香港城市大學
City University of Hong Kong

396EM Airline Operations and Scheduling/ 6075MAA Airline Scheduling and Operations

Lecture 1a
Module Introduction

Developed & Revised :
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Module summary

- Enable students to understand, analyse and improve airline operations and planning related to the airline dynamic environment.
- Adopts a practical approach to outline the functions, processes and relationships of airline operations.
- Various factors that affect the operations and management of international and regional airlines.
- Introduces both simulation and analytical techniques and/or methods relevant for optimising airline network flow and scheduling, route structure and planning, fleet planning and assignment, crew scheduling, maintenance scheduling, gate assignment and aircraft load planning.
- Students will be able to identify/evaluate airline operation and planning problems and solve these problems using operational research techniques (both deterministic and probabilistic).

Intended Module Learning outcomes

- Critically evaluate the key issues of operations and scheduling within airlines and appraise the various factors that affect the operations and management of international and regional airlines, as well as the functions, processes and relationships of airline operations and planning.

- Deploy accurately existing techniques of simulation and operational research analytical methods to model and solve a range of situations for airline operations such as airline fleet planning, flight scheduling, aircraft routing and gate assignment, to propose suitable solutions for airline business decision, and to critically appraise the best course of action for any operational problem that might be faced in the airline environment.

- Predict and manage any irregularities and disruption that might happen during any airline operations. This includes applying the knowledge of decision making process under uncertainty concept.

Assessment methods

This is a course-work only module with 2 equal weighted coursework

	Type	Weight
Coursework 1	Analytical Applications	50%
Coursework 2	Simulation	50%

Submission: Week 5-10

Pass requirements:

Individual Coursework must be at least 40% and Module Mark must be at least 40%

Tentative Teaching Plan

Subject to changes

Week	Topics	Workshops / Notes
1	▪ Introduction to Airline Operations and Scheduling ▪ Linear Programming	• Tools and Data • Linear Programming Exercises
2 3 4	Planning Optimization ▪ Airline Network Flows and Integer Linear Programming ▪ Flight Scheduling ▪ Fleet Assignment (Part I) ▪ Fleet Assignment (Part II) ▪ Aircraft Routing & Airline Network ▪ Airline Irregular Operations	• Solving Linear Programming with different software • Integer programming • Shortest Path Problem • Fleet Assignment • Coursework 1 Support and Discussion
5 6 7	Simulation ▪ Simulation Concepts ▪ Queuing Simulation Models ▪ Operations Visual Modelling Languages ▪ Simulation Approach ▪ Data collection for simulation ▪ Modelling simulation prototypes ▪ Simulation Steps and Experimental Design	• Solving simple queuing problem • Building SIMUL8 model • Coursework 1/2 Support and Discussion
8	Planning Optimization ▪ Crew Planning & Manpower Planning ▪ Revenue and Fuel Management ▪ Gate Assignment Module Reflection Session	Techniques and software Reflection

Brief Introduction
&
Module Outline

Introduction: Brief History of Air Transport

- 52 states signed at Chicago Convention (1944) regarding civil aviation rules and created ICAO (International Civil Aviation Organization) **Link**
- 1970s – no new airline created and air fares approved by CAB (Civil Aeronautics Board) in USA are disputed.
- The Airline Deregulation Act (1978) is a United States federal law intended to remove government control over fares, routes and market entry (of new airlines) from commercial aviation. (=> free market)
- Apart from lifting the veil, it also encourages healthy competition between aviation corporations.
- After deregulation, the competition was not only between the pre-deregulation airlines, but also from the new entrants.
- Airlines were no longer protected, and if they wanted to be profitable, they had to manage their operations more efficiently.

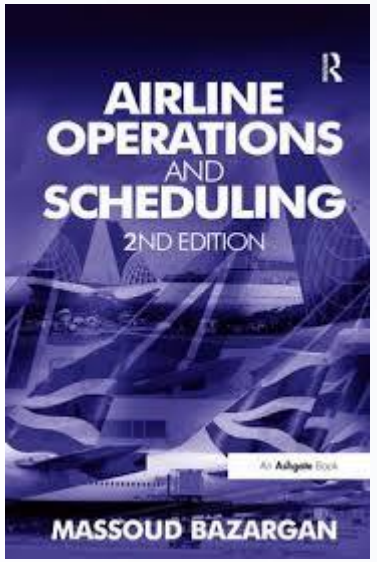
Operations Research and Airlines

- Operations Research, or Operational Research (UK)
- Some call Management Science (OR/MS)
- The principle is to use mathematical/ analytical methods to make sensible and “close to realistic” assumptions/decisions
- To be competitive in global air transport market, Airlines have been using operations research techniques since the 1950s
- Advanced computer technology and optimization models have enabled airlines to tackle more complex problems and solve them in a much shorter span of time

Module Outline

Introduction & Linear Programming

- Module Textbook (US)
- Review on Linear Programming



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Airline Network Flows and Integer Programming Models

- The basic concepts of network flow
- Integer programming models
- Use Excel Solver to find the optimisation solutions

Module Outline (Con't)

Flight Scheduling

- Route Development
- Flight Scheduling Process
- Airline Network (Hub-and-Spoke)
- Load Factor and Frequency

Fleet assignment

- Basic airline fleet assignment model
- Matching air traffic demand with different aircrafts with their seat capacity, landing weight, crew and fuel costs

Module Outline (Con't)

Aircraft Routing

- The process of assigning individual aircraft to fly each flight segment assigned to the fleet

Crew Planning

- Crew pairing
  - Determine which flight segments should be paired
- Crew rostering
  - How the pairings are assigned to the crew incorporating various rules and regulations

Module Outline (Con't)

Manpower planning

- Discuss the manpower planning for ground crew through case study

Revenue Management

- Probabilistic Models

Revenue Management - Finnair
https://www.youtube.com/watch?v=x1LGCBPyAao

Dr. Bill Brunger shares information on ticket pricing and revenue management within the aviation industry
http://www.youtube.com/watch?v=FlWrp2Wqm38

Module Outline (Con't)

Fuel Management System

- Jet fuel costs,
- hedging strategies,
- maths model for fuel tankering

Cathay Pacific expected to post a profit rise despite hedging loss

Airline makes wrong-way bets on price of aviation fuel as cost of crude oil plunges

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Fuel surcharges on flights from Hong Kong were scrapped in February 2016. Photo: Jonathan Wong from last monthMedia tour of Cathay Pacific's 777-300ER Aircraft introducing Cathay Pacific's new livery, at Hong Kong International Airport. 01NOV15

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Cathay Pacific Airways, reporting full-year results on Wednesday, is expected to post a profit increase that is mostly thanks to fuel savings, though its loss from fuel hedging could be bigger.

The group, in a poll of 19 analysts by Bloomberg, is expected to post net profit of HK$5.5 billion for last year, up 75 per cent from HK$3.15 billion in 2014. Their estimates for revenue average at HK$104.5 billion, a slight decrease from HK$105.99 billion a year ago.

Cathay: Oil Hedging

Module Outline (Con't)

Airline irregular operations

- Airline cannot fly their published flight schedules aroused by lack of resources or disruptions
- Include delays, and cancellations
- The irregular operation maths model

Gate Assignment

- Gate assignment principles
- Maths model of gate assignment

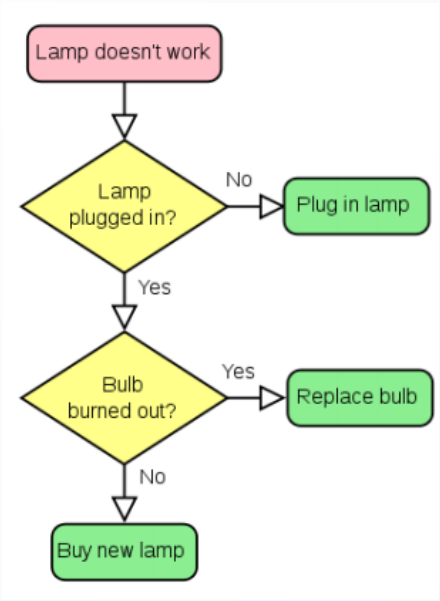
Module Outline (Con't)

Queue in Airline Systems

- Queue Definition
  - Why We Simulate Queues
  - Outcome of Simulated Queues
  - How to Reduce Queues

Modelling of logic system

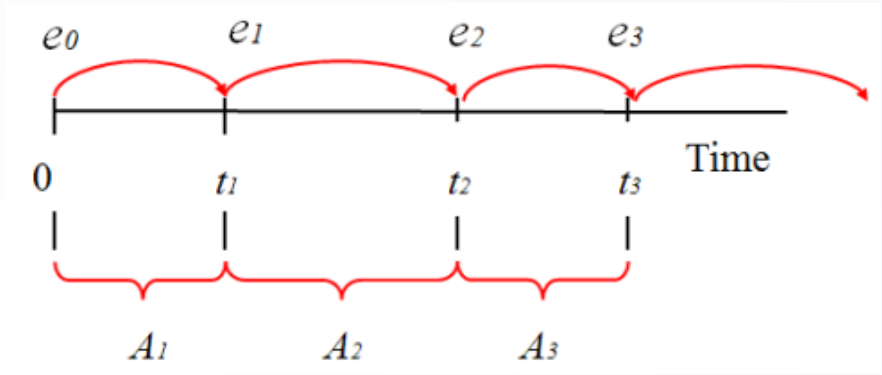
- Flowchart Definition
- Why We Use Flowcharts
- Flowchart Field of Applications
- Types of Flowcharts
- Flowcharts Building Blocks
- Visual Example



Module Outline (Con't)

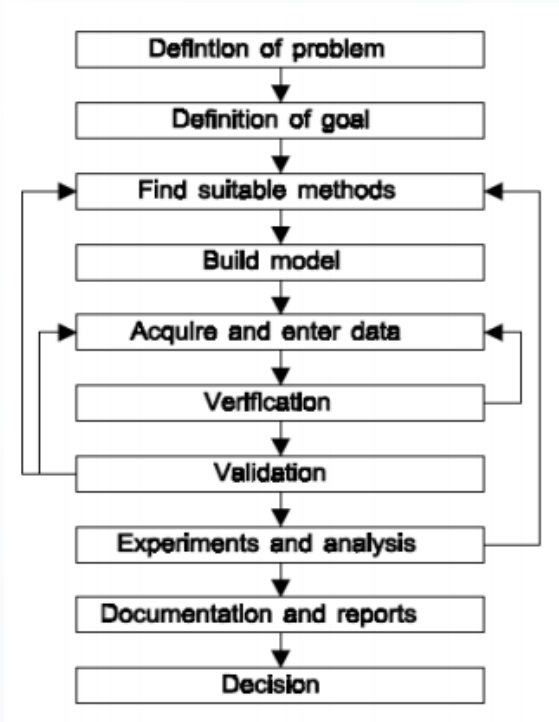
Simulation approach

- Discrete Event Simulation Approach
- Discrete Event Simulation Approach: Why
- Methodology of Discrete Event Simulation
- Discrete Event Simulation Components



Developing simulation prototype

- Steps in Simulation Study
- Problem Formulation
- Translation to a Model
- Verification vs. Validation
- Experimental and Analysis of Results



Module Outline (Con't)

Data collection for simulation

- Data Definition
- Data Collection
- Preparing for Data Collection
- Data Collection: Quantitative Tools
- Advantages of Quantitative Tools

Experimental results analysis

- The "As-Is" Simulation
- "As-Is" Results
- Experimentation
- Goals of Experimentation
- Experimental Design Process
- How Results Can Be Presented?

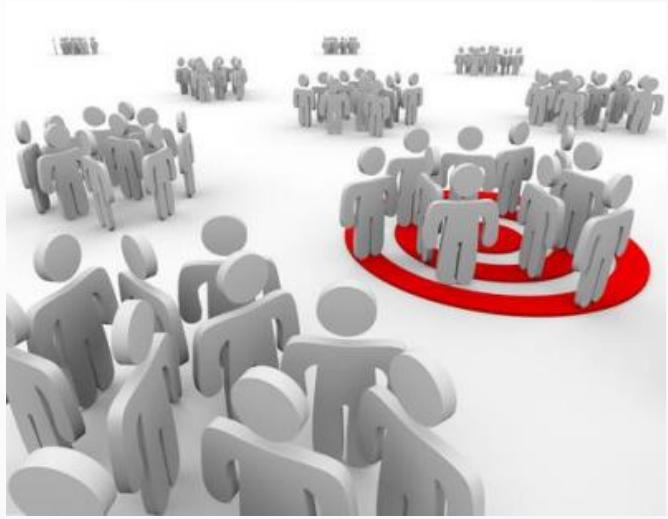
AHRQ Prevention Quality Indicators

Dehydration Admission Rate (PQI 10)

Counties/Numbers highlighted in GREEN are significantly lower than the National Average.

Counties/Numbers in RED are significantly higher than the National Average.

County Name	Cases	Population	Crude Rate	Risk Adj. Rate LCL	Risk Adjusted Rate	Risk Adj. Rate UCL
Adair	79	13,774	5.74	4.62	5.89	5.78
Allen	28	14,299	1.96	1.41	2.08	2.69
Anderson	12	16,453	0.78	0.25	0.84	1.42
Ballard	8	6,538	1.22	0.24	1.03	1.83
Barren	102	31,112	3.28	2.56	2.93	3.31
Bath	15	8,943	1.68	0.84	1.55	2.26
Bell	122	23,056	5.29	4.52	4.96	5.41
Boone	68	78,320	0.87	0.85	1.14	1.42
Bourbon	20	15,245	1.31	0.70	1.26	1.81
Boyd	32	39,393	0.81	0.39	0.72	1.06
Boyle	32	22,387	1.43	0.88	1.34	1.79
Bracken	18	6,700	2.69	1.78	2.63	3.47
Breathitt	40	12,381	3.23	2.84	3.58	4.15
Breckinridge	23	15,006	1.53	0.94	1.50	2.07
Bullitt	23	52,112	0.44	0.23	0.58	0.93
Butler	9	10,366	0.87	0.18	0.86	1.64
Caldwell	13	10,281	1.26	0.39	1.00	1.61
Calloway	28	29,186	0.96	0.50	0.90	1.30
Campbell	54	86,477	0.81	0.53	0.88	1.07
Carlisle	5	4,216	1.19	0.00	0.93	1.89
Carroll	20	7,990	2.52	1.77	2.56	3.35
Carter	18	21,160	0.85	0.37	0.85	1.34
Casey	47	12,646	3.72	2.72	3.38	3.89



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