safety procedures of aircraft manoeuvring on the apron
- Allow efficient aircraft movements and dispensing apron services
- Flexible to accommodate different size of aircraft types and future expansion needs

Parking Configuration

c) Taxi-in/land-out (parallel parking)
d) Taxi-in/push-out
Parking Configuration

- Taxi-in-taxi-out
  - angled nose-in parking

- Taxi-in-taxi-out
  - angled nose-out parking

Airport Site Selection

- Determine purpose for which airport is required
- Consider forecast future demands (operational and economic) and quantity and type of traffic
- Define type of airport and operational systems for forecast traffic
- Major steps to consider
  - Selection of site that provides adequate space and size and suitable locations to serve the residents and commerce
  - Evaluation of feasibility of possible locations through the forecast period from economic, geographic, engineering and aeronautical standpoints
Airport Site Selection

Factors influencing airport size:-
- Performance characteristics and size of aircraft
- Anticipated volume and character of traffic
- Meteorological conditions like wind and temperature
- Elevation of airport site

Factors influencing airport location:-
- Type and development of surrounding area
- Atmospheric and meteorological conditions (Fog, Haze, turbulence, heavy rainfall)
- Accessibility to ground transport (existing highway)
- Availability of land for expansion

Factors influencing airport location (con’t):-
- Presence of other airports and availability of airspace
- Traffic flow patterns of airports (restricted airspace)
- Surrounding obstructions (around airports particularly for approach and departure paths, obstacle limitation surfaces)
- Economy of construction
- Availability of utilities (electricity, fuel, water supply etc)
- Proximity to aeronautical demand
Environmental Studies

- Noise Pollution
  - Proper planning of land use for areas surrounding airport
- Air Pollution
  - Aircraft engine, exhaust, fuel venting, auxiliary paves unit, fuel storage and ground service tanks, motor vehicles, construction operations
- Water Pollution
  - Sanitary wastes, storm water, maintenance wastes and industrial wastes
  - Waste water may be treated before discharging, removing split oil by containment and spill recovery (absorbent etc)

Environmental Studies

- Archaeological considerations
- Seismic considerations
- Inclement weather
Financial Plan

- Economics and Financial Feasibility
- Economic and financials models of alternative master plans (iterative process)
- Master Plan should be targeted to generate sufficient revenues to cover annual costs of capital, traffic, operations and maintenance expenses
- Cost benefit analysis
Changi Airport Terminal 3 completion - 2007

Changi Airfreight Centre Master Plan (2003)
Heathrow Airport (Interim Master Plan Alt)

Thailand International Airport

SUVARNABHUMI AIRPORT (BKK)
Useful Reading Material

- Airport Planning Manual (Doc 9184), Part 1, Master Planning by ICAO
- IATA Master Planning Manual
- Airport Engineering by Norman Ashford
- FAA Airport Master Plan
- FAA Airports designs